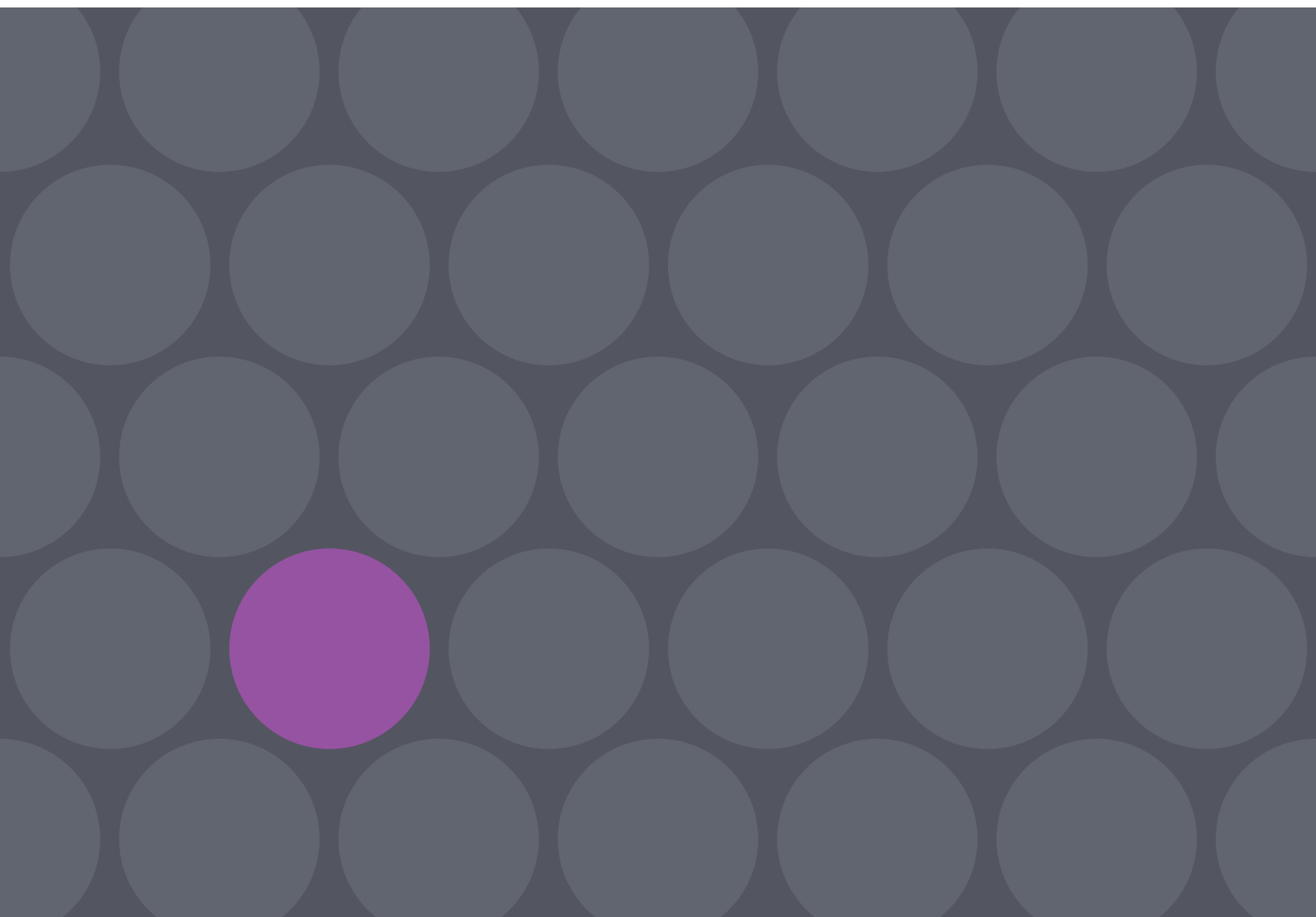# HiNZ
Health Informatics New Zealand

2017 HiNZ Conference
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PROCEEDINGS

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Contents

HiNZ Case Studies

A Novel Approach to Comprehensive Clinical Note Taking – from Concept to Product

Scott PEARSON[1]

1. Noted Ltd

INTRODUCTION

Taking comprehensive notes is time consuming and clinicians often feel writing them gets in the way of their 'real job' - treating their patients. Yet accurate, detailed clinical records are of vital importance as part of the process of clinical reasoning, to meet professional and funder expectations, and to inform communication with other health professionals. They also provide the basis for datasets used to track outcomes and inform the allocation of resources. The author wished to create a system that would make it more practical to take more comprehensive, useful notes within the stress of every day clinical experience.

USE OF TECHNOLOGY AND/OR INFORMATION

The author developed a novel approach to capturing clinical notes, based on highly context specific forms, that allow clinicians to take the notes they need faster with less typing. The solution also captures data in a way that is well suited to reporting and analysis, from the level of individual consumers and organisations, right up to entire populations.

IMPLEMENTATION/PROCESSES

To begin with the author wrote a prototype in JavaScript to validate the idea. In parallel, form content was developed and tested using Open Office documents. Later, after raising a small amount of capital, a working user experience was created, which in turn was developed into an alpha version of the product that was tested in clinic. Further funds were raised, a team of software developers put together in early 2017, and a commercial product was released in June 2017. Along the way, content was created for educational psychology, dietetics, physiotherapy, acupuncture, mental health nursing, residential care nursing, and others. The system is designed for multi-disciplinary organisations, supports any number of professions working together, and is highly scaleable. It works equally well on desktop and mobile devices. The system is designed to support fine-grained reporting and meta analysis. It has a modern API and is designed to integrate with other systems and organisations. As of the writing of this abstract 30 allied health organisations are using the software. In addition there has been substantial interest from secondary care and other large organisations.

CONCLUSION

Early indications suggest that the fundamental approach of the system is sound and that it could offer tangible benefits across the health sector, for the NZ public, clinicians and health management. Next steps include the addition of shared care, a patient portal , automated health coding (SNOMED), sophisticated real time reporting tools and more.

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ID: 660 - CLINICAL CASE STUDY

A Picture of Health - what does a Health Needs Analysis look like from a PHO perspective?

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1.   Procare Health Ltd

INTRODUCTION

Procare Health Ltd is a large primary health organisation (PHO) serving over 180 practices and over 800,000 enrolled patients. Traditionally DHBs have conducted health needs assessments in order to prioritise service funding and planning. However, in the last decade the depth and breadth of GP collated data has become increasingly available and has huge potential to support learning from data and clinical quality improvement.

USE OF TECHNOLOGY AND/OR INFORMATION

We aimed to undertake a systematic assessment of the enrolled population health needs that utilises and triangulates existing primary care performance data, primary care visit data a PHO-specific clinical information repository and national data collections. Specific questions related to the completeness and accuracy of risk factor data, prevalence of long term conditions classified by Read coding, the equity of primary care processes, management and patient outcomes by age, gender, ethnicity and deprivation.

IMPLEMENTATION/PROCESSES

We extracted data from a series of datasets linked to the PHO age-sex register and conducted simple descriptive analyses stratified a priori depending on the clinical question (i.e. by patient domicile, practice, age group, gender, prioritised ethnicity or NZ Dep Index). For each measure we wished to understand the key issues affecting the quality and generalisability of the data and variation across practices, populations and DHBs.

CONCLUSION

This has given us a baseline of key data across a large network of practices and has provided practical insights into what a picture of health looks like from a PHO perspective, what might be 'easy wins', what can primary care information systems offer and where are the key gaps in information quality, evidence-based provider processes and patient outcomes. As Deming has been quoted as saying "In God we trust, all other must bring data." Enormous variation exists across all data and all strata raising questions regarding the major causes of such variation and therefore focus potential solutions. The analyses are directly informing Maori, Pacific and Asian PHO policy development, and will help setting of priorities for local and regional targeted action to improve population health and address inequities.

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A salt-reduction smartphone app for people with cardiovascular disease: trial findings

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2. University of Otago
3. University of Sydney

INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of early death worldwide. Reducing dietary salt intake lowers blood pressure (BP) and risk of secondary cardiac events, and as such is a key component of cardiac rehabilitation programmes. However, such programmes are often under-prescribed, largely due to access issues. Moreover, identifying low salt foods can be challenging.

USE OF TECHNOLOGY AND/OR INFORMATION

Smartphone technology may offer a solution. SaltSwitch is a simple smartphone application (app) that enables shoppers to scan the barcode of a packaged food and receive an immediate, interpretive, traffic light nutrition label on the screen, alongside a list of suggestions for lower-salt alternatives (Figure 1).

IMPLEMENTATION/PROCESSES

A six-week, two-arm parallel, randomised controlled trial was undertaken in 2014-15 in Auckland, New Zealand (2-weeks baseline and 4-weeks intervention). Sixty-six adults with CVD were randomly allocated in a 1:1 ratio to receive either the SaltSwitch app (n=33) or control (usual care; n=33). The mean (SD) age of participants was 64 (7) years. The primary outcome was the salt content of household packaged food purchases during the 4-week intervention. Secondary outcomes were the saturated fat content, energy content, and expenditure of household food purchases; systolic BP; urinary sodium; and use and acceptability of the app. Participants in the SaltSwitch group purchased significantly less salt from packaged foods compared with the control group (mean difference (95% confidence interval), -0.30 (-0.58 to -0.03) g/MJ or ~0.7g of salt per person per day; p=0.03). There were no significant between-group differences for any secondary outcomes.

CONCLUSION

The SaltSwitch smartphone app may be effective in supporting people with CVD to make lower-salt food purchases. A larger trial is warranted to confirm pilot trial observations and determine effects on clinically important outcomes, such as BP.

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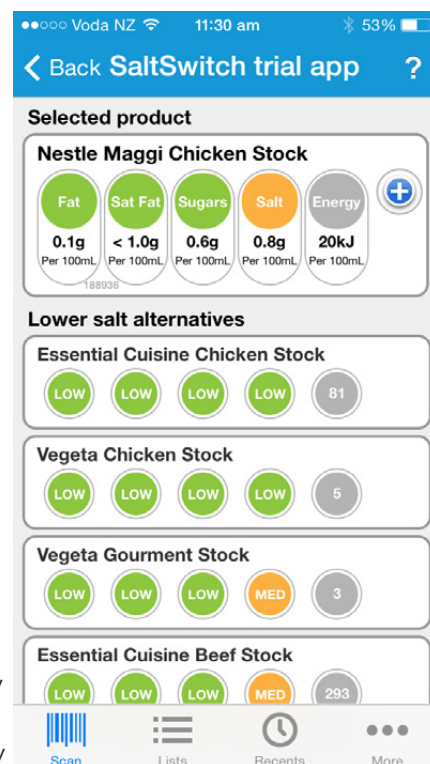
A single Hospital Record – Learnings from The South Island

Chris DEVER[1]

1.   CDHB

INTRODUCTION

In September 2010, the Minister of Health launched NZ Health IT Strategy at HINZ. This laid out a future direction for health IT across the sector. A major component of that plan was to encourage a regional approach to Hospital Health IT. The expectation was that the DHBs would work together in their regions to share health information.   Following an enthusiastic call to action, response was slow. DHBs saw sharing data had the potential to lose their sovereignty. For Canterbury, 2010/2011 was disrupted by a year of significant earthquakes. In spite of this, the South Island CIOs go together and in response to the plan proposed consolidation of hospital based clinical systems.

USE OF TECHNOLOGY AND/OR INFORMATION

Significant change is always led by a few tentative steps. The CIOs decided that rather than radical 'Let's build a new structure' there was belief that success was more likely to achieved if the Region consolidated on a few existing implementations and consolidated onto single instances of those applications. A plan was hatched that identified the applications successfully implemented in the South Island and how we would move to that platform.

IMPLEMENTATION/PROCESSES

South Canterbury DHB was the first DHB to join the CDHB instance, which had been identified by the CIOs as the goal architecture. SCDHB did not have an existing clinical workstation. Luckily CDHB had entered into a strategic partnership with Orion Health who and they provided significant assistance. Following successful implementation at SCDHB, WCDHB was keen to join. West Coast had been running HealthViews and this added complication. Implementation took a huge effort from both CDHB and SCDHB and WCDHB teams. This formed a sub-region single instance of Clinical Workstation, Éclair, PACS, clinical documentation (Discharges and some other documents).It was some time before the other DHBs began their migration to this platform. Eventually SDHB and NMDHB did join. This formed a single instance hospital clinical record across the South Island – referred to as Health Connect South. Parallel to this, the HealthOne project was underway to integrate Primary care into this platform – but that is another story!

CONCLUSION

This formed a single instance hospital clinical record across the South Island – referred to as Health Connect South. Parallel to this, the HealthOne project – but that is another story! The journey was long and at times arduous.   There were many champions and many lessons learnt. The presentation will explore the most important lessons and encourage other regions to be courageous.

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A Whānau Ora approach to musculoskeletal care

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2. Whanau Tahi

INTRODUCTION

Hawkes Bay District Health Board (HBDHB), Health Hawkes Bay and Iron Maori partnered with Whānau Tahi to develop a Whānau Ora model of care for people with musculoskeletal conditions. The objective of the programme is to provide early, tailored interventions to help people manage their condition better. Quality of life will be improved and the need for surgery may be reduced. Whānau Ora builds local capacity and capability, and increases social and cultural participation for populations experiencing inequitable adverse outcomes. It is being trialed for Māori, Pacific and quintile 5 people experiencing joint pain for more than 3 months and are not eligible for ACC funding. The service aims meet the needs of the working age and elderly populations in HBDHB communities of highest deprivation (9&10) and highest Māori and Pacific populations: namely rural sites of Wairoa and Takapau and urban sites of Flaxmere (Hastings) and Maraenui (Napier).

USE OF TECHNOLOGY AND/OR INFORMATION

The service has been co-designed with consumers, community leaders and providers, and compromises of a "core" team of contracted physiotherapy, Whariki Long Term Conditions programme (Stanford model) and the Mananui Collective, which includes healthy lifestyle providers such as Iron Maori, fitness providers and Te Taiwhenua o Heretaunga among others. Together they provide services to local communities in gyms, outdoors, schools, Marae and workplaces. Whānau Tahi's, Navigator solution supports this inter-disciplinary and multi-agency approach, providing one place accessible to all, for information to be recorded and shared in an integrated care record and collection of outcome data, including standard quality of life, patient reported and clinical outcome measures.

IMPLEMENTATION/PROCESSES

The pilot has commenced implementation. Iron Maori will provide a referral and navigation hub, with eligible patients receiving an initial assessment by physiotherapists, then referred onto other services. Assessments for the programme have been incorporated into Whānau Tahi Navigator, enabling different providers to view, record and share information about a person's mobility journey.

CONCLUSION

Outcome/exit measures are being collected including; reduced pain, improved function, increased social and cultural participation and increased local capacity. The Whānau Ora model is clearly an improvement on the current state, building on the strengths of existing programmes and removing access and other barriers for targeted populations.

The outcomes will inform the most effective way to deliver services to reduce the burden of pain and disability in New Zealand.

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Achieving value and scale with care coordination improvements: an evidence based and platform approach

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1.   DXC Technology

INTRODUCTION

While the value of care coordination is well established, what is not so clear is how to achieve this goal. Care coordination spans the care continuum, encompasses a wide variety of strategies and tool sets and involves potentially all healthcare professionals as well as patients and their families. Technology has much to offer in addressing this challenge. Australian and New Zealand health care services have been exploring integrated or coordinated care improvement concepts for some years. While many of these projects demonstrated value, few have been able to scale up to function on a system or organisation wide basis. Gartner's Hype Cycle for Healthcare Providers 2016 describes "an explosion in health IT innovation efforts triggered by both technology advancements and a compelling need to reinvent healthcare; practice 21st-century medicine, not 20th-century medicine; tackle chronic diseases; and drive unwarranted variances out of quality, cost and access."

USE OF TECHNOLOGY AND/OR INFORMATION

How can healthcare providers leverage this technology explosion to transform operations and provide more effective and efficient care? Consider promising or proven technologies such as tools for; patient engagement, clinical collaboration, mobile workflows, automated vitals capture, critical condition surveillance, medication management, predicting the risk of poor outcomes and resource scheduling. In addition to leveraging new technologies, healthcare providers also need to move from an activity based to an integrated and value based healthcare model – this transformation is not trivial and requires significant system redesign. A digital transformation journey is necessary to support the required change.

IMPLEMENTATION/PROCESSES

Building on the experience of other industries such as banking, travel and insurance, we know that a key technology enabler of any digital transformation is creation of a digital platform that is designed for change. As we don't know what the future holds and speed to benefit is important, this agility is vital. Once a digital platform is implemented, the task of delivering new tools and capabilities to clinicians and patients can be accelerated and simplified. Underpinning care coordination initiatives is access to information currently trapped in silos. The platform approach can be used to access and normalise data for use in different workflows and systems by a variety of health care professionals and patients. The goal is to create a single-source of information about a patient – a longitudinal record.

CONCLUSION

For care coordination, a platform approach means not only faster and easier adoption of new technologies, but also, through improved data access, a new understanding of performance to guide improvements.

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Agile development and public private partnering solving the problem of non-patient, urgent and emergency messaging to community providers

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2.   Healthpoint

INTRODUCTION

Waitemata District Health Board (DHB) has been working with Healthpoint Ltd to develop a cloud-based communication platform to improve communication of non-patient clinical information from the DHB, and other health organisations, to primary care health providers (including general practices, Urgent Care Centres, community pharmacies, NGOs and other community based health service providers). This is currently a challenge for Waitemata DHB and other health providers within the Region in communicating emergency and urgent messages. Currently Waitemata DHB channels urgent messages through an automated fax system and Primary Health Organisations (PHOs) while non-urgent messages are distributed through the PHOs or published in the monthly Primary Care Newsletter. Unfortunately, key messages do not always meet target groups in an effective or timely manner. In addition, the DHB is not always able to confirm that a message has been received or read.

USE OF TECHNOLOGY AND/OR INFORMATION

With the support of Waitemata DHB, Healthpoint Limited developed the cloud-based communication platform. It enables health organisations, like DHBs, to publish and push key messages to primary care providers ('Recipients') using a variety of methods depending on clinical risk and recipients' preferences. The platform has been designed to enable additional groups of providers, like NGOs, to be added as 'Recipients' at a later stage. 'Publishers' such as PHOs, Pharmac, ACC and MOH can also be brought into the platform.

IMPLEMENTATION/PROCESSES

The solution was developed by Healthpoint in consultation with Medtech, MyPractice, Healthlink, Vodafone, ARPHS, Labtests and supported by Waitemata DHB in a successful public private partnership. The project used the lean, agile development process. Over 40 workshops, interviews, meetings were held between January – June 2017 with primary care, publishers and key stakeholders where hypotheses were presented and assumptions tested.IP and an API enabling data and processes which are currently available in the Healthpoint directory has been utilised by the platform. This optimising speed of development, implementation and activity.

CONCLUSION

WDHB and potentially the other 3 Northern DHBs will be utilising this technology from the mid August 2017 for emergency and non-urgent clinically relevant messages. Benefits of the project are: • Reduced organisational and patient risk as key messages can be directly communicated to nominated parties within specified timeframes; • 'Recipient' workloads are reduced via the platform prioritising messages (same hour, same day, same week) and reducing message duplication. Lessons learnt, themes: How private/public partnering can support innovation and implementation. Advantages of agile development processes. Innovation lead by customer values and needs.

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Allied Health Capacity at a Glance

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INTRODUCTION

The allied health (including needs assessment and service coordination) workforce is department based and is therefore not managed or allocated to a specific ward resulting in no transparency of staffing capacity on each ward to nursing and medical teams on any given day. There is no single communication strategy to communicate capacity across the inpatient wards. Team leaders email charge nurse managers with any significant capacity concerns as they occur. Clinicians communicate workload via meetings and cell phones to reallocate resources according to clinical need and priority of each patient. Furthermore; there is no visibility of allied health staffing capacity across the North Shore and Waitakere Hospital campuses.

USE OF TECHNOLOGY AND/OR INFORMATION

The objective was to have an electronic visual view that is updated daily, of the inpatient allied health service that can be viewed by all staff via the intranet. The tool would use a consistent and transparent approach to viewing capacity across the inpatient wards and increase connection and communication between the allied health teams with the inpatient wards to streamline and integrate the service provided with patients.

IMPLEMENTATION/PROCESSES

A review of current practices in other DHBs was completed, which found only one DHB at the time utilised a capacity tool. However the tool only displays three allied health disciplines and does not provide ward level detail. Development of prototypes and variance boards took place for key stakeholder discussion before implementing a trial over eight weeks to fine tune variance indicators using a traffic light system to mirror the existing capacity at a glance board prior to development. The tool demonstrates staffing capacity at a quick glance across wards and campuses using a traffic light system with green showing standard staffing through to red showing a critical care capacity deficit. The variance indicators guide provides a consistent and transparent approach to defining capacity and the implications of each colour.

CONCLUSION

The allied health capacity at a glance has been successfully trialled across the Allied Health inpatient teams. In conclusion, the allied health capacity at a glance increases the visibility of allied health across the inpatient wards. This is a consistent and transparent approach using the percentage of staff available across all disciplines with a specific variance to the traffic light system.

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Applying Deep Learning to Electronic Health Records

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1.   Orion Health

INTRODUCTION

Deep learning (DL) has demonstrated effectiveness in cognitive tasks such as vision, speech recognition, and natural language processing. Increasingly, researchers have started applying deep learning to Electronic Health Records (EHRs), and have achieved state-of-the-art performance in tasks such as future disease prediction, discharge code extraction, and de-identification of patient clinical notes. One of the challenges working with EHRs is the wide range of data sources (text, images, and charts), both unstructured and structured. These needs to be processed and transformed separately prior to ingestion by DL networks. The goal of this research is to 1) identify effective representations for data types found in EHRs. 2) Investigate how to leverage different data types for predictive tasks using DL. For example, "automatic ICD-9 code extraction".

USE OF TECHNOLOGY AND/OR INFORMATION

The Python deep learning library Keras is used for building the DL networks. The "MIMIC III" dataset, a publicly available dataset of 40,000 critical care patients, will be used. For each admission, the dataset contains information such as demographics, vital signs, laboratory results and prescriptions.

IMPLEMENTATION/PROCESSES

As of 15/06/2017 about 45,000 admissions have been extracted from the dataset. Each admission (an instance) include multiple data types such as discharge summaries, prescriptions, lab test results, vital signs, as well as the corresponding ICD-9 codes (instance label). We divided the instances into 90/10 train/test split -- 90% of the data used for training DL networks, and the remaining 10% for evaluation. We then repeat the same process multiple times with different random seeds. We have applied transformation on discharge summary and prescription only for each admission instance. We found that by simply concatenate the two vectors and train a single DL network, the predictive performance was poor. Instead, we trained multiple DL networks on the individual input data as well as a final network for the merged output from all previous networks.

CONCLUSION

Experimental results based on the combined discharge summary and prescriptions have shown improved ICD-9 code recognition accuracy, compared to models trained on single data source only. This implies that 1) the proposed data source transformations are effective in feature representation, and 2) the proposed ensemble DL networks were able to learned from the diverse data sources. The next step is to investigate how predictive performance can be increased with ingestion of additional data sources.

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Assessing documentation of "sulfur" adverse drug reactions in an electronic prescribing system

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1.   Canterbury District Health Board

INTRODUCTION

Adverse drug reactions (ADRs) are responses to medicines that are noxious and unintended. The presence of a valid ADR record is crucial to prevent re-administration of culprit medicines. The elements of a valid ADR record include: the drug and class, adverse reaction, certainty, severity and time/date of the event. The ADR record should be enduring and inform electronic prescribing systems. Canterbury District Health Board (CDHB) implemented MedChart™, an electronic prescribing and administration software platform, in 2015. The drug class structure used for alerts in NZULM MedChart was developed by NZF and CDHB; in this work sulfonamides ("sulphur drugs") were identified as a particular challenge. Of note there are many, and inconsistent, definitions of which drugs are sulphonamides. Accurate documentation of reactions to sulfamethoxazole, a sulfonamide, is needed for the ADR alert function when prescribing in electronic systems. An incorrectly recorded ADR will not alert when prescribing potentially harmful medicines. Currently it is not known if prescribers are recording sulfamethoxazole ADRs correctly.

USE OF TECHNOLOGY AND/OR INFORMATION

Collaboration between clinicians, pharmacy services, and a health infomaticist led to the development of data extraction tools. These were used to extract data from MedChart, allowing a quantitation of sulfamethoxazole ADR records.

IMPLEMENTATION/PROCESSES

A pilot dataset of three months period of patient ADR documentation data was extracted from MedChart for analysis. Data analytics were performed using Tableau™. ADR documentation for sulfamethoxazole was examined by identifying records coded for sulphonamides by drug or class, and by multiple key word searches for free text entries: "sul*", "sulphur", "sulfur", "sulphonamide, and "sulmethoxazole".

CONCLUSION

There were 314 patients with recorded ADRs to sulphur drugs identified. Of these 190 had been appropriately recorded as 'sulfonamide antibiotic' or 'sulfamethoxazole'. A further 98 had been recorded as "sulfur" or "sulfur-precipitated" - which would still generate an ADR alert against a sulphonamide antibiotic. 29 records (9%) had the ADR incorrectly entered as a non-drug allergy, which would not generate an ADR alert, potentially placing these patients at risk. A valid definition of sulphonamide drugs underpins provision of valid alerts to potentially harmful medicines. Without the close collaboration of the infomaticist, investigation of ADR documentation would not have been feasible. The next steps are, firstly to integrate this into regular reporting to enable feedback to individual prescribers, and correction of unsafe documentation. Secondly, to use this process, of data analysis and targeted reporting to other ADRs.

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Blockchain – Does this solve challenges of information sharing in Healthcare

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1.   IBM

INTRODUCTION

How valuable would it be to have the full history of an individual's health? What if every vital sign that has been recorded, all of the medicines taken, information associated with every doctor's visit, illness, operation and more could be efficiently and accurately captured? The quality and coordination of care would be expected to rise, and the costs and risks likely to fall. There are three issues that hinder the sharing of information to support meaningful coordination and collaboration in healthcare and they are privacy concerns, lack of interoperability standards and even where data is shared, it is not trusted as either incomplete or includes errors. Although we know that if there was more sharing of data there would be better outcomes for patient. There needs to be a way to overcome these issues and engender trust in the ecosystem.

USE OF TECHNOLOGY AND/OR INFORMATION

Blockchain a new technology that can support a new generation of transactional applications and streamlined business processes by establishing the trust, accountability, and transparency that are essential to modern commerce. These features are attracting healthcare organisations to consider blockchain as a transformative technology for the industry.

IMPLEMENTATION/PROCESSES

Healthcare organisation are actively looking at blockchain to enable their businesses and potentially transform healthcare through trusted sharing of information across the ecosystem. There are now a number of examples were blockchain projects are being undertaken in healthcare - one of those projects is with the FDA with IBM to study how blockchain technology could be applied to health care in data sharing. However we also see examples in adjacent industries looking at supply chain and food safety with Walmart. These are only two of what is believed to be opportunity areas for blockchain, other areas are Clinical trials data & process transparency, claims management and device data being added to patient records.

CONCLUSION

Blockchain looks like it will play an increasingly significant role in healthcare IT and bring beneficial disruption and new efficiencies to many stakeholder in the ecosystem. It is important that healthcare organisations understand and explore blockchain technology today through innovative projects to ensure they are ready for the changes sure to come tomorrow.

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Bringing the Air NZ check-in experience to the patient

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2.   Fingermark

INTRODUCTION

High volumes of outpatients, many of whom have multiple activities within their outpatient appointment present a number of challenges: Long queues at reception (many elderly, infirm patients), Patients' clinic length of stay is up to 3 hours with long waits for each stage and Patients unaware about how long their actual wait will be.

USE OF TECHNOLOGY AND/OR INFORMATION

A project was formed to address these challenges but primarily to improve the patient experience and event visibility within the clinic. Four Computer Studies University students were engaged for a summer internship to developed prototype solutions for: Patient self-check in - To improve patient experience and waiting, kiosks have been installed to allow patients to check themselves in upon arrival to the clinic. The kiosk application is designed to work in conjunction with the whiteboard application to determine which waiting room to direct the patient to, once they have checked in. Patient queue whiteboard. The patient queue whiteboard application collects data on activities and wait times and displays that information for patients. Overall, the whiteboards provide more information to patients to allow them to feel more in control by showing them real time information on wait times, and how far they have progressed through the pathway. Clinic Tracking The clinic tracking system allows clinic staff to have access to real-time overview of all patients in the clinic, and where each patient is during their journey. A vendor partner was selected to complete and implement these solutions into the largest outpatient clinic in the DHB.

IMPLEMENTATION/PROCESSES

The original concepts developed by the students were used by the vendor to develop a commercial product that will be available for use in other clinics and other hospitals. Development was undertaken in close consultation with clinical and administrative users via user stories to ensure that it was fit for purpose.

CONCLUSION

The solution will be fully implemented into the largest outpatient clinic within the DHB by the end of September and implementations into other clinics are planned. The feedback from the proof of concept phase was very positive so we expect to be able to provide positive feedback from patients and clinicians in our presentation. Major Lessons learnt: Developing a solution to address Security risks for Kiosk infrastructure is critical. Admin staff within the clinic have great contributions to make alongside their clinical colleagues. Close collaboration /co-development with short sprints delivered an optimal solution.

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Building the world's most innovative e-health organisation

Petrina CHAI[1], Brian O'CONNELL[1], Andrew SLATER[1]

1.   The National Telehealth Service

INTRODUCTION

Is technological innovation the key to our health and mental health woes? We at the National Telehealth Service think it will be a game changer. New Zealand's healthcare system is experiencing challenging but also changing times. We need to look at different ways to deliver health and mental health care closer to home and in places that New Zealanders' live work and play.

Not only are we trying to ensure all our channels digitally accessible by text, webchat, email, video chat and social media, but are looking beyond that, at the role artificial intelligence, big data and personalisation will play.

USE OF TECHNOLOGY AND/OR INFORMATION

Cost, distance, and hours of accessibility of services are often the biggest factors preventing many people from accessing help. Lack of anonymity is also a major factor for many. E-therapy options can address all these barriers to care.

Technology has driven the expedited growth of industries making them more efficient and cost effective, now it's time to drive this in the mental health space. All of us at the National Telehealth Service are fully invested in the future. We have teams members that are dedicated to changing the way we are doing things and designing new more innovative ways to reach those in need.

IMPLEMENTATION/PROCESSES

In the mental health space we are increasing digital and social media access points – rolling out web chat and email across Gambling, Alcohol & Drug, Depression, 1737 websites and other external mental health and addictions websites.

The recently launched mental health and addictions helpline 1737, need to talk? is the first of its kind 4 digit text and call helpline in NZ. Accepting both calls and texts, 1737 is an easy to remember number.

We are in the process of taking Healthline digital, how that will look is being worked on as we speak. We envisage this will help create a nation-wide connected network among DHB's and health organisations.

etalk (ekorero) provides for up-to six 45 minute virtual sessions with a counsellor, free as part of primary mental health.

CONCLUSION

The future of health in NZ is an exciting space to be in, we have had a successful 2 years of National Telehealth Service operations and look to continue to roll out more and more live improving and saving technological innovations.

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ID: 708 - CLINICAL CASE STUDY

Canterbury Health Implements New Zealand's first electronic Advance Care Plan

Jane GOODWIN[1]

1.   Canterbury Initiative

INTRODUCTION

Canterbury Health's vision is of an integrated health system that keeps people healthy and well in their own homes, providing the right care and support, to the right person, at the right time and in the right place. The establishment of Advance Care Plans (ACP) across health settings in the Canterbury region is helping them fulfil this vision. Advance Care Planning enables a competent person to think about, and discuss with their families and primary care clinicians, their wishes concerning the medical care and treatment they would wish to receive in future if they were unable to communicate these wishes themselves, which are then documented online. ACP allows healthcare professionals access to up-to-date information on the patient's medical record and their wishes for how they would like to be cared for at the end of their life, breaking down communication barriers and reducing stress.

USE OF TECHNOLOGY AND/OR INFORMATION

A connected interface was the biggest challenge for Canterbury Health – ensuring the patient's future care plans were stored in a user-friendly and accessible platform. It was crucial all healthcare providers across the South Island had access to ACP, whenever and wherever necessary. ACPs were created via Care Pathways, an Orion Health toolkit that enables workflow solutions to be built across the entire healthcare network, through a series of tasks, rules, and forms.

IMPLEMENTATION/PROCESSES

The first ACP was published in Canterbury in December 2013. Since then the numbers of plans generated has increased significantly. How responsive and user-friendly the system is has the substantial impact on uptake and use by health care professionals, particularly those creating plans in primary care.

CONCLUSION

To date, 1400 ACPs have been created, 80% in general practice. Since September 2014, the majority of patients with an ACP have been supported to die in their preferred place of death, with only 18% dying in hospital (the New Zealand average is 34.2% of all deaths occurring in hospital). An updated, more intuitive electronic platform was implemented in July 2016. As a result, the number of ACPs increased 45% from 212 in the January to June period to 307 in the July to December period. In the six months following the update, 31 practices produced their first ACP. The rest of the South Island is also looking to implement a region-wide Advance Care Plan, based on the agreed national template.

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Challenging New Zealand's approach to patient engagement

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INTRODUCTION

What is New Zealand's patient engagement strategy? We're working with multiple regions across Europe who are redefining their approach to patient engagement in order to deliver new and improved models of care. Successfully convincing patients to proactively engage in their own care is key to moving the health system towards a preventative approach. The regions of Burgundy and Paris in France, and the national health services of Scotland, Northern Ireland, and the Republic of Ireland view patient engagement as a critical strategy for motivating patients to be more proactive and involved in their own care.

USE OF TECHNOLOGY AND/OR INFORMATION

Enabling patients to be in charge of their own health through technology is only part of the solution. It also requires changes in the way that technology is delivered, government regulations and patient on-boarding. This last part is critical because a focus on patient experience and education is often a missing component from most technology that is introduced into the health system.

IMPLEMENTATION/PROCESSES

It's a relatively simple process, but it is often poorly delivered. Typically it involves the following steps: Define the model of care you want the patient to engage with – e.g. Burgundy identified its distributed population issue and introduced an online patient portal that could be accessed from computers and mobile devices, to allow the extended family to monitor their loved one, wherever they lived. Start with a simple scope for the patient - the priority is to get them using digital tools for basic tasks. While clinical leadership is critical, educating clinicians, patients and their extended family on the benefits of digital tools is crucial and often overlooked. Adding richer functionality that improves the coordination and delivery of care will ensure clinicians and patients start to build a constructive dialogue of care management through tasks and goals.

CONCLUSION

Patient engagement helps to improve health literacy and engages patients in managing their illnesses. Empowering patients while they navigate the health system. We don't need to reinvent patient engagement - what can New Zealand learn from our colleagues in Europe?

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Changing Behaviours in Healthcare

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INTRODUCTION

With change comes angst; this is nothing new. Healthcare is an area where changes are often big, impactful and necessary. The way a healthcare organisation's leadership team communicates, leads, and manages change can have significant impact on end-user adoption of the "new" product or process. Remaining forward focused can spread positive thoughts, calm fears of the unknown, and result in a successful transition.

USE OF TECHNOLOGY AND/OR INFORMATION

Do standardised process work or is standardisation stymied by the notion that each healthcare organisation is unique? One common them across all organisations is how to manage change effectively since it takes commitment on all levels. The audience will take away from this presentation the following Keys to Successful Changes: Decisions are made at the executive level but should include the voice and involvement of the end-users impacted. Communicate the change early, be open to difficult conversations, and create a forum for idea sharing. Explain the reason for the change, the desired outcomes of the change, and identification of who will be impacted by the change. Talk often – daily and weekly huddles with specific end-users to discuss how they are feeling during the transition and what their concerns are. Once the new product or process is in place, continue huddles to support idea sharing across end-users.

IMPLEMENTATION/PROCESSES

There is no trick or magic outside of having a structured change management process. Organisational projects are more likely to meet their targets and objectives if a structured Change Management methodology is applied. As part of the change management process, leadership must remember three important points. Dedicate sufficient time to understanding and neutralizing the resistance to the proposed change. Build trust by making it visible that end user feedback –words, actions and thoughts – are included as part of the process and the final product/process. The communication plan surrounding the change must be clear, consistent and repeatable. Leadership must remember that just because they communicated the message not all end-users heard it. The organisation should remove competing agendas and messaging, both official and unofficial.

CONCLUSION

While change is hard, it is also important. Effectively leading change can be the difference between a project succeeding or failing. When Healthcare leadership teams embrace change, they benefit from successful projects and happy, supportive end-users.

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Chasing Wolves in the Wilderness (Rolling out of a Mobile Device Management Platform)

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1.   Counties Manukau Health

INTRODUCTION

Implementing a Mobile Device Management (MDM) platform is a task that we all need to tackle if we truly want to keep our corporate information safe on our ever expanding fleet of mobile devices. At Counties Manukau Health (CM Health) we decided to approach this task with honesty – the roll out is about keeping our information safe, being compliant with government requirements and providing a platform for the future rollout of applications.

IMPLEMENTATION/PROCESSES

We opened enrolment to those with both corporate owned as well as personally owned devices. Our strategy was one of persuasion focusing on providing great resources (videos, step by step guides, comprehensive frequently asked question information and top tips), a dedicated support team and enrolment clinics (where we either talked you through or did your enrolment for you). We had done our research before we launched looking at what had worked successfully in other large scale deployments and we did extensive user acceptance testing.

CONCLUSION

We expected that we would struggle a little bit without a digital carrot (killer application) that people wanted to use. We also expected that there would be the normal resistance to change that all digital projects face and that people would need to be chased and reminded. And we knew that without a drop dead date for native access to email agreed people would passively resist the change. We didn't expect the resistance to change driven out of the intensely personal relationship that many have with their mobile device and the divide it crosses between personal, and business life like nothing else did. We didn't expect the level of distrust that we encountered when it came to the implementation on personal devices. And we didn't expect the level of misunderstanding that we encountered on what we could see on devices and our intentions when it came to geo-location functionality. Our lessons learned provide food for thought for those who still need to go on this journey and some insights into adoption of an MDM platform that might make their journey through the wilderness less challenging.

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Chronic health management using connected health solutions

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INTRODUCTION

NSW Health provides support to over 5,000 patients with chronic conditions including heart disease, cardiovascular disease, hypertension, lung disease, and diabetes. Patients with chronic conditions are heavy users of the hospital system. This prompted us to conduct a six-month telehealth trial with 10 patients, with the aim of providing greater support to patients and ultimately reducing unplanned hospital admissions. Patient selection was based on geography, frequency of emergency hospital admissions and if they had one or more of the top five chronic diseases i.e. COPD, heart failure, diabetes, hypertension, cardiovascular disease. The pilot goal was to reduce hospital visits, emergency admissions and bed utilisation days.

USE OF TECHNOLOGY AND/OR INFORMATION

Using medical grade peripheral devices, patients were guided through a customised health interview via the ICP myClinic patient management software, to measure their vital signs and answer health questions. Patients were provided with mobile internet devices to ensure the timely and secure data transmission to the nursing staff. Patients' results were automatically transmitted to ICP Triage Manager for review by the patients' care team. Deviations outside the individualised health parameters alerted the care team to investigate and patients were contacted by phone or video conferencing. Vital signs and trend data from the patient management system also supported the monitoring of health outcomes. Health coaching, video conferencing, education, and self-management assisted in early recognition, detection, and intervention of chronic disease issues.

IMPLEMENTATION/PROCESSES

Participant control data was collected six months prior to the pilot for hospital admissions (26), emergency department presentations (60) and total number of bed days (163). Patients were coached on how to use medical devices in their own homes, enabling them to monitor pulse oximetry, blood pressure, temperature, lung volumes, ECG and weight. GPs were notified of patient conditions and consulted before any changes were made to the monitoring plan.

CONCLUSION

The implementation of telehealth services over the trial period resulted in reduced, unplanned hospital admissions and increased the continuity of care with a team approach. In the six months since telehealth implementation, total admissions for the selected group were reduced by 42% total, emergency department presentations for the selected group were reduced by 41%, and the total number of bed days for the selected group were reduced by 56%. Patients regularly visited their GP's and medication compliance was excellent at 40%, and patients were not readmitted to hospital within six months of using telehealth monitoring. The pilot improved patient quality of life, reduced anxiety, offered social support, and allowed care givers to participate in patients' health management.

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clinFHIR: A tool for Clinicians and Business Analysts

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INTRODUCTION

FHIR® (Fast Healthcare Interoperability Resources) has emerged Internationally as the pre-eminent way to share healthcare information – both existing IT systems as seen in hospitals and general practises, and in new spaces such as mobile devices and patient interfaces. The value gained by opening up such information is immense; the opportunity is not only to improve existing data sharing, but also to allow the business side of healthcare delivery – clinicians and business analysts – to become more involved with integration projects. To help understand FHIR, clinFHIR has been developed as a training and development tool for technical and nontechnical alike. It has become widely used within the HL7® community to develop the FHIR standard and has been instrumental in explaining the benefits of FHIR and the value to healthcare users.

USE OF TECHNOLOGY AND/OR INFORMATION

clinFHIR is an open-source browser application usable by anyone. Developed as a 'Single Page' application using AngularJS and directly accessing FHIR servers, it allows users to:

• View FHIR data for patients on any FHIR server using various helpful visualisations

• Connect resources like lego blocks to represent clinical scenarios

• Connect to terminology services for structured, coded data

• Build logical data models as part of the analysis phase of a project.

• Build the profiling artefacts required to represent information in FHIR

IMPLEMENTATION/PROCESSES

Development in clinFHIR started 3 years ago to assist clinicians within HL7 as they defined the resources that are the core models for FHIR data exchange. Initially used at the 'Clinicians on FHIR' events, it rapidly became invaluable wherever there was a need to explain FHIR to a non-technical audience. clinFHIR provides real-time visualisations and the ability to drill down from overviews like Graphs and reference charts to resource details, and the ability to easily build representations of real clinical data.

CONCLUSION

clinFHIR has become the standard way to view FHIR data for training and resource development purposes. It continues to be developed in response to user feedback and is widely used within the FHIR community. FHIR training is important as it will be part of creating a "Smart System" for Health IT in New Zealand which is one of the major themes from the New Zealand Health Strategy Future Direction report. This submission will give an introduction describing clinFHIR in sufficient detail for a new user to understand in general and its value to them. The drivers for its development and how you can use it to become 'FHIR enabled'.

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Clinical and Business Intelligence Program at Taranaki District Health Board: "Empowering excellence in health with trusted information and insights"

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INTRODUCTION

The data volumes in our organisation are exploding; we have created more data in the past two years than in our entire previous history. We believed that by better integration and use of data in healthcare we could save lives and reduce costs In 2016 TDHB defined a Clinical and Business Intelligence (CBI) Strategy. In implementing the CBI Strategy we can ensure we are using data in the best way to support corporate and clinical decision making. We are presenting the process, the frameworks and the technology aspects of our BI and Analytics solution at TDHB.

USE OF TECHNOLOGY AND/OR INFORMATION

The clinical and business Intelligence Portal at TDHB has been build using Microsoft Business Intelligence and analytic technology suite but is not limited to this technology. The portal experience provided to our clinicians and corporate users an intuitive way to access Analytic solutions that has been build using any technology like Qlik, Tableau, IBM Analytics, etc as well a powerful integration with online analytic services like IBM Watson analytics and Microsoft Azure Machine learning.

IMPLEMENTATION/PROCESSES

Defining a Strategy and a Roadmap provided alignment across our organisation and as result Analytics has been defined as focus areas in the TDHB Health Action Plan "Using analytics to drive improvements in value". The adoption of Agile Analytics put the focus on the early and continuous delivery of business value throughout the development lifecycle. Once we had the team, the infrastructure and the frameworks in place we followed the next steps to deliver value: Define Scenarios Define Ownership, Define Business/Clinical User's Roles with Management and Tactical representation, Define User Stories' catalogue, Group and prioritise stories, Create a 90 days plan, Start delivering features every few weeks.

CONCLUSION

The implementation of an Analytics solution in our emergency department in the early stages provided visibility and a real example of the set of tools that can be used for decision making. After the 3rd iteration in our Agile Analytics approach, we have delivered "n" scenarios across the organisation with the corporate and clinical perspective. Main Challenges and critical success factor has been: Leadership Team endorsement and support, End User's involvement and ownership, Right Prioritisation to ensure we focus our effort in those areas where we can add more value with less effort. Technology partnership, Agile CoachingTeamwork. Next steps in our journey are to complete the implementation of all scenarios across the organisation and adopt advanced analytics to support clinical decisions.

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Co-creating a self-management eHealth resource by the people and for the people with persistent pain – iSelf-help

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INTRODUCTION

One in five New Zealanders report chronic or persistent pain, which is the leading cause of disability worldwide. Multidisciplinary interventions enhancing self-management skills such as self-reflection and self-monitoring, and problem solving have been shown to improve outcomes by reducing pain-related disability in people with persistent pain. Access to pain management services or multidisciplinary health professionals who can support people with persistent pain in learning these self-management skills is limited.

USE OF TECHNOLOGY AND/OR INFORMATION

Self-management eHealth resources (e.g. websites) have been shown to be efficacious and cost-effective in managing long-term health conditions such as hypertension, diabetes, anxiety and depression. Web-based self-management support may be a cost-effective and scaleable way of providing access to self-management training to people with persistent pain. A recent scoping review of self-management eHealth resources providing information about core self-management skills identified no New Zealand specific, culturally relevant eHealth resource for people with persistent pain.

IMPLEMENTATION/PROCESSES

In collaboration with Pain Management Service of Capital Coast District Health Board (CCDHB) and people with chronic or persistent pain, we will co-create a culturally relevant, evidence-based eHealth resource (iSelf-help) for people with persistent pain in New Zealand. Using participatory action research, people with persistent pain will be co-researchers, actively involved in developing, designing and testing the self-management eHealth resource - iSelf-help. In parallel a two-phase, mixed methods study recruiting health practitioners providing clinical care to people with persistent pain across New Zealand will investigate the knowledge of, and attitudes towards recommending and integration of eHealth resources into clinical provision of persistent pain management. Using a randomised trial design, we aim to evaluate the efficacy of iSelf-help as compared to face-to-face management of persistent pain in improving the health outcomes of people with persistent pain.

CONCLUSION

This collaborative research project is strategically aligned with the goals of National Health Strategy (2016-26). Particularly, the proposed self-management eHealth resource (iSelf-help) for people with persistent pain is in line with three main themes by empowering people with persistent pain ("people-powered") and creating innovative technologies that are "closer to home" with the potential for developing and integrating "smart systems" into the management of persistent pain. Importantly, the proposed eHealth resource co-created with people with persistent pain has the potential to be implemented as a comprehensive, culturally relevant, national resource for people with persistent pain in New Zealand.

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Collaboration & Connectivity: a digital platform that supports New Zealanders to improve healthcare

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INTRODUCTION

One of the challenges identified in the NZ Health Strategy, is that health organisations "need to get better and faster at sharing the best new ideas and evidence and putting them to work throughout the system"[1]. Alongside this there is growing expectation that health organisations will use improvement science to accelerate improvement of patient care. In New Zealand, there is no one repository that supports and aligns with improvement science methodology that could provide a digital platform for delivering quality and patient safety improvement projects.[1] Ministry of Health (April 2016). New Zealand Health Strategy Future Direction. Pg27. Retrieved from https://www.health.govt.nz/system/files/documents/publications/new-zealand-health-strategy-futuredirection-206-apr16.pdf

USE OF TECHNOLOGY AND/OR INFORMATION

Life QI, a cloud-hosted digital platform, was developed in England by a regional NHS organisation. Life QI provides an online workspace for quality improvement projects that is accessible from any location via secure log-in. The platform adopts improvement science methodology, specifically the Model for Improvement walking a team through a project from beginning to end. The platform includes functionality to create driver diagrams, Statistical Process Charts (SPC) for performance tracking, and a simplified mechanism for project reporting. The platform provides a shared repository of current and completed projects across New Zealand for health organisations to learn from, collaborate and enhance building of a QI community of practice.

IMPLEMENTATION/PROCESSES

A partnership was formed between a national organisation and two DHBs who were simultaneously looking for a similar solution. A 3 month trial of the Life QI platform, re-configured for New Zealand commenced in March 2017 with the aim of evaluating the effectiveness of a cloud-hosted and collaborative New Zealand quality improvement platform. 60 healthcare professionals working from and with the three heath organisations were selected to trial a license providing access to the platform. Each user was invited to complete a pre-survey and a user experience questionnaire. In twelve weeks across the 60 users, there were over 40 projects from 9 health organisations.

CONCLUSION

The trial demonstrated that health organisations would use a digital platform to apply a consistent approach to improvement projects. Having the consistency of the project templates and the visibility of other projects on the platform enhanced users understanding and application of the Model for Improvement whilst also reducing administrative effort required to set up and report on a project. With informatics being the biggest change on the healthcare horizon, a digital platform makes sense and is beginning to build a collaborative and connected QI community across New Zealand.

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Community Pharmacy at the' frontline' of Shared Care

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INTRODUCTION

For too many years our communities have suffered from a siloed approach to health and community care support. The growth in Long Term Conditions coupled with Aging Populations and disease states such as Diabetes exacerbated by lifestyle choices are at an epidemic scale. Early intervention is the key to interrupting counter-intuitive behaviours and needs to be accessible and attainable at the frontline! The 'frontline' is not a $50 GP visit for a script of drugs that you cannot afford to pick up. The 'frontline' is someone who can connect your care across the healthcare continuum and help you to 'get well, live well and stay well' and achieve your well-being goals. I am a Community Pharmacist, I am the 'frontline' and this is my story.

USE OF TECHNOLOGY AND/OR INFORMATION

Using Whānau Tahi's Connected Care (WTCC) platform I am now a key member of my DHB's Multi-Disciplinary Care team which includes secondary care, primary care and community care providers. I have 3 elderly clients who used to support each other attending their weekly GP visits. This cost them 3 days a week in energy, money and time sitting in a doctor's surgery and leaving them each $200 out of pocket every month with no health gains. I am now their 'frontline' care giver and have given them back 3 days a week. They now visit me together once a week and visit their GP just once a month, saving $150 a month each. I am now making a real difference to their well-being and bound out of bed every morning with clients to care for rather than pills to count.

IMPLEMENTATION/PROCESSES

Re-engineering the roles of secondary care, general practice and community pharmacy. Realigning responsibilities into that of a multidisciplinary team (MDT) working towards achieving a common goal of creating more meaningful outcomes for clients using WTCC as the technology enabler. One plan in one place where the collective team including the client defines and tailors a solution specific to their own needs and aspirations. Management of Long Term Conditions (LTC), drug interactions and genetics, diet and lifestyle monitoring are now a core part of my community pharmacist role.

CONCLUSION

My LTC clients are getting optimum wrap around care including setting goals that are meaningful to them using an MDT approach which actively involves them in their care planning. The result is reduced health risk and increased well-being for individuals; GP visits are reduced, ED visits are minimised, care and well-being is maximised.

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Controlling Clinical and Corporate Documents

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INTRODUCTION

Controlling clinical and corporate documents is critical for Southern District Health Board (SDHB) to meet its health care objectives, keep its patients, community and staff safe, and meet legal obligations.

The MIDAS upgrade to Pulse project replaced a complex ten year old policy and controlled document set up with a SharePoint solution.

The original MIDAS consisted of a content and metadata database, a bespoke web publishing tool and shared drive storage. Controlled documents and their metadata are now entirely managed and used within Pulse – SDHB's 2013 SharePoint system, reducing the cost and complexity of managing and using controlled documents.

Pulse provides document management, intranet and non-clinical activity management applications for SDHB. The addition of MIDAS controlled documents enhances its position as a one stop shop for knowledge and reference material as well as a communication and collaboration tool.

Key challenges in implementing MIDAS included the migration of content and the steep learning curve for administrators in supporting MIDAS after a decade with the previous solution.
- Critical to the success was
- Ownership of the solution and the project by a DHB quality assurance manager
- Rigorous testing of migrated content and functionality
- Crisp information architecture
- An agile approach to design allowing for functionality not identified in initial requirements
- Training for administrators throughout the project
- Commitment to driving granular findability of content

USE OF TECHNOLOGY AND/OR INFORMATION

The solution uses out of the box SharePoint extended by iWorkplace and document viewer add-ins. The pre-publication process enables users to register controlled document topic and process information Review, co-authoring, approval and publication processes are automated and simple to use.

IMPLEMENTATION/PROCESSES

The powerful search delivers MIDAS documents to users accurately and more easily. This, rather than navigate and browse has become the default way all users locate published content. Searching on the document ID or a keyword from the main search returns MIDAS documents through smart configuration of the ranking algorithm, and search results can be further refined by audience, department and topic. Along with real time publication rather than overnight processing, users can quickly get the most up to date policy, procedure, form or patient brochure from any internet connected device.

CONCLUSION

This presentation will cover key aspects of the MIDAS project, looking at how Information Leadership and SDHB successfully partnered on requirements, design, build, content migration, training, roll out and project management, overcoming a number of obstacles and picking up on a opportunities along the way.

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Creating an ecosystem for sharing health information in New Zealand

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INTRODUCTION

While it's important for health care providers to have patient information available when delivering care, a lot of the information that gets collected is effectively 'locked' up in digital silos at the location it was captured. Making this data more available (where appropriate) could vastly improve the quality and convenience of health and wellness in several ways:

- Assisting care deliverers so they have the information they need when making clinical decisions
- Providing transparency to data subjects so they're aware of what information is being shared about them and are able to check it for accuracy
- Making it easier to find and schedule clinical services
- Enabling Clinical Decision Support systems to apply clinical reasoning algorithms across both individual and aggregated information
- Collecting anonymised data for use in population based analytics

If we can make this information more widely available in a secure ecosystem of information and services then we'll enable innovation similar to what has been seen in other domains like finance and travel.

USE OF TECHNOLOGY AND/OR INFORMATION

In large part the technology is already available to achieve this, though not yet connected in the clinical domain. Storing data in the cloud is becoming increasingly accepted as a safe and effective way of storing data. Interoperability standards such as HL7® FHIR® , and Terminologies like SNOMED enable the sharing functionality between systems.

Standards like CDS-hooks enable applications to seamlessly invoke decision support services.

Security and authentication standards such as TLS and OAuth have been widely applied outside of healthcare and are being rapidly adopted within healthcare, with standards like SMART making it easier for application developers.

IMPLEMENTATION/PROCESSES

Creating the ecosystem within which information can seamlessly flow requires more than standards and technology. Leaving aside the governance that's required – another topic in itself – we need to consider the other services that will be required such as:

- Terminology services
- Authentication
- Provider and service registries
- Workflow management
- Auditing
- Privacy and access control

In this submission we'll discuss these requirements in more detail, and explore how they might be implemented in the context of a New Zealand ecosystem.

CONCLUSION

To some extent, health IT is behind the ball compared to services available in other domains. This isn't too surprising, given the complexity and sensitivity of health information, but the time has come to apply the lessons learned from other domains for the betterment of healthcare in New Zealand. To ensure all New Zealanders live well, stay well and get well.

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Creative disruption through a new context to present health information: An Inpatient Portal for communicating personalised treatment goals via in-room video

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INTRODUCTION

Service users find conversations with their clinical team a valuable resource in understanding their care—but frequently limited in duration and information may only be provided once. These issues are amplified for clients with memory difficulties, such as after brain injury. We planned an in-room video portal to enhance clinician-inpatient client communication and understanding of goals during inpatient rehabilitation. The portal was intended to enable clients with brain injury to independently review information to orient them to their treatment goals and progress.

USE OF TECHNOLOGY AND/OR INFORMATION

A native iPad app was developed to provide inpatients with regularly updated videos outlining their rehabilitation goals. Bluetooth wristbands were used to authenticate users eliminated the need to recall usernames or passwords. Across each of six areas—being healthy and safe, having something productive to do, leisure and relaxation, being connected with others, having a place to call home, and spirituality/wairua—videos covered why (life role and community participation meaningfulness), what (anchoring to activities and capabilities), and how the client was working towards each goal. Both clinicians and clients appeared in videos.

IMPLEMENTATION/PROCESSES

Co-design workshops were run with clinical staff at the partner service and with clients and family/whanau to refine functionality and design. The app was field tested with a series of clients. Quantitative data on app usage was collected, plus focus groups conducted with clinicians and clients/family whanau on discharge. Reaction from users was positive. A larger than expected creative disruption was observed as the clinical team engaged in discussions about goal setting philosophy and practices. This led to a further invigoration of the existing service philosophy around meaningful goal setting and some sharpening of clinician practices.

CONCLUSION

The project validated end-user acceptance and desirability of such a portal. This project also raises policy questions, such as where are the boundaries are around what should be considered part of the formal health record, and infrastructure issues around where large files like video data should best be stored, transported, and referenced when sharing health records between providers using standards such as FHIR. The app will be demoed in this presentation, and is coming to the iOS app store. This research was supported by a seed grant from the Medical Technologies CoRE and AUT Strategic Research Investment Fund.

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Designing filtering, trust building, thinking, and learning tools for distributed high-performance teams

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INTRODUCTION

Whilst exponential improvements in communication have transformed our economy, they have also put into sharp focus the limits of the ability of organisational cultures to adapt to new contexts. Our cognitive limits prevent us from better understanding the full implications of all our actions. This makes it increasingly important to design technologies for people and machines to improve filtering of information streams, trust building, critical thinking, and knowledge sharing. Over the last two years workshops at the unConference for Interdisciplinary Innovation have highlighted that a lack of trust is a major obstacle in collaboration in the healthcare sector, and that entrenched group identities can be a significant obstacle in establishing trust.

USE OF TECHNOLOGY AND/OR INFORMATION

The Cell Platform is an open source distributed semantic repository technology with applications in many domains, based on incremental development of trust and collaboration between agents. The Cell Platform is designed for use cases that are becoming possible in a world of pervasive digital connectivity.

IMPLEMENTATION/PROCESSES

In organisations with complex supply chains in other sectors the MODA + MODE methodology and specifically the following heuristics assist in promoting constructive collaboration across organisational boundaries:
1.   Start by assuming that there is no shared understanding and that there are no shared values.
2.   Explicitly and openly share core values between all parties.
3.   The overlap of core values determines the foundation for collaboration.
4.   Explore what is possible based on the current level of shared understanding, joint domain expertise, and joint capacity.
5.   Have the courage to share new ideas. Perform joint exploration of new ideas in the form of small-scale experiments and by mapping to past experiences.

The potential of this approach in the healthcare sector is apparent when considering the success of distributed self-management at Buurtzorg in the Netherlands. Buurtzorg is a decentralised organisation with 7,000 staff. According to Ernst & Young close to € 2 billion would be saved annually if all home care organisations in the Netherlands reached this level of operational efficiency.

CONCLUSION

Knowledge intensive economic sectors such as healthcare delivery can benefit greatly from technologies that mirror our value systems, our domain expertise, and our level of shared understanding, and which thereby significantly improve the quality of collaboration. Technologies that recognise human cognitive limits and that are explicitly designed to counteract cultural inertia represent an opportunity to nurture trusted collaboration, and they also have the potential to reduce conflict and mistrust between organisations and people from different cultural and educational backgrounds.

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Development of an electronic notification system for notifiable disease surveillance in New Zealand

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INTRODUCTION

In New Zealand, medical practitioners have been required to report the cases of specified infectious diseases for over 100 years. Currently, 57conditions are "notifiable" to a Medical Officer of Health (MOH) under the Health Act 1956. General Practitioners (GP's) are presently notifying cases of notifiable diseases by telephone, fax or mail. This process is often time consuming, slow and in some cases not done. Once the notification is received by the MOH, these notifications are manually entered into the national notifiable diseases data collection system, called EpiSurv. Information transcribed into EpiSurv may contain errors or may not be sufficiently complete leading to data quality issues for case investigation and surveillance reporting.

USE OF TECHNOLOGY AND/OR INFORMATION

Almost all GPs are using Patient Management Systems (PMSs) in New Zealand. These PMSs are not only used for maintaining the Electronic Health Records (EHR) of the patients but also for health information exchange between health organisations. For example electronic submission of the ACC45 form, for specialist referrals and for notifying cases of influenza like illnesses. Nationwide use of PMSs offers the opportunity to modernise the way GPs notify cases of notifiable diseases to the Medical Officers of Health. This will be potentially a quick, well-documented and reliable way to acquire data compared to fax, phone or mail. In this project, we developed a system to replace the manual method of notifications from GPs for notifiable conditions.

IMPLEMENTATION/PROCESSES

We implemented an interactive advance form, which integrates seamlessly with the EHR in the PMS using the HISO Online Forms Standards. This form will allow a GP to create an electronic notification and provide associated clinical and risk factor information with minimum effort when a patient presents with symptoms matching a defined case definition for notification. An HL7 messaging framework is implemented to securely transfer the information between PMS and EpiSurv.

CONCLUSION

The system will potentially add new capabilities to the national surveillance systems by increasing the amount of useful data received from practices in near real time. Currently, planning is underway to perform a three-month pilot implementation study at six General Practices: two in Auckland, two in Wellington and two in Hawkes Bay Regions. This pilot will focus on exploring the feasibility of the system for a national roll out.

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Does a whole of organisation approach bring IT people and clinicians together or divide them?

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INTRODUCTION

Counties Manukau Health in 2013 were facing challenges similar to other NZ DHBs and worldwide with a unsustainable healthcare model, inefficient IT systems, staff dissatisfaction and an historic underspend in IT. With the knowledge that a significant investment was required to overhaul a fragmented outdated system, Counties Manukau Health embarked on a public-private partnership in collaboration with the NZ Health Innovation Hub and support from the National Health IT Board.

USE OF TECHNOLOGY AND/OR INFORMATION

Taking a population health focus to derive a multi-year technology investment programme requires a lot of factors to come together to get the engagement needed, agility to respond to changing influences, and commitment to deliver. We hear all the time it is not about the technology, it is mostly about people and process change. But what happens when people who are perceived as 'IT' want to engage in discussion on the future of healthcare delivery and changing models of care? What happens when great engagement leads to high expectations?   What as an organisation did we learn from the approach taken, what did we get right and what could we have done better?

IMPLEMENTATION/PROCESSES

With the support of our strategic partner, a team inclusive of staff, our primary care partners and consumer advocates set the scene across the district for a transformational change programme that was targeted at enabling an enhanced model of care. People were asked to define what a good future model of care would look like and how they could see technology enabling this future. People were encouraged to not let the frustrations they encountered today constrain their thinking for tomorrow. Once the vision was established the team undertook a deep dive into current practices and technology, involving shadowing staff to gain a full appreciation of current challenges. From here an investment plan was established that was constrained by the reality of affordability and a changing regional and national landscape.

CONCLUSION

A 2016 reflective analysis was undertaken of the 18 month journey, which identified 8 core themes: Governance and Decision making; Procurement and Partnership; Collaboration; Clinical leadership and Engagement; Communication; Technology; Resourcing; and Regional and National context. These learnings and subsequent recommendations, for those considering large technology investments in the future, will be discussed.

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ID: 759 - DIGITAL HEALTH IDEA

Doing whatever it Takes

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INTRODUCTION

'Doing whatever it takes' - A Collective Impact Model of Care

At Turuki Health Care our job is to provide whānau/family-based health, wellness and social services to whānau in South Auckland. We have spent many years weaving together health, social and community services 'Doing whatever it takes' to get more meaningful outcomes for whānau knowing that we only become ill when we don't have the resources to stay well. Our integrated care approach requires partnering in alliance model of care with providers across the health, social and community care continuum focussed on whānau specific needs and desires. Aspirations for well-being belong to whānau, our role is to weave services around them to help them achieve their goals.

USE OF TECHNOLOGY AND/OR INFORMATION

To address our population's need we will adopt a co-ordinated integrated care approach – a 'Collective Impact' Alliance of service providers creating a village of care around whānau. Initially we will agree our common agenda and outcome measures and develop the backbone support structure to report on this agenda, a key component of which is an ICT solution that enables shared care. We will extend our use of the Whānau Tahi platform to integrate health, social and community services around whānau and communities.

IMPLEMENTATION/PROCESSES

We are at the very beginning of our journey towards cross-sector collaboration: workshopping with partners to identify Collective Impact goals and measures, building a communications coalition to ensure open and clear communication to build trust, establishing what financial supports we need to succeed, stablishing a common report card for All of Government. To breakdown service barriers we must focus on our community and build a common action plan for all partners to work to and report upon. This work will develop between now and conference and we will bring you our learnings on establishing a Collective Impact Alliance where our common agenda enables and strengthens whānau/ community towards self-determination.

CONCLUSION

Look for synergetic relationships with people and services with whom you dare to innovate, be courageous to fail fast and then move on with the learning. Binding organisations and practitioners to work together with a common philosophy and shared values is key. In the best scenario, we are working with whānau, funders and service partners to keep tweaking services to 'get it right' over time. We are developing a strategic approach to institute systemic sustainable change, creating meaningful outcomes for whānau all with an eye on the social return on investment.

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Electronic discharge summaries and EMRs – experience of a paediatric institution

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INTRODUCTION

A succinct and timely discharge summaries (DS) facilitates ongoing care for patients discharged from acute care settings. Many institutions have introduced electronic DS (eDS) templates to improve quality and timeliness of clinical correspondence. However, significant intra-hospital and intra-unit variability and application exists. A systematic review of 54 articles and guidelines revealed 13 key elements that should be included in a best practice DS. This was compared against our paediatric institution's (Royal Children's Hospital Melbourne, RCH) electronic DS template – housed within an integrated electronic medical record (EMR) and used across most inpatient hospital units.

USE OF TECHNOLOGY AND/OR INFORMATION

EMR at the RCH includes a standardised structured template for eDS which includes auto-populated patient demographic and care information, diagnoses and procedures. It allows for inclusion of automatic refreshing links, which pull key data elements from various sections of the patient's record (e.g. discharge medications, future appointments), as well as free text information at the author's discretion. The template was based on previous iterations of eDS templates pre-EMR introduction, and developed with key stakeholder (primary care clinicians and consumer) consultation.

IMPLEMENTATION/PROCESSES

Uptake and adherence to the suggested key elements was measured by comparing all discharge summaries for long stay inpatients (>21-day admission) during the first year of the EMR eDS template's usage (May 2016-Apr 2017).564 patient files were reviewed with 472 DSs available for evaluation. 6/13 key elements were completed in >98.0% of DSs. Only <5.0% included allergies, adverse reaction data and ceased medications, and <11.0% included pending laboratory results. Inclusion of procedure information and pending laboratory results significantly improved with time (p=0.05 and p<0.04, respectively), likely as doctors became more familiar with EMR and auto-population functions. Inclusion of 'differential diagnosis' differed significantly between medical (n=406/472;99.0%) and surgical (n=32/472;51.6%) DSs.

CONCLUSION

Best practice DS elements	RCH DSs with included best practice elements N, (%) Total n = 472	Best practice DS elements	RCH DSs with included best practice elements N, (%) Total n = 472
[1] Patient details	472 (100)	[8] Adverse reactions	19 (4.04)
[2] Admission diagnosis	472 (100)	[9] Ceased medications	19 (4.04)
[3] Discharge diagnosis	438 (92.8)	[10] Discharge medications	463 (98.1)
[4] Investigations	439 (93.0)	[11] Pending laboratory results	51 (10.8)
[5] Procedures	436 (92.4)	[12] Medical problems at discharge	468 (99.2)
[6] Hospital treatments	472 (100)	[13] Follow-up details	472 (100)
[7] Allergies	11 (2.33)		

Uptake and adherence to an EMR eDS template designed to meet best practice guidelines in a paediatric institution was strong, although significant improvements in specific data elements are needed. Strategies can include a modification of existing eDS templates and junior medical staff education around best practice.

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Enabling Integrated Care for children - A new model of care

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INTRODUCTION

Planned Proactive Care (PPC) for Children is an initiative of Primary and Integrated Care at Counties Manukau Health, targeting improved health for children with long term conditions. The aim is to promote a child and family centred model of care by enabling practices to be more innovative in providing early intervention and planned, proactive care for children with chronic health problems.

USE OF TECHNOLOGY AND/OR INFORMATION

Whanāu Tahi Connected Care (WTCC) is a software platform which works with existing IT systems. WTCC provides the benefit of an integrated summary health record viewable by health providers across organisations. It is a key tool for the delivery of the PPC model for children. A child enrolled into PPC for Children, by their general practice, is assigned a care-coordinator who works with the child and their family to set goals and monitor progress in consultation with other health and social providers. A Child Health Planning Tool (in place of the 'Partners in Health Assessment' used for adults) has been developed by the PPC for children working group and implemented in WTCC to enable a child focused approach to care.

IMPLEMENTATION/PROCESSES

PPC for Children expands on the existing CMH Planned Proactive Care model which has used the WTCC, for the adult population. It is being implemented stepwise in order to establish, and then build up the model of care. Child asthma, chronic constipation and eczema are the focus of the first step. Management for each of these conditions, and the PPC for children process are supported by primary care HealthPathways. Learning sessions held in April and May 2017, facilitated by a GP and nurse with primary care child health experience, focused on how to deliver an integrated approach to child health. Clinicians were enthusiastic about the opportunities PPC for children can provide to enable holistic care of children.

CONCLUSION

The PPC for children expands the adult PPC model of care, with appropriate adjustments for children and their families, to improve their knowledge and capability in the management of chronic health problems and to build trust in general practice as their healthcare home. The WTCC is the essential platform to support this programme. The impact of the programme will be measured by audit of the action plans that result from PPC, and change in the use of secondary care services. Planning is underway for other conditions with the PPC for children approach including, for example, children with bronchiectasis, developmental concerns and obesity.

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Enabling Integrated Care through Digital Case Conferencing

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3. Whanau Tahi
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INTRODUCTION

Multidisciplinary teams (MDT) combining secondary, primary and community care services are key to supporting patients to stay well throughout their health journey. Whānau Tahi has developed a digital approach to Case Conferencing in response to a request from Northern Region health and medical professionals challenged by the inability to communicate through secure electronic means, which resulted in limited information available for reviewing and discussing cases with minimal visibility of health outcomes.

USE OF TECHNOLOGY AND/OR INFORMATION

The Whānau Tahi Connected Care platform provides a single location for MDTs and organisational teams to co-ordinate, plan meetings, and record and store shared actions and outcomes for patients. Care Team members can electronically submit a patient to be part of an upcoming GP based inter-organisational multidisciplinary team meeting. Once the meeting is finalised a notification is automatically sent out to attendees confirming the meeting details and providing a secure link for them to access the shared summary record for all referred participants. During the meeting, discussion outcomes are electronically captured and saved to the Connected Care patient record.

IMPLEMENTATION/PROCESSES

A collaborative working group was established with Secondary and Primary healthcare representatives from ADHB, CMH in addition to Whānau Tahi and healthAlliance. The group identified requirements, provided feedback on designs, reviewed demonstrations and completed end user testing. Connected Care Programme leads are working with selected inter-disciplinary teams to implement this process and gather feedback for further enhancements. This collaborative, iterative approach has been very successful for ensuring that the technology met the identified needs and clinicians were engaged and supportive.

CONCLUSION

A digital approach to Case Conferencing enables Multidisciplinary teams to easily arrange meetings, record discussions and the consensus on actions in a secure environment that is visible to all MDT members. It is hoped this will facilitate integrated patient care across services and organisations. This collaborative approach is highly beneficial and will be utilised to support future development.

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Enabling new models of aged care through technology and information

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INTRODUCTION

The landscape for aged care has shifted. NZ cannot afford to sustain the current model, and New Zealanders want a fresh approach that allows them to remain safe and well at home and preserves the independence they value so highly.

USE OF TECHNOLOGY AND/OR INFORMATION

A combination of technology-enabled services will allow new 'theoretical' models of care to become real. Smart monitoring of people's homes and personal health information will inform and reassure their care network, and facilitate early intervention when needed – avoiding costly and potentially life-threatening escalations further down the track.

IMPLEMENTATION/PROCESSES

A self-contained kit that includes wireless internet connectivity is installed in the person's home for a finite period. A training and familiarisation session overcomes any reluctance to adoption, and remote support makes it easy for the participant to use the equipment over the period of engagement. A regular schedule of collecting vital signs is established, and the individual is responsible for checking in with their telehealth RN at set times and days (empowering them to take more control). Vital signs and questionnaire responses are reviewed and triaged by the telehealth nurse, informing the virtual face-to-face check-in. The use of video allows the nurse to 'eyeball' the person and assess any change in condition (including social cues as well as health indicators). This non-emergency service is ideal for people managing chronic conditions and general frailty that can be associated with ageing. Health information is shared (under consent) with the person's GP and can be uploaded to their clinical record.

CONCLUSION

Technology and gadgets alone do not provide the necessary impact to allow people to stay well. Engaging the person in their own health and well-being through coaching with a trained health professional – supported by time series data collected from monitoring devices – allows people to be able to 'age in place' safely. The regular contact with the telehealth team provides a small-but-important point of contact, helping to encourage more diverse relationships and thereby reducing the feeling of social isolation. Continued R&D will identify new opportunities for ever cheaper, smaller, faster and more convenient device and software components within the solution. Next steps for this initiative is to broaden the reach of the service, and to scale-up to be able support large numbers of individuals from a central location.

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Enhancing Nurse Education Initiatives at Southern Cross Hospitals with Evidence-Based Information Resources

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INTRODUCTION

Southern Cross Hospitals is a network of ten wholly owned and four joint venture private surgical hospitals, located from Auckland to Invercargill. This geographical spread covers twelve of the twenty DHB regions, which poses many challenges when it comes to standardising nursing practice and procedures as well as supporting nursing education initiatives.

USE OF TECHNOLOGY AND/OR INFORMATION

Southern Cross Hospitals sought to streamline their policy and procedure process as well as their nursing education initiatives with the help of an evidence-based nursing information tool they could rely on. Their criteria for selecting a nursing resource included evidence-based content on a variety of disease and conditions, continuing education modules, robust skills content, as well as linking and integration capabilities.

IMPLEMENTATION/PROCESSES

The decision was made by Southern Cross Hospitals to purchase Nursing Reference Center Plus to help meet the diverse education needs of their nurse population. With the help of this evidence-based information tool Southern Cross was able to: Utilize evidence -based CE modules, skills sheet and evidence-based care sheet to support the delivery of robust in-service sessions based on the latest evidence. Provide trusted content to enhance their comprehensive new graduate RN program, supporting new nurses to embrace evidence-based nursing practice as they develop competence and confidence in their skills. Produce a strong and well-rounded education campaign for focused topics such as Medication Safety Week.

CONCLUSION

This presentation will provide practical examples of how Nursing Reference Center™ Plus is currently used across the Southern Cross Hospital network to support excellence in nursing practice, best practice patient care, high quality education and individual nurse's professional requirements.

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Enhancing patient access to General Practice

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INTRODUCTION

Enhancing patient access to General Practice. Counties Manukau Health is working in partnership with 4 PHOs and 9 General Practices in an 18 month pilot phase for our Enhancing Primary Care programme of work. Following similar principles as the Health Care Home model, the collaborative has been focused on a module that streamlines how patients use technology to access and interact with their General Practice team.

USE OF TECHNOLOGY AND/OR INFORMATION

Patient portals have been implemented by all of our 9 practices and their telephony systems have been upgraded to allow for accuracy of information such as call counts and dropped call rates. However a key component has been to establish a tracking process at the Practice level to measure patient portal uptake and telephony counts as well as potential benefit to the Practice, in effect asking the "so what" question.

IMPLEMENTATION/PROCESSES

Over the last 6 months the collaborative programme team have been working with the Practices, portal vendors and telephony companies to understand what data is available, streamline this information and then present it back to the Practice team in a dashboard format that allows for meaningful interpretation.

CONCLUSION

9 pilot Practices have all implemented portals and installed telephony systems with reporting capabilities. As at June 2017, across the programme 15,887 have been enrolled on to a patient portal and this equates to a 21% of the eligible pilot practice population as enrolled. A deep dive into one Practice's portal activity demonstrates that if each activity on the patient portal accounted for a phone call to the practice then the potential work load that has been saved by the practice is 337 hours in that month (measured by an average phone call of 47sec).

Key lessons learnt have been:

Define the data that you wish the vendors to provide e.g different portal vendors run different reports in variable formats and there was complexity in interpreting the raw data feed.

Work with the end users in terms of what information is meaningful to capture on their monthly dashboard, for instance the Practice teams want to know information about portal uptake, key features being used in the portals and then how this translates into time and cost savings.

Next steps are to continue with testing the dashboard design with a wider roll out planned for the next tranche of Practices in the CM Health area.

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Ethics and Governance of Health Data Research in New Zealand

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INTRODUCTION

Demand for health data for secondary-research is increasing, both in New Zealand and worldwide. The NZ Government has established a large research database, the Integrated Data Infrastructure, and an independent ministerial advisory group, the Data Futures Partnership (DFP), to engage with citizens, the private sector, and non-government organisations to help bring change across New Zealand's data-use ecosystem. Better use of data underpins the government's "social investment approach" which aims to increase the use of public sector data to drive innovation, save costs, and better target services to people in need. In the health context, secondary-use research involves using clinical data for purposes other than that for which it was collected and which is generally outside original patient consent. It involves re-using, sharing and linking data to better understand New Zealand's health needs. The collection and subsequent use of data must be undertaken with great care, as highlighted by MSD's "Data-for-funding" policy which the Privacy Commissioner found was excessive and lacked transparency about the purposes for which the data was collected and for which it might subsequently be used. Currently, NZ lacks effective ethical governance of health data research. The existing regulatory approach is insufficient:(1) Health and Disability Ethics Committees (HDECs) primarily review interventional/observational clinical research and may lack sufficient relevant expertise to review sophisticated data linkage projects;(2) there is no definition of 'public interest'; or guidance on when consultation with Māori is required;(3) fragmentation makes it difficult for the public, media, or the research community to track who is accessing patient data and for what purposes; and(4) current guidelines focus predominantly on individual-level interests such as consent rather than collective interests such as national research priorities, equity, and public access to research results.

USE OF TECHNOLOGY AND/OR INFORMATION

N/A

IMPLEMENTATION/PROCESSES

N/A

CONCLUSION

To address the problems described in section 1, we propose the following unique solutions to establish effective governance of health data research at a national level: (1) a specialist Health and Disability Ethics Committee (HDEC) to review applications for secondary-use of data;(2) a public registry of approved secondary-use research projects (similar to a clinical trials registry); and(3) detailed guidelines for reviewing and approving secondary-use data research, including expanded guidance on the public interest . Our solutions are based on core values of expert oversight, public engagement and transparency.

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Free informational e-health webinars teach to people how to prevent illness and improve and self manage their health and wellbeing

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1. The Art of Health

INTRODUCTION

In response to nationwide enquiries for help with chronic pain, fatigue, depression and anxiety, an Auckland based clinic began to research options for delivering remote e-health education.

USE OF TECHNOLOGY AND/OR INFORMATION

Since 2011 the clinic had been trialling webinar delivery platforms for e-learning delivery. The clinic needed software which could record the webinars live and allow the MP4 recordings to be saved and then uploaded for on demand viewing. The software needed to be easy to operate for both participant and webinar leader, and it needed to have in-built registration function. Affordability was also an important factor for the clinic which was operating on minimal funds. Whilst various applications offered certain features, none of the applications offered all the features sought in one package. Finally in 2016 a webinar software was sourced which offered all of the required features.

IMPLEMENTATION/PROCESSES

In October 2016 the clinic started running free weekly webinars. Participants can register to watch live or later on demand, and are notified of upcoming topics each week via enewsletter, Twitter and Facebook posts. After the live event the MP4 recordings are downloaded, edited using basic video editing software (to tidy up and cut extraneous information) and uploaded to Youtube for on demand viewing. In March 2017 the webinar software was upgraded, enabling simultaneous live streaming on Facebook. Facebook Lives are automatically recorded by Facebook and available to watch ongoingly. Topics include how to manage depression, reduce stress, understand how ACEs (early childhood experiences) contribute to chronic illness and more. Videos have been viewed in many countries including New Zealand, Australia, UK and USA. The topics have been well received: for example, one viewer wrote in from New York "I watched your video online about emotion and pain. It had a profound effect on me and I woke up with a drastic reduction of neck pain this morning!"

CONCLUSION

Online e-learning is immensely effective in teaching and disseminating valuable information which people may not otherwise come across or have easy access to. With one of the clinic's main goals being to encourage people to take greater care for their own health, and a prime directive of the New Zealand healthcare strategy being to "live well, stay well, get well in a system that is people-powered and provides services closer to home", the clinic believes online e-learning has huge potential for motivating and assisting people to look after their wellbeing.

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GASP improves asthma outcomes

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INTRODUCTION

New Zealand has one of the highest rates of asthma in the world, with Maori and Pacific peoples disproportionately affected. It is one of the most common causes of hospital admission in children. GASP (giving airways support to patients) is a personalised web based asthma management tool and education package used by health professionals which has been shown to reduce hospital admissions and emergency visits in all age groups by increasing the percentage of patients with well controlled asthma.

USE OF TECHNOLOGY AND/OR INFORMATION

The GASP package is a toolkit for clinicians working in general practice, combining an electronic assessment and decision support tool with a 2 ½ day education programme. The education package equips clinicians with the knowledge and skills to successfully manage asthma. The GASP tool streamlines the assessment process enabling time efficiencies, with the decision support giving management advice based on current guidelines.

IMPLEMENTATION/PROCESSES

The journey began in 2008 when nurse Wendy McNaughton felt there needed to be an easier way to capture and audit asthma assessment information. She worked alongside an IT specialist to create a one page interactive tool which operates within both Medtech and My Practice. With nurses that had already received the 2 ½ day training, a pilot study was completed; results were encouraging. Now 9 years on with 8 years of data collected the GASP package has been shown to reduce hospital admissions by as much as 54%, similar reductions were seen in exacerbation rates, courses of oral steroids and asthma symptoms. Results were reproducible in Maori and in children.

CONCLUSION

Health professional education and a decision support tool improves outcomes in Asthma. The GASP package has proven its worth locally. Interest from Australia, led to an Australian version of the tool being developed and a trial is currently underway in Sydney.

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Giving data capture purpose, direction and visibility – connecting Allied Health Clinicians with the Patient

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INTRODUCTION

The challenges currently facing all health services such as fiscal restraints, patient expectations, changing patient demographics, Information Technology development and an aging health workforce, each demand a change across healthcare provision. Allied Health (AH) services seek to respond by addressing their resourcing, service delivery models and professional evolution. The purpose of data collection for Allied Health has moved from a historical perception of service justification to one of value assurance for the patient and health system, resource identification and skill development. We aimed to provide a visible and interactive electronic solution, accessible anytime and from any device, to support staff and strategic leaders to derive knowledge to benefit the patient.

USE OF TECHNOLOGY AND/OR INFORMATION

We established a collaborative relationship with our information analysts who operate on an agile basis to manage each project to support workflow management. Data capture by 180 AH staff occurs each quarter for 2 weeks using an application loaded onto individual iPods. The AH data is extracted and merged with broader health system data elements. Meetings were frequent to ensure mutual understanding about progress and timely response to changes required. Multiple stakeholders were required to sign off the final dashboard and involved in quality assurance and peer review before the final release. An initial survey was also completed by AH leaders prior to publishing.

IMPLEMENTATION/PROCESSES

Using Tableau™ a dashboard was created and refined to illustrate a number of key measures; AH contact time, proportions of activity by location/health specialty, distribution of contact time duration, contact by age/day/discipline, referral and outcome type frequency.(please see attached graphic - supporting file 'AH Dashboard')

CONCLUSION

We are all seeking to understand and provide evidence of our service efficacy. Transparency and visibility of information seeks to support the engagement of staff with learnings to improve service value to the patient. This solution also provides evidence to support the resourcing, service delivery and professional evolution of our Allied Health services.   We are keen to continue the evolution of this dashboard to view a full patient timeline and provide improved detail.

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Going social - connecting for digital health

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INTRODUCTION

In all our efforts to engage and collaborate using digital health technologies, we often overlook the most powerful platform for communication and information exchange: social media. At Waitemata DHB we recognise our staff as our most valuable asset and, properly trained in professional behaviour online, they can participate in social media to connect and collaborate with each other and with patients.

USE OF TECHNOLOGY AND/OR INFORMATION

We developed our plan in association with the Mayo Clinic social media network socialmedia.mayoclinic.org and gained access to their online social media training program. A staff survey revealed current use of social media for healthcare purposes and interest to help lead this initiative across our organisation. A small team within i3, our institute for innovation and improvement, is assisting the self- identified clinical leads to promote uptake of social media use in their departments.

IMPLEMENTATION/PROCESSES

Initial discussion with our Corporate Communications team for alignment of purpose and connection with our organisation's values. Development of a social media strategy with clarification of corporate and i3 roles and responsibilities. Agreement to share and complement content wherever possible. CEO support for the plan as part of our digital transformation strategy. Established relationship with Mayo Clinic social media network – visit to i3 by MCSMN Director and Medical Director. Organisation membership of MCSMN arranged and online training begun. i3 Twitter handle established and hashtags #DigitalPX and #i3Qi registered with Symplur.com Medical staff survey distributed and responses analysed. Follow up contact with self-identified social media championsi3 social media fellow appointed and literature review of social media in healthcare completed Phase 1 of implementation plan begun and clinicians engaged including participation in an online community with cancer patients.

CONCLUSION

78 clinicians completed the online survey (45 male, 33 female) with an even spread across age groups. Preferred platforms for personal use of social media were Facebook (61%) and You Tube (43%) with 20% of respondents not using any platform. Twelve clinicians from ten departments identified themselves as social media champions and are leading our drive to engage colleagues. Going social has transformed our personal lives and we believe it is a necessary part of any digital transformation in healthcare. We share the view of the Mayo Clinic that we should use social media to help us serve patients better and work with them for their health.

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Harmonising global standards to integrate New Zealand healthcare

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INTRODUCTION

In New Zealand, two global standards are used to identify and exchange information about medicines. In clinical practice SNOMED CT identifiers are becoming widespread as New Zealand Universal List of Medicines (NZULM) based clinical systems are rolled out. In supply chain management, the GS1 Global Trade Item Number (GTIN) system via the National Product Catalogue (NPC) is widely used. Currently these standards are not inter-operable. Globally this is seen as a barrier to enhancing healthcare outcomes, improving patient safety and improving care delivery efficiency. A NZ pilot involving a sample of pharmaceutical suppliers demonstrated that NPC and NZULM data can be harmonised and automated by exchanging data elements between systems providing inter-operability. The pilot has and will continue to contribute to an international Guidelines and Principles SNOMED: GTIN linking document.

USE OF TECHNOLOGY AND/OR INFORMATION

The collaborative NZULM and GS1 New Zealand pilot, sought to automate and harmonise the exchange of multiple data attributes between the NPC and the NZULM, providing additional, hitherto unprocurable data in the NZULM. It demonstrated that a single NZULM identifier (SCTID – clinical identifier) populated into the NPC can then be 'published' to the NZULM along with the mandatory GTIN (i.e. the product identifier in the supply chain), harmonising the two Standards.

IMPLEMENTATION/PROCESSES

Following the successful pilot, the process is now being collaboratively extended to all providers of medicines information to the NPC to;
• Increase supplier understanding of the NZULM.
• Map individual NPC product lists to their counterparts in the NZULM.
• Develop new processes to increase process efficiency and enhance quality management.

CONCLUSION

The pilot and subsequent extension to all suppliers demonstrates SNOMED CT and GS1 standards can be harmonised and provides a global reference model for similar initiatives. A wide range of benefits across clinical practice and the supply chain arise from system harmonisation. These benefits align with the NZ Health Strategy road-map, ranging across service management efficiency gains, patient safety improvements, and workforce sustainability to smart system enhancements from analysis of combined data sets. The range of benefits is expected to grow as users become familiar with the harmonised standards. Keeping the burden on suppliers to a minimum is critical to obtaining their support. Better use of NPC data transfer and management tools is essential to expanding the harmonisation process. Further business process development to handle an expanding set of scenarios can be expected.

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Harnessing the NMDS to investigate surgical outcomes

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INTRODUCTION

There is no widely used multivariable clinical tool for predicting perioperative mortality that has been validated in New Zealand patients. We aim to remedy this, by building a model which can be implemented as a clinical tool using a large dataset of New Zealand patients. The National Minimum DataSet (NMDS) contains all information reported to the MOH from hospitals around New Zealand; we are using a two-year sample from this dataset to build our model, along with mortality information on each patient in the dataset. The model can be used to predict mortality across cohorts, compare outcomes across groups of patients and provide information on longer term surgical outcomes.

USE OF TECHNOLOGY AND/OR INFORMATION

We have a dataset from the NMDS of roughly ~360,000 surgical hospital admissions during 2013-2014. We have broken this dataset down by age, gender, cancer status, ASA (American Society of Anesthesiologists) status, surgery type, ethnicity and acuity of surgery to compare outcomes between groups. This provides information on covariates to be used in an overall predictive model. The model predicts perioperative mortality at 30 days, 1 year and 2 years post-surgery. Most current modelling predicts outcomes at 30 days, we will extend that and also aim to prove that surgery has risk associated with it far past one month.

IMPLEMENTATION/PROCESSES

As of 13th June 2017, we have collected and pre-processed our data to extract all relevant information. We have modelled hazard rates for each covariate – age, cancer status, gender, ethnicity, ASA status and elective vs non-elective surgery – to compare across groups within each covariate (e.g. comparing hazard rates for different age cohorts). This modelling illustrated clear differences across groups and also showed that surgery increases risk differently in different groups of patients. We have also estimated excess surgical mortality – the rate at which surgery increases a patients chance of dying – for each cohort over an extended time period.

CONCLUSION

We have demonstrated that there are clear differences in survival rates between groups, e.g. between ASA groups, and we can show excessive surgical mortality often extends far past the usually reported 30-day threshold. We have also compared multiple parametric models, and combinations of various survival models and believe that using a Gompertz-Gompertz model of the form $a*exp(qt) + b*exp(ft)$ best captures the hazard rates we are seeing in our dataset. Our next steps are to begin predictive modelling of mortality rates using our chosen combinations of covariates, and evaluating the success and predictive ability of our models.

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HOPE (Health Outcomes Prediction Engine) for Stroke

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INTRODUCTION

The HOPE for Stroke project is developing a prototype electronic clinical decision system which makes health outcome predictions tailored to individual patients. This prototype is part of a wider project, funded by the Precision Driven Health initiative, a research collaboration of Orion Health, University of Auckland, Waitemata DHB, and MBIE.

Stroke is an important condition affecting around 800 people in our DHB each year which impacts independence and quality of life. Currently, treatment decisions and assessment of prognosis are derived from a clinician's personal experience and knowledge of published evidence. The evidence may not differentiate outcomes based on the specific characteristics of the patient before you. Post-stroke is a difficult time when patients and whanau seek clarity about what to expect in the future.

USE OF TECHNOLOGY AND/OR INFORMATION

We have created algorithms to predict outcomes following stroke, which use electronically collected data collected over the past 5 years. Many predictor variables were tested, with the best being age, stroke severity (as measured by the NIHSS), Oxford stroke class, stroke type, comorbidities, thrombolysed, time of presentation to ED, comorbidities, such as congestive heart failure and atrial fibrillation, prior living situation and level of home support. We have defined a new outcome of 'dependence at one month post-discharge', a rank order variable combining outcomes relevant to the patient's local environment. The five levels of this variable are return to own home with no funded support, three levels of home-based and residential care, and death. Algorithms are being developed for three other outcomes: inpatient death, length of stay in hospital, and need for inpatient rehabilitation. A combination of statistical modelling techniques are being used, including logistic regression, random forest and gradient boosting. Results have been promising, with an AUROC of 0.94 for the inpatient death model.

IMPLEMENTATION/PROCESSES

The mobile stroke team first assessment is usually performed on the ward, the day after the actual stroke. A Clinical Workflow Suite (Orion application) form will be used to collect the assessment details, present relevant past information about the patient, and then display the HOPE predicted outcomes to the clinician. The stroke clinicians will use this information to aid decision-making and communication of prognosis. The project recognises the difficult task of communicating risk to patients, and will work with stroke clinicians to avoid insensitive or confusing wording in the reported predictions. A prototype form has been built and will be live by about September 2017.

CONCLUSION

We expect to have a working clinical decision support tool to present at conference. We can offer delegates a model not only for developing predictive algorithms, but incorporating them into clinical systems at point-of-care. We anticipate that this tool will be particularly useful to junior doctors or general physicians, and transferable to other New Zealand DHBs.

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How not to miss the diagnosis—an electronic solution

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INTRODUCTION

Waitemata District Health Board completes approximately 23,000 outpatient appointments each month, 74% of which are follow up appointments. We need to better understand the purpose and outcomes of outpatient appointments to help us manage demand and improve practice. Critical to this understanding is the diagnosis, confirmed by a clinician. To address this, we initially added the relevant field to our paper forms however this was inefficient and error prone, necessitating double handling by the clinician and administrators. The paper solution doesn't scale well because each service requires a specific diagnosis list. We here present an electronic solution that addresses these limitations.

USE OF TECHNOLOGY AND/OR INFORMATION

We developed an electronic outcome form in clinical portal with our rheumatology service. Clinicians and administrators were actively involved in the solution alongside an external software developer and internal information system specialists. We mapped the current process to understand how the form was used by each team member - the front desk administrator, nurse, physician and booking clerk. We incorporated diagnosis, as well as the following fields into the electronic form: appointment time tolerance (to facilitate clinically-appropriate booking of follow up appointments), alternative methods of follow up (eg virtual clinics and Self-referral On Symptom [SOS]), and clinician to be seen (the same or an alternative clinician such as a clinical nurse specialist).

IMPLEMENTATION/PROCESSES

We tested the electronic outcome form in our rheumatology service. Critical success factors were: identifying a service that is engaged in collecting electronic information about the diagnosis, and is committed to using these data to inform and improve their service; active involvement of staff throughout the development service; initially implementing the proof of concept with one clinician to understand the complexity of the process and the potential risks to the delivery of patient care.

CONCLUSION

We demonstrated the feasibility of an electronic outcome form in rheumatology outpatients and plan to expand this process to other specialties. The electronic process guides the clinician to enter a diagnosis and outcome and will enable: monitoring of appointment frequency by diagnosis; monitoring any difference between clinician-requested follow up and follow up offered to the patient; prioritised booking of follow up appointments. Subsequent stages of the project will explore integration with the Patient Administration System (PAS), so that the PAS is automatically populated with the administrative parts of the data from the electronic form. This will remove the need for front desk staff to re-enter data into the PAS.

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iMOKO: Connecting the Community to Democratise Healthcare

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INTRODUCTION

In New Zealand (NZ), health inequities continue to persist, with large disparities existing between groups in health risks and outcomes. With increasing incidence of acute rheumatic fever and serious skin infections leading to hospitalisation in NZ children, early detection and treatment are crucial. Maori and Pacific children, and those with lower socioeconomic status are at increased risk. Facilitating access to health services is crucial as this is core to improving health outcomes.

USE OF TECHNOLOGY AND/OR INFORMATION

iMOKO uses store-and-forward telemedicine to bring health services to high-needs populations, and is delivered through connecting community members and clinicians. Teaching/administration staff or parent/community volunteers run health checks for children in sites such as schools, and enter health information of children into an application on a tablet. Information is remotely assessed by a telemedicine team to create a management plan which is approved by a clinician. Medications can be prescribed and sent directly to parents/caregivers. iMOKO currently addresses skin/strep throat infections, head-lice infestations, and dental problems, and is a demonstration model of how virtual solutions can facilitate access to healthcare.

IMPLEMENTATION/PROCESSES

iMOKO is implemented in 110 sites across NZ, serving 6500 children. Unique to this programme is involvement of non-clinicians in telemedicine. To assess acceptability, research was conducted on perceptions of a school-based telemedicine model of care, involving interviews with staff who deliver iMOKO. This was framed by the Social Actor Model which views users of IT as actors in a system, through four constructs: identities, affiliations, interactions, and environments. Delivering telemedicine extended identities of staff as carers. Affiliations were core to iMOKO's success, and existing relationships with children enabled the programme. It facilitated interactions, which reflected feelings of empowerment. Aspects of environments highlighted challenges, including those to daily processes of schools, but use of environments contributed to sense of connection. Telemedicine is acceptable, empowering, and beneficial to supporting health knowledge and social cohesion.

CONCLUSION

iMOKO brings existing health services closer to the community and this research confirms this is an effective and appropriate model of care. iMOKO's implementation has brought about role redefinition for staff, with positive perceptions and several challenges, such as increased responsibility for children. This example of telemedicine resulted in potential benefits of children's increased health awareness and early access to treatment. It is evident that this model of care displays potential for involvement of community members in healthcare delivery, enhanced connections, and for telemedicine to have a significant positive impact on high-risk communities.

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Impact of locally customised "blood thinner" alerts in MedChart™

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INTRODUCTION

Blood thinners (anticoagulant and antiplatelet medicines) are the leading cause of severe adverse drug reactions. For a given patient, combining blood thinners increases bleeding risk. For example, the Health Quality and Safety Commission (HQSC) recently highlighted a combination (enoxaparin and dabigatran) to avoid. MedChart™, an electronic prescribing and administration system with locally configurable clinical decision support (CDS), has been rolled out to ~1300/1400 inpatient beds in the Canterbury District Health Board (CDHB). To reduce bleeding risk, the CDHB Clinical Decision Support Working Group (CDSWG) constructed five distinct CDS alerts that trigger when prescribing combinations of 23 unique blood thinners. CDS should have high specificity to minimise alert fatigue. Data from MedChart™ would help determine the specificity of these alerts, but there is no such reporting layer.

USE OF TECHNOLOGY AND/OR INFORMATION

CDHB MedChart™ alert data were extracted and parsed from a daily backup of the local MedChart database with data cleaning and analytics via R and Tableau. The CDSWG specified requirements for the data.

IMPLEMENTATION/PROCESSES

MedChart™ alert data were extracted for 1 August to 31 December 2016 and filtered for the five blood thinner alerts. A subset of data ('validation dataset') was subjected to detailed manual review to check for 'technical appropriateness' (triggered as configured), and 'clinical appropriateness' (useful to the prescriber).We found 1011 alerts, with 5% (52/1011) leading to the immediate cancellation of the blood thinner prescription triggering the alert. The 'validation dataset' comprised 280 alerts. All were 'technically appropriate', and 81% (228/280) were 'clinically appropriate'. The triggering prescription was immediately cancelled in 6% (17/280), and another 22% (62/280) were changed within 30 minutes of the alert firing. The combination of enoxaparin and dabigatran was associated with 34 alerts, of which 88% (30/34) were 'clinically appropriate' and 74% (25/34) were associated with a change in blood thinner prescription within 30 minutes of the alert firing.

CONCLUSION

Targeted CDS can reduce high risk prescribing. However, even carefully constructed alerts targeting the highest risk prescribing has specificity considerably below 100%. It is important to assess temporally proximal changes to prescriptions following an alert, and not just focus on the decision at the point of the alert. These data will inform further development of CDS alerts.

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Implementing a World-Leading Medications Management Service at Canterbury District Health Board

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INTRODUCTION

Having patients actively engaged in their healthcare at home is a key priority for Canterbury District Health Board (CDHB), due to the rise of chronic diseases and escalating health costs. The least effective (and most expensive) medication is the one the patient is prescribed, but not taking. CDHB needed a solution that helped provide people most at risk of medicine-related harm with intensive pharmacist care to help them better understand and self-manage their medicines. The solution also needed to enable pharmacist and GP collaboration, in order to optimise the patient's medications in line with their goals of care. Key objectives were driving improved medication outcomes, health literacy and, consequently, patient wellness.

USE OF TECHNOLOGY AND/OR INFORMATION

Two solutions to support medicines workflow were created to combat this issue—Medicines Use Reviews (MUR) and Medicines Therapy Assessments (MTA). The program works by creating a series of tasks for the pharmacist that can be viewed in a task list in the patient's record. The pharmacist reviews the medications with the patient and assesses the patient's adherence to, knowledge of and effectiveness of the prescribed medications. Recommendations are communicated to the patient, their family and their carers to improve medication outcomes. As the pharmacist gathers information and enters it in the system, it populates a single master dataset. Data recorded in the Circle of Care, Medications List and Problem List all contribute to the solution and pre-populate documents throughout the process.

IMPLEMENTATION/PROCESSES

Pharmacists required the quick deployment of a solution that facilitated the enrolment and completion of a comprehensive medicines-focused review for patients. The solution needed to include an automated task generation that guided the user through a workflow to capture information, document recommendations and report back to the patient's general practice team. The solution was implemented with a very tight timeframe and the project went live just five months after initiation, with over 55 community pharmacies participating within the first two months of implementation, rising to 80 the following month.

CONCLUSION

There has been an average of 100 reviews performed per month since initiation. The solution will continue to be refined and new functionality added over time, including customised sorting of medication lists, patient medication schedule printing solution, clinical decision support and an automated referral process from GPs.

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Implementing an electronic Prescribing and Administration (ePA) solution in a non-early adopter site – to reinvent the wheel or not?

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1.	Auckland District Health Board

INTRODUCTION

The District Health Board (DHB) has recently started implementing ePA into its hospitals. As a non-early adopter site we were able to take on board the lessons learnt from early adopters and leverage these learnings to ensure effort was focused on what was unique to the DHB rather than what is common to all DHBs.

USE OF TECHNOLOGY AND/OR INFORMATION

The DHB implemented the same ePA system used at the early adopter DHBs. This made re-use of their project documentation and application of the lessons learnt highly appropriate. The following documentation from the early adopter DHBs was reviewed:

*	Build configurations
*	Integration Documentation
*	Clinical Decision Support (CDS)
*	Training documentation
*	User Acceptance Testing (UAT)
*	Technical Documentation

This also enabled the project team to identify the areas that were unique to the DHB that required intensive focus.

IMPLEMENTATION/PROCESSES

The project team evaluated this documentation along with clinical stakeholders to determine what was fit for purpose and what required adaption. During this process the team were continually challenged to consider the benefits of adaption to ensure that this added value and/or reduced risk to the DHB and its patients.

Technical setup and training approach could largely be re-used with only very minor adaption, whereas the project identified a number of DHB specific clinical workflows and processes that meant that other streams such as CDS, UAT and Training Material required significant adaption.

The DHB paid particular attention to the integration elements of the project and made the decision to include a number of additional integration points to add further value and to ensure completeness of the patient record, specifically:

*	Importing laboratory results for CDS
*	Exporting dispensing requests to pharmacy dispensing software electronically
*	Exporting medication orders to discharge summaries
*	Exporting prescribing and administration history to the DHB electronic clinical record

The decision to add this additional integration, added complexity, cost and time to the project but the benefits were significant and substantially aided the clinical acceptance of the ePA solution.

CONCLUSION

Other DHBs looking to implement an ePA solution, and intending to use the shared work of those that have implemented previously can learn from our experience.

The lessons learnt from other DHBs are invaluable and must be considered and there is significant work already done that can be leveraged. It is important to understand what is unique to your DHB so that effort can be focused on delivery of unique requirements rather than reinventing what has already been done elsewhere.

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Improving algorithms and improving readmission rates

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INTRODUCTION

Hospitals have limited staff devoted to readmission prevention programs, meaning the readmission prevention team can't possibly work individually with each patient. This leaves the readmission prevention team with the dilemma of which patients to prioritise. Through data gathered within the electronic medical record (EMR), an algorithm was developed to identify and rank patients at risk for readmission. Northern Arizona hospital wanted to decrease its readmission rate. To do this, it focused on properly educating and following up with the patients most likely to readmit. To achieve optimal readmission risk, Northern Arizona chose to implement a readmission prevention solution.

USE OF TECHNOLOGY AND/OR INFORMATION

The readmission prevention solution includes a readmissions algorithm, which looks at 40 unique clinical indicators found within the EMR. The system looks at information from previous visits as well as the current visit. These unique indicators include demographics, comorbid condition, past health care utilisation, as well as other indicators. The algorithm then weights each indicator based on its correlation with hospital readmission. The algorithm calculates an all-cause readmission score and stratifies the patient's risk into high, moderate, or low. In addition, the solution also identifies patients by the Society of Hospital Medicine's Project BOOST P method. Patients who qualify by either algorithm or BOOST are added to a real-time dashboard. Unique interventions are suggested for patients who qualify. The algorithm is continually improved and updates are pushed out to hospitals via cloud technology. This means, as new research and data are found related to readmissions, improvements to the algorithm can be taken quickly and seamlessly, instead of costly manual updates.

IMPLEMENTATION/PROCESSES

Data points were mapped from the local EMR to the cloud and then tested. However, the algorithm was not the only piece. A key part of implementation was ensuring adoption and compliance of the tools. It was not enough to just build the algorithm – the team had to be invested in its success. Adoption varied from clinician to clinician, but with the help of reports, the team could hone in on which clinicians needed the most support during implementation.

CONCLUSION

Readmissions was rolled out during 2014. A post-implementation analysis found a 49% reduction in congestive heart failure readmissions. The adoption of the readmission prevention solution, coupled with process improvement policies, enabled Northern Arizona to identify and educate its readmissions population. Because of this, they have seen a significant reduction in readmissions.

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Improving sepsis outcomes through algorithms

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INTRODUCTION

Thousands of people are diagnosed with sepsis annually in Australia and New Zealand. Identifying sepsis can be difficult and is not always front-of-mind for clinicians. Early intervention is critical to successful treatment. Faced with increasing length of stay (LOS) and erratic mortality rates attributed to sepsis, New York Methodist (NYM) sought an automated system to detect sepsis early, without the use of time-intensive methodologies. NYM chose a sepsis screening algorithm that continually monitors patients' vital signs and pathology results. The algorithm alerts at first sign of sepsis ensuring treatment may commence expeditiously. Through implementing an automated sepsis screening algorithm, NYM hoped to more accurately identity septic patients and decrease both sepsis mortality and LOS.

USE OF TECHNOLOGY AND/OR INFORMATION

The algorithm continuously monitors all patients' vital signs and pathology results captured discretely in the EMR, seeking signs of deterioration. If SIRS and/or sepsis criteria are met, the algorithm sends an alert via the EMR. Triggering criteria are presented to the clinician, within the alert. Depending on qualifying criteria one of two alerts will generate: SIRS alert - patient meets 3 SIRS criteria; Sepsis alert - patient meets 2 SIRS criteria plus one organ dysfunction criterion.

IMPLEMENTATION/PROCESSES

Implementation began with mapping all required data points. Concurrent with mapping, design sessions were held with NYM subject matter experts to discuss reference ranges for the algorithm – ranges were then configured to address NYM's unique patient population. Additional implementation steps included alert language, workflow updates to accommodate alert escalation process, and clinical staff education. Furthermore, reporting was created to track prevalence alerts and diagnosis of sepsis. Reporting provided visibility to true positives; false positives, true negatives, false negatives, and added capability to further investigate patient-specific details. With this report, NYM could make post-conversion algorithm adjustments to improve sensitivity and specificity.

CONCLUSION

Baseline data was collected February 2012 – July 2013. Pre-implementation rates; mortality – 30%, LOS – 18.79 days. NYM turned on its' sepsis algorithm August 2013. Post-implementation analysis conducted October 2016 revealed; mortality – 23%, LOS – 14.11 days. This translates to 23% overall reduction in sepsis-related mortality and 25% reduction in sepsis-related LOS post conversion. This was achieved by alerting clinicians of potentially septic patients based on information already available within patient charts, most industry tools do not work in this fashion. Adoption of the algorithm within NYM workflow enabled clinicians to identify septic patients early and accurately, ultimately improving overall sepsis-related mortality and LOS.

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Increasing speed-to-value through an agile approach – how sector partners collaborated to deliver an integrated data set proof-of-concept within 4 months

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INTRODUCTION

Partners Canterbury DHB, Waitemata DHB, Green Cross Health and Orion Health accepted a challenge from the Ministry of Health (MOH) to collaborate and self-fund an innovation project to leverage existing information, capability, and expertise within the sector. Partners worked in a non-traditional way to create an integrated dataset from disparate primary and secondary care sources in a single data platform. The project tested a new approach for collaboration, adopting relevant industry standards, incorporating open APIs, and hosting the solution in the cloud; enabling analysis to surface the value propositions for the combined dataset. Lessons learned are being documented, creating a blueprint for future research projects planned to be delivered via the Precision Driven Health (PDH) research partnership.

USE OF TECHNOLOGY AND/OR INFORMATION

Demographic, encounter, and medication information were identified as valuable for an integrated data set, these were mapped and contributed by the partner organisations into an Amadeus data platform provided by Orion Health and hosted in AWS Sydney. Teams worked closely to navigate the data privacy requirements, enabling the data set to be aggregated and shared with the contributing organisations for analytics purposes (by limited named users). DHB partners then conducted deep-dive analytics, investigating patients' combined medications data (from Primary and Secondary care) with likelihood of inpatient visits, length of stay, re-admission etc. In future there is potential for supporting clinical care, for example reducing drug-drug interactions; providing proactive, medicine-specific interventions; and tackling medicines non-adherence.

IMPLEMENTATION/PROCESSES

The partner organisations streamlined the planning phase, and project teams were split into sponsor and technical workstreams, enabling close collaboration and reducing time spent awaiting decision-making. An agile approach with regular communication helped create a sense of urgency around delivery, enabling the ambitious timelines to be met in the most part. The project adopted industry standards and demonstrated alignment with the NZHIT Interoperability charter, enabling future access by other organisations through APIs, maximising value and avoiding vendor 'lock in'.

CONCLUSION

This innovation project demonstrated the ability to extend the inherent value in existing data sets, achieved through sector collaboration and a new way of working. It signals the potential for improved DHB and primary care planning through access to a richer data set, and identifying interventions to improve patient outcomes. It is closely aligned to the MOH's Future Direction targets of "Smart Systems"; through the availability of accurate, reliable online information at the point of care and of "One Team"; by operating as a team in a high-trust system.

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Integration of an e-wound measurement tool into routine clinical workflow

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INTRODUCTION

In the pre-digital era, wound (ulcer) size was measured manually, using tools such as a ruler. Measurements were slow, cumbersome and inaccurate. Several integrated technologies now combine digital wound imaging with accurate measuring techniques. We describe our local approach to integrating this new technology, into routine clinical care and e-HR (electronic health records).

USE OF TECHNOLOGY AND/OR INFORMATION

A wound measuring data capture and analysis system, SilhouetteTM, was introduced into a secondary care high-risk diabetes foot clinic. The system integrates a camera, laser measuring beams and software for individual patient's data capture, with aggregated data from multiple cameras and patients. The DHB server system hosts the aggregated centralised database. Data is then fed into the e-HR, allowing secure sharing of wound care information among clinicians. The system also facilitates electronic, rather than paper based, clinical audit: Using NHI data linkage, centralised SilhouetteTM information was linked with clinic attendance records. Data was then cleaned and analysed.

IMPLEMENTATION/PROCESSES

The following beta testing/design thinking approaches were used during integration: i) An image/graphics/cartoon based questionnaire was developed to explore clinician UI (user interface) preferences using an appreciative enquiry approach, ii) a team of IT and clinical experts was assembled to design clinician-friendly data displays, within the existing e-HR, iii) Up to five cameras were available for multi-clinician use; clinical audit explored clinician differences in use of the technology and iv) optimal clinical use of wound metrics was explored statistically.

CONCLUSION

Outcomes: The Table shows the quarterly number of images captured by 1.6 FTE diabetes podiatrists:

Quarter	Q3-2015	Q4-2015	Q1-2016	Q2-2016	Q3-2016	Q4-2016	Q1-2017
Images	691	579	399	564	542	623	604

During routine workflow, >85% of wounds were imaged, demonstrating high clinical acceptability of this technology. The visual wound image display, combined with the objective nature of wound trajectory graphics, facilitates case management discussions among clinicians and also aids discussions with patients around optimal self-care behaviours. Lessons learnt: i) Patients develop multiple wounds over time (e-HRs showed one patient with 12 separate lower limb wounds). This requires a sophisticated wound labelling system capable of documenting multiple discrete wounds. ii) There were between-clinician differences in imaging of lesions on unbroken skin. Processes have now been standardised. Next steps: The impact of this technology on patient satisfaction and self-care behaviour appeared to be positive but this requires formal assessment. The development of a sophisticated wound labelling system would be useful. The plan is to roll this technology out to other departments.

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Interrogating InterRAI (LTCF) data to see how well we meet the spiritual needs of residents in residential aged care

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1.   The Selwyn Institute for Ageing and Spirituality

INTRODUCTION

Spirituality is a core dimension of wellbeing. There are a multitude of ways that residential aged care (RAC) organises and provides for spiritual care. This includes pastoral care provided by chaplains, access to nature and sunshine, availability of sacred spaces, etc. Up to now we did not have a reliable tool to measure how well we meet the spiritual needs of our residents at an organisational level nor could we compare ourselves with other providers in the sector.

USE OF TECHNOLOGY AND/OR INFORMATION

The InterRAI Long Term Care Facility (LTCF) is an internationally developed and standardised assessment tool used to inform research, best practice and improve outcomes for our elderly population. InterRAI (LTCF) has both qualitative and quantitative components. It is used at an individual assessment level, as well as for management purposes at facility and organisation level. This tool mostly used by registered nurses was made mandatory as primary assessment tool nationally by the Ministry of Health in 2015.

IMPLEMENTATION/PROCESSES

Recent access to the InterRAI Data Warehouse has allowed us to do an analysis of resident's preference to have spiritual activity and if they are involved in such activity. The quantitative data retrieved, shows that over a 17-month period (1,712 interRAI assessments) 12% of our long term residents would prefer to have spiritual activity, but are not involved in it. This showed slightly favourably with the national data of 14%. With this exercise we realised the powerful opportunity of interrogating InterRAI data to better the lives of the people in our care and would like to share this with our colleagues nurses.

CONCLUSION

While InterRAI (LTCF) has limited spirituality coding, it provide a useful component by documenting spiritual activity and involvement, at both a quantitative and qualitative level. By exploring spiritual activity data, we may be able to determine where more care is needed on an individual resident level, further in-depth assessment should be applied in these cases. Organisationally, the data could be used to provide support, and information on where to target education on spirituality for our nurses and care staff.

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iTui App- a valuable tool improving paediatric assessments

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INTRODUCTION

The clinicians understanding of a child's perspective remains an important and difficult area in Paediatrics. This is particularly important in the area of abuse, adolescence and mental health. These issues are seen in Paediatric Gateway (child abuse) assessments frequently. Existing questionnaire tools are not satisfactory with difficulty in administration and limited usefulness for clinicians. The iTui App for iOS is a novel, innovative App designed to improve patient rapport, interaction and clinician understanding of a child and their perspective.

USE OF TECHNOLOGY AND/OR INFORMATION

The iTui App is a drawing App that allows the clinician and child to explore ideas of interest and relevance without reliance on the usual eye- to eye interrogation method of communication. The App is a valuable 'ice breaker' that allows the child to lead the interaction at times in a play based manner. The App allows collaborative drawing and moving of objects to shape the interaction towards areas of interest and relevance. The App has also been a useful distraction device which is particularly useful for those children with poor impulse control and 'busy hands' in clinics.

IMPLEMENTATION/PROCESSES

The App was made with the help of Health Innovation, Unitech, IBM, AUT and the WDHB Innovation team. The App design was led by Dr Maneesh Deva. Thus far, things have gone very well and we have been using the App for several months with great feedback from clinicians, children and families. We are currently completing our validation trial on this.

CONCLUSION

The App is a valuable tool which is being used in Paediatric Gateway assessments in Waitemata DHB. We are currently validating the use of the App with research and will aim to disseminate to the other DHBs in New Zealand- of which there has been great enthusiasm. There has also been interest from other health professionals working in the area of disability who also face similar challenges. Despite the fundamental problem of how we interact with some of our patients being well appreciated, there are few existing useful tools in this area.

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Life at the coal face, the reality of data mining within a DHB

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1.   MidCentral DHB

INTRODUCTION

Like so many District Health Board's our DHB recognized that their current state for analytics was neither sustainable or effective. The decision was made for a small investment in data science and hence improved data analytics. The hope was the classic dream that many organizations have for data science projects. "Big data" would be used to generate new insights into old problems leading to new solutions.

USE OF TECHNOLOGY AND/OR INFORMATION

The data science solution adopted was the "R", a computer language that has developed into what some call the lingua franca for statistical computing. A partnership with Massey University provided the initial training, and ongoing support. The number of projects has been steadily growing, with positive results.

IMPLEMENTATION/PROCESSES

Statistical process techniques were the basis of the development of a decision support tool for interpretation of renal function tests. This advice is presented to providers at the time of care and is individualized in time and space to the consumer. The widespread deployment of this application has lead to a statistically significant increase in testing the investigation of at risk consumers. Text mining and sentiment analysis has been used on multiple occasions. Its potential is just being understood but the benefit is already obvious. The use of text mining in locality surveys is challenging the existing mythology around community priorities and attitudes. The results match other fora but do not match provider priorities and beliefs. To better understand Diabetes management with the district, large data set analysis techniques have been used to study conjoined district data sets. This study showed that predominantly Diabetes was managed in the community. With the exception of renal health, there was no evidence of any health inequities across the cohort of consumers who sought help from primary care for their diabetes.

CONCLUSION

As our confidence and ability has grown with the positive results, our awareness of the limitations of data science has also grown. Access to data remains a significant issue, with data quality, quantity and patch protection leading to data silos all being problems. Data science is the iterative collaborative study of data and usually for a client. Without participation from the clinical teams or support from management or governance, only finite gains will occur. One option to address these issues is develop data champions and even data leadership across the DHB.

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Losing the Pagers: An overdue change

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1.   Capital and Coast Health

INTRODUCTION

Pagers have been used for generations to contact staff in hospitals. From July 1st 2017 they would no longer be available from Spark but could be purchased through the Fire Service. Our clinicians had previously said that technology for interpersonal communication was a major issue/deficiency within our organisation. We decided that enough was enough and we would not continue with the pagers after July 1st.

USE OF TECHNOLOGY AND/OR INFORMATION

Mobile phones were the proposed solution with standard text messaging the short term technology. We needed: Analysis of all pagers and volumes, mobile device management platform,   a phone or phones, a method for other staff to send text messages, business changes, contact directory changes, organisation policy changes, systems for mobile application assessment and approval, and a communication strategy. The emergency call system (eg cardiac arrest) needed an application solution that was suitable for telephonists, had redundancy and was obvious to users. AtHoc was chosen and is a cloud based service with a phone app using cellular and wireless. The added value was users can acknowledge attendance from the app, the call centre can monitor receipt and acknowledgement, and can phone late responders directly.

IMPLEMENTATION/PROCESSES

660 pagers received 26500 pages per month. 200 pagers did not need to be replaced. A "basic" Nokia model and iPhone 5SE were chosen. Apple Airwatch provided the mobile device management. A minimal profile was made removing the camera function. A basic app list and an organisation phone contact directory were created. Multi chargers, portable batteries, cables, cases, were purchased. All plans had unlimited calls and texts. All phones were configured to access the staff wireless network. Staggered role out over two weeks in June as house officers and registrars changed roles. The existing intranet contact directory was cleaned up, position descriptions standardised, and "team" names included in titles. AtHoc was implemented, users trained with a one week overlap of phones and emergency pagers.

Issues

Nokia phones were not well received. It was an enormous effort tracking down all the users. Profile settings were necessarily restrictive. The change communication "culture" took weeks to settle in. Lost phones and resetting phones new work for the Help desk.

Benefits

Immediate benefit of all doctors being accessible and having mobile communication. Financial benefit from not paying for unused pagers. Mobile phone based contact directory very well received. Limited range of apps but very useful.

CONCLUSION

This project releases all the expected benefits of mobility but is a large in size, complex and labour intensive. It confirms that communication is an important part of our normal business.

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Making Adverse Drug Reactions Visible

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2. Canterbury DHB

INTRODUCTION

Adverse drug reactions (ADRs) cause morbidity and mortality for patients and add unnecessary costs to the health system. Between 5 and 10% of hospital admissions and emergency department visits are attributable to ADRs. Every patient admitted to hospital in New Zealand has diagnostic information coded using an international coding system, the "International Statistical Classification of Diseases and Related Health Problems" (ICD-10). ADRs are coded in this process, but this information is not generally available to inform clinical care. This project was to make the information about ADRs recorded in hospital coding data accessible and useful to clinical care.

USE OF TECHNOLOGY AND/OR INFORMATION

Hospital coding data are housed in the Canterbury District Health board (CDHB) data warehouse in a structured accessible form. Data visualisation software (Tableau™) was used to create "dashboards" to display the ICD=10 codes with user selectable filters, including hierarchical drug classes and adverse reaction types. A multidisciplinary working group with clinical governance oversight was the key technology. The primary user of the dashboard is the CDHB medication safety group and it is configured to support use by individual services and wards as well as by the whole institution. The dashboard will be used to identify and monitor trends in ADRs and the efficacy of interventions to reduce ADRs.

IMPLEMENTATION/PROCESSES

A multi-disciplinary working group made up of clinicians (a medical specialist, a pharmacist and a junior doctor), informaticians (data warehouse manager and information analyst) and administrative staff (senior coder) was convened by the CDHB Medicines Safety Group. The relevant coding data were identified and extracted to form a reporting data set. Stakeholder user requirements were established. A dashboard was developed to visualise the ADR coding data.

CONCLUSION

A multidisciplinary team of clinicians and informaticians enables efficient utilisation of clinical data. Further work on common taxonomies, definitions and denominators is necessary for meaningful quantification of clinical data, for example by mapping ICD10-codes to taxonomies used in clinical guidelines. Data visualisation requirements defined by an existing clinical governance groups enabled implementation. The dashboard will be shared with other Australasian hospital services at the Health Round Table – Medication Safety meeting (June 2017). National implementation via the Health Quality and Safety Commission (HQSC) Atlas of Healthcare Variation is planned.

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Making connections with data and staff in a busy renal day unit

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1. Northland DHB

INTRODUCTION

A frustrated renal consultant who felt the staff in the unit were not getting the recognition and extra staff they required as there was no data to support them. The unit had become more complex and busier and there was nothing in place to show the difficult and time consuming patients. As a new trendcare coordinator he gave me the challenge of introducing trendcare to the unit and showing the impact that good data can have.

USE OF TECHNOLOGY AND/OR INFORMATION

Trendcare was introduced and set up in the renal unit - it was set up as four units Renal, Renal home haemodialysis, Renal hub and Renal PD

IMPLEMENTATION/PROCESSES

-plant the seed - with the assistance of the ACNM who was keen and eager to introduce trendcare to the unit -introduce the tool by showing the trendcare tool, how it would show their acuity and how they could roster accordingly - set renal up with the assistance of ACNM as different units As that would work best for them-a great deal of education prior, during and after implementation- support and presence on a daily basis initially -build up relationships-

CONCLUSION

- the importance of maintaining sense of humour - never under estimate the power of good working relationships - never under estimate time for education and support - keeping everyone informed of progress and changes - people learn at different paces -often the most negativity people initially can become the most positive - realising how quick you can learn a system that you have to teach yourself! As a result of introducing trendcare to this unit - staff feel valued, they can now articulate with data how busy they are and they can actually put a value/time when they are talking to patients on the phone/leasing with other units or setting up equipment or appointments

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Mobile teledermoscopy to help with the early detection and management of skin cancer

Hayden LAIRD[1]

1.   Firstcheck Skin

INTRODUCTION

New Zealand is in the middle of a skin cancer epidemic which costs the country lives and hundreds of millions a year in treatment costs. 2 in 3 develop skin cancer by the age of 70. The fight against skin cancer requires both prevention and early detection. Much has been done to improve education around the prevention of skin cancer. More can be done to help achieve the early detection of skin cancer. Numerous studies and leading dermatologists are promoting mobile teledermoscopy for being a technology that is "here and now" and able to enhance the self skin examination process and to facilitate timely skin checks. Previously, a barrier to mobile teledermoscopy was the cost of the software and hardware. Technology has advanced to remove those barriers with free smartphone software and $30 smartphone dermatoscopes.

USE OF TECHNOLOGY AND/OR INFORMATION

Mobile teledermoscopy facilitates affordable and convenient "spot checks", thereby improving access to clinical opinions. Mobile teledermoscopy is able to break down many of the real and perceived barriers that mean that clinical opinions are either not sought, or delayed in being sought. Store-and forward teledermatology enables patients to consult a doctor virtually anytime, anywhere. Studies show that up to 70% of melanomas are first noticed by the patient or their partner - and that simple education can improve the effectiveness of a self skin examination further. SSE plays a pivotal role in the early detection of skin cancer as a tool which prompts the seeking of a clinical opinion on suspicious lesions. Mobile teledermoscopy is itself a tool that supports and enhances SSE and further empowers patients to take a pro-active role detecting skin cancer early.

IMPLEMENTATION/PROCESSES

Firstcheck Skin's mission is to make mobile teledermoscopy affordable and accessible to all. The software has been made free to download from app stores and reporting doctors have free access to a web portal. Firstcheck is making the hardware affordable with $30 smartphone dermatoscopes. Reporting doctors set their consultation price. Firstcheck has dermatologists and skin cancer doctors around New Zealand available for virtual consults.

CONCLUSION

Firstcheck Skin has been credited for saving lives and is achieving its goal of achieving the early detection of skin cancer with popular uptake. Cases suspicious of melanoma can now be prioritised with doctors having foresight of presenting conditions. Firstcheck Skin is contributing to education around the importance of self skin examinations, full body skin checks, and the benefits of dermoscopy.www.firstcheckskin.com

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Nationwide Interoperability: Israel network integrates clinical data for 8 million patients

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1.   Allscripts

INTRODUCTION

Clalit Health Services is one of the world's largest health service organizations, serving more than 4 million patients and accounting for more than one-third of all acute-care beds in Israel. In 1999, Clalit executives began thinking about how best to share clinical information among widely dispersed hospitals and clinics. Several challenges emerged, including the realization that dozens of disparate electronic health record (EHR) systems and health information systems deployed throughout the organization didn't provide a full patient picture and couldn't communicate with each other. The desire to aggregate patient information from disparate sources, do it quickly and present it in a way that made sense to caregivers gave rise to what is now called the Ofek Network, powered by the Allscripts dbMotion™ Solution, across Clalit Health Services. With New Zealand considering a similar initiative, the Ofek Network serves as an excellent example of success.

USE OF TECHNOLOGY AND/OR INFORMATION

Engaging clinicians, the organization's committees developed a list of prerequisites for a new system, including: Minimal data set - all basic information viewed on one user-friendly screen Ability to drill down into data for rapid diagnosis using detailed information. Decentralized data structure Strict security and privacy - adheres to Israeli privacy laws and meets international standards of security compliance. Performance - a 10-second maximum time to collect and display relevant data Scalability, flexibility and robustness The dbMotion interoperability solution is web-based; a query returns a single record based on virtual patient objects aggregated from disparate systems. There is no single point of failure, so if information fails to flow through the system, the user is informed at the time results are presented.

IMPLEMENTATION/PROCESSES

Initial implementation occurred within 12 months, with no disruption to workflow and minimal training because of its familiar, Windows-based functionality. Over a 4-year period, the rest of Clalit Health Services facilities were brought online, with non-Clalit facilities joining the network in the years to follow.

CONCLUSION

At the end of 2011, the Ministry of Health signed a contract to implement the Ofek Network in all other HMOs and general hospitals across Israel. In addition to Clalit Health Services' 14 hospitals, today there are 24 more hospitals, three more HMOs, and the Israel Defense Forces (IDF) connecting to the Ofek Network and servicing Israel's eight million residents. "We're very proud of being the first and only country to implement such a solution in a national way," Clalit Health Services Chief Technology Officer Ludovic Abraham said.

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New Zealand health data review

Quentin-Gabriel THURIER[1]

1.   Orion Health

INTRODUCTION

New Zealand has excellent health data due to national ID number and high quality health providers, and a high standard of data scientists. We seek to link them together by making health data easier to access for research. We have reviewed publicly available (sometimes after approval) health datasets in New Zealand, produced a website to collate links to this data, and analysed relationships between datasets.

USE OF TECHNOLOGY AND/OR INFORMATION

We have produced a publicly accessible web version of the data review. To do so we have been using various web technologies like Jekyll (a static site generator) and several JavaScript libraries (Tipue Search, List.js and Multiple Select) as well as the graph database Neo4j and Github Pages (the Github static site hosting service).

IMPLEMENTATION/PROCESSES

We focused on data which is already publicly available. Our research has tagged over 330 datasets, with the majority coming from: Ministry of Health (#105), District Health Boards (#80), and Figure.nz (#45). We have produced two public web pages: datasources.precisiondrivenhealth.com which allows visitors to find, filter and order the datasets based on their providers or topics and also to search within the datasets descriptions; datanetwork. precisiondrivenhealth.com which offers a graph view of the health datasets ecosystem and a programmatic querying feature on the datasets attributes (click on top left corner, choose a node type then double click on the nodes to start to explore the network)

CONCLUSION

We believe our website to be the most comprehensive view of publicly available health data in New Zealand and have combined this with useful tools for exploration. While administrative authorities websites already provide a good overview of the health data collected by the New Zealand administration the data stored in separate District Health Boards and primary health care organizations information systems is the most difficult to identify and capture. We plan to grow and maintain this resource for our health and data science communities. So far we have been focusing on setting up a data reviewing collaborative system and to make it publicly available. The webpages per se don't disclose any private information since we only give references to the datasets owners or links to already published resources.

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Northland's Te Hono project

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INTRODUCTION

Getting access to various education sessions can be a challenge for rural GPs. Equally answering case based questions can be repetitive for urban specialists if each GP is asking the same question and the response isn't disseminated amongst their team (often due to isolation). Te Hono aims to provide a f2f platform for shared case presentations and shared learning from specialists for rural GPs.

USE OF TECHNOLOGY AND/OR INFORMATION

A virtual "classroom" has been established where GPs present their cases and questions to the specialist in a shared environment. This enables all present to learn from each case discussed.

IMPLEMENTATION/PROCESSES

Various "early adopter" specialists and GPs were identified to participate in sessions during business hours where real clinical cases were presented and discussed in a shared learning environment.

CONCLUSION

Anecdotally this forum has been well attended and has had positive benefit. We will discuss thoughts, attitudes and feelings of the GPs and specialists around the use of Te Hono, as well as their suggestions for future development. We will present the successful data around Hepatitis C management in primary care and discuss how this sort of project can be used to improved primary care management of specific diseases.

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Online multi-speaker e-learning summits assist people to transform childhood trauma, stress and illness

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1.   The Art of Health

INTRODUCTION

In 2009 it was recognized that technology and the internet were changing the face of communication and learning. The opportunity to reach more people via telehealth was turning from a possibility to a reality. The provider decided to invest time and money researching ways to deliver health education in an online 'one-to-many' format. In 2011 the first online multi-speaker health summit (10 speakers) was created and another in 2012 (30 speakers). A break was taken in summit creation to develop an online e-learning portal, and more summits are now in development.

USE OF TECHNOLOGY AND/OR INFORMATION

A suitable technology for delivering live online teleseminars was researched and chosen for ease of use by both the summit developer and participants. Participant registration and payment gateway software was also chosen. Potential speakers were invited to speak, topics chosen, a website created and participants invited via email and social media.

IMPLEMENTATION/PROCESSES

Each summit took 3 months to prepare. Gauging from feedback, the summits were well received, many people writing in with positive feedback. For example one participant wrote "Thank you so much for putting together this series. I was diagnosed with CFS and struggled to find anything to help me recover. This information was the key to my return to health and a life worth living. Thank you". For the summit developer it was a huge learning curve and quite stressful, with many unexpected obstacles. One of the main problems was lack of admin or technical help due to not having the funds to pay for expert assistance, which resulted in a 'trial and error' approach which although mostly worked was stressful. Secondly, in 2011 teleseminar software was still quite new with its limitations (for example, MP4 videos of the live event were not downloadable for play later) and in 2012 the registration software chosen proved ineffective for the job, resulting in hours of unnecessary work. After this research continued for improved software which was sourced in 2016. The summits only broke even financially which was disappointing given the enormous number of hours given to create the events, but much was gained in experience.

CONCLUSION

The good news is technology has improved with more efficient software applications for delivery and registration available. More life transforming summits are in development and a virtual assistant (VA) has been sourced to help manage technology and workflow. The possibility of reaching more people more efficiently to share life-changing health and wellbeing information is exciting.

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Open EMRs – what is the alternative to the single vendor EMR?

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1.   Calvary Care

INTRODUCTION

At its core the medical record is a documentation system where clinicians record care and communicate assessments, findings, conclusions and plans to other carers. It can also include orders and results, prescriptions and drug administration records. The single vendor electronic Medical Record (EMR) is popular for digital hospitals, but have limitations and may not always suit multi-organisational health and care systems.

USE OF TECHNOLOGY AND/OR INFORMATION

The cost to license and implement is high, as are support and maintenance costs, and there is slow private sector uptake of these systems, particularly in Australia, where the business case for them is less clear. The systems tend to be built on technology that lacks flexibility. Because the systems are bought and built primarily for hospitals, their scope restricts attempts to integrate care around the person throughout their care journey, meaning that integrated care models that reduce the overall burden of healthcare to the population are difficult to implement.

IMPLEMENTATION/PROCESSES

Technologies that have disrupted banking, transport and shopping have the potential to integrate care, enable innovation and even avoid the need for EMRs altogether. The advent of 'data lakes' and cloud computing, enabling access to data via open APIs, has facilitated the explosion of innovative mobile applications, and are equally applicable to the healthcare context. Data are supplied by systems that run different areas of the health business (these could be EMRs but don't need to be) and supplemented by data provided by use of apps. Algorithms can work across the enterprise, and beyond, to support decisions and drive workflow through notification tools, independent of the organisational constructs or systems behind them. A solid understanding of clinical data semantics is still essential, so processing of data is still required to convert data and terminology to a common form, however the judicious selection of source systems reduces the risk of complexity, avoids competing data models and terminologies, and ensures that APIs are accessible. This is the future of the Open EMR.

CONCLUSION

Several large healthcare providers are looking at data lakes with Open APIs to drive value and flexibility into their business, and enable more patient-centred care. Some have EMRs in situ as well but others are looking to open data lake technology to support cost-effective integrated person-centric care across hospital, aged and community care settings without the expense and constraints of the single vendor EMR.

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Patient and physician experience with SmartHealth - A unique patient portal

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1.   Waikato Hospital

INTRODUCTION

The lack of a broad based platform that connects secondary care healthcare staff (physicians, nurses, allied health) with community based staff militates against a good integrated care delivery. Often patients also suffer adverse consequences from not having access to secondary care team, especially with consultants who may be more knowledgeable about their conditions than their own family physicians. The rapid increase in the use of internet, mobile wi-fi and greater use of mobile devices have led patients to expect a more rapid and closer to home delivery of health-care. It is important that healthcare systems take advantage of advances in communication technology to deliver safe, effective and expeditious care.

USE OF TECHNOLOGY AND/OR INFORMATION

SmartHealth is a unique patient portal implemented by Waikato DHB. All of the patients receiving care from Waikato DHB including those domiciled in other DHB catchment areas are eligible to register and use the patient portal. This portal allows patients to link with their healthcare team members and also allows various healthcare team members in the community and hospital to link up with each other. The portal allows patients and staff to message each other and also schedule video and text based consultations. All of the patient's details are stored in the cloud storage. The DHB aims to replace 30% of current in-person consultations with SmartHealth based video-consultations.

IMPLEMENTATION/PROCESSES

This system was first implemented in the renal unit. 120 patients are now enrolled in the website and linked to various physicians and nursing staff. 10 patients have been provided with iphones and blue-tooth linked BP devices. Enrolment in the transplant clinic is concentrated in those within first year of transplant. Every other clinic visit in such transplant takes place via video-link using SmartHealth. 50 video-consultations have resulted in the saving of 11,581 kms travel, and 159 hours of travel. An average of 3 text consults per week are answered by staff.

CONCLUSION

The use of this unique platform has been very useful in enhancing the quality of life of patients by obviating the need for disruption to their work and life to travel to clinic visits by delivering care closer to home. The ability to message their consultants has resulted in queries being answered expeditiously and is hugely helpful in ensuring continuity of care.

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Patient Reported Outcome Measures (PROMs) and Predictive Analytics

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1.   Waitemata District Health Board

INTRODUCTION

Our programme is about empowering patients to tell us about the impact of their condition and whether what we do actually makes a difference to their lives. Performance in the New Zealand health system is largely measured by provider KPIs and clinical metrics; at present very little attempt is made to understand patients' perspectives of their health outcomes. Patient-Reported Outcome Measures (PROMs) include questions about things like quality of life, functional outcomes, and mental and emotional wellbeing – outcomes that matter to patients. People are surveyed at first contact, before and after interventions, and at set periods after management plans have been agreed. People can be surveyed over time to understand the enduring impact of illness and healthcare. Our PROMs programme has three elements: Adopting a 'universal' quality of life measure (e.g. EQ-5D) to understand general wellbeing at a population level. Implementing disease-specific or service-level PROMs using internationally validated survey instruments in two pilot services (Young Adult Diabetes and Urogynaecology). Research to locally validate international tools and understand what really matters to our particular patient populations in terms of their health outcomes.

USE OF TECHNOLOGY AND/OR INFORMATION

A key enabler is our recently completed electronic survey system which allows us to digitise all patient and staff surveys. The digital platform removes the administrative burden of paper surveys, allows us to use multiple modalities (e.g. tablets, smart phones, web links) and survey people in and out of hospital. Importantly it includes sophisticated analysis of results that are presented back to clinicians and patients in real-time.

IMPLEMENTATION/PROCESSES

We are working with industry partners to develop an analytical engine that will allow us to triangulate multiple data sets and use them predictively. This will bring together PROMs, patient experience, clinical metrics and economic analyses to provide a clearer picture of the value of health care in people's lives. Our data visualisation work will allow us to present information back to patients in novel ways and support them to understand complex health data.

CONCLUSION

Clinical engagement in this programme has been outstanding, with 12 services immediately requesting to be pilot sites. This highlights a key challenge – managing the scope of work while maintaining widespread enthusiasm! This programme has significant potential for making use of big data for health literacy and empowering patients, supporting clinical decision-making, streamlining processes, and will potentially provide a model for other providers nationally and internationally.

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Personalised Care Plan- what matters most to the patient

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2. Older Persons Health and Rehabilitation (OPH&R)

INTRODUCTION

Across healthcare records there is considerable duplication and waste, even though many services are working towards the same outcomes for the patient. We're aiming for a single repository for patient's current goals and actions to support their healthcare across the system from primary, secondary and community services.

USE OF TECHNOLOGY AND/OR INFORMATION

We collaborated with local health services to configure existing software in order to create a single platform which would support a system wide personalised care plan. This includes life areas, patient issues, restorative goals and actions which multiple services/ agencies can contribute to and view in one place.

IMPLEMENTATION/PROCESSES

Local clinical knowledge, detailed service level workflow data and feedback from consumers drove a proposal for change of digital systems. Different services aligned various pieces of work by creating a collaborative project team to agree principles for use under one platform in the form of a shared care plan. Piloted with services from DHB and community, we identified workflow requirements, creating a digital workflow on the agreed principles, education for users and continued refinement via the project team. A user reference group was set up to develop quality standards and support governance of the work.

CONCLUSION

A tool was created to support patients to better manage their health condition(s) and allow a patient centred, coordinated approach to care provision. We believe that patient care plans that provide a platform for multiple agencies to direct their care from, will benefit the patient's care via transparent coordination, eliminating time waste and increasing efficiency in service provision. There have been reports of better cross agency collaboration for care and enhanced patient experience. The next steps include on-going refinements of quality standards and a progressive adoption of the tool across the system. This will include the development of digital workflows that sit around the core components of the care plan that are visible system wide. In future, this will include services in other areas of New Zealand. Over time this will be accessible via patient portal for patients and whanau or carers to view their healthcare goals and progress.

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Pitfalls with medication safety data

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INTRODUCTION

Adverse drug events (ADEs) are a significant source of patient morbidity, mortality and healthcare expenditure. Globally there are drives to reduce ADEs, but effective, targeted interventions require good local knowledge of ADE incidence, causes and severity. Cost-effective and practical means to establish these data has been challenging. The Institute for HealthCare Improvement's 'Trigger Tools', a validated toolkit for identifying and recording ADEs, is used in several New Zealand hospitals. Current Trigger Tools reports are pre-set and not interactive, creating the need to visualise and interrogate the data effectively.

USE OF TECHNOLOGY AND/OR INFORMATION

Tableau™ data visualisation software was used to create a 'dashboard' with interactive filters and data hierarchies. This allowed interrogation of the data to attempt to monitor trends in ADEs and identify high risk medications and clinical areas. The aim was to integrate this information with other clinical information to inform clinical practice and, through the Canterbury District Health Board (CDHB) Medication Safety Group, direct targeted interventions to reduce ADEs.

IMPLEMENTATION/PROCESSES

Data collected by specialist pharmacy staff are stored in a Microsoft Access™ database. It was then extracted to Microsoft Excel™ and cleaned by data analysts in collaboration with clinicians. Issues to overcome included: having multiple drugs for each reaction stored in an array; selecting denominators for the ADE incidence; creating hierarchies to classify drugs; and classifying ADEs. Some aspects of the data storage were unable to be maintained in the current format. A functional, pilot Tableau™ dashboard allowed selection and filtering of data. The data have high validity but the small sample size results in high signal-to-noise ratios limiting detailed analysis. A multidisciplinary approach including pharmacists, health informaticians and clinical pharmacologists was integral to achieving this.

CONCLUSION

Trigger Tools is a validated tool which demonstrates between 20 and 30 harmful ADEs per 100 admissions at Christchurch Hospital, consistent with global rates. The methodology provides a valid measure of overall ADE incidence and severity over time, and will be used as part of a wider medication safety dashboard. Trigger Tools, however, is unable to provide detailed analyses of ADEs; these are best addressed with larger data sets. When introducing processes to collect large data sets, it is critical to consider how to access and use the data from the outset. Pilot projects, including useful outputs of data, could allow early process refinement and cost savings. Multidisciplinary collaboration between healthcare informaticians and clinicians is critical to effective and efficient data utilisation.

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PM-Py: An Open Source Personalised Predictive Modelling System

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INTRODUCTION

Most of the current methods in predictive modelling for clinical data use global models where the model is created on the basis of the full problem space which provides good overall accuracy but can have poor predictive power on minority sub populations of patients. Since each data sample pertains to an individual/person precision is critical as false diagnosis can cause worsening of the patient's health or even death in some cases if the condition is left untreated. To meet this objective, Personalised Modelling (PM) methodology was proposed whereby a unique computational diagnostic model is created for each individual on the basis of the information available for the individual and other similar individuals. The rationale behind PM is that each person is different and hence they have different requirements and responses to the same treatment. Thus the most effective treatment for an individual can be achieved only by the detailed analysis of data available for the particular patient. With the advancement of science and technology, we have more clinical information available for use which can be used for creating efficient and effective treatment for patients with aggressive diseases like cancer. Here we present a new implementation of the PM methodology, named PM-Py as an open source to offer it for a wider clinical practice.

USE OF TECHNOLOGY AND/OR INFORMATION

The PM-Py is implemented in Python language as Open Source Software. Important features of PM-Py are: various machine learning methods, including Deep Learning Neural Networks; methods to overcome class-imbalance problems with clinical datasets; feature selection methods; visual profiling of individuals in terms of importance of variables to predict the individual outcome; optimisation methods to optimise the model in terms of both time and accuracy; etc. The PM-Py system will be offered as tool in hospitals for performing personalised risk analysis and prognosis of outcome of treatment of individual patients.

IMPLEMENTATION/PROCESSES

The PM-Py is presented as an open source software written in Python language along with several demo case study data and problems for:- Individual health risk prediction;- Early disease diagnosis;- Treatment outcome prognosis;

CONCLUSION

The PM-Py system can be used in clinical practice to reduce treatment costs for patients as well as the health care system, along with providing better quality of life for patients. The system will be able to provide and visualise profiling information for the patient by displaying individual risk factors and outcome probabilities rather than discrete outcomes to better guide clinical practitioners.

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Powering palliative care with EMR

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INTRODUCTION

Patients and families rely on healthcare professionals for decision making assistance during complex life phases, such as; life-threatening illness or end-of-life care. It is vital patients understand treatment and care options, while also receiving support from a collaborative palliative care team for emotional and spiritual needs – essential to improving patients' quality of life. The need for a better methodology to identify patients who could benefit from emotional, spiritual, and specialised care became evident – patients were being missed. Clinicians needed to identify potential palliative care patients without added work effort. This was achieved through development of a palliative care identification algorithm.

USE OF TECHNOLOGY AND/OR INFORMATION

The palliative care algorithm evaluates multiple patient indicators: serious condition, high hospital utilisation, functional limitation, and identifying symptoms. Some identifying symptoms include ambulation assistance, falls history, and Diagnosis. The algorithm continuously runs in the electronic medical record (EMR) evaluating indicators charted for all patients. Once identified by the algorithm, the patient is flagged as a possible palliative care patient. A care plan and palliative care consult are suggested. Suggested care plan and consult uses information available within the EMR and requires no additional nursing or clinician documentation.

IMPLEMENTATION/PROCESSES

The algorithm underwent three 30-day iterations. Improvements were made using quantitative and qualitative data. 1,788 chart reviews were conducted during 2nd and 3rd iterations to ensure the algorithm recommendations matched those of clinicians. Third iteration results showed a positive predictive value of 80% - these patients were correctly identified.

CONCLUSION

The palliative care algorithm can predict palliative care patients with 80% accuracy, which can have a large impact on patients receiving needed quality-of-life care. In a post-development analysis, the number of palliative care consults suggested by the algorithm was compared to the number of palliative care consults recommended by clinical staff. Clinical staff, when unassisted by the algorithm, failed to identify 14%-22% of the palliative care population. When the palliative care algorithm is used, patients are more likely to receive appropriate care. Hospitals may currently use a palliative care screening assessment to assist clinicians in identifying palliative care patients. These tools can take 1-3 minutes to complete, or roughly 27-81 nursing hours per month (depending on patient volume). Implementation of an algorithm, running in the EMR, can give clinicians more time with their patients. The palliative care algorithm saves clinician documentation time while also connecting patients to the specialised support palliative care patients require.

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Practical uses of IoT (Internet of Things) in Hospital Services

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INTRODUCTION

We cannot manage what we cannot measure. Hospital services such as equipment and resources are too numerous to count but are equally important to manage and coordinate. The challenges facing hospital services is identifying where the work is required, finding the right resource and coordinating the correct response. The difficulty with a dynamic environment like healthcare is that one cannot help but react to the situation. Coordinating these tasks would be easier if the location of the staff and equipment were known to direct the right resource to the task. The biggest challenge in a hospital setting is proper use of time and resources. Collection of data would provide live and factual information providing a smarter and efficient way of managing operational tasks.

USE OF TECHNOLOGY AND/OR INFORMATION

Internet of things (IOT) technology allows us to monitor and measure and automate actions and responses enhancing efficiency and effectiveness of workflow. It is now possible to collect and measure data using IOT technology. The data feedback can set triggers and provide responses to location, utilisation, activity and status and generate information that can then be used to actively manage resources and equipment.

IMPLEMENTATION/PROCESSES

Smartphones, Low energy bluetooth devices (BLE/ibeacons) and smart radio transceivers provided real time data of location and communication. These were provided to staff and beacons placed across the hospital. The technology was very simple and cost effective providing a large amount of data for analysis and resource management. A comparison of data collected before and after initiatives were applied showed a marked increase in presentation time of orderlies to the task allocated to a point where cancellations started to increase as the assigned tasks were not ready for action.

CONCLUSION

It is clear that Internet of Things (IOT) technology can provide a more efficient and responsive workflow but finding the right vendor to partner with these initiatives prove challenging. The implementation showed that there are huge benefits that other uses are now being considered to measure and manage.

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Precision Driven Health Partnership – lessons from our first 18 months

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INTRODUCTION

New Zealand has huge potential for healthcare data research, utilising data collected since the New Zealand National Health Index was introduced in 1993 and the Health Information Privacy Code was developed in 1994. The unique ethnic diversity and cultural environment within New Zealand enables exclusive research opportunities, and our technology-capable population serves as a great sample size for testing new innovations. We will share the early successes from over twenty projects in the Precision Driven Health (PDH) research partnership, a seven-year, $38m research partnership between Orion Health, New Zealand's District Health Boards and Universities.

USE OF TECHNOLOGY AND/OR INFORMATION

Precision health targets personalised treatment, and is possible when all information about an individual – including his or her genetic and social profile - is available as part of an electronic health record. Our research utilises data science, such as machine learning, to design the software tools to enable this.

IMPLEMENTATION/PROCESSES

PDH has completed several initial projects, including a review of global programs in precision health, the views of New Zealand's clinicians, and an assessment of data available for data scientists to explore. These reviews have confirmed a lot of untapped potential within the health sector, and strong support for innovative uses of data. Over last summer, eleven young research students from medical and IT related fields at the University of Auckland and AUT completed projects sponsored by PDH. They explored topics ranging from using chatbot technology for diagnosis, a decision support tool for atrial fibrillation which helps predict whether one intervention (cardioversion) is likely to be effective in a specific patient, and the design and use of apps for wellness and patient discharge. At HINZ, a number of projects supported by PDH will be presented. Each one represents a partnership between clinical, scientific and commercial parties. Some of the current exciting PDH projects include a surgical mortality calculator which improves patient outcomes, a health outcome prediction engine which can tailor interventions to individual patients, and an investigation of ways that informed consent can be provided electronically.

CONCLUSION

New Zealand's strengths of a supported public health system, innovative clinicians, data scientists, and global commercial leaders, provides a unique combination to transform the way health care is delivered. Precision Driven Health has learned from early projects to ensure that all of these elements are engaged and supported, so that research leads to changes in practice, rather than just interesting insights.

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ID: 583 - DIGITAL HEALTH IDEA

Precision-driven Population Screening for Abdominal Aortic Aneurysm

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INTRODUCTION

Population-based screening for disease can be highly effective, but it is often inefficient. Crude eligibility criteria mean that many patients with low probabilities of testing positive get screened, while others with high probabilities are sometimes excluded. Thus screening programmes operate at sub-optimal cost-effectiveness, and potentially cost-effective programmes are not implemented. Abdominal aortic aneurysm (AAA) is a disease where the aorta gradually balloons out and can rupture, usually with fatal consequences. If detected early by ultrasound examination, aneurysms can be repaired and death prevented. Some countries have established population-based screening for AAA but NZ has not. A constraint to establishing AAA screening in NZ is that certain groups (e.g. East Asians and lifetime non-smokers) have a very low incidence of AAA. We describe the development and testing of a "precision-driven" IT system to screen for AAA.

USE OF TECHNOLOGY AND/OR INFORMATION

An algorithm to predict the likelihood of a patient testing positive for AAA was developed based on risk factors identified in previous international and NZ-based studies, using data that is routinely available in primary care patient information systems. An IT system was built to extract the necessary inputs from primary care electronic health records, and calculate patient risk scores. Challenges faced included the availability of systematically recorded clinical data, being able to collect the data efficiently from many practices and systems, and providing primary care with tools to report on the calculated risk.

IMPLEMENTATION/PROCESSES

We are implementing a system to enable GPs to view patients' AAA risk, and if above the eligibility threshold, to electronically invite them for screening, with functionality to enable them to book their appointments. We have tested the algorithm, first in its ability to predict known AAA in three Auckland practices where all Māori had already been invited for screening, and then prospectively by inviting for screening 532 patients in 4 distinct risk groups. The accuracy of the predictive model at detecting AAA in these samples will be presented, along with a descriptive account of experience and user satisfaction with the IT screening system.

CONCLUSION

From international experience and local cost-effectiveness modelling, AAA screening is highly cost-effective above 2% prevalence. This demonstrates that predictive modelling can reliably identify groups of patients with this prevalence rate. The predictive value of the system will be enhanced using machine learning methods. There is already interest from the Ministry of Health in a precision-driven approach to AAA screening integrated with primary care as a future national programme.

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Preventing the unexpected – a tool to screen and target interventions for Sudden Unexpected Death in Infancy.

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INTRODUCTION

Each year in New Zealand around 45 infants die of Sudden Unexpected Death in Infancy (SUDI). SUDI deaths occur disproportionately for Maori and Pacific families and babies living in socioeconomic deprivation. There is compelling evidence that SUDI deaths are preventable by addressing the risks that contribute to a baby's vulnerability and by providing a safe sleep environment every time a baby sleeps. The goal of this research was to develop a universal screening tool for SUDI risk and thereby enable equitable access to interventions to reduce SUDI.

USE OF TECHNOLOGY AND/OR INFORMATION

Risk factors for SUDI are well established. However, there are complex interactions between risk factors making it difficult to estimate the magnitude of risk in a clinical situation and to know what intervention will make the most impact on risk. Individual level data from five major case-control studies, including the New Zealand Cot Death Study has been used to develop an algorithm which has then been applied to develop a web based risk assessment tool called the Safe Sleep Calculator (SSC).

IMPLEMENTATION/PROCESSES

The SSC has been adapted as a webform for Medtech32 and My Practice. The data are stored onto the infant's clinical record and sent to an accumulating data set. The SSC is completed at the six-week infant check and the result is illustrated through use of a risk scale. Factors that reduce risk are identified with the risk reduction achieved by modifying each factor. The SSC is linked to a clinical support pathway.

CONCLUSION

Practice nurses report that the SSC enables them to confidently screen for SUDI risk and prioritise factors that will have the most impact on reducing risk. Future developments will be to; implement the SSC throughout primary care nationally, introduce the SSC into routine use by midwifery and Well Child providers, and to develop the capability to refer directly to the local Safe Sleep Programme from the SSC webform. More than 500 calculations are now on the dataset. Twenty percent of calculations show a risk ≥ 0.4/1000 (MOH 2016 target <0.4/1000 SUDI for Maori) and most have modifiable factors. The SSC enables targeting of additional support to this group. Accumulated population data will be used to improve the predictive power of the SCC for the New Zealand population.

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Realizing the benefits of introducing a large electronic system into St John emergency response processes

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INTRODUCTION

Despite high focus on the development of business cases that propose benefits before investment is approved, there is often a paucity of activity focused on measuring these benefits after sign off. A significant project was undertaken by St John in 2011 and they purposely planned to explore and measure if the promises at the beginning were being realized.

USE OF TECHNOLOGY AND/OR INFORMATION

The goal of this case study is to share some of the steps undertaken and present findings (benefits realized) at six months post implementation of the electronic patient report form (ePRF) and highlight some of the lessons learnt along the way.

IMPLEMENTATION/PROCESSES

This was a large and complex implementation requiring at a minimum, the training of 5000 paid and unpaid ambulance officers working in 600 vehicles, across 205 Stations throughout NZ; to electronically capture the information on around 365,000+ emergency incidents (circa 2016), enabling the transmission of data safely and confidently into a robust information repository and reporting system.

Potential gains of implementing ePRF were mapped to one of four benefit realization domain; Improved Patient Outcomes, More Efficient Operations, Professional Development and Capacity Building and an Effective Organisation and Health System.   The following are a few examples of the benefit state at six months post implementation. Improved Patient Outcomes: Recording of ethnicity, increased from <2% to almost 90% compared to the old paper data capture forms.   More Efficient Operations: ePRF has demonstrably improved the processes and time taken for undertaking audits and reportable events, from 3 months to around 5 days. The goal of auditing 5% of ALL cases attended was achieved two years ahead of plan. Professional Development and Capacity Building: Capture of core compulsory information previously unmeasurable, now has a baseline completion and a regional view so tailoring support now happens down to a station and even team level. Effective Organization and Health System: Accurately reporting on the population served is an essential step in this process and can be used to improve understanding of the population served and underpin avenues for health sector collaborations. For example, the data showed that individuals in the Central and South Island regions were 20% more likely to have repeat ambulance call-outs compared to those in the Northern region, and emergency call rates per 100,000 for Māori in the Central, were higher than all others. This information offers opportunities for knowledge exchange that previously was not possible.

CONCLUSION

This case is a good example where the benefits identified in the business case were intentionally kept at the forefront of the implementation process. This enabled this complex project to be organized and positively guided by these identified benefits and as the implementation progressed, all layers within the organisation could see what, how and where the intended gains were being actualised.

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Remote assessment of complex wheelchair needs

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INTRODUCTION

Complex wheelchair/seating assessments for people with physical disabilities is an advanced practice skill with considerable health and fiscal implications. Poor assessment of wheelchair needs can lead to avoidable hospital admissions, absence from work/school activities and abandonment of ill-fitting equipment with considerable wastage of health resource. Remote assessment of wheelchair needs by highly specialist assessors though the use of technology could avoid these negative and costly health outcomes and to improvements in the quality of care.

USE OF TECHNOLOGY AND/OR INFORMATION

A scoping review of remote wheelchair assessment has revealed this to be an under-developed area of technology innovation. A wide variety of technologies have been trialled from integrated systems (e.g., video, still image, onscreen measurement and data storage) to use of landline telephones using very small samples and largely non-randomised research designs. Preliminary research indicates remote assessment can be as accurate as in-person assessment under certain conditions however the specific technology needed is as yet unclear and anxieties from some stakeholders, particularly health professionals and service managers suggest early consultation in the design and development of such services is critical to uptake. Local contextual factors, such as bandwidth and security requirements are also important design factors in the usability of technology.

IMPLEMENTATION/PROCESSES

A national stakeholder consultation is proposed in which wheelchair users, specialist and non-specialist assessors, funders and information security stakeholders are consulted on their perspectives on the design of a remote wheelchair assessment service. Assessor confidence, consumer and assessor preferences, and funder/ security stakeholder requirements will be sought first through an online survey distributed through professional networks; secondly through indepth interview and focus groups. This study will be guided by the New Socio-technical model for health information technology and aligns with the New Zealand Health Delivery Investment Signal and Vision Mātauranga, given the higher representation of Maori in disability and remote communities.

CONCLUSION

The use of technology to facilitate remote assessment of wheelchair needs is an under-developed aspect of rehabilitation that could afford considerable health and fiscal benefits. New Zealand's geographical, health and digital context presents a unique opportunity to lead international development of this area in the timeliness, academic rigor and usability of such a system.

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Remote telehealth consultations help teenager overcome serious eating disorder by resolving hidden emotional trauma

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1.   The Art of Health

INTRODUCTION

A mother approached the clinic for help for her 17 year old daughter suffering for 6 months with a worsening eating disorder. The patient was seeing a psychologist, GP, GI specialist and naturopath but was not making progress. The patient was exhausted and had stopped attending school. Symptoms included no desire to eat, muscle pains, constipation, stress, dizziness and low mood, with an overall SUDS (Subjective Units of Distress Scale) rating of 8/10.

USE OF TECHNOLOGY AND/OR INFORMATION

Consultations were carried out remotely via Skype. The client was also given access to a self-help online program for clearing emotions and learning self care. Consultations were followed up with self-help assignments and worksheets via email.

IMPLEMENTATION/PROCESSES

During the first session it was ascertained various traumatic childhood events had set up deep-seated beliefs and feelings of inadequacy, along with fears of speaking up for herself. The unconscious habit of suppressing hurt, fear, sadness and frustration had led to an (unconscious) need to 'control' food. The client said opening up about her past felt like 'a weight off her shoulders'. The client also shared she had not revealed the severity of symptoms to her GP. The clinician felt the client's physical health was in potential danger and advised her to visit her GP immediately. She was admitted to hospital same day, put on a feeding tube and moved to a specialist eating disorder clinic 10 days later. Whilst the client wished to continue emotional healing sessions she was advised by the doctors to wait until discharge. Once the client's weight had stabilised 8 weeks later emotional healing sessions were resumed once she was an outpatient. Past emotional traumas were healed and she was taught how to voice her feelings in social situations. Within 6 weeks and a total of 8 sessions she was back at school and feeling competent to continue daily life. The SUDS rating had reduced to 1-2/10.

CONCLUSION

Telehealth consultations are effective in clearing deep-seated trauma and related symptoms. The combination of hospital care and remote consultations allowed the client to return to excellent health within 4 months.The client's Mother wrote "By the time I found Kim our daughter's battle with anorexia was desperate. She was within days of death. There have been three key things involved with our daughter's recovery and Kim was one. I can honestly say without her there is a very real chance our daughter would not be with us today".

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Rural Renal Nursing Telehealth: Expanding from Virtual Clinics to Research

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INTRODUCTION

The Bay of Plenty (BOP) renal service falls within the catchment area of the Midland Regional Service (Waikato). The Waikato hub provides renal support to the spokes (the two satellite units of BOP: Tauranga and Whakatane). The Rural Renal Nurses (RRNs) who run these units face unique challenges due to geographical isolation: increased medical vulnerability, reduced engagement with the hub and reduced professional educational opportunities. The adoption of telehealth, which includes innovative video technology for both clinical (direct patient care) and non-clinical (education, managerial and research) uses has helped address this vulnerability. The RRNs who form crucial links (by acting as proxies for the physicians in the virtual clinics) end up up-skilling not only in clinical skills, but also in academia: research, presentations and publications.

USE OF TECHNOLOGY AND/OR INFORMATION

RRN research development in BOP has not really started until recently. Integrating virtual technology into daily practice has created multiple opportunities for learning, coaching and an explosion of research opportunities which incorporates data collection, data analysis, abstracts preparation, conference presentations and publications. All the prep work has been done almost exclusively using virtual video technology by linking in with physician-mentors.

IMPLEMENTATION/PROCESSES

Infrastructure for video links was already well established from running the virtual clinics between BOP and Waikato: Cisco Jabber system, webcams, multiple computer screens and rooms for the consultations. The research development simply utilized existing infrastructure. Within 2 years, at least 10 RRN abstracts (including this one) were formulated, discussed and developed using virtual technology. In particular, the detailed analysis and complex calculations of data (using Excel spreadsheets) were shared and discussed using the screen sharing component of Cisco Jabber. In addition, the design of at least 4 posters and 2 slides presentations for various conferences were facilitated using video links; with multiple practice sessions conducted via telelink. This has, in turn, spawned the submission of several publications in medical journals (with two articles in press at present).

CONCLUSION

The extension and development of the role of RRNs in research is completely unexpected in the evolution of telehealth in BOP. Uniquely, RRNs could now actively participate in high-level research in ways that were previously impossible; the virtual connections have increased mentorship with renal physicians and other allied specialties. Indirectly, the telehealth-facilitated research has expanded the role of RRNs and fostered a culture of learning, auditing, measuring, publishing and service improvement. This has led to improved healthcare for patients and expanded the horizons for professional nursing development.

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Saying goodbye to paper

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INTRODUCTION

In the healthcare setting, communication must be accurate and rapid, and documentation must be available at the right time for the right person. The shift to a paper-lite or even an entirely paperless system remains challenging. Hybrid but sub-optimal paper/electronic systems persist especially in the absence of an effective mobile solution. Paging and phoning remain the predominant method of communication leading to a dependency of availability or restricted ability to convey information.

USE OF TECHNOLOGY AND/OR INFORMATION

We have deployed a solution designed around optimising communication and care documentation among multi-disciplinary teams that complements and enhances the workflows of staff caring for inpatients. The solution is a fully native mobile application and data platform, with workflow and task management, fully digital clinical notes, team communication, electronic ordering and result notifications. It is intuitive, fast, responsive and reliable in the hospital IT environment integrating seamlessly with other hospital systems i.e Orion's Clinical Workstation, Eclair, and Patient Administration Systems, as well as other mobile applications and data repositories. The solution uses a combination of structured notes, dynamic workflows and highly customisable forms to provide an end-to-end solution for digitising paper-based systems. The platform also collects previously unobtainable data about the patient journey, to allow hospitals to identify bottlenecks in the patient journey for system improvements.

IMPLEMENTATION/PROCESSES

The solution has been deployed in a multi-disciplinary environment over multiple wards enabling doctors, nurses and allied health clinicians full visibility of tasks, orders and notes related to all patients under their care. The deployment was the culmination of multiple iterations, pilots, real-world use and dynamic feedback cycles ensuring that from go-live it has met users' needs and solves workflow problems that have previously been deemed intractable in a paper environment. A clinical steering group and governance group structure had full participation from all stakeholders with equal influence of all 3 major clinical groups. An engaged IS team also contributed greatly to the success of the deployment reinforcing the importance of engaging all stakeholders as early as possible.

CONCLUSION

Initial feedback has been overwhelming enthusiastic with buy-in across the clinical spectrum. There is evidence of organic 'viral' growth of the solution among those users whose primary work environment is outside of the currently enabled wards. These clinicians have expressed a desire to deploy the solution in their own specialities.

Initial data from the deployment shows evidence of a shortening of length of stay, reduced number of bed days, significant reduction in RMO pager calls and up to 15min per user per hour in saved time. We now have unique data around workflows that would have been impossible to collect at scale otherwise, leading to opportunities to gain insight into care and patient flow bottle necks.

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Security is a team sport

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1.   Comrad

INTRODUCTION

Comrad Medical Systems has recently released a new platform called Aura which is a suite of Radiology Information System and patient workflow applications. This presentation describes how we embedded a security-first mindset into our team and software delivery process.

USE OF TECHNOLOGY AND/OR INFORMATION

Information risk awareness; security design reviews; code analysis tools; penetration testing.

IMPLEMENTATION/PROCESSES
*   Conversations about functional and non-functional system requirements were used to identify security concerns.
*   Working with an external consulting partner provided independent advice on security best practices.
*   Development processes used Agile methodologies to provide visibility of security-related work and assign ownership of issues across the team.
*   Significant investment was put into up-front design and documentation for the security architecture of the solution.
*   Security penetration testing was used to identify and remediate vulnerabilities.

CONCLUSION

Security in digital healthcare applications needs technical and non-technical solutions. It requires establishing partnerships internally and externally; following proven industry standards; adequate funding; and a willingness to invest in cultural behaviours which promote a security-first mindset. Tools alone do not make software secure but they help scale the process and enforce policy.

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Semantic Interoperability and Clinical Terminology – An Overview of Current Code Systems and a Discussion of the Future Clinical Application Direction

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INTRODUCTION

Current use of non-standard terminology code systems is one of the biggest sources of poor data quality when used within electronic health records (EHRs). It is a barrier to achieving semantic interoperability, data mining capabilities, secondary health data use, and optimised clinical decision support. Applications of clinical terminology systems such as predictive analytics and semantic search capabilities within EHRs can greatly improve individual and population health outcomes plus significantly reduce care delivery costs. Sharing the outcomes of such novel applications aligns with the strategic themes from the New Zealand Health Strategy Future Direction of providing "Value and High Performance" and a "Smart System".

USE OF TECHNOLOGY AND/OR INFORMATION

To overcome the issue of inconsistent nomenclature and poor searching interfaces within EHRs, application of clinical terminology systems such as Systemised Nomenclature of Medicine – Clinical Terms (SNOMED-CT) can assist in standardising clinical data in a meaningful way. Enriching clinical information in such a way supports various clinically meaningful applications and has the potential to benefit individuals, populations and evidence based decisions to provide cost effective care delivery. Applying novel technologies such as natural language processing and machine learning algorithms supported by code systems and improved processes have significant potential to improve clinical workflow and, ultimately, health outcomes.

IMPLEMENTATION/PROCESSES

Research in collaboration with various institutions and industry partners aims to improve current clinical workflow through evaluation and application of semantic search capabilities to unstructured clinical narratives using natural language processing (NLP) and machine learning. Other applications of these techniques and technologies are also being investigated with the aim of improving health outcomes.

CONCLUSION

Research outcomes include evaluating current clinical workflows against proposed NLP techniques. On confirmation of a solution, a clinical application will be prototyped and built, with the objective of achieving advanced search capabilities for users. Broader applications of this technology holds potential for opportunities across other New Zealand healthcare domains. Outputs from these applications will be shared to support New Zealand's Health Strategy and Future Direction.

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Smart device apps in clinical practice

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INTRODUCTION

Waitemata DHB has been working on a Mobility Strategy for approximately 2 years. This has included policy (for both corporate devices and BYOD), infrastructure, free & comprehensive WiFi connectivity, security, integration with existing health IT systems, mobile device management (MDM) and a mobile enterprise application development platform (MEAP). Now the use of devices is becoming more commonplace in clinical practice both inside and outside the hospital, we need a process for the evaluation and approval of clinical apps.

USE OF TECHNOLOGY AND/OR INFORMATION

A MBA student group prepared a report summarising governance and prioritisation processes required to manage demand for smart device apps in clinical practice. The process was refined by Waitemata DHB's Innovation Partnership Working Group (IPWG) – a group of clinical, IS and strategic members. IPWG developed a request form based on elements of the u-MARS (short version of the Mobile App Rating Scale, Stoyanov et al, 2015) and the DHB's priorities. healthAlliance (IT) further refined the technical assessment.

IMPLEMENTATION/PROCESSES

DHB staff access an online app request form via the intranet. Each submission requires team/clinical lead endorsement. The IPWG review submissions at a fortnightly meeting which requesters are encouraged to attend. IPWG members agree a sign off process for each submission according to degree of clinical, technical and privacy/security risk. IPWG members are assigned to complete usability and technical reviews of requested apps and recommend privacy/security and clinical governance sign off as appropriate using existing governance groups. If resources are required (eg for integration or new development), the recommendation of the group goes up to the Innovations Governance Group for approval of resources. Apps can then be purchased and pushed to devices via the MDM.

CONCLUSION

A total of 9 apps have gone through this process to date. Apps are categorised as high, intermediate and low risk. High risk apps are those that require integration into health IT systems or store personal health information on the device; intermediate risk apps include advice/calculators/algorithms that require checking for accuracy; low risk apps do not touch DHB systems or personal health information. We have found that even low risk apps may require a brief review process, particularly around clinical applicability, use of advertising, and technical usability (eg 'bugs', battery use). Requesters and their team/clinical leads take ownership of use of the apps, particularly promotion of use and regular review to ensure updates/changes do not adversely impact users/practice. We continue to refine and improve the process.

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Smart MedRec (Medication Reconciliation)

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INTRODUCTION

As the adoption of Health IT increases, time and attention spent on interacting with IT becomes a major issue. Medication reconciliation has proven benefits to patients and recipients of the reconciliation but is a time-consuming exercise for the clinician. Studies have shown that Medication Reconciliation reduces overall costs despite increasing the labour cost of discharge by around $100 per patient (Ref: http://www.hqsc.govt.nz/our-programmes/medication-safety/news-and-events/news/545/). Currently, in a Health Information Exchange, dose instructions are unstructured because medications data for a patient originate in a wide range of disparate systems and environments (community care, hospitals, etc.) and when these systems exchange this data, details of the doses and products are not represented in a sufficiently structured manner. This results in a tedious and labour intensive medication reconciliation process, even using best-of-breed software.

The Smart MedRec project aims to answer the question: can we automate (possibly using methods similar to natural language processing) the conversion of unstructured dose instructions to a structured dose representation? Achieving this could enable highly-automated computer-assisted medication reconciliation. This could enable further innovations: efficient medication reconciliation, more advanced automation and assistance of medication reconciliation, clinical decision support, medication error detection and alerting, and pharmaceutical data mining. All of these have the potential to improve the quality of care that patients receive, both in New Zealand and internationally.

USE OF TECHNOLOGY AND/OR INFORMATION

Using machine learning (ML) and natural language processing (NLP), we will develop an automated converter to convert free text dosage instructions to a structured representation. Although ML and NLP have been used for electronic health records in a variety of ways[1], this will be the first time they are being used to enable structured medication reconciliation.

[1] For example Miotto, Riccardo, et al. "Deep patient: An unsupervised representation to predict the future of patients from the electronic health records." Scientific reports 6 (2016).

IMPLEMENTATION/PROCESSES

At the time of writing this abstract, the project is just starting. The approach will be as follows: The initial focus is on acquiring suitable data sets to use with supervised, semi-supervised and unsupervised ML. For supervised ML, the inputs are unstructured dose text data, and the target labels are the associated structured version of that data. The structured version is available from two types of de-identified and anonymised sources. The first type is systems that store dose instructions in a structured manner in addition to an unstructured form which is derived from the structured form. The second type results from manually labelling some of the unstructured data. Manual labelling will be done by experienced clinicians. Unlabelled data can also be used for semi-supervised learning[2], which incorporates a generative adversarial network[3] (GAN) in the training of the converter. Since both the derived dose instructions text and the manually entered dose instructions text tend to follow fairly rigid conventions, rule based parsing is also considered for recovering the structured form. Unsupervised ML is used to cluster training data to ascertain coverage of the rule based parsing, and also to assess the relative balance of the classes represented by the clusters.

Development of the structured dosage schema proceeds in parallel, and in an iterative manner. The range of dose styles in the datasets will guide the design choices for the structured dosage schema.

CONCLUSION

The expected outcomes include: a schema for dosage representation that covers a high proportion of the dose styles encountered in the data sets; a prototype of the automated converter from unstructured dose instructions to a structured dose representation; a methodology for training a converter on new datasets; and demonstrations of how

this can improve automation of medication reconciliation.

This project hopes to enable the future development of software features in both the user interface and data processing aspects that will reduce the burden on clinicians and help improve the quality of care patients receive.

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[3] Goodfellow, Ian, et al. "Generative adversarial nets." Advances in Neural Information Processing Systems. 2014.

SMS4BG: text messaging self-management support for people with diabetes

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INTRODUCTION

The National Institute for Health Innovation (NIHI), in collaboration with clinicians and patients from Waitemata DHB, has developed a self-management support programme for people with poorly controlled diabetes. The programme is delivered completely via text messaging (SMS) with a supporting website. A successful pilot study (42 participants) led to a large national randomised controlled trial of its effectiveness.

USE OF TECHNOLOGY AND/OR INFORMATION

The NIHI team developed an SMS delivery engine that combined a database of enrolled/consented participants, participant preferences and tailoring variables, multiple topic modules consisting of pre-written text messages, and business rules of 'who gets which messages when'. The scheduled messages were pushed to participants via a third party gateway company. The system allowed incoming messages from participants with, for example, their blood glucose results in response to a reminder to do the test. These were automatically graphed according to time/date and made available for the participant via the website for self-review of trends. At 3 and 6 months participants were asked via SMS if they wished to continue receiving messages, for a potential total programme duration of 9 months. All messages were zero-rated via the gateway to ensure no cost to participants.

IMPLEMENTATION/PROCESSES

A total of 366 participants were recruited into the trial and 183 were randomised to receive the SMS4BG programme. 52% of the participants were male, 65% had type 2 diabetes, and the mean age was 47 years (range 16-80). Most (55%) were European, 23% Māori, 13% Pacific Island, 8% Asian and 1% from other ethnic groups. The system sent >75,000 messages to participants and received back >17,000 messages, including approximately 16,000 blood glucose results. Of those interviewed at completion of the programme, 95% reported SMS4BG to be useful, 97% would recommend it to others and 99% thought text messaging was a good way to deliver this type of intervention. Nine participants reported technical issues including user issues (n=4), cellular reception issues (n=2), website access (n=2) or not being able to reply to messages (n=1).

CONCLUSION

In this presentation we will focus on the implementation of the text message programme, including the delivery options beyond the end of a trial, integration into standard practice, the full cost of delivery, and the potential impact of scaling up to a full national programme.

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South Island Patient Information Care System

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INTRODUCTION

The SI PICS programme was approved by the Ministers of Health and Finance in 2014 and represents one of single largest investments in health IT for the public health system in over a decade. When it is rolled out across all five South Island District Health Boards by 2020, it will make the lives of thousands of health workers easier, and millions of patients better. The programme will replace 9 legacy Patient Administration Systems across the South Island, including three at Canterbury DHB. The programme aims to transform the way people interact with the health system and receive care, and the way health professionals work. It will enable a faster, smoother patient journey.SI PICS is an integral part of a broader suite of regional initiatives, as well as supporting the vision of the Canterbury Health System specifically. The programme achieved a significant milestone mid-2017 with the successful completion of phase one of the programme at Canterbury DHB. This saw the deployment of SI PICS to Older Persons Health & Rehabilitation. Services based at the new Burwood Hospital facility – now New Zealand's sixth largest hospital – exclusively use SI PICS, including inpatient, surgical, outpatient's clinics, allied health, Spinal Unit and community services teams. This session will cover the lessons learnt from the first implementation of this regional programme at Canterbury DHB. Specific topics include: change management implications arising from regionally agreed work practice and functional design; alignment of our digitally enabled health system vision, paper-light project, facilities redevelopment programme, data-driven health system, clinical and patient portal initiatives and the SI PICS programme; our approach to reorienting the way we work and deliver health care services and how we design and use technology to support that; sharing some of the successes and challenges we encountered, and; what the patient journey of the future will look like across the South Island, enabled by SI PICS.

USE OF TECHNOLOGY AND/OR INFORMATION

N/A

IMPLEMENTATION/PROCESSES

N/A

CONCLUSION

N/A

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Tablet Computer Implementation for Clinical Staff

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INTRODUCTION

With the advent of healthcare technology, mobile devices are becoming increasingly common to assist clinical staff at the point of care (when interacting with patients). Computers on wheels (COWs), laptops, tablets, smartphones and wearables each have their role in the evolving digital landscape. We ran a pilot in late 2016 involving 40 tablets and are now rolling out more devices to the wider hospital.

USE OF TECHNOLOGY AND/OR INFORMATION

The pilot yielded valuable insights and learnings – most critically that correct devices must be matched to the clinical user and workflow. While COWs were in fashion in early 2000s, they are slow, cumbersome, and provide challenges for storage and moving between wards. We decided on hybrid tablets for the majority of our mobile multi-ward staff, due to the balance of screen size, weight and portability, with flexibility to transform into a laptop using detachable keyboard or COW if placed on a trolley. We evaluated a range of systems specs: battery, weight, screen size and resolution, durability, device handling, portability, connectivity, security and infection prevention. In parallel we also investigated ward infrastructure, wifi, recharging and support.

IMPLEMENTATION/PROCESSES

The process was driven by clinicians for clinicians, recruiting a large number of passionate volunteers as beta testers and super users. Technical and clinical staff worked together seamlessly to resolve issues and speed was a critical success factor to maintain staff engagement and morale. This exposed the wider hospital to tablets and paved way for change management and workplace culture shift. Targeted emails, newsletters, multimedia, meetings and grand rounds were used to augment this process. We focused primarily on junior staff (nurses, pharmacists, doctors and allied health) due to their high administrative task load and confidence with technology.

CONCLUSION

The 2016 pilot was a key stepping stone ahead of the wider rollout. Results include positive qualitative surveys, time in motion studies and high level projected benefits. The device costs pale in comparison to patient experience and safety, quality of care, time savings and productivity gains. Each staff member with a point of care device gains nearly one hour per shift. In addition E-radiology, vitals and prescribing give cumulative benefits and unlock new functionality such as requesting radiology at the bedside or reviewing patient charts remotely. There are hospital wide benefits including reduction in length of stay, duplication and errors. These devices can also be used in primary and community settings to provide true integration of care.

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'Team Based Care - Connecting Providers to put Clients first'

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1. Whanau Tahi

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INTRODUCTION

The HBDHB Mental Health and Addiction Service provides care to 3,000 clients at any one time. Mental Health and Addictions Services (MH&AS), range from inpatient through to intensive care, community-based services and community-based case consultation. While the MH&AS had moved to the use of an electronic record, the system did not provide the ability to create a living, updatable 'Assessment' and 'Plan' document leading to many issues: Clients having to repeat their story multiple times. Clinicians spending considerable time recreating assessments which were not updatable. Multiple documents confusing providers and clients - introducing the potential for clinical risk. No capacity to audit or generate reports on provider compliance. No capacity to carry out analytics on client wellbeing assessments/targets met.

USE OF TECHNOLOGY AND/OR INFORMATION

The MH&AS wanted to develop new plans that were 'living documents' to ensure one 'Assessment' and one ' Go To Plan' per client available at the click of a button and to guarantee that all carers were working on the 'same' plan. After an extensive market review Whānau Tahi Limited (WTL) was chosen as the provider of choice for HBDHB Mental Health & Addictions Services to be delivered safely and successfully using its Connected Care platform.

IMPLEMENTATION/PROCESSES

MH&AS engaged consumers/providers to define pathways for the 'Plans' to ensure that we met needs of consumers, multiple clinical disciplines and health care providers, along with various treatment settings (e.g. child and adolescent mental health, substance use treatment through to inpatient mental health). This served to gain early 'buy-in' to change as we had developed clinical and consumer 'champions' before the 'Plans' were developed into electronic forms in collaboration with Whānau Tahi.

CONCLUSION

Significant benefits have emerged from the introduction of the Whānau Tahi Connected Care solution: Clients have one collaborative (shared care) plan accessible at the click of a button to the multi-disciplinary team members who share care their care delivery across secondary, primary and community care provider organisations. Reduced administration of records means more time for clinicians delivering frontline care. The full audit functionality means that we can measure our progress at the click of a button and have information available for analysis to improve: health outcomes for our clients, financial sustainability of our services. Must Do's: have high expectations, well documented and communicated, and encourage a feeling of excitement about innovation. Be clear about what you want and why and share your vision using 'sponsors' and 'champions'. Engage a vendor as a 'partner' willing to collaborate to do something different.

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Telehealth trial between Waikato DHB and Springhill Prison

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INTRODUCTION

Springhill Corrections facility is located on a 215 hectare site near Meremere in the Waikato and is one of the country's largest prisons with a capacity for 1002 minimum to high security male prisoners. It is located just under an hours drive away from Waikato Hospital and prisoners requiring transportation to the hospital are usually accompanied by two prison officers as well as a driver for the transport van.

USE OF TECHNOLOGY AND/OR INFORMATION

Using the well established telehealth network, of WaikatoDHB multiple specialty clinics have been established over the past six years to provide a health service to the rural hospitals and also to some of the regional hospitals including Tarawhiti. Using this resource, in collaboration with Springhill corrections facility and supported by three vendors, clinics have been established for renal, diabetes, mental health and addictions, oncology, respiratory and gastroenterology. Initially this project will offer outpatient clinics but future thoughts are video links to Emergency department expertise, education and supervision.

IMPLEMENTATION/PROCESSES

This three month trial has been underway since late 2016. Firstly the need to identify those necessary to form the group to move this project forward, discussing the benefits of trialling such a project, which if successful, could possibly have a national impact, installation of equipment, training of staff to use equipment, identifying the specialties who are most used by Springhill, building a community among DHB, Corrections and the vendors so everyone moves forward in excitement were all included in the development of this project. WINTEC were also generous in offering to conduct an evaluation alongside the project which will used to measure the project and identify the success or not of the project. So far all practice consults have been successful. Staff at Springhill can see multiple benefits in the use of this technology

Benefits foreseen:
- Travel costs reduced
- Staff costs reduced
- A more efficient, faster and convenient service for patients at Springhill prison
- More education for Springhill staff
- Safety for staff and patients

CONCLUSION

This project will be completed in three months' time so tentative results will be presented at the conference.

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The digital age of occupational therapy home visits

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INTRODUCTION

Home visits for occupational therapists in an inpatient setting are time intensive, removing the occupational therapist from the ward and reducing their availability to see other patients. A home visit requires preparation, planning, the visit, report writing, ordering equipment (if required) and liaising with family/multidisciplinary team. During the home visit the occupational therapist has the opportunity to observe functional performance, ascertain if adaptive equipment might be beneficial, identify access issues, liaise with family to develop a plan to support the patient at home, discuss risks with the patient and their family (if appropriate) and to assess if the discharge home is likely to be sustainable. An average home visit takes between of 3-4 hours.

USE OF TECHNOLOGY AND/OR INFORMATION

There is an emerging trend in using technology as a means to increase efficiency and effectiveness of occupational therapists in a variety of settings. An occupational therapy environmental questionnaire has been developed for use with relevant patients, and/or their family/friends, taking photographs of the patient's environment and specific measurements to gather information regarding the home environment. The occupational therapist can obtain a visual view of the home environment and measurements without leaving the ward. The benefits of this project include: providing the best care for our patients via utilisation of resources and technology indicating when a home visit is required, and the use of technology to offer an alternative option to a home visit, resulting in completion of home visits by a therapist for high complexity patients only.

IMPLEMENTATION/PROCESSES

A pre-trial questionnaire was completed to gather therapist's perceptions of this new way of working. The questionnaire will be completed again in September. A three month trial of the environmental questionnaire is underway, currently in the last month. Patient experience data will be gathered to understand the experience of friends/family members who have supported the project. The number of environmental questionnaires being completed and how many negated the need for a home visit based on the photographs and measurements provided will also be collected for analysis.

CONCLUSION

The trial is due to finish at the end of August 2017, with the available data being collected and analysed. As at 4th August 2017, 59 environmental questionnaires have been completed with therapists indicating 10 home visits have not being required as a result of the combined use of the environmental questionnaire and digital photographs.

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The eMeds Journey – midway learnings

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INTRODUCTION

The safety of electronic medicines (eMeds) solutions cannot exist in isolation from their context of use. Studies show that the adoption of eMeds solutions in hospitals is a complex sociotechnical activity that can facilitate errors in environments lacking comprehensive management, coordination, a well designed system and continuous improvement processes. Indeed, design and implementation is not simply a technical problem, but one of optimizing the combined socio-technical system (inclusive of technology, people, processes, organisational and external environmental factors)

USE OF TECHNOLOGY AND/OR INFORMATION

Taranaki District Healthboard (TDHB) is one of the three initial pilot sites for electronic medicines management in NZ. It was tasked with an integration focus and to date has implemented automated drug cabinets (Pyxis, 1999, hospital wide), medicines reconciliation (Orion SMT, 2011, 68% patients), local ePharmacy (2010, hospital wide) then a regional version (2015, Midlands wide) and ePrescribing/Administration (MedChart, 2012, 40% patients). However hospital wide implementation of all systems is incomplete and integration is limited. This contributes to inefficiencies and workarounds that can impact patient safety.

IMPLEMENTATION/PROCESSES

For each individual implementation, workflow analysis and a pre and post evaluation was carried out to optimise system benefits and minimise threats to patient safety. However ongoing evaluation has been more ad hoc as resources have allowed. More latterly, due to delays in the hospital wide implementation of a fully integrated solution, a global "stocktake" was undertaken of the current state of the medication use process at TDHB and how it had been impacted. Areas of risk have been highlighted and investigation is ongoing. Of particular note is how the Pharmacy service has changed, including a massive shift from discharge to admission interventions. This has directly impacted patients' medicines management at discharge and has the potential to cause harm.

CONCLUSION

The digitalisation of the medicine use process offers a wide range of patient safety benefits but there are also unintended consequences. While the implementation of each individual eMeds solution at TDHB was evaluated to ensure patient safety, partial implementation, lack of integration, the cumulative effect of multiple unintended consequences across systems and the increased use of pharmacists as a backstop for workarounds, has resulted in reduction of some pharmacy services, including medicines management for patients transitioning to the community. A continuous quality improvement approach encompassing the entire medicines use process is required to mitigate such risk and ensure that the patient safety benefits of eMeds' solutions are realised.

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The Future of Healthcare is in the Cloud

Lorna GREEN[1], Laura PIETROMICA[1]

1. Hyland

INTRODUCTION

Over the last 10 years, healthcare organisations have embraced electronic health records (EHR) and enterprise content management (ECM) systems to create a better clinician and patient experience as well as manage and secure content. Traditionally premise based, the future lies in the Cloud.

USE OF TECHNOLOGY AND/OR INFORMATION

Storing content in the Cloud can help address the organisation's disaster recovery needs by backing up your content in multiple locations. Content is still available even if you experience hardware failures, power outages, inclement weather or catastrophic events. Healthcare organisations receive a vast amount of personal health information (PHI) daily, which can be lucrative to hackers. To combat the dramatic increase in malicious and intentional security breaches, Cloud vendors encrypt content while in use, in transit and at rest. Local data centres cater to geographically specific compliance and security regulations. Cloud based deployments are cheaper with no up-front purchases. Organisation pays for what they use making it easier to scale users, storage and resource levels up/down as required. Reduced up-front cost, only paying for what is used, and eliminating the need for additional staff allows the organisation to deliver a faster return on investment.

IMPLEMENTATION/PROCESSES

When considering a Cloud solution make sure you are not sacrificing functionality. Remember that there will still be elements of the business that still takes place on the ground. Pieces of paper will arrive in the mail or with the patient, and someone has scan the paper on a physical scanner. For a Cloud solution to be practical and all encompassing, it must account for the fact that paper still exists and incorporate data extraction from physical documents into the Cloud alongside its digital data. Similarly, a Cloud solution has to play nicely with your organisations other business systems, which may or may not be in the Cloud. All systems must integrate seamlessly to be effective. Lastly, look for a vendor that has years of experience, an established history of outstanding service levels and security, and a large customer community your organisation can interact with and learn from.

CONCLUSION

Perhaps it is time to raise a call to action to ensure that sensitive PHI is secure and not prone to malicious attack. Perhaps it is time to get our heads in the Cloud and be ready for the future of healthcare.

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The General Practice Train Wreck- Dealing with same day acute demand using GP Triage and an Advanced Form

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INTRODUCTION

The problem facing general practice is to ensure that patients presenting acutely get an appropriate appointment, without adding to the overburden already being felt by GP's. Practices working in the "Health Care Homes" model are meeting this challenge using doctor triage, a process that helps doctors prioritise and manage same day demand. This involves a doctor calling back patients seeking a same day acute appointment to determine appropriate care.

The challenge was how to support doctor triage in a way that safeguards clinicians doing triage but is also simple and intuitive. We also needed to capture the outcomes of triage, allow service invoicing and monitor/evaluate the triage process.

USE OF TECHNOLOGY AND/OR INFORMATION

Created an advanced form in MedTech was central to addressing the challenge. The structure of the form is designed to align with the natural flow of a consultation. An invoicing function is built into the form. The form sets a standard process for undertaking clinical triage that is medico-legally safe, integrated with the PMS and has audit capability. It's simple enough to require no end-user training.

IMPLEMENTATION/PROCESSES
1.   Mapped the doctor triage process/outcomes.
2.   Validated the process/outcomes with clinicians.
3.   Drew up a prototype form
4.   Approach Procon to develop the advanced form
5.   Loaded the form at 3 practices for testing
6.   Finalised advanced form specifications
7.   Develop reporting capability on outcomes/key metrics
8.   Went live with Clinical Triage using the advanced form

CONCLUSION

The Clinical Triage Form has been used by 7 doctors since 23 March 2017. As at 30 May, 451 triage calls have been made with 37% requiring a same day appointment, 54% resolved over the phone during the triage call. Of the remaining calls, 19 were booked to a future appointment, 1 referred to another service, 23 were unable to be contacted and 1 was not completed. The average time taken per triage call is 1 minute 18 seconds.

GP's doing triage tell us they're much more in control of their acute demand and have all but eliminated double booking. From here we will be rolling this advanced form out to more doctors nationwide. Next step is to develop a similar form/process to allow clinicians to manage virtual/telephone consults.

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The good, the bad and the ugly of implementing a DHB wide Virtual Health Care tool

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1.   Waikato DHB

INTRODUCTION

We all know that we are facing massive challenges with an ageing workforce and population. How do we maintain a healthservice in the face of this adversity without our providers reaching breaking point? Waikato DHB is the largest rural DHB in the country with 60% of our patients living in the rural environment and a Maori population of 22%. Waikato DHB also provides tertiary services to the other Midland DHBs. In this environment we have adapted an American application which provides a communication channel and information holding between patients and clincians. This presentation will cover the challenges and successes of implementation and a glimpse at the future.

USE OF TECHNOLOGY AND/OR INFORMATION

HealthTap provided the DHBs application and we have worked in partnership to develop a useable application suitable to the NZ environment. This has meant finding safe ways to store information, protect privacy and enable patients to have as painless a sign up process as possible. It has meant re-working how we operate our outpatient clinics and engage with our patients and the community as well as engaging our Clinicians to work differently.

IMPLEMENTATION/PROCESSES

Currently we have over 6000 patients enrolled in the application with about 500 consultations through text and video over the past 3 months. This includes consultations in a virtual after hours service for urgent health needs. We are actively engaging services to work through requirements with them and should have at least 4 more outpatient services using the application by November with good data to discuss.

CONCLUSION

It has been a very challenging 2 years for this project which has been significantly slower than we had hoped. However by discussing the challenges and successes we hope to engage in further conversation as to how applications such as this may help us not only with our workload in the future but also have patients manage their health better.

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The Role of Health Records in IT Governance

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INTRODUCTION

The digitisation of healthcare is a wonderful thing since it brings greater collaboration between clinicians and health records and provides higher quality and safety of care. However, digitisation also brings challenges around the governance of the electronic health record (EHR).Developing and maintaining an organised governance program is imperative to success in the digital age. Without governance, chaos will ensue and the full potential and benefits of the EHR not reached.

USE OF TECHNOLOGY AND/OR INFORMATION

Governance begins as an initiative from leadership and forming an IT steering committee is the first step in the process. The IT Steering committee should have:1. Structural aspect involving software acquisition and evaluation, long-term planning and financial considerations2. Process aspect ensuring that decision made benefit the entire organisation with correct input gathered before moving forward3. Cross representation from IT, Health Records, Clinical (i.e., Physicians, Nursing, Allied Health, and Pharmacy), Finance and Administration.

IMPLEMENTATION/PROCESSES

As the governance process matures, advisory teams from individual specialties maybe formed to ensure that quality of care and patient safety are at the forefront of any software or process changes proposed. Committees and teams should meet on a regular basis and have accountability to leadership.The voice of Health Records bridges the communication gap between technology and clinicians. Health Records will ensure that the digitised record is a valuable and usable tool for the organisation. Health Records staff should be empowered to provide input to the steering teams helping to ensure that the electronic record is meeting the needs of the patient and the staff caring for them.The audience will take away the following learning points:1. The benefits of forming an IT Governance structure2. The components of an IT Steering Committee3. The role and value of the Health Records professional on the committee.

CONCLUSION

Without a clear Governance processes in place, the implementation of an EHR can become a beast bigger than anyone can tame. Forming an IT Steering committee early on will provide the ability to evaluate, plan and implement technology to its fullest. Organised IT governance structure is a required component of the HIMSS analytics EMR adoption model (EMRAM) and having one in place will benefit organisations striving to reach Stage 7.

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The Wonderful World of Renal Basics - an Online Learning Platform.

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INTRODUCTION

Renal (kidney) patients are multi-morbid, have complex acute medical problems and are challenging to manage medically. Part of their care provision is the training of local medical staff (particularly nurses, both renal and non-renal) in the hospital and community. Such renal education includes pre-dialysis, dialysis, transplant, dietetics, medications and conservative management. Nationally there was no renal online learning resource. Independent renal units had their own education booklets. Locally, a paper package presented restrictions: updating, reprinting, collating and combining into booklets. Completed booklets required grading, returning to participants and liaising with human resources to facilitate learning hours credited. With increasing medical acuity and numbers of renal patients, the need for more efficient methods of renal education is called for, hence the move from paper-based to paperless online learning; Renal Basics Platform (RBP).

USE OF TECHNOLOGY AND/OR INFORMATION

The RBP has several key features: user-friendly, self-directed, free, web-based and with remote support. Accessible from anywhere, anytime and on any device: desktop, laptop, tablet and mobile phone (Windows, Android or Apple), this package gives complete flexibility to the student/user (from home, office and out-of-hours) and also the teacher/provider (freed from providing physical presence and paperwork for verifying learning credits). RBP has 8 modules and covers a range of renal topics (including kidney anatomy/physiology, in-patient care, dialysis, fluid balance and electrolytes).

IMPLEMENTATION/PROCESSES

Management endorsement and attendance of a computer language workshop were important initial requisites. RBP was written using PHP (Hypertext Pre-processor, a general purpose computer scripting language) and Moodle (open-source software with a General Public License). The content (written in easy-to-understand language) was amalgamated from previous paper package form plus current international guidelines for kidney patients (ISPD and KDOQI). Before general release, a pilot course involved 10 participants (from a variety of health fields, including a renal physician) to test interpretations, outcomes and feedback. Since its release, RBP uptake has grown, with 350 current enrolled users. Staff and patient feedback were excellent: all reported marked knowledge improvement and all would recommend to others. The platform content is continuously updated remotely.

CONCLUSION

RBP has excelled in renal knowledge dissemination and is a viable and sustainable education option. It is cost-effective, labour-efficient, flexible and far-reaching with reduced carbon footprint. Increased engagement by all parties leads to better patient outcomes. By decreasing time spent on basic renal education, renal nurses regain quality patient-nurse direct contact. Future plans include aiming nationally, integrating pre/post course surveys, making RBP more interactive and creating a patient-specific platform.

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Triple T effect of e-referrals for Allied Health

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INTRODUCTION

Allied Health referrals have historically been all paper based and triaged by multiple clinicians. This resulted in taking away from valuable clinician TIME with patients, inconsistency with triage outcomes and also an unreliable paper trail of events with valuable communication attached but not TRACEABLE or TRANSPEARENT to the multidisciplinary team. We have implemented e-referrals for all our Paediatric Allied Health referrals through a central referrals system of which all referrals are electronically processed by an Allied Health Clinician, Triage coordinator. One particular discipline on which we have been able to have the entire referral process electronic is our Dietetic outpatient service.

USE OF TECHNOLOGY AND/OR INFORMATION

Initially our Dietetic outpatient team were not part of our central referrals system; however we were receiving a number of their referrals. We were then having to decline these referrals and send them on with the triage process starting again through their service via fax and were processed all on paper. This took extra TIME and because this was all on paper none of this was TRANSPARENT to others involved who could not access the paper file nor was it TRACEABLE if in any of the triage stages were missed.

IMPLEMENTATION/PROCESSES

Proposal made to transfer all Paediatric Allied Health Dietetic referrals to be triaged through e-referrals at central referrals and then electronically forwarded to Dietetic practitioner for prioritisation and then administrator for booking. This decreased triage TIME spent by the Dietetic clinician as they are not dealing with declines or having to gathering extra information. As all these referrals are transformed into an electronic referral and sit on the patients electronic file has resulted in the referral and triage information being easily TRACRABLE and also TRANSPARENT to all involved with the child.

CONCLUSION

Time and effort was put into setting this up right at the start, with good processes and also very clear referral criteria. The central referral process has enabled TIME to be saved and given back to clinician's to work on their clinical caseloads. Implementing the electronic process of these referrals through the e-referrals system has provided a safer triage system that is electronically TRACEABLE as you can view the history of who and where the referral is at any time. It has also provided clear communication as TRANPARACY to all who can access the patient's electronic file of which is where all clinicians have access to and our community therapist have their own electronic devices.

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"Txt" Follow-up of Regional Anaesthesia

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1.   Counties Manukau Health

INTRODUCTION

In late 2015 Counties Manukau Health (CMH) Anaesthetic Department commenced a pilot programme to trial the use of text messages to follow-up patients who received regional anaesthesia as part of their care.   This programme showed that a text message platform is an efficient, low cost method that allows early identification of post-operative complications and an effective way to be more responsive to the needs of patients.

USE OF TECHNOLOGY AND/OR INFORMATION

Regional anaesthesia (the numbing of an area of the body by placing local anaesthetic around major nerves) is commonly used to provide pain relief – usually following surgery. It can also be used as a sole anaesthetic technique for patients who cannot (or do not wish to) have a general anaesthetic. Major complications are rare, but 2-3% of patients have neurological symptoms (abnormal pain, weakness or numbness) persisting beyond the first couple of days, and 1/4000 have symptoms present at 6 months. A further subset is made up of patients who have other, less significant concerns that they may wish to contact an anaesthetist about. Because major problems are so rare, few centres contact their patients to follow them up. Those centres that telephone all patients allocate up to 20 minutes of time per call. This was an unaffordable resource at CMH, where we perform >2000 regional anaesthetics a year. Sadly, without a ready means of contact, the small fraction of patients who needed help struggled to access it.

IMPLEMENTATION/PROCESSES

Because 96% of CMH patients have a cell phone, we hypothesized that text message follow up would be an efficient, scalable way to follow up patients. In our trial patients received a text message 3 days after block insertion, inviting them to text back if they had any concerns. On interview, our initial series of 12 patients were unanimously positive, with all stating that text was their preferred method of contact. Of the first 100 patients, 10% texted back and were phoned by a Pain Nurse Specialist. One of these patients required specialist review; the others were appropriate for phone advice and reassurance.

CONCLUSION

Based on our experience, text follow-up was integrated into the perioperative software suite we have been developing. This means that an anaesthetist can schedule a follow up text at the time of performing a regional anaesthetic procedure, and the process is almost entirely automated. The service has also already been adopted by another DHB on a trial basis.

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Use of secure clinical communication including images for realtime clinical advice

Steve VLOK[1]

1. Celo

INTRODUCTION

Clinicians often seek advice or expertise from their colleagues. This can be done in a number of ways but many clinicians currently make use of their own smartphones to either record and/or communicate information (including images) to a colleague for advice. Smartphones have an enormous intrinsic value as they are easy to use, can allow capture of clinical images and allow connectivity with a large amount of information irrespective of the location of the clinician.

USE OF TECHNOLOGY AND/OR INFORMATION

Celo was introduced as a clinical communication tool both in secondary care and primary/community care that facilitated the secure use of smartphones to record and communicate patient information on the go (including photographs). Nurse Maude and Canterbury District Health Board have adopted the use of Celo in several of their departments.

IMPLEMENTATION/PROCESSES

Implementation of Celo is very straightforward, and it takes less than 5 minutes to download the Celo app and register the user to get started. Feedback from users was hugely positive, and the ease in which the Celo application was able to be used made the adoption from clinicians almost instant. Learning to use Celo is easy as it is very similar to familiar messaging tools such as email, text or apps such as Facebook Messenger or WhatsApp. Clinicians felt comfortable and at ease that they were able to get the patient's consent for images recorded using Celo and also that the Celo application was Ministry of Health approved and secure/auditable.

CONCLUSION

Overall, Celo is a secure tool that has been used for communication between departments and for accessing expertise in real time. At Nurse Maude, Celo has been used in the community, and the ability to share wound images has been found to reduce the need for referral for appointments with clinical specialists when used to obtain advice at the point of care. Follow up clinical images can also be sent. Images have the time/date/NHI attached, and an e-consent form can be generated and attached to the photo. The "read" reports are beneficial for staff knowing others have seen the message. At CDHB, Celo has been used within the secondary care setting and the ability for colleagues to collaborate with each other using their smartphones significantly reduces the amount of time spent on the phone as well as the capacity to get hold of the right expertise quickly with information rich communication allowing almost instant advice.

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Usefulness of an online clinical education portal for acute medical management of meningococcal disease

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1.   St John of God Hospital

INTRODUCTION

Description: Meningococcal disease is a life-threatening, rapidly developing medical emergency. Physicians will rarely encounter such cases. Maintaining current knowledge with the presenting features, diagnosis and urgent management of meningococcal disease is therefore most challenging for physicians especially in geographically isolated practices. A high quality online education portal, with evidence-based best practice guidance and background links to journal references, is useful to support clinical decision making. An example of this will be presented in the context of a clinical case of meningococcal disease. Resource will be demonstrated in "real time" during the presentation.

USE OF TECHNOLOGY AND/OR INFORMATION

Outline of Presentation: Australian rural GP working in the Emergency Department at a Health Service treats a 15 year old female patient, with apparent flu-like symptoms. Rapid worsening of symptoms/signs occurs, and it appears that the diagnosis is more significant than a viral flu syndrome. Meningococcal rash appears. Early blood results suggest bacterial sepsis. GP uses DynaMed Plus (DMP) to provide clinical decision support. Inclusive online portal also provides links to other local context best-practice diagnosis and treatment guidelines. DMP provides immediate action plans for initial management/workup, diagnostic tests, and antibiotic advice. Links to the National Therapeutic Guidelines are embedded in DMP. Links to recent evidence-based articles are immediately available in DMP. Further management and ongoing care is provided. The key entry point to all of these linked resources is via DMP, in a time critical situation. Patient doesn't survive despite best standard management with urgent IV antibiotics and supportive care. Follow-up of this case involves support for staff members involved in the patient's care, and focused intensive support for the family and friends of the patient. Important part of the follow-up is a full case discussion and education programme for the medical and nursing staff to try and help should a further similar presentation be encountered in future at the Health Service. Journal club meeting is convened to discuss current guidelines and evidence-based approaches to meningococcal disease. Full search of recent peer-reviewed articles is easily obtained through the DMP portal, to help the doctors preparing the education session. Nurses and medical students writing up a case report about this patient can also use the functionality of the literature review section of the relevant DMP topic articles. DMP offers functionality and a current peer-reviewed evidence base to support the clinical decision making, general education, journal club meetings and case report preparation in relation to this case.

IMPLEMENTATION/PROCESSES

N/A

CONCLUSION

N/A

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User experience design and mhealth apps – an application to child growth charts

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INTRODUCTION

New Zealand's obesity epidemic has not spared children, among whom Māori and Pacific children experience a disproportionate burden. The 2016 NZ Health Strategy includes strategies for early prevention of obesity in childhood, among them better child growth monitoring. Child Growth charts are tools used by clinicians and parents/caregivers to track the growth of a child over time and visualise both normal and abnormal growth trends in children. This is particularly important for children who are overweight or obese; if recognised early, follow up action can be undertaken. It is well documented that child growth charts are not well understood by either parents/caregivers or health professionals. This project aligns with the 2016 NZ health strategy priorities of innovative health technologies and proactive monitoring of child growth.

USE OF TECHNOLOGY AND/OR INFORMATION

Currently growth charts used in New Zealand are paper based, research shows interpretation of these charts is poor. We propose developing a child growth chart as a mhealth application to expand the possibilities of how growth charts can be designed. This change in format from paper to digital will change the way users interact with growth charts and has the potential to improve understanding of growth charts and child weight status.

IMPLEMENTATION/PROCESSES

Currently I am completing a literature review of the history of child growth charts, the different formats of child growth charts today, mhealth and design theory. While there is some research on electronic health record integrated growth charts, and limited research exploring the importance of growth chart design and user preferences there is no research on the best way to design and present electronic growth charts that improves use and understanding. To date, we have found no research on interactive app-based growth charts. To explore this, we are conducting an online survey to firstly investigate how user experience design can aid understanding of complex health information and secondly establish user design preferences.

CONCLUSION

This research will contribute new knowledge on user design preferences with the aim that it will contribute to a larger project currently proposed by the National Institute of Health Innovation that will explore the impact of app-based interactive growth charts. The potential to apply the findings from the processes undertaken to other fields is significant for NZ but also has the potential to be adapted to meet the needs of countries world-wide. In this presentation, the steps used and outcome developed will be discussed.

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Using a Data Discovery Tool (Qlik Sense) for General Surgery Care Redesign

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2. Waitemata DHB

INTRODUCTION

Our project has used the data discovery tool, Qlik Sense, to develop a patient pathway explorer for General Surgery, which is supporting changes to the way care is delivered. This presentation details the end-to-end system, from the development of the best practice protocols for three common conditions (appendicitis, acute cholecystitis and abscess) to the development of a Qlik Pathway Explorer to track against the pathway, to the use of that data to drive reduction in unwarranted variation in care, length of stay and cost of care. Traditional BI tools primarily provide static reports with limited end user interaction, and a focus on operational reporting. Access to our vast and rapidly growing clinical datasets was limited to a small, centralised team of analysts. Our clinicians want agile, interactive solutions, and the more technically savvy demanded a self-service capability.

USE OF TECHNOLOGY AND/OR INFORMATION

Our DHB is undertaking a large-scale implementation of Qlik Sense, with a plan to have over 1000 users within two years. We had a clear directive from our Chief Executive: it must benefit clinicians wanting to improve patient outcomes and experience. Accordingly, each dashboard has a clinical lead who guides the design and content. To release the bottle-neck on access to clinical data, clinicians are given access to build their own dashboards. Building one dashboard, the General Surgery Patient Pathway Explorer, started with clinicians developing best practice pathways. The Qlik explorer brought together data from many sources to track each patient's adherence to the pathway, including Emergency Dept presentations, ward stay, radiology, surgical pathology, laboratory tests, pharmacy, surgery, complications, acute booking details and costs.

IMPLEMENTATION/PROCESSES

The service had never had access to all data in one place before, focused around a patient cohort, so the first phase involved improving data quality and refining criteria by drilling down to the patient level. The data has enabled the clinical team to identify opportunities to improve patients' experience and reduce variation, length of stay and cost of care, and thus an improvement project has commenced led by the Clinical Director.

CONCLUSION

Qlik provides the rapid translation of evidence into clinical practice. We have seen the value of putting integrated data into the hands of clinicians with the insight and willingness to change clinical practice. The real value is only realised when data access and visualisation is an integral part of a larger clinical change culture.

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Using Electronic Prescribing Data to direct Antimicrobial Stewardship

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INTRODUCTION

The World Health Organisation has identified antimicrobial resistance as a critical threat to modern medicine and recently proposed several objectives for addressing this including antimicrobial stewardship (AMS).AMS within Canterbury District Health Board (CDHB) hospitals consists of a multidisciplinary committee focused on rationalising use of antimicrobial agents to optimize both patient outcomes and improve antimicrobial resistance patterns. Critical to effective AMS is accurate information on antimicrobial usage, both quality and quantity. At CDHB quality based assessments are largely confined to audit of paper-based prescribing. Quantity based assessments currently rely on post-hoc review of antimicrobial issues from pharmacy dispensing software which does not accurately reflect administrations to patients nor the prescribers involved. CDHB has no readily achievable method of identifying patients who could benefit from a ward round to optimise antimicrobial therapy, except via referral from clinical staff.

USE OF TECHNOLOGY AND/OR INFORMATION

In 2016, CDHB implemented MedChart electronic prescribing and administration software.   In order to gain meaningful use from this software solution, local efforts were developed in parallel with implementation to extract and parse data from the MedChart database. A list of 'high interest' antimicrobials was provided by the AMS committee; a query and subsequent workflow was created from this to identify patients that could benefit from an AMS ward round. The reporting mechanism was adapted to facilitate daily updates and identification of ward patients.

IMPLEMENTATION/PROCESSES

Utilizing a workflow extracting data from a daily backup of the local MedChart database with data cleaning and analytics via R and Tableau, a pilot dataset of 3 months of surgical ward antimicrobial prescribing data was created. Analysis of this retrospective data was performed (including adherence to AMS guidelines), and resource implications for AMS were quantitated.

CONCLUSION

From the retrospective data, 176 unique prescriptions of 'high interest' antimicrobials were identified. There was a median of 2 antimicrobial prescriptions per day (range: 0 - 7). An indication for the antimicrobial was entered in only 36 cases (20%), and of these only 14 (8%) indication entries provided adequate information to meet AMS guidelines. The advent of MedChart prescribing within CDHB, with in-house developed data extraction, allows an AMS team to explore real-time, system-wide proactive identification of patients who may benefit from review. Based on the successful pilot identification of cases, a prospective pilot will be completed by October 2017. The next steps are to expand this service across Christchurch Hospital, link this prescribing data with data warehouse data and develop an automated process.

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Using the ProCare Risk Stratification Tool

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INTRODUCTION

It is evident that the majority of hospital admissions come from a relatively narrow and defined cohort in the population. Similarly significant general practice workload is generated by relatively few patients. There is a spectrum of strategies to reduce the burden of disease - targeting individuals with the highest need who use the most health resources. We chose long term condition management because it is near in time to a likely poor outcome but not so close, as in acute care, where the event is already happening. I will then highlight some of the strategies used to stratify patients according to risk.

USE OF TECHNOLOGY AND/OR INFORMATION

Before we started the Risk Stratification project we mapped out the process and used a tool called Alteryx to clean and load the various data sets. Tableau visualisation tool was used to build dashboards for viewing consistency of data before reporting was sent to each practice. The final report and RSD type messaging was co-designed with our GPs. I will show some of these reports and others that demonstrate the risk stratified population.

IMPLEMENTATION/PROCESSES

I will show how the model is developed by looking at a population and seeing who had an acute hospital admission. Then we look back two years and using regression analysis determine what factors were associated with those admissions. I will touch on each of the four data sets we used and show which of the variables were contained in the final algorithm. We included 800,000 individuals in this analysis which is a considerable number and supported patient centered care planning. Patients acutely admitted are six times more likely to be in the high risk group. I'll then show how we successfully used the algorithm for early outcome HbA1c control.

CONCLUSION

The most important factor is the intervention that supports people to a better health outcome. Efficient targeting of resource to individuals who have greater risk of poor health outcomes. There were several lessons learnt getting to this point. Implementation proved to be a challenge - Sourcing data from ~200 practices and three DHBs. Getting frequent data feeds that were consistently reliable - satisfying the algorithms requirement for two years of events. My presentation has a number of charts and infographics to show our risk stratification journey and findings.

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Virtual Reality - A Starter Kit

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INTRODUCTION

Limited affordable and effective non-pharmacological solutions to reduce pain, anxiety and depression presented an opportunity for investigation.

USE OF TECHNOLOGY AND/OR INFORMATION

This investigation led to the development of a variety of easy-to-use Virtual Reality solutions to aid patients whilst enhancing patient experience. The solution is a mash-up of story-telling, clinical assessment tools, Pubmed research, directly observed behaviours and clinician contributions. This mash-up manifests itself in various virtual reality solutions, which are based upon cloud gaming platforms deployed to consumer grade technology.

IMPLEMENTATION/PROCESSES

A 90 day innovation programme investigated areas where Virtual Reality could be used as an alternative solution or to enhance existing models of care. This investigation led to the identification of the following therapies, for which solutions were defined, developed and some implemented.

Exposure (Play) vrTherapy: Facilitating a virtual practice run for children and families prior to scheduled procedures with the aim of reducing anxiety, building confidence, and improving patient experience.

Distraction (Game) vrTherapy: Active and passive distraction for children and adults prior to, during and following procedures with the aim of relieving anxiety, pain, discomfort, and improving patient experience.

Activation vrTherapy: Encouraging normalised and spontaneous movement for chronic non-malignant pain patients.

Cognitive Behavioural vrTherapy: Providing an opportunity for depression relief and a coping strategy for long-stay patients and families.

The programme created four different Virtual Reality solutions, delivered by two hardware models, two different cloud-based platforms and off-the-shelf and custom virtual reality experiences. The content is mapped into a vrFormulary which outlines the criteria for use for specific procedures. Exposure, Distraction and Activation vrTherapy have been implemented and are in use. The outcomes for patients going through the experiences are further informing the vrFormulary which will continue to be shaped as virtual reality is used more and more.

CONCLUSION

The hardware, content and vrFormularies together form what we call the vrPharmacy. Improved patient experience and outcomes have been observed in patients who have gone through virtual reality therapies from the vrPharmacy. We recently wrapped up our initial implementation of the three aforementioned solutions. The biggest challenge we faced was engagement from clinical staff. However, once the value of virtual reality became clear, clinicians largely advocated for the technology. We are currently looking at operating model impacts of making the vrPharmacy more widely available in the hospital as well as in community and patient homes, and supporting formal research trials to formally assess virtual reality's benefits.

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Virtual reality and healthcare: a CLEVRER approach?

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1.   Waitemata District Health Board

INTRODUCTION

Life-threatening ward-based emergencies are high-pressure incidents that are often clinically complex. Our most junior members of staff are usually the first to attend. With the stakes so high, experiential learning in this context is far from ideal. We here present a solution that involves innovative use of virtual reality—the CLEVRER study (Clinical Learning Evaluation of VR Emergency Roles).We currently train Post-Graduate Year 1 doctors using didactic lectures, simulation and small group seminars. These training methods are limited due to [their resource-intensive nature] [difficulties booking rooms, securing facilitators and time constraints]. High-fidelity simulation replicates the fast-paced environment of an emergency but is also time- and resource-intensive. Training delivered off the wards also reduces staffing. Rotation and rostering of junior doctors creates significant challenges for standardised training delivery and attendance over the course of the year.

USE OF TECHNOLOGY AND/OR INFORMATION

Virtual reality (VR)—3D interactive environments—offer an as yet untapped opportunity to provide on-demand, highly realistic training. Innovations such as google glass and increasing smart phone capabilities mean it is increasingly affordable and accessible. VR has been used extensively to teach surgical skills and for patient rehabilitation. To date no published work has applied VR to teaching junior doctors as a group, or acute ward emergencies as a subject.

IMPLEMENTATION/PROCESSES

Seed funding was sought from within our organisation. A specialist advisory group was formed including junior doctors, senior doctors and medical educationalists to develop content. The group worked with an external vendor to develop five scenarios. A pilot study was conducted with both quantitative and qualitative arms, aiming to assess feasibility, effectiveness and experience.

CONCLUSION

We now better understand the resource requirements for creating effective VR. Initial observations have shown how junior doctors interact with new technology. From an education perspective we've learnt how to craft an effective scenario for educational purposes. It is particularly important to define learning objectives very clearly and obtain universal agreement in advance. The more we work with this technology the more possibilities within the wider healthcare industry reveal themselves. Our experiences have scratched the surface of what VR can offer in this field. As the technology and technical capabilities grows the only limiting factor will be our vision.

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Waitemata DHB Leapfrog Programme: Phase 2

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INTRODUCTION

Waitemata District Health Board (DHB) commenced a CEO-sponsored programme of strategic DHB-wide projects (the Leapfrog Programme) over 2 years ago. The accelerated innovation programme involves initiatives identified as likely to have a significant impact on the DHB's priorities of improving health outcomes and experience, and that will enable a substantial step towards digital transformation. Many of these initial projects have now come to a close. These were presented at last year's HINZ conference. A second phase of the Leapfrog Programme was approved by the Board. This presentation will update progress.

USE OF TECHNOLOGY AND/OR INFORMATION

New technologies being explored in the second phase of Leapfrog projects include check in kiosks and online booking for outpatients' clinics, a patient engagement system, a business intelligence tool for clinicians, and cloud technology to improve existing systems. Mobility continues to be an important stream of work, with apps now being pushed out to devices via the mobile device management programme and being developed via the mobile enterprise application platform.

IMPLEMENTATION/PROCESSES

The Leapfrog team have continued to refine their processes for prioritising and fast-tracking projects. The Programme is supported by Waitemata DHB's new Institute for Innovation and Improvement (i3) and pre-existing Health Information Group. New roles have been developed particularly around clinical change management, data and IT innovation support. The team also works closely with healthAlliance and increasingly with the regional DHBs. Projects continue to be seen as short-medium term steps with large impact on the road towards a future vision of a more digital integrated ecosystem.

CONCLUSION

Success factors have been CEO/Board support, clinical leadership and ownership of projects, selection of appropriate projects, building a great team/capability, a 'doing' philosophy, and a future focus.

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What is Distributed Healthcare? And why is it so important to put the patient at the centre of their own care?

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1.   Orion Health

INTRODUCTION

Distributed healthcare is the concept of providing decentralised care services and moving these closer to the people who need them. This way a healthcare system can help to keep people healthy and in their own homes, by providing the right care and support, at the right time.

USE OF TECHNOLOGY AND/OR INFORMATION

At the beginning of this century, healthcare services were predominantly provided in the home. With the evolution of modern medicine, hospitals replaced house calls. The advantages of hospital-based care, however, have started coming under scrutiny, especially with the high operational costs involved. Could you achieve the same outcome by maintaining the same level of healthcare to people by shifting the service provision away from high-cost settings and back into the person's home?

IMPLEMENTATION/PROCESSES

Moving services into a person's home has the potential to improve quality, reduce costs and improve the experience for the patient. Current home-based healthcare provides greater convenience and satisfaction for patients; this is especially true for older and less mobile people. Interdisciplinary teams monitor the patient and identify any exacerbation in their condition, then proactively manage the patient to prevent any hospitalisations. These teams provide coordination for the patient's care and involve their family. Home-based healthcare programs serve patients goals rather than just treating the disease. They put the patient at the centre of their own care. The issue is how does a health system transition from the traditional model to the new model of distributed healthcare? The new model creates complexity requiring coordination of services across multiple organisations, providers, community and social services. This requires a common data platform to enable a shared, dynamic view of the person's medical record.

CONCLUSION

Being able to view a secure shared care record allows timely, safe and informed decision–making to occur, for and with the patient. A study from Canterbury DHB outlines their journey to provide an integrated person-centred health system that crosses the boundaries between primary, community and hospital-based care. Canterbury's program helps to prevent acute admissions to hospital. It's designed to meet the needs of all people who would otherwise be referred to hospital but who can safely be managed in the community. This submission will discuss distributed healthcare and the concept of providing healthcare services closer to home with the primary example being Canterbury DHB.

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World First for Health Underwriting

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1. Accuro Health Insurance

INTRODUCTION

In May, Accuro launched the world's first automated underwriting platform for health insurance. We wanted a way for members and advisers to be able to receive an offer of terms as fast as possible while still providing great service with a low error rate. Under the previous system of operating with a pen and paper, multiple phone calls and back and forth, it could take days to complete the health questionnaire and receive an offer of insurance. Often details would still fall through the cracks as people attempted to get through the process as fast as possible We were looking for a way to change this when we were approached by Intelligent Life and QuoteMonster.

USE OF TECHNOLOGY AND/OR INFORMATION

The online tool is accessible to advisers via QuoteMonster and our website. It allows users to answer a series of yes/no questions and arrive at an outcome for their health insurance. If there are no exclusions, the policy is automatically issued on the spot. If there are more complicated aspects to the application then one short call is all that is required. The automated underwriting platform is a giant step towards a more efficient and effective way for consumers to have more control and remove the common barriers of delving into health insurance.

IMPLEMENTATION/PROCESSES

Underwriting needs to be a very thorough process so that we can get a full understanding of the individual's health situation. A major challenge was looking at our questions and changing them to yes/no rather than full written answers. It meant having to change how we got to a decision while still making sure that we covered the risk to Accuro and kept things fair to the member. The result is that there are still some situations that still require light manual underwriting. Regardless, we have significantly streamlined the process and we can issue a fully underwritten policy on the spot day or night and from anywhere in the world in 30min.

CONCLUSION

The whole process moved faster than we expected and the feedback has been extremely positive. We are the first health insurer in the world to release automated underwriting, an amazing feat for our small not-for-profit. We already see the success of the platform with applications rolling in right off the bat. We would like to show attendees at the HiNZ annual conference how we made a previously challenging part of health easy and accessible.

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NZNI
Case
Studies

70 years of paper was weighing heavy on nurses

Sally DENNIS[1], Michelle NICHOLSON-BURR[1]

1.   CMH

INTRODUCTION

Introduction (setting, problem/challenge)Nurses have battled paper charts for decades and as the rest of the world embraces electronic recording and are enjoying the ease of storing and searching information, New Zealand has been slow to adopt modern methods. This paper will walk the listener through the experiences of two nurses in early adopter wards as they transition from a paper-heavy system to a paper- light one with the introduction of an electronic nursing enabler.

USE OF TECHNOLOGY AND/OR INFORMATION

Use of technology and/or information (for the problem/challenge)As X Hospital celebrated its X birthday in May 2017, we were still managing the recording of patient vital signs and nursing assessments in a similar way to 1947. Earlier work by other DHB's not only paved the way for electronic systems to be introduced, it also informed our change process. Implementation of an electronic system to record information electronically instead of in a paper form was an exciting development for bedside nurses. The initial phase switched from completing paper based observations, monitoring forms, nursing and risk assessments, to that of inputting patient information electronically via iPad minis. . Managing the change in practice has seen various reactions and engagement. Nurses needed to not rely solely on the information captured electronically, they needed to continue with analysing a raft of information to make informed decisions using their critical thinking.

IMPLEMENTATION/PROCESSES

Implementation/Processes (what you did, how it went)The importance of working alongside nurses during their journey from paper-heavy to a paper-light environment was recognised early in the planning phase. A team of clinical coaches was developed to efficiently and effectively walk beside the early adopter wards throughout this transition. . This paper will outline the lived experiences of two nurses in the early adopter wards who were involved in transitioning from the old world, of entering the same information in up to four places, to the new world of information being pre-populated, having automatic scheduling, and the ability of viewing real time and accurate data, together with extracting reports.

CONCLUSION

Conclusion (outcomes and lessons learnt)Early engagement with stakeholders demonstrated the collaboration required when disruption to workflow and current practice was going to occur. This is an example of how a small change in the way information is recorded and how it is used, has opened up a refreshing new way of working for nurses.

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A structured approach to telephone assessment of palliative patients in District Nursing

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INTRODUCTION

Around 8% (n=1200) of all District Nursing referrals to Nurse Maude are for palliative symptom control. In some cases telehealth support calls are used to monitor symptoms, promote self-care and prevent unnecessary visits for both the patient and the service. Calls are relatively unstructured. This project sought to design, develop and trial a standardised holistic screening tool for District Nurses to complete and share within the team electronically.

USE OF TECHNOLOGY AND/OR INFORMATION

Each nurse was provided with cues to support the palliative assessment process, guidelines for rating KBS and instructions for using the documentation. Nurses used mobile devices (tablets) to document outcomes of calls on using a macro-enabled word document, which was then saved to a shared network folder. The document captured call data, patients' symptoms and related problems classified according to the OMAHA standardised taxonomy. Patients' knowledge, behaviour and status relating to problems was scored using the Omaha KBS rating tool.

IMPLEMENTATION/PROCESSES

Following initial literature review and development of the tool the implementation involved an iterative process of trialling the tool in practice. Roll-out of the tool to the pilot team took place over a one-week period and was facilitated by the Informatics Nurse who provided individualised training.

CONCLUSION

The tool provided a standard framework for assessing palliative care clients over the phone. The project also provided an opportunity to trial the Omaha KBS scoring system with district nurses. The nurses were positive about the tool and supported its more widespread introduction. The concept of having cues in the form of questions relating to problems that the client identified was identified as particularly useful for those new to palliative care, and students. Following the trial some of the nurses have continued to use the tool within their teams. The trial provided the organisation with valuable information in a number of key areas relevant to the development and upcoming roll out of its Electronic Health Record. This included information on the use of the Omaha System in an electronic form, using technology in the field, and highlighting the amount of slowdown that needs to be factored into the District Nurse's day to accommodate the introduction of tablets and e-records which likely require more information being captured than in their traditional hard copy.

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Aggregation of Tacit Knowledge in Health IT Development: Hearing the Nurses' voice

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INTRODUCTION

In all aspects of healthcare, nurses have been identified as the primary users of electronic health records (EHRs), making them responsible for a large portion of the documentation surrounding quality and safety measures, and the overall clinical representation of the patients' health. Moreover, as nurses operate in the forefront of healthcare, they directly influence the implementation outcomes of any health IT. However, the knowledge and experiences of nurses are commonly undervalued and underutilised in the development of health IT. As a result, developed health IT solutions tend to fail the expectations of nurses who uses it most. The question then is, how do we involve nurses as active contributor to the development and maintenance of health IT?

USE OF TECHNOLOGY AND/OR INFORMATION

The openEHR clinical knowledge manager (CKM) enables the collaborative and cooperative contribution of domain experts' tacit knowledge from different walks within the field of interest. The aggregating of tacit knowledge provides developer with a perspective to the diverse expectations of end-users, whereby the developed health IT is better suited to achieving its intended use. Through this approach, nurses are able to voice their concerns and recommendations, thereby enabling them to contribute to the development of health IT, thus offering a new insight to addressing the challenges within health and healthcare.

IMPLEMENTATION/PROCESSES

Our research study followed the international openEHR review of the tobacco smoking summary archetype. We aimed to explore and understand the socio-technical aspects of the archetype development that enables the accurate capture of patient smoking data, whilst achieving data interoperability and reusability. The aggregation of tacit knowledge assisted the developers in aligning their vision with the concerns and recommendations of domain experts, ensuring that subsequent development of health IT is better able to achieve its intended use.

CONCLUSION

The rise in the burden of disease signifies the need for healthcare systems to be vigilant in adapting to the ever-changing demands of the population, which is largely achieved through the interoperability and reusability of data amongst all sectors of health and healthcare. The involvement of nurses in the development of health systems offers the addition of untapped tacit knowledge that could be of great value to health system developers. Furthermore, as nurses operate in the forefront of healthcare, it is essential that they be involved in the strategic planning and implementation of health IT.

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Delivering education to RNs across the Waikato – a new insight into reaching health professional communities for ongoing clinical education

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INTRODUCTION

Building on the increased use of video communication technology (VCT) in health care, this paper looks at the response and efficacy of using VCT across a region to cross continuum groups of nurses.

USE OF TECHNOLOGY AND/OR INFORMATION

The advantages of VCT for education has been recognized as a highly flexible instrument to reach students across a variety of locations, while being adaptive enough to address a wide range of learning modes. There is considerable potential for reducing equity issues by ensuring access to education, consistency of care provision, and increased knowledge and understanding between care and social support providers.

IMPLEMENTATION/PROCESSES

The Nursing and Midwifery Professional Development Unit (PDU) at the Waikato District Health Board (WDHB) delivered a 2-day workshop via VCT in August 2016 for registered nurses (RNs) working across the Waikato region. In collaboration with the Waikato Institute of Technology (WINTEC) nursing department the expectations from the participating nurses and their responses after the workshop were collected and evaluated. The main broadcasting centre was established at Waikato Hospital Wairoa building, linking to five hubs in DHB facilities around the district. Each hub had a nurse educator acting as a facilitator to provide onsite guidance and to interactive group activities. Presentations and discussions were viewed and engaged with in real-time by all participating RNs.

CONCLUSION

The data gathered encompasses the responses from the participating RNs to the mode of delivery, the content of the workshop, and the connection with the wider nursing community in their areas. The paper presented will also show the advantages of engaging staff from a variety of clinical settings, and from a facilitating perspective, how future planning of similar educational sessions could be moderated following this experience.

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Electronic Assessment Cross Referencing: A quality improvement opportunity

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INTRODUCTION

The connection of support services to patients who would benefit has always been dependent lead carers (typically nurses and midwives) offering and then completing a referral or connecting the patient to a service. Feedback from patients and support services indicated this connection too frequently does not occur. With the introduction of the Whakataketake combined risk assessment the challenge was to find a way to re-address these missed connections.

USE OF TECHNOLOGY AND/OR INFORMATION

The electronic Whakataketake combined risk assessment is completed for all inpatients within Whanganui DHB, this allows ward staff to identify patients who wanted support services such as the Te Hau Ranga Ora (THRO) Māori heath team with a single click on the wider assessment. This removed the need for ward staff to refer patients, as the THRO team would simply pull clients from the electronic system into their service.

Despite this service improvement patients and services continued to 'miss' each other. The electronic assessment improved connections, but a seamless process had not been achieved.

The challenge was now to identify where the system was failing and how data driven evidence could improve the service delivery to an extent that would ensure a seamless connection.

IMPLEMENTATION/PROCESSES

Baseline data from the Whakataketake indicated the number of patients who wanted to see the THRO team. An assessment was developed to be completed by the THRO team after patient contact. Data from these assessments were cross-referenced within an excel format. The resulting data indicated that many patients did engage with the THRO service, however this need was not identified on their initial assessments, also many patients who wanted to be seen by the THRO service were not.

Evidence indicating the level of unmet demand was presented to the THRO team and processes were developed to improve the outcome for patients wishing to engage with the service. This data when presented to the wards has increased awareness of the number of patients who actually wanted THRO support.

CONCLUSION

Cross-referencing of electronic assessment data has allowed a new perspective to be taken of service delivery and act as an enabler for organisational change. This quality improvement has increased the uptake and the delivery of our THRO service to those requesting it. Improved access to THRO services is anticipated to improve Māori patient satisfaction levels and improve coordination of services as they progress back into community setting.

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Embedding nursing informatics in the curriculum to connect nursing to digital health

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INTRODUCTION

All countries face the challenge of preparing nurses for future practice with advances in technology, increasing consumer expectations and changes in healthcare. Nurses need to be prepared to work in a digital health environment. Despite the efforts of many and evidence of the need, nursing informatics is not routinely included in nursing curricula both in New Zealand and internationally (Australian Institute of Health and Welfare, 2015; Department of Health, 2012; Parry et al., 2013; U.S. Department of Health and Human Services, Health Resources and Services Administration, & National Center for Health Workforce Analysis, 2014).

USE OF TECHNOLOGY AND/OR INFORMATION

Using a curriculum mapping approach three New Zealand Schools of Nursing examined how nursing informatics is woven through their respective curricula showing the development of a nursing informatics curricula thread. The respective curricula were mapped against the Australian 'National informatics standards for nurses and midwives' (Australian Nursing and Midwifery Federation, 2015) as no New Zealand guidelines currently exist.

IMPLEMENTATION/PROCESSES

Using the Australian standards each School of Nursing mapped their current undergraduate nursing content into three domains: Computer Literacy, Information Literacy and Information Management. Once mapping of content across these domains was completed it was evident that there were gaps in the current curricula in regards to nursing informatics. Measures to address the gaps include ensuring students undertake a self-assessment of digital literacy on admission, self-reflect on their own information technology (IT) capabilities, ensuing the curriculum meets graduate attributes in regards to IT capability. Throughout the curriculum students need opportunities to be introduced to nursing informatics concepts and skills, have those concepts and skills reinforced, and have the opportunity to apply those concepts and skills in clinical practice.

CONCLUSION

We envisage that results of this content mapping will inform the development of New Zealand nursing informatics competencies specific to undergraduate nurse education and support the 17 nursing schools across NZ to produce work-ready nursing graduates. We acknowledge that, embedding nursing informatics within a nursing programme brings a number of challenges including that of having faculty who are prepared and confident to teach this subject, and the role modelling of safe and appropriate use.

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HealthTap Ready: Evaluation around use of HealthTap in Aged Residential Care Facility

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INTRODUCTION

HealthTap Ready aims to support Aged Residential Care (ARC) facilities to develop processes to incorporate HealthTap into their business as usual. Health services internationally face the impending challenges of an aging population, alongside an aging workforce. This District Health Board (DHB) region is no different, with predictions that the 65 plus age group will have increased 33% by the year 2026. In order to address this challenge, providers need to consider alternative models of service delivery. In particular healthcare is moving towards closer to home, more patient directed services which align with the current Waikato DHB Strategy.

USE OF TECHNOLOGY AND/OR INFORMATION

One way of allowing patients to have greater control over the location and timing of their medical intervention is virtual healthcare. In 2016 this DHB initiated "The Virtual DHB" (now SmartHealth) powered by the application HealthTap. This was in addition to the telehealth system which uses a secure internet network to link health professionals throughout the DHB.

IMPLEMENTATION/PROCESSES

By using Kotter's eight stage model for change management the group have worked with an ARC facility to review how HealthTap could be implemented to support healthcare delivery to residents. Through this process the group identified and overcame obstacles to develop a process for implementation, which included the development of a starter pack to become 'HealthTap Ready'.

CONCLUSION

Once integrated and productive partnerships have been developed with ARC facilities, it will assist in eliminating health inequalities for aged care in rural communities. It will deliver quality timely services to meet the needs of ARC populations, reducing the need for unnecessary travel by providing a people centred service. Future recommendations to facilitate this initiative are: Outpatient appointment rollout needs to be in place with key services that impact on the ARC population before any further implementation in ARC facilities takes place. Build upon the enthusiasm of the ARC staff, to utilise them to share their experiences and to support future ARC facility implementations. The DHB to develop productive partnerships with other ARC facilities to implement use of HealthTap. To investigate which virtual health product, i.e. Telehealth and/or SmartHealth, is more appropriate in delivery of outpatient appointments and out of hours doctor service.

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ID: 645 - NURSING INFORMATICS CASE STUDY

Improving Strength, Balance and Agility - Grace's Story

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INTRODUCTION

Grace [1] is 83 years old, living alone in a central Auckland suburb. Grace attends a weekly programme for those who are socially isolated. She has fallen in the last year and is worried about falling again. She is frightened to go out by herself. When a Strength and Balance programme was advertised, Grace was encouraged to enrol.

USE OF TECHNOLOGY AND/OR INFORMATION

Grace's individual assessment (Sit to Stand, Timed Up and Go and 4 Step Balance tests) prior to commencing the programme gave her real insight into which aspect put her most at risk of falling. In her personal work-book she had her scores mapped on her chart and could see those scores that were in the shaded pink area meant she had a higher risk of falling. The focus for Grace was both strength and balance as both these scores initially put her in the "at risk of falling" range.

IMPLEMENTATION/PROCESSES

Grace attended all 10 weeks of the programme. She learnt about keeping safe during the programme, had her own personal handbook which included a homework diary and instructions and diagrams on homework exercises. The programme is set to well-known music with the tempo increasing as the session progresses, there is a quiz around the music, the focus is on fun rather than the awful 'E-word' that many of us avoid! Grace started the programme standing using a chair as support but as her confidence grew she mostly was comfortable doing her routines free-standing. Grace participated well in the programme, and week 10 came around quickly. Grace once again completed her Sit to Stand, Timed Up and Go and 4 step Balance tests. She was delighted to see how much improvement she had achieved. During the programme she had said how much better she was feeling, however when she could see the improvements on her graph, and the fact that now she was no longer in the pink zone, she was very proud of herself.

CONCLUSION

Grace improved her balance by 30%, her agility by 20% and her strength by 18%. She has developed some friendships with other group members and has committed to a regular walking group. Grace was convinced by the tangible before and after measurements that demonstrated her improvement. Grace tells me she has her confidence back and that she feels well again.

[1] Not her real name.

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Move to "Paperlite": Progressing the Electronic Patient Record at a new Day Stay Facility

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INTRODUCTION

In early 2015, a private not-for-profit surgical hospital, made the decision to build a new stand-alone Day Surgery facility on its campus. The goal was to move all of its Ophthalmology and Endoscopy cases out of the main theatres to the new facility, to be followed by other services such as Day Stay Urology, Orthopaedics and other minor procedures. The hospital uses TrakCare as its Patient Administration System (PAS). The system was implemented in 2007, is integrated and utilises a module based platform. However, despite having many items recorded electronically, like many organisations, there is a plethora of paper records that are used in conjunction with the electronic records. Upgrades to the system over the years often focused on implementing "Like-for-Like" functionality meaning that new functionality was not often utilised.

USE OF TECHNOLOGY AND/OR INFORMATION

The opening of the new facility in July 2016, was the impetus to move forward in the digital health world. From the outset, the plan was to establish new clinical processes and to utilise existing functionality of the hospital's PAS to its maximum benefit in order to reduce paper documentation as much as possible. The goal to become "Paperlite" rather than "Paperless" wherever possible was felt to be realistic and achievable.

IMPLEMENTATION/PROCESSES

We have successfully implemented the use of a comprehensive Electronic Patient Record (EPR), transitioned to using mobile tablet devices for much of the clinical charting, have progressed to on-line documentation for nursing notes and now automatically upload and graph vital signs. Pre-operative phone assessments drive scores and on-screen icons to highlight clinical risks and we will soon be progressing an electronic discharge summary and are working with the Theatre staff to transition to on-line intraoperative charting.

CONCLUSION

We have certainly learned a few things along the way, in terms of what worked and what didn't and the plan is to move these changes and improvements back to the main hospital. All of these changes involved the IT Staff, our vendors, a variety of clinical users including the Director of Clinical Services, the Manager and front-line nursing and administrative staff. We've also engaged our Consultants to trial charting directly online for Discharge Summaries. We believe that these changes have been significant improvements to the quality of the data and the availability of the information across the EPR and relate well to the theme of the NZNI 2017 conference of "Making Connections in Digital Health".

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Pathways to Improving Practice

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INTRODUCTION

The Primary Health Care (PHC) Nursing Development Team (NDT) supports 30+ new graduate nurses over a geographical area that includes Waiheke Island, Auckland City Centre, Wellsford, Kaipara, Warkworth and New Lynn. We visit these nurses infrequently due to the large geographical area, so we are closing the gap with online connections. This diverse group of nurses have different learning styles, knowledge, backgrounds and work in variety of settings, including PHC, aged residential care (ARC), Hospice, Plunket, NGOs including Iwi and Pacific providers. We identified that we need to work smarter and in a different way, our resources need to stretch further – we need to do more for less.

USE OF TECHNOLOGY AND/OR INFORMATION

Moving beyond the classroom we established an online presence with a forum for connecting and disseminating information. We began providing dynamic resources online as the new graduated nurses needed them, giving access to previously hidden gems. The nurses are able to access the forum and resources when and where they want, at a time convenient to them. Their access does not expire and is not limited to working hours. The resources are continuously updated to ensure current best practice.

IMPLEMENTATION/PROCESSES

With guidance from the Learning Technologies (LT) team, we were able to explore different technique to engage learners, develop our team's capability to independently manage our learning community's space. Training was provided to the nurse educators (NEs) to develop the site, encouraging them to step outside of their comfort zone and embrace new technology and new methods of teaching and learning. With the support of the LT team, the PHC NDT created space where students could collaborate, discuss, and get the most up-to-date resources.

CONCLUSION

Our knowledge in learning technologies continues to grow as we gain experience and work with the LT team further. The NEtP online space has improved access to resources and increased learning opportunities for new graduate nurses working in PHC. There is interest from other PHC groups to use this resource, and the NEs are building confidence in discussing these opportunities. Future plans: Evaluation of current site and then co-design with new graduate nurses to implement improvements to meet end user needs. The PHC NDT continues to work with the learning technologies team to facilitate teaching sessions for NEs to use the platform to its full capacity.

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Rural Renal Nursing Telehealth: Expanding from Virtual Clinics to Research

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INTRODUCTION

The Bay of Plenty (BOP) renal service falls within the catchment area of the Midland Regional Service (Waikato). The Waikato hub provides renal support to the spokes (the two satellite units of BOP: Tauranga and Whakatane). The Rural Renal Nurses (RRNs) who run these units face unique challenges due to geographical isolation: increased medical vulnerability, reduced engagement with the hub and reduced professional educational opportunities. The adoption of telehealth, which includes innovative video technology for both clinical (direct patient care) and non-clinical (education, managerial and research) uses has helped address this vulnerability. The RRNs who form crucial links (by acting as proxies for the physicians in the virtual clinics) end up up-skilling not only in clinical skills, but also in academia: research, presentations and publications.

USE OF TECHNOLOGY AND/OR INFORMATION

RRN research development in BOP has not really started until recently. Integrating virtual technology into daily practice has created multiple opportunities for learning, coaching and an explosion of research opportunities which incorporates data collection, data analysis, abstracts preparation, conference presentations and publications. All the prep work has been done almost exclusively using virtual video technology by linking in with physician-mentors.

IMPLEMENTATION/PROCESSES

Infrastructure for video links was already well established from running the virtual clinics between BOP and Waikato: Cisco Jabber system, webcams, multiple computer screens and rooms for the consultations. The research development simply utilized existing infrastructure. Within 2 years, at least 10 RRN abstracts (including this one) were formulated, discussed and developed using virtual technology. In particular, the detailed analysis and complex calculations of data (using Excel spreadsheets) were shared and discussed using the screen sharing component of Cisco Jabber. In addition, the design of at least 4 posters and 2 slides presentations for various conferences were facilitated using video links; with multiple practice sessions conducted via telelink. This has, in turn, spawned the submission of several publications in medical journals (with two articles in press at present).

CONCLUSION

The extension and development of the role of RRNs in research is completely unexpected in the evolution of telehealth in BOP. Uniquely, RRNs could now actively participate in high-level research in ways that were previously impossible; the virtual connections have increased mentorship with renal physicians and other allied specialties. Indirectly, the telehealth-facilitated research has expanded the role of RRNs and fostered a culture of learning, auditing, measuring, publishing and service improvement. This has led to improved healthcare for patients and expanded the horizons for professional nursing development.

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The Trial Implementation of Electronic Prescribing Software within Critical Care at North Shore Hospital, Auckland

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INTRODUCTION

Electronic prescribing and administration (ePA) systems enable the prescribing, dispensing and administration of medicines to be recorded electronically. It aims to reduce medication errors through improved legibility, dose calculation and clinical decision support. They have been found to significantly reduce harm to patients caused by medication errors and adverse drug events. As a result of this, the Ministry of Health is keen to introduce ePA systems throughout New Zealand. The electronic prescribing process at Waitemata was commenced in 2015. MedChart (the ePA of choice) had been implemented successfully throughout the DHB, with the notable exceptions of the Emergency Department and Critical Care. The aim was to provide increased legibility, accountability and efficiency to a process of prescribing that differs considerably to ward based medicine. In August 2016, Waitemata DHB recruited ICU/HDU at North Shore hospital to participate in a trial implementation. The six bedded ICU and eight bedded HDU is staffed by seven Senior Medical Officers, six Medical Registrars and approximately fifty Registered Nurses. Following a period of training for prescribers and administrators and suitably equipping the unit, the trial period commenced. It was limited to scheduled medications and PRN prescriptions as the management of intravenous fluids and titration of infusions was considered too challenging for the software in the first phase. A project team consisting of Senior Medical Officers, Registrars, Nurses and Pharmacists was established and met formally on a weekly basis. The goal of the project team was to develop the ePA system to the best of their ability before formally evaluating it. The team addressed problems relating to the hardware, the software, the environment and any issues staff were being faced with at the bedside. Weekly action plans were produced to overcome each of the challenges with clear ownership assigned to the appropriate member of the MDT. Considerable changes were made to the hardware that supported the ePA. This saw the introduction of IT in each of the bed spaces, which provided clinicians with greater access to other healthcare data systems at the point of service delivery. In March 2017, the Critical Care staff were formally surveyed and whole project was evaluated. Despite the notable progress that had been made, the unit chose not to adopt this ePA system for Critical Care at North Shore.

USE OF TECHNOLOGY AND/OR INFORMATION

N/A

IMPLEMENTATION/PROCESSES

N/A

CONCLUSION

N/A

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The Wonderful World of Renal Basics - an Online Learning Platform

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INTRODUCTION

Renal (kidney) patients are multi-morbid, have complex acute medical problems and are challenging to manage medically. Part of their care provision is the training of local medical staff (particularly nurses, both renal and non-renal) in the hospital and community. Such renal education includes pre-dialysis, dialysis, transplant, dietetics, medications and conservative management. Nationally there was no renal online learning resource. Independent renal units had their own education booklets. Locally, a paper package presented restrictions: updating, reprinting, collating and combining into booklets. Completed booklets required grading, returning to participants and liaising with human resources to facilitate learning hours credited. With increasing medical acuity and numbers of renal patients, the need for more efficient methods of renal education is called for, hence the move from paper-based to paperless online learning; Renal Basics Platform (RBP).

USE OF TECHNOLOGY AND/OR INFORMATION

The RBP has several key features: user-friendly, self-directed, free, web-based and with remote support. Accessible from anywhere, anytime and on any device: desktop, laptop, tablet and mobile phone (Windows, Android or Apple), this package gives complete flexibility to the student/user (from home, office and out-of-hours) and also the teacher/provider (freed from providing physical presence and paperwork for verifying learning credits). RBP has 8 modules and covers a range of renal topics (including kidney anatomy/physiology, in-patient care, dialysis, fluid balance and electrolytes).

IMPLEMENTATION/PROCESSES

Management endorsement and attendance of a computer language workshop were important initial requisites. RBP was written using PHP (Hypertext Pre-processor, a general purpose computer scripting language) and Moodle (open-source software with a General Public License). The content (written in user-friendly language) was amalgamated from previous paper package form plus current international guidelines for kidney patients (ISPD and KDOQI). Before general release, a pilot course involved 10 participants (from a variety of health fields, including a renal physician) to test interpretations, outcomes and feedback. Since its release, RBP uptake has grown, with 350 current enrolled users. Staff and patient feedback were excellent: all reported marked knowledge improvement and all would recommend to others. The platform content is continuously updated remotely.

CONCLUSION

RBP has excelled in renal knowledge dissemination and is a viable and sustainable education option. It is cost-effective, labour-efficient, flexible and far-reaching with reduced carbon footprint. Increased engagement by all parties leads to better patient outcomes. By decreasing time spent on basic renal education, renal nurses regain quality patient-nurse direct contact. Future plans include aiming nationally, integrating pre/post course surveys, making RBP more interactive and creating a patient-specific platform.

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Towards a Paper-Light system for Haemodialysis Treatment Documentation

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INTRODUCTION

Thrice weekly unit-based haemodialysis treatment for kidney patients require hardcopy documentation for each session (patient observations and dialysis parameters); generating vast paper-based records. These records are stored in tiny satellite dialysis units (separate from the main central records). The lack of administration staff results in haphazard storage and tracking issues. Over time, space becomes an issue; especially for deceased or inactive patients. The result is increased clinical risk, with privacy and safety issues due to reduced care continuity. A nurse-led strategy towards a paper-light system for haemodialysis documentation could improve the management of these files.

USE OF TECHNOLOGY AND/OR INFORMATION

Key issues of a paper-light system include security, cost, compatibility, ownership, usability, legality and ethics surrounding documentation. One simple solution is scanning clinical data (PDF into renal folders) directly into existing Hospital IT System (HITS) together with other records (patient demographics, clinic attendances, laboratory results and clinic letters). However, a specialist interactive renal data system is superior: entirely digital, easily accessible (web-based), secure, user-friendly (with individual logins) and seamlessly linking with the current HITS. Examples include Proton, Vital Pulse and Data Therapy Management Systems (Fresenius); all are already in use (both in New Zealand and internationally) but have huge associated costs.

IMPLEMENTATION/PROCESSES

Initial discussions with local stakeholders have taken place and the concept has been agreed in principle, with ongoing enquiries regarding the various data management systems. The dialysis treatment data for each session in local haemodialysis machines is downloadable, but the system is not widespread in New Zealand. With dialysis tender renewal negotiations still ongoing, any IT system decisions cannot be finalised presently. However, discussions with IT and clinical applications team are ongoing towards development of a Digital Haemodialysis Pro-forma (DHDP); for documenting the progress of each haemodialysis session.

CONCLUSION

Once this project is implemented, predicted outcomes include: reduced clinical risk due to increased clinical data sharing and the freeing-up of valuable storage space in the haemodialysis units. This concept could also apply to peritoneal dialysis patient files. So far, the enterprise has revealed a huge amount of red tape. Involvement of all stakeholders would take considerable time and progress is likely to be slow. The next steps would involve further research into the various options, the development of the DHDP and a cost-benefit analysis of all options. Finally, a business case to fund this project is required. This can only be achieved after a wider discussion and approval from all the various stakeholders.

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Transplant patient follow-up via video-consultation using a novel patient portal (smarthealth) – a New Zealand first experience

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INTRODUCTION

Kidney transplant recipients require regular out-patient follow-up which is especially frequent in the first post-transplant year (approximately 38 visits between months 2-12). Conventionally patients in the first post-transplant year are required to come to the transplant clinic in the Waikato Regional Renal Centre regardless of their domicile. This could mean several hours of travel time for those in out-reach areas as our renal unit covers a very wide geographical area with patients spread across four different district health boards (Waikato, Bay of Plenty, Lakes and Tairawhiti). The consequences for patients with this approach include, petrol costs, loss of earnings due to time off-work, physical strain and less time with family.

USE OF TECHNOLOGY AND/OR INFORMATION

Transplant patients were offered the opportunity to sign-up to SmartHealth, a novel patient-portal. SmartHealth can be accessed via a website link or through apps on Android and Apple devices. It enables patients to link with members of their health-care team (doctors, nurses and allied health-care staff) and communicate with them through both text messages and have video-consultations with staff via a secure link.

IMPLEMENTATION/PROCESSES

Enrolment was focused on patients within the first post-transplant year.   Training to use the video-link was also provided where needed using a dedicated technician. Clinics were conducted by a consultant.

12 patients signed up on SmartHealth.10 patients were from outside the Waikato DHB catchment area. Between 16th Jan 2017 and 19th May 2017 we scheduled 41 video-consultations via SmartHealth. This saved 128 hours of travel time and 9389 kilometres of travel distance for patients. Petrol costs saved for patients is $7229.00. All of the patients reported excellent satisfaction with the video-consultations.

CONCLUSION

Enabling patients to have their transplant appointment by a video-link resulted in considerable cost and travel time savings which was hugely appreciated by the patients. A formal assessment of clinical outcomes and satisfaction measures are planned for the future.

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Untying the hands: The information we have, the information we need and want

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1. Nova Healthcare

INTRODUCTION

Within health we have a huge amount of information; much of this information is poorly utilised. We see every day clinicians double handling information: nurses who document paper notes, and then these not making it back to the clinicians in the community in a timely manner. In some situations we restrict the flow of information; this can result in a huge cost to our populations and our patients. Clinicians are often not empowered by information but slaves to inputting it. Systems need to be improved.

USE OF TECHNOLOGY AND/OR INFORMATION

The ultimate challenge is to empower clinically lead decision making. To achieve this, I focused on using an array of technology to connect information in an understandable way for clinical use.

IMPLEMENTATION/PROCESSES

I have worked on many projects and gained insights to efficient and inefficient ways to implement best practice, the processes to follow to aid clinicians to get the most out of their information, and negotiating the barriers that exist. We learned a lot working with regional e-pharmacy data and were successful in aiding pharmacists to review and discuss clinical prescription variations between clinical staff. We learnt different skills when applying techniques to Oracle data, procurement and finance. Knowing what data was available and where, enabled us to overcome many hurdles. However, empowering the clinicians on the floor to have access to the information they need is the most important goal, in my opinion. National datasets can have huge clinical benefit but are often tied-up in the back offices. What information do clinicians want and need?

CONCLUSION

Working across many datasets from E-pharmacy to Oracle financial systems, from HR systems to National datasets (such as NBRS, NMDS, NCCP, NNPAC etc). This is a saga of the ups and downs of the implementation of data driven clinician engagement. We can reduce information collection through providing information out of other systems to save clinical time. We can improve healthcare by giving clinicians access to a wider array of information. We do have the ability to automate reports, reduce barriers to access, make the service more efficient and fit for purpose. We have had many successes, a range of failures and a lot of learning that I believe would be extremely useful to help in collaboration. We can do this, we have the information. It's a matter of taking the initiative, collaborating, and implementing the systems.

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HiNZ Scientific Papers (Abstracts)

A review of theoretical frameworks for telehealth to support effective research

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ABSTRACT

Embedding of telehealth into routine care remains problematic and some scholars have recommended a broader systems-approach to understand this with consideration of theoretical frameworks. The telehealth literature was searched using a systematic process and a large, diverse body was identified. Much of the research is atheoretical and when theories are considered they are not necessarily developed specifically for healthcare. Following a critique of exemplar theories a sociotechnical systems theory approach is suggested as a useful framework for examining the complex, adaptive system in which telehealth sits.

KEYWORDS

Telehealth, theory, sociotechnical systems

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A Semantic Web based Framework for Linking Healthcare Information with Computational Physiology Models

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ABSTRACT

Linking healthcare information which nowadays is becoming vastly available with computational physiology models can be instrumental for enabling personalised and predictive clinical decision support systems. In the computational physiology domain semantic interoperability heavily relies on Semantic Web technologies and utilise ontology-based annotations but a wealth of useful information and knowledge sits in EHRs where this technology has limited use. openEHR and ISO13606 provide open standards for the structure, storage and exchange of healthcare data which readily support terminology/ontology based bindings that be exploited to link the two domains. This linkage will be bidirectional which means it will enable data discovery for computational modellers and also model discovery for clinical users. Since the openEHR specifications now underpin many national programs and regional implementations this can unlock unsurmountable potential to create both model and data driven personalised and predictive analytics. Having fit for purpose and standardised ontologies (such as Gene Ontology, Foundational Model of Anatomy) and clinical terminology (such as SNOMED CT, LOINC, ICD) have been a critical first step. However there is still a need to create mappings between these ontologies and develop standard annotation protocols. We describe our high-level methodology with an emphasis on ontology mapping using a crowd-sourcing approach.

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Computational Model Discovery for Building Clinical Applications: an Example of Epithelial Transport

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ABSTRACT

Comprehensive descriptions of computational models of biological systems captured by way of formal ontology based annotations can enhance biomedical research and clinical practice. Semantic annotation helps finding the right model for solving a particular problem which can be a patient-specific prediction. This approach can also be utilised to find relevant health data required to drive personalised and predictive clinical decision support systems. However efficient tooling for annotation using diverse domain ontologies and a model repository to discover and share such knowledge resources are needed. Tools and standards in the computational physiology discipline have evolved over the years such as CellML to encode mathematical models of biological systems, SemGen to describe and annotate real-world ontological meaning; and the Physiome Model Repository to store these models and metadata to ensure the encoded knowledge is persistent, identifiable, and discoverable. In this paper we present how to put these tools and resources to work using an example of solute transport in the kidney.

KEYWORDS

Model discovery, CellML, PMR, epithelial model, clinical decision support systems

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Enhancing Clinical Safety through Traceable Model Transformations

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ABSTRACT

"Logical FHIR" resources are now permitted by the HL7 FHIR Standards. This implies that a mapping is needed from these Logical Models to FHIR Implementation Models which reuse (or profile) the standard resources. Revision 3 of FHIR introduces a draft FHIR Mapping Language specification to provide a mechanism to facilitate such mappings. It also allows models expressed in other type systems to be mapped to FHIR Implementation Profiles. The authors have been transforming logical and implementation clinical records models using an implementation of the declarative dialect of OMG's standard for MOF Query/View/Transformation (QVT) transformation language. This paper outlines these approaches and their relationships. We then introduce an approach to traceability inspired by OMG-based model transformation tools which could assist in the separation of concerns between clinically-focussed modellers and technology-focussed implementers, thereby improving clinical safety. Finally, we show how traceability is used in an open-source health informatics modelling tool.

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Is a Fusion of OSS and Commercial Providers better for Healthcare Systems?

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ABSTRACT

EHR adoption has increased rapidly over the last 10 years, boosted in several countries by government stimuli and the threat of financial penalties for non-adoption. Unfortunately this growth has not yet generated the much hoped-for significant cost efficiencies and improvements in patient care. Instead, cases of massive cost overruns and implementation disasters are now common, and the commercial EHR market has condensed down to a few dominant players, thereby reinforcing traditional problems such as vendor lock-in, poor interoperability, and slow evolution and innovation. In stark contrast, the broader software industry has seen a veritable revolution over the last 10 years, driven by the Open Source Software (OSS) movement. Over 90% of software companies surveyed in 2016 found that OSS has improved efficiency, interoperability, and speed of innovation, and 55% had already included OSS in their company's deployed code. Significantly increased usage of OSS has been seen across all industries, and also in all software architectures from operating systems to cloud computing. This paper will describe and compare two successful open-source EHRs that have active long-term developer communities, and discuss the promising future of such systems to meet the challenge of reducing costs and increasing efficiency whilst significantly improving patient care.

KEYWORDS

OpenMRS, OpenEMR, Open Source, EHR

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openEHR Approach to DCM Development: Lessons Learnt from the International Review of the Tobacco Smoking Summary Archetype

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ABSTRACT

Data modelling for electronic health records (EHRs) is complex, requiring technological and cognitive sophistication. The openEHR approach leverages the tacit knowledge of domain experts made explicit in a model development process aiming at interoperability. Our research aim was to explore the data modelling process for a tobacco smoking summary archetype and its implications on information systems development with specific reference to interoperability. The first author became a member of the OpenEHR Clinical Knowledge Manager review platform and observed a set of reviews of the tobacco smoking summary archetype, and the editors' discussions following each iterative review, and made field notes. The first author also interviewed eight reviewers. The data were analysed using a general inductive thematic approach. The success of the openEHR approach was mostly attributed to a very large and active community of relevant domain experts, the insightful coordination and guidance of the editors, and a well-defined process with excellent tooling support by the openEHR CKM.

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Supporting older adults to age in place using technology: Findings from a workshop of experts

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ABSTRACT

This paper presents findings from an ongoing project which explores how the use of innovative technologies can be used to distribute information and knowledge throughout an older person's formal and informal networks to better support them to live independently in their own home.   The project examines the requirements of different stakeholder groups if technologies such as social media, digital devices and Smart home technologies are used to integrate healthcare providers more closely with the informal social support network of an older person.   This paper presents the finding from a workshop of experts conducted at the HINZ Conference in 2016. We find that this approach will result in changes in relationships between different stakeholder groups and will require ongoing negotiation and adaptation of boundaries and responsibilities in the provision of care and support.

KEYWORDS

Aged Care; E-Health; Telehealth; Social Media

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The Internet of Things and Big Data: Benefits and the Risks to Confidentiality and Privacy in the Era of Connected Health Devices

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ABSTRACT

The Internet of Things (IoT) and big data analytics are creating new opportunities in all industrial sectors and healthcare is not immune from this data tsunami. The benefits include improved patient care, lowered healthcare costs, faster research and development of new drugs, and more rapid responses to public health risks. In the headlong rush to acquire these benefits however, the privacy of the patient and the confidentiality of their data are at risk of taking a back seat to progress. This article outlines the benefits arising from the use of IoT and analytics in healthcare and describes the risks to patient confidentiality and privacy that healthcare providers, from individual clinicians to healthcare administrators, meet when working within this new paradigm.

KEYWORDS

Big data, Internet of Things, Privacy, Confidentiality

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Author
Index

Author index, in alphabetical order by first name

Petrina CHAI **16**

Phoebe ELERS **139**

Pieter RODENBURG **5**

Ping-Cheng WEI **118 138**

Priscilla VAN OORSCHOT **36**

Qian Yi CHUAH **13 51 108**

Quentin-Gabriel THURIER **48 66**

Rachael MCLEAN **6**

Randall BRITTEN **88**

Rebecca GRAINGER **24 81**

Rebecca MCCARROLL **6**

Rebecca MUIR **72**

Reece ROBINSON **12**

Renee KONG **107**

Reneti TAPA **120**

Reza KALBASI **134**

Richard FRASER **18**

Richard HARMAN **107**

Richard MCNEILL **62 73**

Rob EAGER **140**

Rob TICEHURST **53**

Robbie HANNON **26**

Robert DOUGHTY **6**

Robin MANN **69**

Robyn WHITTAKER **56 87 90 112**

Rochelle STYLE **41**

Ronney KENITAHANA **140**

Rosie DOBSON **90**

Rowena WOOLGAR **72**

Roy DAVIDSON **67**

Roy MALTO **76**

Rupert MURCH **127**

Russel PEARS **74**

Ruth LARGE **99**

Sally BRITNELL **121**

Sally DENNIS **116**

Sally WALLACE **81**

Samuel MACKENZIE **131**

Samuel WONG **80**

Sandi MILLNER **123**

Sandra PUGH **62**

Sarah CLARKE **67**

Sarah METCALF **108**

Sarah PICKERSGILL **117**

Sarah RADKE **80**

Sarah TAILBY **125**

Sarah THIRLWALL **32**

Sarah WALMSLEY **56**

Sasha KLJAKOVIC **111**

Scott PEARSON **4**

Sharon COAD **46**

Sharon GARDINER **108**

Shelby JASPER **54 55**

Sheree EAST **117**

Simon DALTON **108**

Simon HOERMANN **24**

Stella WARD **56 57 91**

Stephen PERCIVAL **57**

Steve VLOK **104**

Steven PARRISH **23**

Stuart BLOOMFIELD **112**

Stuart JENKINS **10**

Sue WELLS **5**

Suzanne BOARD **25**

Te Puea WINIATA **33**

Terry HANNAN **137**

Terry JENNINGS **83 126 129**

Terry QUIRKE **31**

Tim BENTLEY **133**

Tony DOWELL **24**

Tony NORRIS **140**

Tracey WATSON **96**

Tristram INGHAM **24**

Tsiel OHAYON **65**

Valentyna SYLEVYCH **62**

Vanessa SELAK **49**

Vaughan ROBERTS **32**

Vinita JANSARI **74**

William LEUNG **24**

William LEVACK **29**

Yannan JIANG **6**

Zaffar ANSARI **106**

Appendix

HiNZ Scientific Papers (Full papers)

A review of theoretical frameworks for telehealth to support effective research

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Abstract

Embedding of telehealth into routine care remains problematic and some scholars have recommended a broader systems-approach to understand this with consideration of theoretical frameworks. The telehealth literature was searched using a systematic process and a large, diverse body was identified. Much of the research is atheoretical and when theories are considered they are not necessarily developed specifically for healthcare. Following a critique of exemplar theories a sociotechnical systems theory approach is suggested as a useful framework for examining the complex, adaptive system in which telehealth sits.

Keywords: Telehealth, theory, sociotechnical systems

1. Introduction

Telehealth, the delivery of health care services at a distance using information and communication technologies, is one potential solution to challenges in health services delivery such as accessibility, quality, professional resource scarcity and increasing costs [1-3]. Despite its potential, research indicates that the diffusion of telehealth into ongoing and routine care remains problematic [4] and there are many examples of telehealth programs that are not successful past the pilot stage [5-8].

There is a large, growing body of literature in the telework area with work drawn from many disciplines [9, 10]. However, much of the research presented is atheoretical and the lack of theoretical basis in telehealth research has been criticised [10, 11]. In addition, when theories have been used to inform telehealth research they have not fully considered the context of health when presenting frameworks from other fields and applying them to a healthcare context [11-13]. An improved use of theory has been encouraged in healthcare research as a way to help understand the nature of the research, support research design and methodology, make sense of analysis and generate knowledge [10-12, 14]. Moreover, researchers have suggested that in order for telehealth to be implemented effectively and sustainably it is important to understand how the various components work together as a complex, whole system [6, 15] and that a systems approach is needed to consider the multiple, interrelated aspects of telehealth [2, 8].

This paper presents results from a search of recent literature and a critique of the most common theoretical approaches taken in telehealth research. A sociotechnical systems theory model is then introduced as a useful research lens in which to examine telehealth.

2. Literature search methods

Initially, an exploratory search was carried out to establish the scope of the telehealth literature and to identify the keywords used in this area. This was done through the Massey University library website using their electronic databases. A list of keywords reflecting the telehealth concept was developed from this exploration. Four databases, Scopus, Business Source Complete, Web of Science and PubMed were chosen as being the most suitable for retrieving telehealth information [16] and were used to search the literature using these keywords in the source title. The search was restricted to English language, published as an article, a review, an article in press, a book chapter, or book after 2006. Searching for only publications after the year 2006 was selected as part of the strategy since it was a decade preceding the search and also to reflect the recency of technological advancements. The full search strategy is outlined in Table 1.

The citation and abstracts of the references found (n=5,607) were imported into EndNote and then printed. Each abstract was then read. During this process attention was also given to the general types of research design including

theoretical perspectives, design framework, methods of data collection, the interactions that the research examined and the stated outcomes. Upon reading the abstracts, a line was drawn through those that *did not* report on a broader system or multiple components of a system. Abstracts that considered the broader system, definitions, research framework and reviews were also retained. The abstracts that were crossed out included those that concerned only technology, tele-education, only text messaging, coaching, health Apps, telesurgery, robots, just telephone interventions or programs, just electronic medical or health records and small scale pilots studies reporting only on clinical outcomes. The remaining references were exported into an EndNote library and the full text publication sought. Other relevant references were gathered using a 'snowball' technique when reading full text articles and examining the reference lists.

Table 1 Search strategy

Field code	Keywords	Operator	Limits	Database
TITLE	Telehealth Telecare Mhealth "Mobile health" Telemedicine Ehealth "Virtual health*" Telemonitoring Telehealthcare	OR	English language After 2006 Article, review, article in press, book chapter, book Exclude: trade publication, conference proceeding, undefined	Scopus
				Business Source Complete
				Web of science
				PubMed

3. Results of the literature search process

There were more than 600 abstracts that were deemed potentially relevant. The source of the literature was mostly journal articles (92%) with 6% sections of books. Many disciplines show an interest in telehealth and the literature search process facilitated identifying six main general areas of health informatics, technology, management, implementation science, economics and business and medicine and health clinical practice. In addition, telehealth research has drawn on a range of approaches to examine various aspects of telehealth, as exemplified in Table 2, and there is considerable overlap between these disciplines and the approaches used in the field of telehealth research.

4. Discussion

Considering theory is important because it aids in understanding the nature of the research and influences the research questions and methodologies [10-12, 17]. In addition, theory can offer generalisable frameworks and assistance in analysis while helping to generate knowledge and how to use the knowledge generated [11, 14]. A recurring criticism of telehealth research is that it is mostly atheoretical [10]. A low 5% of published research from 1990 to 2005 was found to refer to a theoretical concept in two reviews [11, 18]. Wade, Gray [10] suggests that this lack of attention to theory has not changed significantly in recent times and this was corroborated by the exploration of literature for this review. When theory has been considered a wide range of approaches have been used (Table 2) with many theories only used in one study [11]. The approaches used more commonly have not been specifically designed for the healthcare context but borrowed from other fields of research [11-13], for example, the Technology Acceptance Model (TAM) and the Diffusion of Innovations (DI) theory which are discussed below. One approach, the Normalisation process theory (NPT), was developed in a telehealth context and is also considered before sociotechnical systems theory is introduced.

4.1. TAM

The TAM, or one of its antecedent or subsequent forms, is one of the most commonly used theoretical frameworks in the telehealth field. The TAM was developed initially to provide measures for predicting and explaining computer use to assist with the problem of users' unwillingness to accept and use introduced computer systems [19]. Researchers [20] have found that the TAM may be too simplistic in the telehealth context and suggested that it needs additional factors incorporated for this field. A review of TAM in the healthcare field [13] found that most research did add variables to TAM which may have been an attempt to better understand the antecedents of acceptance of health IT use behaviour. Adding of variables is criticised as potentially diluting the ability to combine or compare study results and perhaps indicating that the TAM is not fully suited to the health care context [13]. The TAM theories are also subjected to criticism that they do not have the ability to consider external variables and barriers which influence technology

acceptance [21] and the interaction between the user and the task is not included [22]. In addition, the focus is on the individual users without consideration of the context of the group or organisation in which it is being introduced and the model does not include any feedback or adaption capacities over time.

Table 2-General discipline, examples of subject matter and approaches used to research telehealth; dotted line indicates the categories are not rigid. Approaches in bold italics appear most frequently in literature

Discipline	Examples of subject matter areas	Examples of approaches used
Medicine and health clinical practice	Cardiology Dermatology Radiology Public Health Family practice Rural practice Psychology Nursing	***Positivism***
Health Informatics	Information technology in health care Information systems Behavioural and information technology Decision support	Analytic Hierarchy Process (AHP) ***Diffusion of innovation*** Health belief model Protection Motivation theory Social Cognitive Theory Social capital theory Theory of Planned Behaviour
Technology	Technology and innovation Technology and healthcare Healthcare Technology Engineering Information and communication technology	DeLone and McLean information systems success model FITT framework Modified Unified Theory of Acceptance and Use of Technology (UTAUT) Path Constitution Theory ***Technology Acceptance Model (TAM)*** Technology-organisation-environment theory
Management	Organisational Change Healthcare Administration Governance Health Policy Healthcare management Business management	Change management theories Configuration Theory Institutional Theory Organisational change theories

Economics and business	Health economics
	Global business
	E-business research
	Health economics
		Economic evaluation models
		  -***cost-effectiveness analysis***
		    -cost utility
		  -***cost benefit analysis***
		Markov Decision Models
		Transaction Cost Theory

Implementation science	Program implementation Evaluation	Maturity models Normalisation process theory

4.2. DI theory

DI theory initially proposed by Rogers [23] is reported as the most commonly used theoretical framework in telehealth research [10, 11]. Based in sociology this theory posits that diffusion is the process by which an innovation is communicated through certain channels over time among members of a social system [23]. The DI theory was

developed initially to consider uptake of technologies in agriculture though it has been used in a wide range of fields including telehealth. For example, Al-Qirim [24] examined the adoption of videoconferencing for dermatology and mental health services in New Zealand, Helitzer, Heath [25] evaluated a rural telehealth program in New Mexico and Brooks, Manson [26] analysed the factors affecting the diffusion of telemental health in Native American communities using DI framework. They all found that the theory was useful in identifying barriers to adoption and elucidating ways that this could be improved. Other scholars have used the theory to propose factors affecting the adoption of telehealth [4, 27]. Whilst its popularity indicates its usefulness in examining telehealth adoption and diffusion the DI framework does not consider other outcomes of telehealth, for example, quality or effectiveness. The theory's focus is the innovation whereas in healthcare models are increasingly patient or user centric, the context in which new technologies are adopted is also important and not accounted for in the DI model [29]. Moreover, the DI framework does not consider the concept or nature of work which is important in the healthcare environment [30]. Beyond the social networks for communication the framework does not account for the multiple interactions between the other parts of the complex system, for example, between provider and patient, between provider and the organisation. Further, the DI framework focusses on relatively linear stages of integration of technology overtime [31] without explicit feedback loops to reflect change.

4.3. NPT

Unlike the TAM and DI theory and other approaches which have been developed in other fields and then applied to telehealth, the NPT was developed in telehealth research. NPT is a sociological theory which emphasises the processes by which the new technology and practice become normalised focusing on the individual and collaborative work that it requires of people [32]. NPT has been used in several healthcare settings beyond its telehealth origins and found to be generally useful as a framework for analysing implementation processes of new technologies [14]. Godden and King [33] used NPT to assist with analysing their interview findings on the potential for telehealth in respiratory medicine. May, Finch [34] and Mair, Hiscock [35] applied the framework to identify factors inhibiting the implementation and integration of telecare systems for chronic disease management and chronic lung disease respectively. Criticism of the theory has been concerned with difficulties interpreting and applying the constructs and the lack of ability to map attitudinal or emotional work constructs in the framework [14]. Positively, the theory encourages a whole-system perspective with multiple stakeholder input and emphasises the work people do, including patients [34, 36, 37]. In addition, it has been developed specifically in the telehealth field which may increase its contextual value. NPT has been described as a 'middle range theory of sociotechnical change' [32] and it has a more narrow focus on how new practices become routinely embedded than other sociotechnical theories.

4.4. Sociotechnical systems (STS) theory

STS theory was developed to help explain the human and organisational consequences of the introduction of mechanisation into coal mining and other industries [38]. STS theory recognises that the work system is open and subject to a wide range of environmental factors including technical and regulatory developments while being comprised of people with inter-relationships [39]. It provides a means of representing the input, throughput and output to a work system within a changing environment with which the system needs to cope [40]. It is in this way that STS theory assists with analysing the effectiveness of work systems in achieving their objectives and evaluating the outcomes of a technical change. Berg [41] was an early champion of a STS approach for health information technology in healthcare, noting the complex nature of healthcare work and suggesting that,

> ' getting such technologies to work in concrete health care practices appears to be a politically textured process of organizational change, in which the users have to be put at center-stage.' p.88

STS theory informed the development of the Systems Engineering Initiative for Patient Safety (SEIPS) model [42].

4.4.1. SEIPS model

The SIEPS framework (Figure 1) has been used to understand the structures, processes and outcomes in health care and their relationships [42]. It builds on Donabedian's [43] structure-process- outcome model by including interactions and interdependencies among system components. With a human factors / ergonomics approach the SEIPS uses a work system model of people, technology and tools, tasks, organisation and environment to emphasise the interactions between people and their environment which shape outcomes of performance, safety, health and quality. The work system affects the work and processes which then influences the individual, group and organisational outcomes. SEIPS helps to explore how the design of the work impacts on all stakeholders of the healthcare system. Changes to any aspect of the work system will, depending on its design and implementation, affect the work and processes positively or negatively and therefore the outcomes. Outcomes in turn affect the work system, indicated by the feedback loops.

The SEIPS model has been used in many aspects of healthcare including health information technology and medical device introduction [30, 44]. It has also been used in some telehealth research in the tele-ICU environment.

Hoonakker, Carayon [45] studied motivation and job satisfaction of tele-ICU nurses using the SEIPS model as a conceptual framework as did Khunlertkit and Carayon [46] looking at the impact of tele-ICU technology on care processes and patient outcomes. Guise, Anderson [47] framed their literature review of patient safety in telehealth in a homecare setting using the SEIPS model.
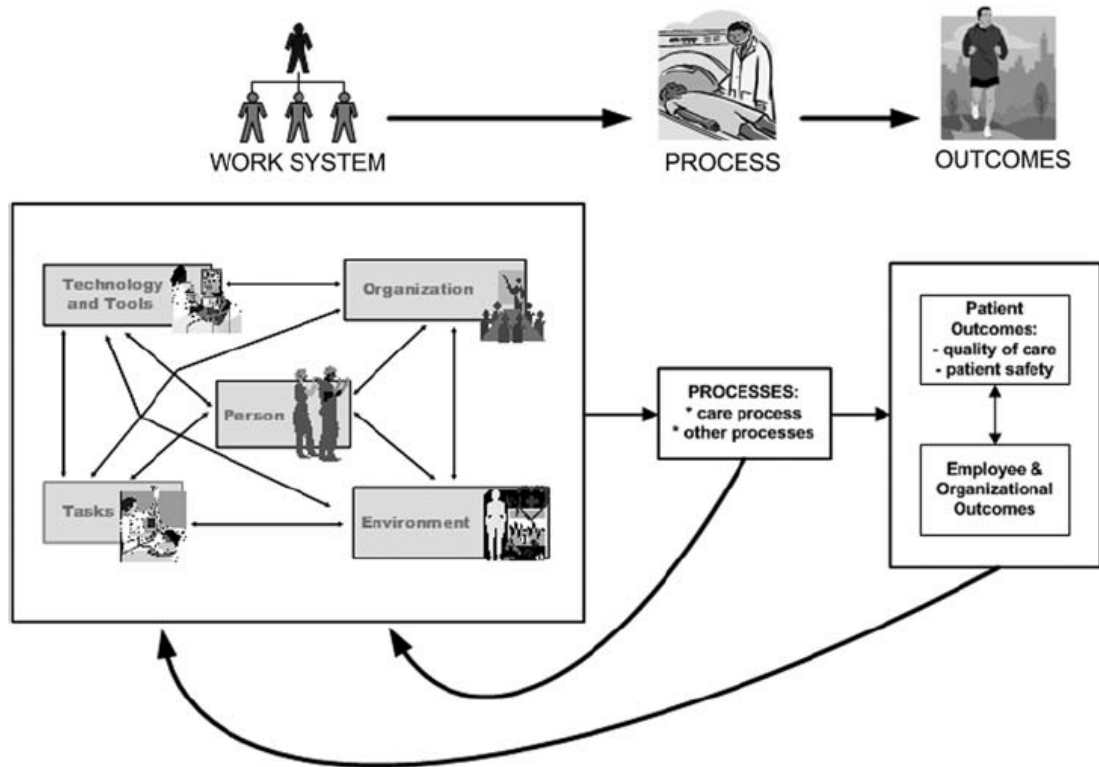

Figure 1 SEIPS framework [42]

A recent focus of changing healthcare systems is placing people centrally in models of integrated health and social services [48]. SEIPS, as a person-centred framework, supports this paradigm with 'person' referring to patients, their families and healthcare professionals (and other individuals and groups). It is recognised that these people may 'do the work'. For example, patient 'work' may include managing health information and treatments. The interactions between the patient and healthcare providers are important for outcomes [30]. This concept in the SEIPS model supports current efforts to engage patients in partnerships with health providers. In addition, it fits with the changing role of patients who, once passive, are now more active in their own care utilising information that is more easily accessible through digital technologies and the internet [49].

Though research using the SEIPS for telehealth has not yet appeared extensively in the literature it would seem to be a useful framework in which to examine the complex sociotechnical system within which telehealth programs sit.

5. Conclusion

The literature search process presented found that telehealth literature is voluminous and comes from a wide range of disciplines. Despite this, telehealth research often lacks a theoretical basis. An increased use of theory would help to support research design, methodology, analysis and knowledge generation in the field. However, the theories that have been used more commonly have limitations for examining a complex, adaptive telehealth system. The STS theory based SEIPS model is a more comprehensive theoretical lens, considering all parts of the system and their interactions, in which to view telehealth than other approaches. It is potentially a useful framework for examining telehealth systems to understand how components work together in an effort to ensure telehealth is effectively and sustainably implemented.

6. Acknowledgments

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A Semantic Web based Framework for Linking Healthcare Information with Computational Physiology Models

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Abstract

Linking healthcare information which nowadays is becoming vastly available with computational physiology models can be instrumental for enabling personalised and predictive clinical decision support systems. In the computational physiology domain semantic interoperability heavily relies on Semantic Web technologies and utilise ontology-based annotations but a wealth of useful information and knowledge sits in EHRs where this technology has limited use. openEHR and ISO13606 provide open standards for the structure, storage and exchange of healthcare data which readily support terminology/ontology based bindings that be exploited to link the two domains. This linkage will be bidirectional which means it will enable data discovery for computational modellers and also model discovery for clinical users. Since the openEHR specifications now underpin many national programs and regional implementations this can unlock unsurmountable potential to create both model and data driven personalised and predictive analytics. Having fit for purpose and standardised ontologies (such as Gene Ontology, Foundational Model of Anatomy) and clinical terminology (such as SNOMED CT, LOINC, ICD) have been a critical first step. However there is still a need to create mappings between these ontologies and develop standard annotation protocols. We describe our high-level methodology with an emphasis on ontology mapping using a crowd-sourcing approach.

1. Introduction

Computational physiology (CP) models, such as those defined by the Physiome / Virtual Physiological Human (VPH) projects, are formal and quantitative descriptors of biological phenomena (1). Computational simulations using imaging data have already demonstrated significant clinical utility such as the virtual fractional flow rate (vFFR)(2). Constrained by the general laws of physics and anatomy CP models can ideally form an integrative and explanatory layer between basic science/engineering and biomedical domains.

Electronic health records (EHR) are sinks of biomedical knowledge and embody manifestations of genomic and environmental aspects that impact on biological systems. CP models when linked with EHR can be used to create patient and population specific simulations with a high degree accuracy that can be used to determine optimal diagnostic or therapeutic clinical decisions (3). This requires compatible standardisation in both domains and common protocols for linkage (4).

Standardisation has been well underway in the CP domain to enable reuse of CP models and integrate them across scales and disparate use cases. Consistent encoding of data, mathematical models and the experimental environment in which they are simulated and validated are imperative for reproducible science. Core Physiome standards include CellML for defining lumped parameter mathematical models, FieldML for defining spatially varying fields, SED-ML for defining the computational workflow and BioSignalML for defining time-varying signals (3,4).

The Computational Modeling in Biology Network (COMBINE) is an effort to define a coherent set of standards and guidelines for annotation of models, experimental protocols and data reporting to ensure interoperability and reproducible science in the wider biomedical community (5). The Physiome Model Repository (PMR) has been established to disseminate CellML and FieldML models including some 600 models most of which are curated and some are semantically annotated by relevant ontologies for defining biophysical or mathematical meaning (6).

CellML is an XML based standard for denoting mathematical equations and RDF based meta-data of CP models (7). A wide range of biological phenomena, most of which can potentially manifest as observable phenotypes, can be represented, such as cardiac electrophysiology, molecular transport mechanisms and biological processes at genetic, cellular or organism levels using a set of mathematical equations. A CellML model contains mathematical variables, their units and relations. Variables can represent editable constants or define state, rate or computed values and form the

parameters of the model. These variables may have meaningful and measurable correspondences to biological phenomena and help reveal underpinning mechanisms which otherwise is not possible to observe.

openEHR[1] provides open standards for the structure, storage and exchange of healthcare information (8). Core openEHR specifications have been adopted by ISO and CEN making it a full international standard which underpins many national programs and vendor implementations worldwide. At the heart of the openEHR formalism is the *Archetypes* which are constraint based models of healthcare concepts (such as blood pressure measurement, lab results, diagnoses etc.) captured in clinical records and messages based on stable technical building blocks called Reference Model (RM) (9). RM defines generic but healthcare specific data structures, types and value sets and a universal health record architecture. A further modelling layer is the openEHR *Templates* which gather one or more archetypes and define use-case specific constraints (e.g. discharge summary, medication order, clinical reports etc.) which is used to drive information systems. While the RM mainly provides syntactic interoperability reusable Archetypes and Templates define domain specific information models and enable semantic interoperability in healthcare. Archetype Query Language (AQL) allows formulation of portable queries using domain concepts unlike field or tables names in a traditional relational database (10). Building on this rigorous information layer openEHR also defines a formal clinical guideline specification (GDL) to drive decision support – all in a single standards stack (11). There's also ongoing work to model and capture healthcare processes and clinical workflows.

The openEHR Clinical Knowledge Manager (CKM) is an online clinical models repository (archetypes, templates and clinical terminology subsets) and advanced web-based distributed knowledge curation tool. The openEHR Foundation maintains the international open access CKM[2] instance (12). CKM supports an editorial process resembling scientific journal peer review where editors with the help of domain experts can conduct online reviews using the CKM's web interface and then publish models. CKM also supports a set of APIs to search and access the content which can be used to link to PMR.

Real-world meaning of both CP and openEHR models elements are expressed using external ontology and clinical terminologies following the Semantic Web approach. A CellML model element can be linked to one or more ontology terms using RDF based meta-data. openEHR also provides the means to annotate whole or parts of the information model by a mechanism called terminology binding. This can then be used to semantically link to annotated CellML models through ontology mapping. This linkage is bidirectional; e.g. from computational models to clinical data and vice versa.

In order for linking the two domains it is imperative to map corresponding ontologies from both domains. However this presents itself as a significant challenge as current mappings are far from sufficient. Our research question is then to examine ontology mapping methods and to identify viable options. We're presenting our high-level methodology and preliminary results in this paper.

2. Ontologies and mapping process

Ontology is a formal specification of a domain knowledge like healthcare or physiology that models real world objects and the logical relationships among them. It is similar to data modelling used in databases (both relational and object-oriented) where model entities are data elements and their relationships. However, the design paradigm of ontologies explains objects and relationships of a domain in a more explicit way. The process of designing and implementing ontologies is called ontology engineering (13).

To find the most appropriate computational models relevant to explain and solve a particular clinical problem (e.g. manifestation of hypertension following renal artery stenosis) integration and information sharing between different domains are required. Such an integration can be established through mapping of concepts from one domain ontology to the other domain ontology (14). The process of defining these entities and their relationships is called ontology mapping/matching (15–17). Based on the level of similarity of the mapping pairs, the relationships can be 100% equivalent (for example theSameAs relationship in OWL) or can be related to a certain degree (for example subclass-superclass relationship).

Although research on ontology mapping techniques is undergoing[3], "…*ontology matching may appear to be virtually impossible…these systems have to improve on performance issues such as time and memory consumption…*" (16). Relevant body of research (15,18–21) suggests that user interaction and collaborative matching strategies have to be further investigated to improve ontology mapping.

In our previous research, we have also shown that ontology mapping issues can be addressed by using collaborative, end-user experience based, and ontology development strategies (22). Collaborative ontology development is a

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[1] www.openehr.org
[2] http://openehr.org/ckm
[3] http://www.ontologymatching.org

methodology based on Web 2.0 technologies such as forums, discussion-thread, wikis etc. The intention is making consensual ontologies/vocabularies which are understandable between both computational physiology and clinical, population health and environmental communities. The advantage of collaborative and social strategies is to exploit the background knowledge through user involvement (21). The research by (15) expresses further advantages for collaborative and community-driven ontology matching such as:

1) supporting growth of the Semantic Web
2) being compliant with scalability, extendibility, and dynamic nature of Semantic Web
3) the mappings are more compliant with the same domain as the knowledge engineers are native
4) finding up-to-date mappings
5) having more motivated and stimulated ontology matching developers
6) reducing the cost of development via volunteers like Wikipedia
7) taking advantage of self-quality control and ontology status evaluation by crowd.

Existing research also indicates there are a few challenges for collaborative ontology mapping as well. These challenges are consensus achievement, filtering the malicious users, ontology translation to natural language statements for naïve users, trustworthiness and provenance of alignments, and the development of user-friendly web 2.0 graphical user interface and enterprise architecture to better represent ontological entities, relationship, and mapping between corresponding entities (21–24).

3. Methods

Our high level methodology for linking CP and healthcare information is given in Figure 1 which illustrates a step-by-step process for going from CP domain to healthcare domain but the reverse is also possible. We have so far implemented steps 1-3 and in the process of obtaining openEHR based clinical data with sufficient terminology bindings.
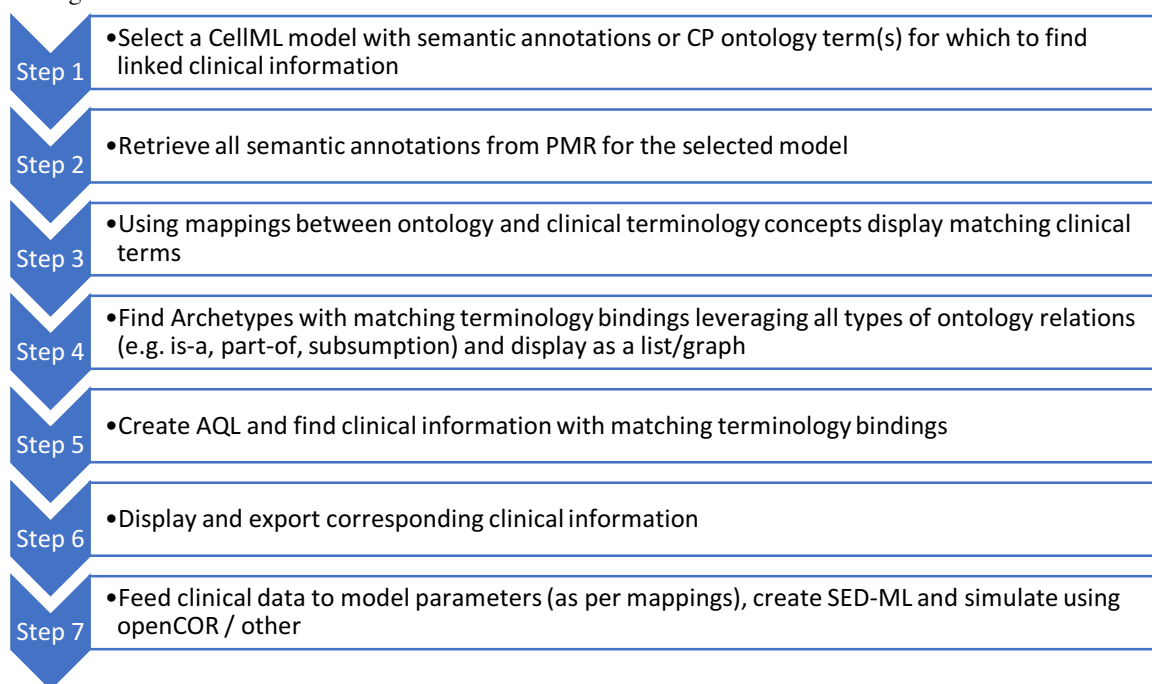
Step 1	• Select a CellML model with semantic annotations or CP ontology term(s) for which to find linked clinical information
Step 2	• Retrieve all semantic annotations from PMR for the selected model
Step 3	• Using mappings between ontology and clinical terminology concepts display matching clinical terms
Step 4	• Find Archetypes with matching terminology bindings leveraging all types of ontology relations (e.g. is-a, part-of, subsumption) and display as a list/graph
Step 5	• Create AQL and find clinical information with matching terminology bindings
Step 6	• Display and export corresponding clinical information
Step 7	• Feed clinical data to model parameters (as per mappings), create SED-ML and simulate using openCOR / other

Figure 1. High level methodology illustrating finding related clinical information given a CP model or concepts

We have deployed a local instance of the EBI Ontology Lookup Service (OLS)[4] and loaded key ontologies from both CP and clinical domains, including SNOMED CT, LOINC, FMA, CHEBI, GO and OPB.

To implement the proposed methodology, we have developed open source software and tools which include:
- A backend component (CP-openEHR[5]) written in Python 3 that interacts with PMR and with the help of OLS retrieves semantic annotations and terminology bindings and exposes a REST API.
- A frontend prototype app (PhysioMedApp[6]) using technologies such as JavaScript, Python, and SPARQL that connects to the backend via API and provides step by step linkage capability.

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[4] www.ebi.ac.uk/ols
[5] https://github.com/atalagk/CP-openEHR

4. Results

A snapshot from the PhysioMed frontend app that illustrates finding ontology terms for a given CP model element (Chloride) from relevant CP domain ontologies is shown in Figure 2.
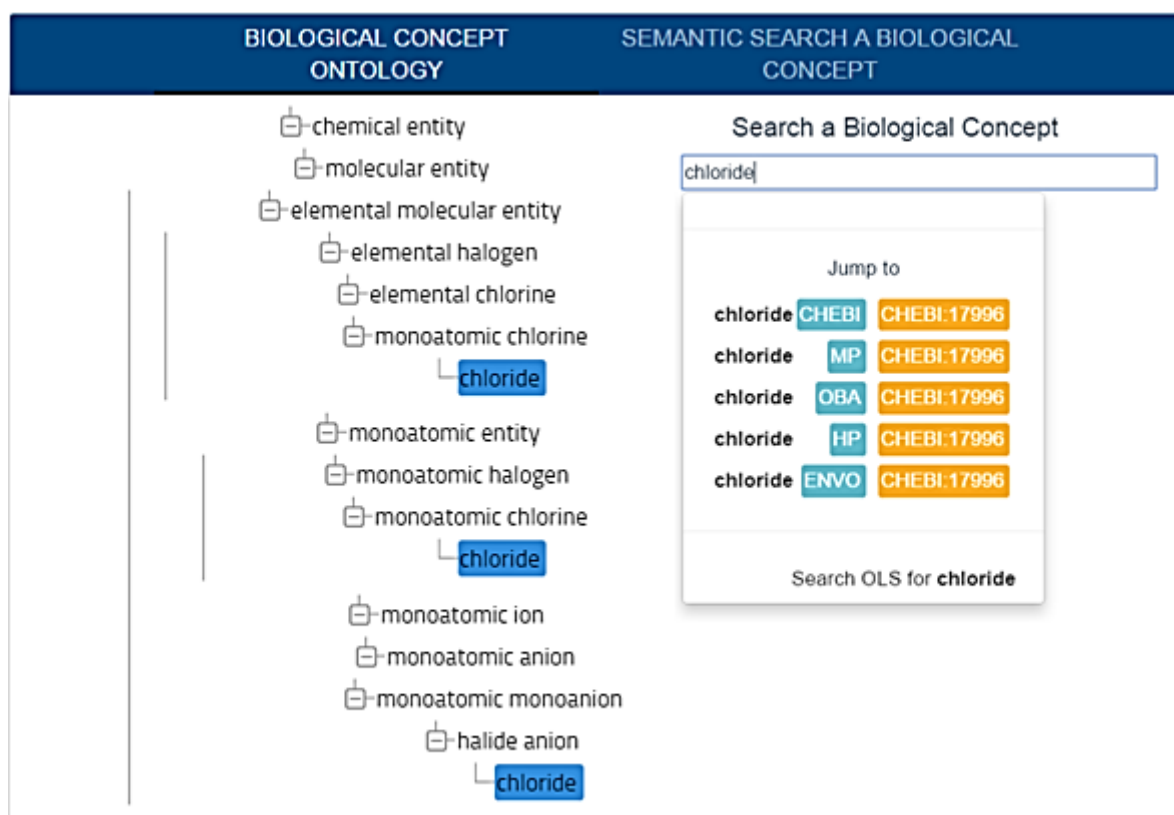

Figure 2. PhysioMedApp showing corresponding ontology terms from different biomedical ontologies for a computational physiology model element. These ontology terms will be used to find associated health information.

There are two scenarios to start using PhysioMedApp:
    1) selecting a computational physiology model which is semantically annotated
    2) selecting a biological concept from an ontology

In scenario 1, by selecting a model, its associated semantic annotations will be extracted from the PMR and in scenario 2, a concept from CP ontologies such as FMA, CHEBI, and GO is selected. In future the results will be collaboratively mapped to corresponding entities in healthcare terminologies (SNOMED and LOINC) and relevant healthcare data from EHRs will be retrieved.

For testing purposes we have created mappings by manually looking up clinical terms for given CP ontology terms (Table 1).

Table 1. Sample mappings between CP Ontology and Clinical Terminology

COMPUTATIONAL PHYSIOLOGY			HEALTHCARE INFORMATION		
Ontology	**Label**		**Label**	**Terminology**	**Code**
CHEBI	thiazide	←→	Thiazide diuretic (substance)	SNOMED	372747003
			Thiazide diuretic (product)	SNOMED	45518007
			Thiazides	LOINC	LP18072-6
CHEBI	aldosterone	←→	Aldosterone (substance)	SNOMED	42605004
			Aldosterone preparation (product)	SNOMED	22474002

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6 https://github.com/rezakalbasi/physiomed

			Aldosterone	LOINC	LP14377-3
			Aldosterone | Urine	LOINC	LP42688-9
FMA	Proximal convoluted tubule	←→	Entire proximal convoluted renal tubule	SNOMED	362220008
FMA	Proximal straight tubule	←→	Entire straight renal tubule	SNOMED	245151008
FMA	Epithelial cell of proximal tubule	←→	Renal tubular epithelial cell (cell)	SNOMED	**>117287000**
FMA	Plasma membrane protein	←→	**No match**		

5. Discussion

We have worked out a high-level methodology and partially implemented a framework to link CP and healthcare information. Annotation of both CP and clinical information models and data instances will allow automated linkage of both domains. This could allow for creation of highly accurate both model and data based predictive analytics and a new breed of clinical decision support tools. In both domains technical standards for the representation of domain models and their meta-data are mature and compliant in terms of formal semantics. However for this linkage to happen, domain ontologies from both domains need to be mapped.

The recent works by Euzenat and Shvaiko (16,21) shows a number of challenges for ontology mapping. First, the current applications of ontology mapping have been developed for research and testing peer-to-peer case studies while the real world scenarios have more complicated architecture. Second, newer techniques of automatic matching need to be developed to address sophisticated test scenarios than the current ones. Third, an optimised combination of existing methods to solve real world issues is still missing. Fourth, as in reality, ontologies of different domains are not overlapping 100%, the current matching techniques are not smart enough to stop the matching process while they cover the common semantics. As a result, this can reduce performance/memory and timing issues for ontology mapping process. For example, one of the trends of ontology matching evaluation and research groups is the study of large biomedical ontologies (Largebio; like FMA-NCI, FMA-SNOMED and SNOMED-NCI) (18). The results of this study show that the effectiveness of all matching services decreases as these ontologies' size is big. However, it is important to note that XMap (25) and LogMapBio (26) have better results among the others as they use UMLS Metathesaurus (27) as their background knowledge to run matching process. Also, the work by (21,28) indicates that KitAMO ontology mapping tool can be used for initial alignment of biomedical ontologies. Nevertheless the review by Manel Achichi et al. (18) reveals that UMLS results in a substantial amount of logical inconsistencies while integrating with the corresponding source ontologies. Also, the results of recent Ontology Alignment Evaluation Initiative (OAEI) 2016, with compared to its previous years, indicates that there was no enhancement to cope with the challenges of large (like biomedical) ontology mappings. Fifth, graphical alignment tools are not user-friendly and mature enough for end-users and even ontology engineers. Collaborative ontology mapping using a crowd-sourcing approach might be a viable solution.

For the purpose of testing our approach we have created a manual mapping between CP (FMA, CHEBI, GO, OPB) and clinical terminologies (SNOMED CT, LOINC). This exercise indicated while there is considerable semantic overlap gaps and semantic mismatches are also present (Table 1). For example there are CP terms with no matching clinical terms or more commonly terms match at different granularity levels (e.g. a CP term maps to a broader clinical term).

There is an increasing trend of adoption of open standards and specifications together with open source software and research data infrastructures in biomedicine (4). To this end the semantic discovery capability that connects computational models, bioinformatics resources and clinical information can be made possible through Semantic Web based ontology mapping as we have outlined in this study.

6. Conclusion

We illustrate how to use ontologies and key standards like openEHR and CellML to link the world of healthcare and computational physiology domains. More work is needed around ontology mapping, annotation methods and tooling.

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Computational Model Discovery for Building Clinical Applications: an Example of Epithelial Transport

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Abstract

Comprehensive descriptions of computational models of biological systems captured by way of formal ontology based annotations can enhance biomedical research and clinical practice. Semantic annotation helps finding the right model for solving a particular problem which can be a patient-specific prediction. This approach can also be utilised to find relevant health data required to drive personalised and predictive clinical decision support systems. However efficient tooling for annotation using diverse domain ontologies and a model repository to discover and share such knowledge resources are needed. Tools and standards in the computational physiology discipline have evolved over the years such as CellML to encode mathematical models of biological systems, SemGen to describe and annotate real-world ontological meaning; and the Physiome Model Repository to store these models and metadata to ensure the encoded knowledge is persistent, identifiable, and discoverable. In this paper we present how to put these tools and resources to work using an example of solute transport in the kidney.

1. Introduction

Computational physiology models help scientists to understand and simulate biological behavior using mathematical equations at many different scales (molecular, cellular, tissue, organ, individual and population) as well as to provide a mechanistic (thus explanatory) basis for diagnosing and treating diseases (1). The Human Physiome[1] and Virtual Physiological Human (VPH)[2] initiatives aim to use computational modelling and simulation to build a complete virtual model of human structure and physiology in order to understand the intricate mechanisms of living beings and help create new diagnostic and therapeutic modalities (2,3). These projects have since led the development of many such models and also provided standards, modelling protocols and open source tools and software (4).

CellML is the mainstay modelling language which supports annotation meta-data in the form of (Resource Description Framework) RDF triples referencing to external ontologies. These semantic annotations define the real-world meaning of biological phenomena encapsulated in computational models. Addition of such meta-data within the context of biology such as species, genes, physical entity a processes into these models make them available to a broader community in biomedical sciences and clinical research facilitating reusability and sharing of knowledge (5). The annotation of such biological processes often requires diverse reference ontologies to create composite annotations. Doing this manually is a time consuming process and therefore it is essential to use a suitable tool. SemGen provides creating composite annotations with multiple reference ontologies (6).

The Physiome Model Repository (PMR) (7) provides an infrastructure to manage models and personal workspaces using distributed version control as well as providing ontology-based semantic annotation and advanced semantic searching mechanisms (including a SPARQL endpoint). By using the well-defined annotations to encode deposited resources enables the full range of information in the repository to be explored to answer specific questions. One use of this exploration is the identification of missing resource(s), which could be addressed via more accurate description of existing resources or the addition of new resource to the repository.

Through accurate and detailed annotation of biological phenomena, encoded in CellML, researchers would be able to capture biological knowledge encapsulated by computational models which can be used to create personalised models. Encoding the models and their description in a computable form and depositing these resources into PMR ensure this information is persistent, identifiable, and discoverable. For example, users can search data and models such as transporters, channels, compartments, species, genes or other relevant information extracted from PMR to assemble a particular computational model – in our example an epithelial cell model.

In addition to the annotation and discovery, we are moving forward to develop a reuse strategy for clinical applications. Clinicians treat diseases and specifically they need patient specific and effective new treatment models than can

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[1] http://physiomeproject.org/
[2] http://www.vph-institute.org/

leverage data captured as part of routine care within electronic health records. The Virtual Physiological Human (VPH) (8) project has introduced technologies, e.g. in silico clinical trials, and made interdisciplinary community to rethink about the value of both model and data driven biomedical applications. In silico clinical trials means personalized computer modelling and simulation in order to be able to test the efficacy and safety of new treatments and biomedical products without involving animal or human testing. They are more efficient and less costly as compared to traditional way of developing biomedical products in pre-clinical settings, i.e. wet lab experiments in a laboratory setting followed by animal and human studies with potential issues around animal welfare and patient harm.

The discovery and reuse of data and models is a key component in achieving the goals of the Physiome Project and the VPH. In order to aid this, the COmputational Modeling in BIology NEtwork (COMBINE) and World Wide Web Consortium (W3C) have proposed several standards (9). The standards used in the model discovery approach required to solve healthcare challenges are will be described.

2. Standards and Tools

2.1. CellML

CellML is an XML-based language that represents biological and mathematical models (10). The aim of CellML is to store and exchange these models in biomedical research. CellML includes MathML for representing equations. It allows the sharing of the models and components within the models and enables to reuse the components using the import feature. By doing so, existing models can be reused in new and novel modelling studies.

CellML has modularity feature that allows for component based development. It hides unnecessary details of various components, and thereby facilitates encapsulation. In (11,12), practical applications of CellML have been discussed. With the increasing number of CellML biological models, it is essential to store them in a repository so that the results produced from these published models can be conveniently curated and annotated (13). CellML community has developed several tools[3].

2.2. Resource Description Framework

The Resource Description Framework (RDF) is a directed graph standard that describes resources as metadata (14). It can be used to annotate metadata, which is machine readable, and allows semantic interoperability between different systems. RDF represents metadata with a set of triples: subject, predicate, and object. Subject contains the entire content of the metadata and predicate is an attribute by which object or predicate value can be accessed. Using Semantic Web technology these RDF triples can be used for knowledge discovery by extracting biological information from a repository. The CellML metadata specification provides guidance on how to annotate the biological semantics captured in a CellML model using RDF (15).

2.3. SPARQL

SPARQL is a Semantic Web-based query language that retrieves information from a RDF graph (16). The main structure of any given query is typically structured around the triple pattern structured similarly to RDF, with the difference being the values we are interested in are replaced with the query variables. For example, a protein model is located in proximal tubule of a nephron. In this case, subject is the protein model; predicate is the located in attribute with a namespace URI; and object is the URI of a reference ontology such as FMA that points to the description of the proximal tubule of a nephron.

2.4. The Physiome Model Repository (PMR)

The Physiome Model Repository (PMR) was initially designed to store and manage CellML models (7) as part of the IUPS Physiome project (2). The scope of PMR is now well beyond only CellML models, and indeed it facilitates managing all information required for a modelling study, with plans to allow discovery of relevant clinical data (4). Using PMR CellML models can be annotated, exchanged, and reused which supports distributed version control system (DVCS) by which users can keep track of the changes made and thereby can share and rollback to any committed point. By doing so, it enhances collaboration between the model developers.

3. Healthcare Applications

Computational modelling has been shown to support care delivery and clinical research. VPH in particular is focused on healthcare applications and to develop technology that could support medical decision making. The long term scenario is the ability to integrate information about human physiology, pathology at very different scales. Some of the clinical applications of the computational modelling are presented.

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[3] https://www.cellml.org/tools

3.1. euHeart

euHeart project was aimed to address five major cardiovascular conditions: cardiac resynchronization therapy, heart failure, radio frequency ablation, aortic and valvular disease, and coronary artery disease (17). The goal was to enable early detection and prevention of the CVDs and improve the healthcare system and medical devices.

The euHeart project used state-of-the-art computational modelling standards: CellML and FieldML so that other models and simulations can reuse and reproduce models with a view to improving healthcare system in CVDs. In fact, this project also reused previously designed cardiac models and applied current technologies, e.g. medical imaging, in order to develop patient-specific cardiac physiology. euHeart developed models of the heart that linked proteins to cells, cells to tissues into whole heart in order to be able to do better diagnosis but also to improve the design of medical devices. Failing heart models can be simulated with artificial stimulation at particular points to improve its contraction to give better output and the use of patient-specific models help to design exactly where to put the leads for that individual.

3.2. Avicenna

The Avicenna project aims at introducing state of the art in silico medicine or predictive medicine in clinical trials, as well as making alliances among academia, industry, and government in biomedical and clinical research (18,19). In silico medicine can be categorized into three user specific areas: digital patient which helps doctors for patient specific treatment and diagnose diseases; in silico clinical trials that helps industry to develop new biomedical product; personal health assessment through patient specific modelling in combination with mobile apps to give feedback to patient.

Avicenna uses computational models and simulation in clinical applications in order to minimise financial cost and optimise the overall clinical research through in silico clinical trials. Traditional trials involve animal and volunteer human testing before going into clinical phase. However, in silico clinic trials can replace the preclinical trial phase by employing computational modelling and simulation. In silico clinical trials can be tailored to a specific patient population or can even be patient specific so that new treatments or biomedical products can be delivered to the right individual. Therefore pharmaceutical companies have started using this approach to assess pharmacokinetics and pharmacodynamics. Also, medical device companies use this technology to make the production cycle and usage more cost effective and efficient. Avicenna initiative has already engaged more than 500 experts from 35 countries in order to emphasize in silico clinical trials for the improvement of healthcare system.

3.3. preDiCT

The preDiCT[4] project (20,21) worked closely with pharmaceutical companies and clinicians to develop models of the heart and also to understand better how computation methods can help in drug development. The aim of this project was to produce safer drugs. New tools have been developed that would allow better use or safer use of the drugs. It has impacted on how patients are treated and to make drug more efficient and safer.

3.4. ContraCanCrum

The ContraCancrum project (Clinically Oriented Translational Cancer Multilevel Project) was focused on investigating the malignant tumour development and treatment options for cancer (22). It provides computer assistive prediction of the best treatment in fighting cancer which otherwise can be very complex with a myriad of treatment options. The project allows for simulation of different treatment options based on patient specific information which can then recommend best treatment options.

3.5. VPHOP

Osteoporosis is the cause of nearly 4 million bone fractures every year costing in Europe nearly 30 billion euros (23). Scientists and researchers predict that this would likely be double by 2050. The VPHOP[5] (VPH Osteoporosis) project focused on more personal and effective steps to prevent bone fractures with the help of computational modelling into clinical settings in order to better understand the body as whole.

4. Linking with Healthcare Data

Linking computational models with healthcare data is critical for patient-specific modelling and predictive simulations (3). We have developed a framework leveraging Semantic Web technologies and shared ontological resources and

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[4] http://www.vph-predict.eu
[5] http://www.vphop.eu

identifiers (4). Figure 1 provides a conceptual overview of the main scientific and technological domains within scope.
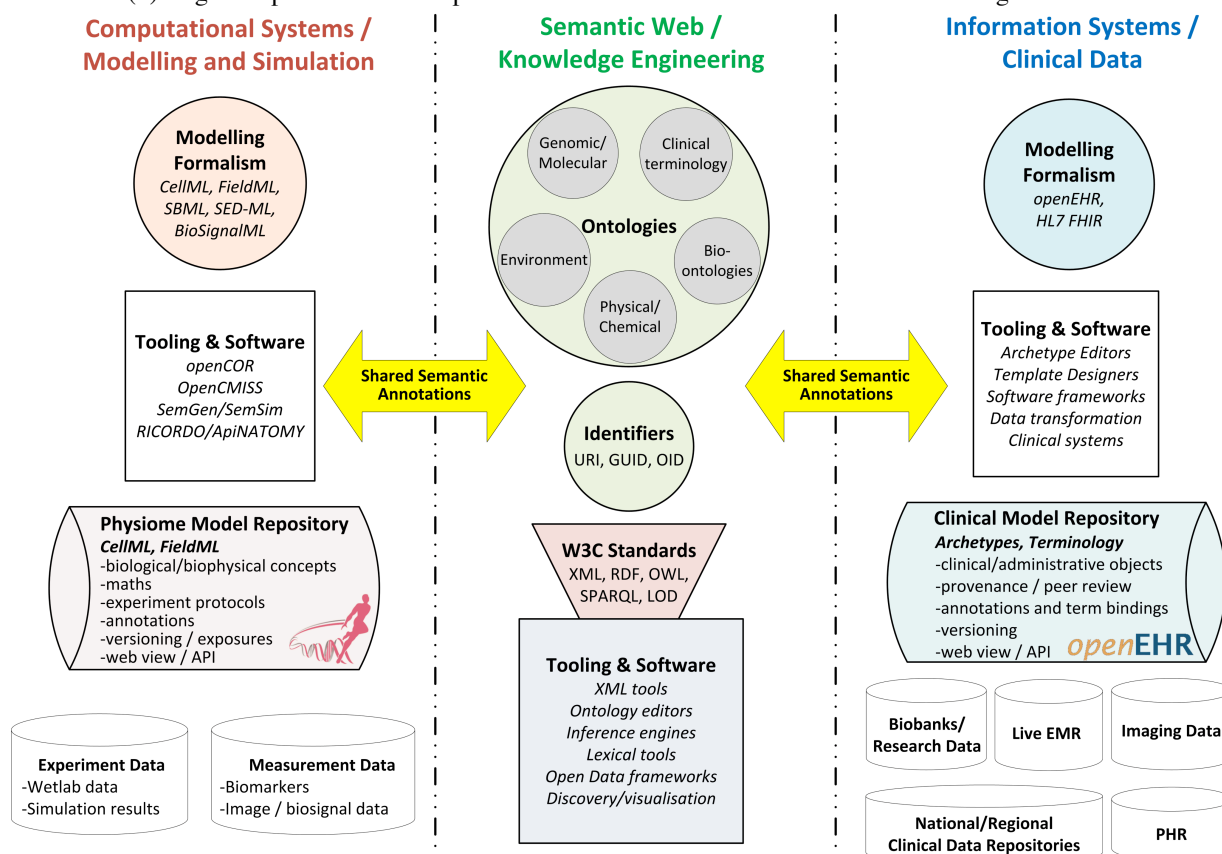

Figure 1. A Semantic Web based framework to link computational models with healthcare data

It is imperative to semantically annotate <u>both</u> computational and health information models using the same or compatible (e.g. SNOMED CT Body Structure has previously been shown to align well with FMA (24) and is currently being revised to follow FMA's ontological structure). openEHR provides a canonical health record architecture and the means to represent and annotate healthcare data . This, in turn, will enable linkages with various 'real-world' clinical data (e.g. EHRs, PHRs, HIS etc.) when used in conjunction with HL7's emerging FHIR[6] exchange standard. Here alignment between openEHR and FHIR will be critical. The goal is, given a clinical problem or computational model, automated discovery of models and relevant data.

5. Results

In initial investigation annotation in PMR, We have annotated seven kidney models using SemGen (25) related to solute transport in the kidney. The aim was to annotate these models with biologically meaningful information. These models span the spatial scales from single transport proteins, to epithelial cell, and through the complete renal nephron. These models all have existing CellML encodings that reproduce the simulation results from the original source publication to varying degrees. Comprehensive descriptions of the underlying anatomical connectivity across multiple renal scales are being mapped to the biologically-meaningful variables in these models in each of these models. For the purposes of annotation, we have concentrated our annotation on some key biological information: protein identification, species used in the source experiments, anatomical information – where possible, the anatomical location, compartment, or region of interest has been identified using the FMA ontology. Combined with appropriate predicates, this enables us to accurately describe the anatomical location or regions relevant to a given process or model.

We have annotated biologically meaningful variables using the SemGen annotator tool and developed a web interface that would allow users to explore models extracted from the annotated information in PMR. Figure 2 presents a search result for flux of sodium with some useful information: Model or CellML entity comprised of model name, component name, and a mathematical variable; biological meaning represents SemGen handling semantic annotation; species; genes; and proteins. In addition to the biological meaning of that variable, users are able to know that Weinstein is a protein model called the sodium/hydrogen exchanger 3, and the experiment was conducted from rat species and Slc9a3 gene. This information could be essential for users to make an epithelial model. The web interface uses a search strategy

using AJAX technology that provides cascading queries to the PMR web service. First, we retrieve models name and biological annotation based on the plain text search terms. Following cascading calls retrieve species, genes, and protein names for that model. This technology provides an interactive and convenient environment for users to discover knowledge from the repository.
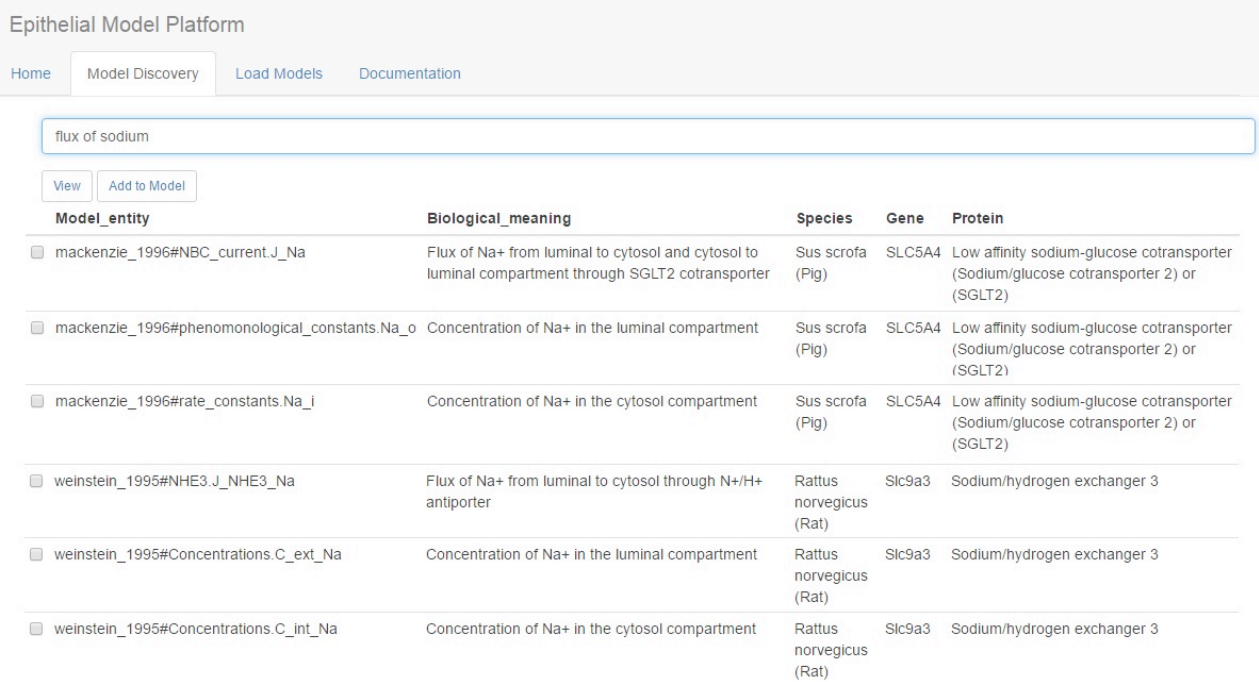

Figure 2. Web interface to discover CellML model annotations

Using ontology terms in CellML annotations we have created mappings to two key clinical terminologies (SNOMED CT and LOINC) (Table 1). The goal is to use these to search and discover relevant healthcare data. A clinical data repository that can support clinical terminology based queries will be needed.

Table 1. Sample mappings between 7 Kidney Models and SNOMED CT / LOINC

COMPUTATIONAL PHYSIOLOGY			HEALTHCARE INFORMATION		
Ontology	Label		Label	Terminology	Code
CHEBI	thiazide	←→	Thiazide diuretic (substance)	SNOMED	372747003
			Thiazide diuretic (product)	SNOMED	45518007
			Thiazides	LOINC	LP18072-6
CHEBI	aldosterone	←→	Aldosterone (substance)	SNOMED	42605004
			Aldosterone preparation (product)	SNOMED	22474002
			Aldosterone	LOINC	LP14377-3
			Aldosterone | Urine	LOINC	LP42688-9
FMA	Proximal convoluted tubule	←→	Entire proximal convoluted renal tubule	SNOMED	362220008
FMA	Proximal straight tubule	←→	Entire straight renal tubule	SNOMED	245151008
FMA	Epithelial cell of proximal tubule	←→	Renal tubular epithelial cell (cell)	SNOMED	**>117287000**
FMA	Plasma membrane protein	←→	**No match**		

Figure 3 shows the epithelial model platform where users would be able to create and validate new epithelial models from the discovered models. This platform allows users to drag and drop models between apical and basolateral membranes. Solutes, e.g. sodium, potassium, encoded in CellML will be floating in their corresponding region of lumen, cytosol, interstitial fluid, and paracellular pathway.
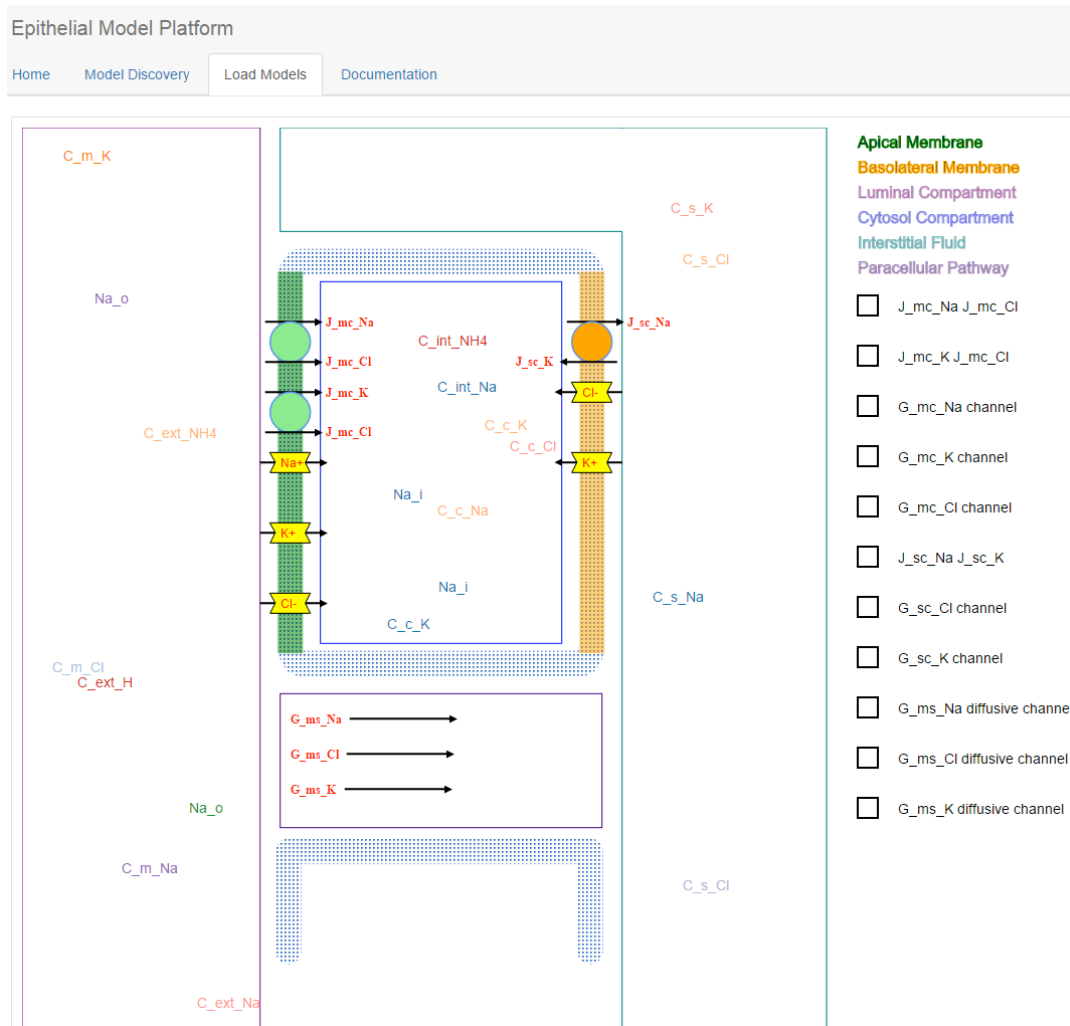
Figure 3. The Epithelial Model Platform

6. Discussion and Conclusion

We have presented a model and data discovery approach which is a new contribution to PMR. Key standards used to encode computational models of biological systems and tools for annotation have been presented. We then pointed out to past and present translational research projects and their applications in healthcare. The ultimate aim is to provide a mechanistic understanding of normal and pathological processes that impact on health and create patient-specific predictive models that can drive a new breed of clinical decision support systems (CDSS).

Computational physiology and bioinformatics communities make good use of Semantic Web whereas its use in healthcare is very limited. Therefore, for their integration, a bridging informatics methodology is needed. openEHR and FHIR are important standards and can provide this semantic bridge which can serve a dual purpose: 1) given a computational model, it can be used to identify associated clinical concepts and furthermore individual data instances from disparate data sources; 2) given a clinical concept (disease, process etc.) it can be used to identify associated computational models and their parameters which can be linked to phenotypic or outcome information.

Modularisation of computational models and modelling practices will determine the extent to which they can be reused and linked across scales when linked to genomic and clinical data. Thus further research will be important to determine a robust methodology to align these models with the underpinning biological and physical phenomena upon which they define quantitative, mechanistic and causal information.

Adoption of open standards and specifications and the use of open source software and research data infrastructures will be critically important. The semantic discovery capability that connects computational models and healthcare data can facilitate further advances in biomedicine. This might further require the definition of computable contracts around data access and quality covering privacy and intellectual property aspects between systems without human intervention. To

this end, this kind of research can help biomedicine integration comprising many disciplines such as bioengineering, biomedical informatics, bioinformatics, molecular biology and genetics, experimental physiology, molecular systems biology and instrumentation engineering communities.

We believe the semantic annotation in PMR and the search strategy with the aid of modern technologies and standards to discover models would encourage users to reuse data and models and would provide an excellent platform to make an epithelial model. Novice modellers could also use this platform as a learning tool.

7. Acknowledgments

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Enhancing Clinical Safety through Traceable Model Transformations

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Abstract

"Logical FHIR" resources are now permitted by the HL7 FHIR Standards. This implies that a mapping is needed from these Logical Models to FHIR Implementation Models which reuse (or profile) the standard resources. Revision 3 of FHIR introduces a draft FHIR Mapping Language specification to provide a mechanism to facilitate such mappings. It also allows models expressed in other type systems to be mapped to FHIR Implementation Profiles. The authors have been transforming logical and implementation clinical records models using an implementation of the declarative dialect of OMG's standard for MOF Query/View/Transformation (QVT) transformation language. This paper outlines these approaches and their relationships. We then introduce an approach to traceability inspired by OMG-based model transformation tools which could assist in the separation of concerns between clinically-focussed modellers and technology-focussed implementers, thereby improving clinical safety. Finally, we show how traceability is used in an open-source health informatics modelling tool.

Keywords: Model Mapping, Model Transformation, Logical Models, Health Informatics, FHIR, Model Driven Architecture, Traceability

1. Introduction

The paper begins by introducing the concept of "Logical Models" expressed in FHIR, and the draft new FHIR Mapping Language standardised in the most recent HL7 FHIR publication version: Revision 3.

We then discuss the implications of the combination of a Logical FHIR model, Mapping Language and Implementation Model, in terms of the model transformation pattern uses in the Object Management Group (OMG) Model Driven Architecture (MDA), and the many variants of it, commonly known as Model Driven Engineering (MDE). One important capability of the OMG standard for model transformation is that it is defined in terms of *relations* which link, or trace, between source models and the targets that are generated from them.

Finally, we suggest a separation of concerns between *Clinical Modeller* and *Model Transformation Author* roles, using generated traces between models as a common artefact to assist in collaboration, model refactoring, transformation/mapping debugging, and as a facilitator of clinical safety. We provide references to open source tooling for model-based clinical document and validation code generation and trace management.

2. What is Logical FHIR?

The Health Level 7 (HL7) industry consortium for clinical records alignment first released the free and open source initiative Fast Health Interoperability Resources (FHIR) in 2014 [1]. The last publication versions of Revision 2, and the new Revision 3 FHIR standards allow for the use of the *StructureDefinition* and *ElementDefinition* resources to define resource types which do not reuse the standard FHIR Resources. These are known as *FHIR Logical Models*.

2.1. Background

FHIR started out with the principle of maximum reuse of standard clinical information types (or "Resources" in FHIR terminology). It was designed so that all of the most common and important information elements were available for reuse, via composition, extension and constraint, for a range of clinical interchange purposes.

Designers of implementable clinical information models were then expected to use extension and substitution mechanisms in the FHIR standard to allow for specialisations to be defined as a list of differences to the base resource. However modellers were explicitly forbidden from creating parallel resources that did not use the FHIR Profile mechanisms for adapting existing base resources. These prohibitions were intended to force FHIR modellers to represent the same kind of healthcare data using the same base data definitions to facilitate interoperability, rather than starting from scratch, defining their own disconnected or overlapping sets of resource types.

Each section of the FHIR specification is assigned a level of maturity. There are seven levels, numbered from 0 (Draft) to 6 (Normative) [2]. The most mature parts of the specification are currently at level 5.

2.2. Motivation for permitting FHIR Logical Models

The motivation for the change was partially to explicitly allow FHIR modelling without extension of base resources that some emerging FHIR Profiling tools, such as Forge from Furore[1], and the HAPI[2] project were facilitating. Another motivation was that it was a much more straightforward migration path from "legacy" healthcare models to allow import or transcription of their structure and base types into the FHIR syntax, with no initial analysis or reuse of the standard base FHIR resources.

Logical modelling in FHIR provides a means to incorporate clinical models and other (for example administrative) healthcare document designs into a FHIR type system environment while postponing the need to map each data group or element representing a concept to the set of base FHIR Resource definitions. The rationale may have been to support the understanding of the FHIR data type definition resources: *Basic Types, ElementDefinition* and *StructureDefinition*, which the OMG model transformation community would call its *metamodel*. These introduce the *Extension* and *Slicing* concepts which are the basis of the FHIR "profiling" paradigm.

The introduction of logical modelling in FHIR has another useful side effect - namely what the model transformation software community terms "support for endogenous transformations". In other words, most model transformation languages and tools require all models to be expressed in the same type system (often a programming or data specification language) in order to allow transformations to be defined which can convert instances of one model type into instances of another *within the same type system*. For example, XSLT can only express the transformation of XML documents into other XML documents; Eclipse Modelling Framework (EMF) tools such as ATL [3], QVT [4] and Tefkat [5] can only transform EMF models into other EMF models.

In most endogenous model transformation frameworks there are mechanisms for model import and export to other formats and type systems. For example, the EMF framework can automatically generate EMF models equivalent to XML Schema models, and facilitates import/export of XML instances in a framework known as "resource implementations". The same framework also provides import and export mechanisms for models from many other environments [6, 7].

2.3. Where do the models expressed in Logical FHIR come from?

As mentioned above, the FHIR specification simply lifted the constraints on replication of clinical models that are already present in the base resource set, meaning that the ElementDefinition and StructureDefinition "metatypes" are available as a syntactic way of constructing any data structure with any substructure. Its comprehensive set of Primitive Data Types means that many of the data types having structural definitions (like dates or numeric ranges) are already available for use. We see that there will be three major sources of FHIR logical models:

1. Clinical document specification models such as openEHR [8], or the previous HL7 standards v2, v3 and the Clinical Document Architecture (CDA), or the ISO standard for Information Technology - Metadata registries (MDR)[3]
2. Clinical model requirements expressed as semi-formal structural contents in systems like spreadsheets, requirements management tooling and tabular textual documents.
3. Data structures written in object-oriented languages, or relational databases.

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3. The Object Management Group's established approach to model mapping

The Object Management Group (OMG) began in the early 1990s as a vendor consortium with a commitment to free and open standards publications for interoperable distributed systems. In 1997 two parallel approaches to modelling of software and its metadata were being pursued: the Unified Modeling Language (UML) [6], which was a set of software design notations, and the Meta Object Facility (MOF) [10] which was a way of modelling object-oriented information, and generating remotely accessible repositories for object instances.

In 2001 the OMG Management recognised a trend among OMG members who already worked in a modelling paradigm for software design, and others who were adopting and implementing the MOF and UML standards in combination with code generation tools by announcing an initiative called the *Model Driven Architecture (MDA)* [11].
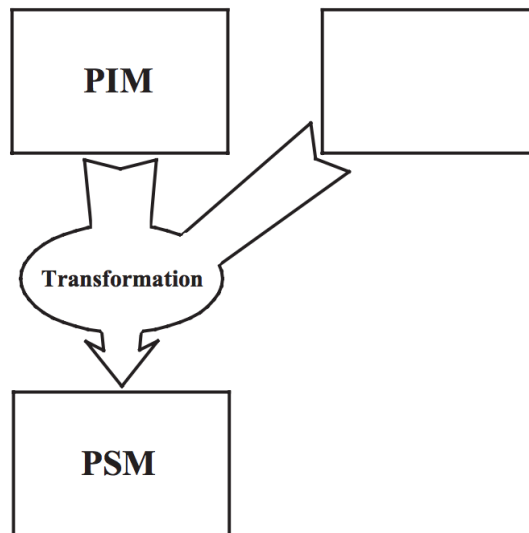

Figure 1 - An early expression of MDA pattern concepts (source: [12])

By 2003 the technical architecture of the MDA was documented by OMG via members of the OMG Architecture Board in *The MDA Guide v1.0* [12]. The key pieces were the modelling languages, and a transformation approach which generated further models. Models were characterised as *Platform Independent Models (PIM)* or *Platform Specific Models (PSM)*. "Platform" is a relative term, and this pattern could be applied several times to map between models at different levels of abstraction. Figure 1 shows the pattern, in which a PIM is transformed into a PSM, using some un-named additional models, patterns or metadata as additional inputs.

Figure 2 shows the application of the above pattern twice, firstly to achieve a mapping from an enterprise-level model (ECA) to an OMG standard abstraction of Message-Oriented Middleware (EAI), and secondly to a specific middleware platform. The paper [13] introduces the terminology Platform Aspect Model (PAM) as a way of being more specific about the relative nature of *Platform-Specific* and *Platform-Independent* that the MDA uses, by naming the platform in question.
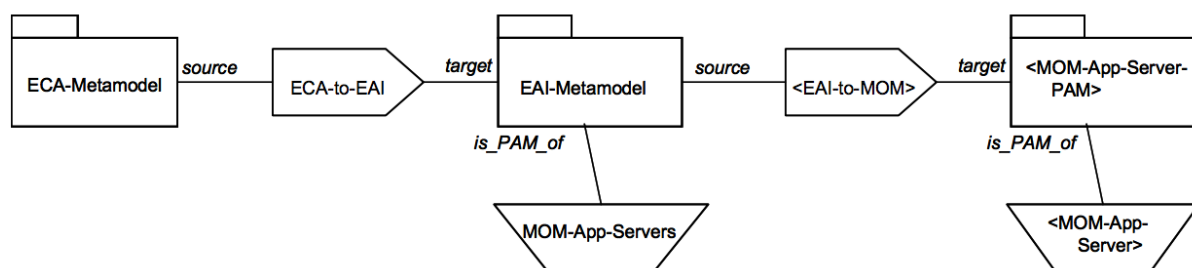

Figure 2 - A Specific use of MDA pattern concepts for Message-Oriented-Middleware (source: [13])

3.1. Missing Mapping Language

The problem for MDA in 2001 was that there was no standard way of defining the transformations, as model transformation for UML and MOF was only available in niche products, such as an internal Tata Consulting tool, components of the Compuware Java Platform OptimalJ[4], and several academic prototypes, for example ATL [3], and Tefkat [5]. In 2002 an RFP for a Transformation Language was issued to fill the gap, and only in 2005 was the final submission of the MOF Query/View/Transformation Language completed [14], with the OMG Finalisation Task Force validating that it was implemented in 2008, by ikv++, as Medini QVT [15].

The later versions of the MDA Guide describe a four stage modelling and model transformation paradigm which is not widely implemented, and most practitioners of model transformation-based software development now refer to their practice as Model-Driven [Software] Engineering: MDSE or MDE, and do not use the OMG's MDA brand or reference architecture.

The situation of an implied model mapping, without a mature mapping engine solution, is currently replicated in the FHIR community. OMG and HL7 FHIR have different ways of adopting standards, in which the former does a staged specification submission process, with validating implementations following adoption, whereas FHIR publishes draft definitions which have tentative prototypes, and these are labeled with maturity levels. The FHIR Mapping Language has followed quickly after the introduction of FHIR Logical Models implied the need for mappings to fully Profiled FHIR implementable types, but the path to maturity and wide adoption of the Mapping Language is still uncertain.

However, due to the technology-neutral specification of FHIR, and the prevalence of Java in the FHIR implementation community, the adoption of QVT and its predecessors, some of which are now mature technologies, is possible by importing FHIR *StructureDefinitons* into the EMF implementation of MOF. Furthermore, in the case of the open source jQVT implementation[5], it is possible to define and execute transformations on ordinary Java objects, which have been used in Java-based FHIR implementations like HAPI, while the FHIR Mapping Language and its implementations mature.

4. Mappings in FHIR

As stated in the introduction, FHIR Release 3 has specified a draft Mapping Language and mapping execution environment. In this context, "Mapping Language" and "Transformation Language" are synonyms. This has been presaged by a long standing placeholder in the FHIR Standard for *Executable Mappings*, which is defined alongside other mapping concepts.

There are four kinds of FHIR Mappings, three of which are loosely structured as "layers" or "levels" that can be overlaid on one another, but formal relationships between them are yet to be defined by the FHIR specification. This is the order in which they are presented in the specification:

1. The *Skeletal Mappings* level, which provides simple structural equivalences between major FHIR concepts and their equivalents in other specification frameworks.
2. The *Conceptual Mappings* level, which provides one-to-one attribute mappings in cases where FHIR attributes correspond directly to attributes in other specification mechanisms.
3. *Logical Mappings*, which is an orthogonal non-layered approach compared to the other kinds of mappings. It permits primitive types to be mapped between FHIR (which uses the XML data typing system as a base, with additional constraints) and other basic data type systems.
4. The *Executable Mappings* level*,* intended to fill the role of a full model transformation specification in both directions between FHIR and other health records formalisms, whether these are first imported as FHIR Logical Models or not.

In this paper we use the term *Mapping* as a general concept and *(Model) Transformation* as synonym for *Executable Mapping*.

4.1. Model transformation approaches to achieve "Executable Mappings"

The authors have used the XML Schema import tools in EMF to create EMF metamodels representing the FHIR *ElementDefinition* and *StructureDefinition* resources, which also generate XML import/export resource implementations. This allows the use of the open source jQVT transformation engine variant of the OMG QVT

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language to model transformation problems involving CDA and FHIR. The QVT language is explicitly designed to store traces between the source and target model instances that are the result of executing a transformation.

4.2. The state of the FHIR Mapping Language

The FHIR Mapping Language is specified in STU Revision 3 (April 2017), and is currently at maturity level 0 (draft). It relies on the FHIRPath expression language, which was first introduced in 2015, and through a number of revisions is now at maturity level 4. The Mapping Language is an attempt to apply the principles of a declarative model transformation language (inspired primarily by OMG's QVT [4]) within the context of the FHIR type system. The abstract syntax for the concepts of model transformation is specified through the resource *StructureMap*[6], and it is supported by a grammar for a concrete textual syntax, although this is not included directly in the specification in the current release (it has a "TBD" placeholder), and a link is given to an open source ANTLR[7] grammar file.

The FHIR Mapping language firstly supports FHIR-to-FHIR (endogenous) transformations. Some healthcare document specific functionality is provided for in the Mapping Language to map codes between code systems, by reusing the already established ConceptMap Resource. The first published usage of the language is in fact a FHIR R2 to FHIR R3 executable mapping, which can automatically "upgrade" existing FHIR resources (where no semantic mismatches occur) from one revision to the next. Another goal is for the mapping language to permit any DAG-structured model instance to be the source or target of a mapping. It achieves this through an architecture where a transformation engine can use an API to "query an element in the instance for its children, its primitive value, and (optionally) its type."[8] In the language of the Model Transformation community, this means that it supports "exogenous transformations." Future FHIR Mapping standards versions and implementations are underway using the case study of converting Consolidated CDA Templates for Clinical Notes (C-CDA) 2.1 documents to FHIR Profiles. However, even the manually crafted conceptual mapping for C-CDA is still incomplete (http://hl7.org/fhir/us/ccda/2016Sep/).

5. Similarities and differences between QVT and FHIR Mapping

5.1. Endogenous vs Exogenous

We have already noted that the MOF QVT specification and its implementations are designed to operate only within the MOF type system. In the draft FHIR Mapping Language the design explicitly includes the possibility of exogenous transformations. Accessing any document graph as a source or target model is based on a "plugin" model navigator architecture. Furthermore the support for only optional typing of model instances means that it also provides a number of operators to manipulate serialised string formats of types, in which the type conversion is performed inside the transformation rules by string conversion operations and type casting. This is in contrast with the paradigm of import/export from a single metamodel and then endogenous transformations within that type which is exemplified by the EMF-based transformation languages mentioned above.

5.1.1. Implications of the FHIR Design Choice

The decision to facilitate exogenous model access introduces a large degree of flexibility in implementation of the engines and plugin graph query implementations, but also has a number of number of design and clarity tradeoffs:

- A large and diverse syntax with a mixture of type-dependent operations, and string-based manipulations which may:
  - Provide disincentives for completeness of the implementations of FHIR Mapping engines, thus endangering the portability and interoperability of *StructureMaps* and textual map files
  - Make the transformation language more complex, and transformations more difficult to read, write and debug
  - Obscure the semantic matching purpose of the rules by mixing in string-based and type-based operations on instances
- A loss of type-safety, which may pose risks in clinical safety. This is in stark contrast to the Basic Type prescriptions given in the FHIR Specification, which are very particular about how basic types are represented in different programming and document serialisation languages. One example is the

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[6] https://hl7.org/fhir/structuremap.html

[7] http://www.antlr.org/

[8] quote from https://hl7.org/fhir/mapping-language.html#execution

prohibition of the IEEE floating point representation for real numbers, and a very specific prescription for what type must be used to represent these in Java.

5.2. Traceability

Although there are in fact three languages defined in the QVT standard: QVT-Relational, QVT-Operational and QVT-Core, the commonality between them is that all are based on the declaration of *relations*. Relations, which are tuples, based on the set-theoretic concept, in which the values are references to model elements with types defined by their metamodels. A relation will typically have two values, one referring to the source model, and the other to the target model type to be created. However, if more than one source element is used to create a target element, there may be three or more places, and if a literal value is calculated to determine the fitness of a rule match, it may also be included in the relation. This design ensures that after a model transformation has been executed, a set of populated relations can be used as a mapping table for the model elements that correspond to source and target models. This unifying part of the design means that regardless of the declarative or operational nature of the transformation rules, the output from executions can be examined in the same way to allow domain experts or transformation developers to check that the models are related in the expected way. The relations are also first-class models, and so can have additional checks or queries made to them to validate results, and they can be persisted to allow for reverse transformations if the target model is changed after the first execution.

Figure 3 - A generic illustration of model transformation with generated traces

Figure 3 shows a generic scheme combining the implicit instance based transformation style of the MDA pattern in Figure 1 with the explicitly metamodel-based example transformations in Figure 2 to show all the major aspects of a trace-generating model mapping and executable transformation paradigm. Figure 3 highlights a transformation defined between two model types, A and B. This transformation is executed by some engine

using a source model instance to create a target model instance, with the relationships between the matching elements stored in a trace for that execution. Note that the additional overshadowed metamodel and model instance boxes imply that more than one source type may be related more than one target type, and that multiple model instances may be required as sources or generated as targets - although a single set of traces will be generated that refer to model instance objects from all the related models.

5.2.1. How Traces Facilitate Clinical Safety

The overarching requirement when specifying healthcare records is clinical safety. This implies that the contents of clinical records are displayed only in context, and always captured in a form that accurately reflects the acts and observations of clinical practitioners, along with the level of uncertainty surrounding these. The same context requirements apply to records made and viewed by administrators of healthcare practices and procedures. Therefore we suggest the use of traces between models to support a division of labour between clinical information modellers and transformation authors.

In working with clinical modellers, the authors have experienced a typical "80/20" scenario when modellers are tasked with defining mappings to implementations from DCMs or structured documents that compose DCMs and some metadata. That is, 80% of the content of the logical model is straightforwardly mapped from one source concept in the logical model to a small number of matching constructs in the implementation model. However, 20% of the content requires a complex refactoring of the information in the logical model and its metadata to place the equivalent information in the implementation model in multiple places, or in a different topological structure (tree vs flat list, repeating structure with single element in header to repeating structure with copies of header element in each one, etc). The expression of such concepts is the bread and butter of functional programmers, who can create the appropriate rules with relative ease, but it requires too much programming overhead to be easily expressed by someone whose job it is to understand the model(s) of the data as they relate to the integrity of healthcare practice. However, the two skill sets may be complemented by a traceability framework that allows the programmer to use significant example sets provided by the modeller to deduce a pattern, and then program a transformation rule set, followed by validation from the modeller using these examples (and then future additional models) using the traces after the execution. This can be repeated in an iterative manner until robust and long lasting transformation rules are developed, at which point the programmer is not required until a change is made to the logical model or implementation frameworks.

There is a perception that in order to achieve the clinical safety goal, a knowledgeable clinician or clinical informatician is involved in every step of a translation from more abstract, or less structured content (such as natural language requirements statements) through to computing type system formalisms (such as Logical FHIR) and then to constrained reuse of libraries of standard data structures (such as the base FHIR Resources). All current proposals for the use of FHIR Logical Models which the authors have encountered require a human-authored mapping from the syntactic content of a FHIR Logical Model (whose semantics is defined elsewhere, for example in an openEHR Archetype, or by links to numbered requirements statements) to a well-formed reuse and extension/constraint over the FHIR base resources.

We would propose a different approach: the use of an executable transformation language with reusable rules that (despite being human authored) is automatically executed on a known semantics from FHIR Logical to FHIR Profile *with the storage of traces between the elements in the source and target models*. The traces can be displayed using tooling that is either designed specifically for clinical modellers to use, or is exported in a format which facilitates simple tabular display, such as HTML with appropriate stylesheets, or an open spreadsheet format. This approach allows a transformation programmer, whose skills in expressing executable transformation rules will surpass the level of declarative/functional programming skill available in most clinical modellers, to author a fully automated mapping, creating transformation rules that need not be fully comprehensible to a clinical modeller *because the modeller may inspect the outcome of the execution.*

6. Related Work

The authors have experimented with the transformation of openEHR-based logical models, using jQVT and a tabular mapping of their elements to the UML Profile for CDA that is implemented in the Model-Driven Health Tools (MDHT)[9]. The CDA UML elements are generated by another jQVT transformation from an XML-based Logical Model using recorded mappings of the previous correspondences between the Logical Model and CDA. Modellers also recorded which uniquely numbered natural language requirements correspond to the Logical

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[9] https://projects.eclipse.org/projects/modeling.mdht

Model Elements (recorded as XML Paths) in a simple table, which is parsed into a trace model instance. In addition MDHT now includes a Schematron Package generator, based on the high quality Schematron Packages published by NEHTA to support validation of their CDA Implementation Guides. It creates a Schematron rule for each constraint implied by the CDA UML model structure, or specified as an OCL or XPath constraint on a CDA UML model. This generator saves traces between the UML model and the Schematron model.

Finally, all related artefacts are correlated in a very simple computation using their unique identifiers (Requirements number, Logical XPath, CDA XPath, and Schematron Package Identifier) and a table is constructed showing the traces from Requirements to Logical Model Elements to CDA Model Elements to PDF Implementation Guide Sections and Schematron Rules. These are visualised through a table-based tool that navigates these model links. The tool[10] displays human-readable constraint and path expressions for clinical safety checking, along with error message codes for developer debugging purposes.

Figure 4: A Web display of a traceability table between Requirements, Logical Model and CDA Model filtered by document section

Figure 4 shows a snapshot of the tool's use, via a Web-based interface, with only the correspondences related to the Implementation Guide section 3.2.1 shown. The table's columns have been pre-customised for different roles, but views of the table can also be dynamically changed to show different model elements, and their attributes. For example, the cardinalities of the Logical Model elements, and their corresponding CDA UML Models are shown in the "Cardinality Matching" view. Despite all artefacts being stored as computer application-supported structured data or models, prior to this tabular view of correspondences (some human-recorded, and others generated by transformation traces) scanning three different PDF documents and a set of Schematron files by eye was the only way to validate that all requirements were represented in the logical model, and all logical model elements were sensibly translated into CDA constraints which could be checked by a corresponding Schematron rule. This process takes many person-days or weeks per revision cycle, and many person-weeks or months during a complete publication process. Human validation is still required, but gaps are identified by the computational correlation, and relevant information is shown side-by-side - often with click-through links which navigate directly to the context in the model of origin.

7. Conclusion

We have described how the introduction of Logical FHIR as a means of representing Logical Models and DCMs, which may have been imported from other formalisms, enables the use of an endogenous transformation language to map them to profile-based FHIR models which reuse the standard resources. The pattern of OMG's Model Driven Architecture (in its early incarnations) may be applied to this problem. The FHIR Mapping

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[10] http://git.eclipse.org/c/mdht/org.eclipse.mdht.git/tree/core/plugins/org.eclipse.mdht.metamodel.traceability.editor

Language provides an early draft specification and prototype for this purpose, but there are also a number of extant transformation languages and their execution platforms which may be applied to this problem, mostly in the Java EMF environment.

The design of the QVT language implies the ability to store traces between models that result from the execution of a transformation (mapping). The use of traces enables the separation of concerns between healthcare modelling, and the far more demanding skills required to do declarative programming for the difficult cases in a mapping where a simple tabular correspondence is not sufficient to express the model refactoring required. The traces form both a debugging framework for these declarative transformation authors, as well as a way for Clinical Modellers and Clinical Safety specialists to validate that a complex transformation has implemented the correct mapping from formats and reference models to FHIR resources.

We encourage the FHIR Mapping initiative to include a standard resource representing model-to-model traces, which reuses and extends open source initiatives which have employed this mechanism for mapping Logical Models to CDA models in the past. We also recommend that a future draft of the FHIR Mapping Language and Engine specifies how trace instances should be created and compared to allow table-based display tools to enable clinical experts to examine the correspondences created when executing and refining mapping definitions.

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Is a Fusion of OSS and Commercial Providers better for Healthcare Systems?

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Abstract

EHR adoption has increased rapidly over the last 10 years, boosted in several countries by government stimuli and the threat of financial penalties for non-adoption. Unfortunately this growth has not yet generated the much hoped-for significant cost efficiencies and improvements in patient care. Instead, cases of massive cost overruns and implementation disasters are now common, and the commercial EHR market has condensed down to a few dominant players, thereby reinforcing traditional problems such as vendor lock-in, poor interoperability, and slow evolution and innovation. In stark contrast, the broader software industry has seen a veritable revolution over the last 10 years, driven by the Open Source Software (OSS) movement. Over 90% of software companies surveyed in 2016 found that OSS has improved efficiency, interoperability, and speed of innovation, and 55% had already included OSS in their company's deployed code. Significantly increased usage of OSS has been seen across all industries, and also in all software architectures from operating systems to cloud computing. This paper will describe and compare two successful open-source EHRs that have active long-term developer communities, and discuss the promising future of such systems to meet the challenge of reducing costs and increasing efficiency whilst significantly improving patient care.

Keywords: OpenMRS, OpenEMR, Open Source, EHR

1. The Power of Community and Open Source

The power and potential of community-based, open-source projects are now widely evident in some of the most heavily used non-profit software and media projects worldwide. Some examples include Wikipedia (5th most popular website, with >280,000 active users per month)[1], Firefox (most popular browser worldwide in 2009, currently #3)[2], MySQL database (#2 worldwide, growing 3x faster than proprietary platforms)[3], and the WordPress website content manager (#1, with 59% market share)[4].

However the open-source movement now runs far deeper than non-profit; it is also revolutionising the for-profit commercial software world. In 2008, North Bridge Venture Partners began surveying software IT managers for their current open-source usage and future outlook [5]. At that time, open-source had little glamour, and was used primarily due to its low cost, freedom from vendor lock-in, and flexibility. Four years later a considerable shift was evident in the 2012 survey, which found that half of the respondents expected that within 5 years at least 75% of their company's deployed code would be open-source, and that OSS in general was reaching a "tipping-point".

In the latest 2016 survey of 1350 companies, OSS was described as "the engine of innovation" for the software industry, and "no longer the exception, but the rule". Over 90% of respondents said they had found OSS to improve efficiency, interoperability, and the rate of innovation [6]. Importantly, the reasons for choosing open source had also shifted considerably since 2008, with the top three reasons for choosing OSS now being high code quality, advanced technical capabilities, no vendor lock-in, easy customisability and code fixes.

Today, OSS is a significant driver of the digital transformation of business processes to be more agile, innovative, efficient and customer-oriented in a hyper-networked world. It has become a pre-eminent force in a wide range of software architectures (see Table 1).

Table 1 –Open source projects with large market shares are now found in all major architectures

Cloud Computing	Operating Systems	Coding Language	Applications	Server Applications	Content
OpenStack	Android	PHP	Chromium	WordPress	Wikipedia
	Linux	Python	Firefox	MySQL	Wikimedia
		Java	OpenOffice	Drupal	Proj. Gutenberg

Perhaps the most well established example of how a commercial software provider can flourish in conjunction with an OSS developer community is the company Red Hat. Founded in 1993, it provides a range of OSS and Linux-based software products that have been tested and certified for enterprise use. In 2012 it was the first open-source-based company to reach $US1Bn in sales, and has continued to grow rapidly since then, reaching $US2.4Bn in 2016. It has regularly appeared at the top of the Vendor Value Survey, and is now used by most of the fortune 500 companies, as well as security and reliability-critical enterprises such as stock exchanges in 24 countries worldwide [7].

Unfortunately the agile and innovative OSS approach has not made similar in-roads into the EHR market. This loss is further compounded by ongoing market consolidation, and the emergence of a few dominant providers (such as Epic and Cerner in the US, which were dubbed the "Coke and Pepsi of EHRs")[8]. The resultant interoperability problems between proprietary systems are still causing huge system-wide inefficiencies [9]. One influential review of the commercial EHR market in the US found that 70% of implementations had significant failings, and that commercial vendors had (i) pushed through legislation exempting their products from the standard pre- and post-market functionality checks (routinely required for all medical devices), (ii) forced reductions in the required functionality and interoperability required by law, and (iii) had gagged clinicians from publicly disclosing cases of software defects, even when patient safety was put at risk [10].

The fragmented commercial software market has led to the creation of many open-source data exchange standards (such as HL7, FHIR, and OpenEHR), and these groups are continually pushing for greater uptake by the commercial software providers. However interoperability metrics have always lagged far behind measures of implementation breadth and depth [11].

The intrinsic benefits of a vibrant OSS community (as now harnessed by the broader software industry) are an ideal antidote for a world of costly proprietary EHR systems which often demonstrate limited flexibility and customisability for specific clinical workflows. The rapid innovation rates possible with OSS will also be essential to take us beyond the "more IT" expansion period seen over the last decade (which does not generally deliver cost savings or better health outcomes), into a "better IT" period of continuous advancement and refinement necessary to reach these critical milestones [12].

Feature-rich, flexible, open-source EHR systems which can now increasingly compete directly with proprietary offerings in many settings are available today. Two leading examples are OpenEMR and OpenMRS. This article will investigate the background and evolution of these two systems, compare their strengths and weaknesses, and then consider their bright future in regions where the cost and technical weaknesses of proprietary systems are widely felt, and the continuous innovation necessary for decreasing costs and improving patient-outcomes is given high priority.

2. A Tale of Two EHRs: Contrasting Evolutionary Paths

Two of the most successful open-source EHR systems available today are OpenEMR and OpenMRS. Both have growing communities of active long-term developers and world-wide implementations in multiple languages at all scales. They also provide more advanced EHR features such as highly granular control of user access roles and privileges, HL7 and FHIR interoperability, and mobile device apps providing access to the centralised database at the point-of-care.

However the conception and core strengths of the two systems differ significantly, and although the differences are decreasing as the systems continue to evolve, they still contrast significantly in many ways.

2.1. OpenEMR

OpenEMR has its roots in commercial practice-management software developed by Synitech Inc that was launched in 2001 under the name Medical Practice Pro. In 2002 it was upgraded to meet US HIPAA confidentiality laws, renamed as OpenEMR, and released to the public as open-source software on Sourceforge [13].

OpenEMR's focus on practice management tasks remains evident today, as these features remain the most advanced and strongly developed. Some of the most highly developed functionalities include billing, scheduling, payment

gateways, support for Continuity of Care Documents (CCD), financial reports, and easy integration with employer-based insurance systems. The system also supports physician reminders, lab-work and e-prescription interfaces, and configurable forms for a wide range of medical specialities [14].

OpenEMR benefits from an active, responsive and growing developer community, with more than 100 active developers [15]. Many of the most prominent developers are also employed by specialist software companies (found in 13 countries worldwide) that focus specifically on providing implementation and ongoing support services to medical practices wishing to install OpenEMR. This strong link between commercial service providers and the practical demands of medical practices in a wide range of countries has seen OpenEMR become perhaps the most widely installed open-source EMR, with an estimated 30 million patients in the USA, and more than 50 million in the rest of world [16]. However there is little insight provided into how these numbers are calculated, and there does not appear to be a reliable list of medical practices running the system (only monthly downloads).

2.2. OpenMRS

In 2000 in western Kenya, 50% of hospital beds were filled with young people dying of AIDS. Poverty, polygamous marriages, and poor physical infrastructure (from hospital equipment to electricity supply), all contributed to an environment of depression and despair. It was in this environment that the Mosoriot Medical Record System (MMRS) was developed by Indiana University (USA) and Moi University (Kenya), to replace paper records, allow detailed patient monitoring, and enable accurate health reporting to the Kenyan Ministry of Health [17].

This database quickly showed its enormous benefits in the management of the AIDS epidemic, and after 6 months replaced all paper records. In 2003 it attracted the attention of the WHO, Gates Foundation and USAID and more lately the President's Emergency Plan for AIDS Relief (PEPFAR/Emergency Plan). These provided funding for up-scaling the system to handle a country-wide implementation with millions of patients [18].

The resultant work created the foundation of the system known today as OpenMRS. It was immediately implemented in Kenya on a wide scale as the EHR for the Academic Model Providing Access to Healthcare (AMPATH) project, which addressed a full range of health-care fields including primary care, antenatal and postnatal care, oncology, TB, nutrition, mental health, diabetes and HIV [19].

From its inception OpenMRS was built as a modular system around a central medical concept dictionary [20-21]. This dictionary allows accurate and repeatable coding of all clinical observations, lab tests, medical procedures, diagnoses and drugs. This creates a standardised format that largely eliminates free-form descriptions (that often vary significantly between individual providers), thereby enabling detailed tracking of medical conditions, powerful analysis of entire database records, and also later integration of other advanced features such as physician decision support systems [22].

The developer community has continued to add new functionality via new module development. In recent years OpenMRS has advanced considerably, for example through the addition of fine control over user access/roles/privileges, HL7 messaging, FHIR compatibility, REST web services and mobile device access to the central database both with and without an internet connection [23].

3. Features of Successful Open-Source EHR Systems

3.1. Community and Collaboration

The full potential of open-source can only be realised when developer communities remain active and productive over extended periods. A 2009 survey of Sourceforge (a large repository of open-source projects) revealed that only 17% of 145,000 projects successfully made it through the initiation phase and three subsequent software releases [24].

Five key factors for success included:

1. a clear vision for the project
2. a list of specific goals that were of value to the users
3. a group of lead developers that were also users
4. strong communication (such as road maps and bug fixes)
5. a modular architecture to allow multiple teams to work in parallel at different levels of complexity

Collaboration is an equally critical component of success, and not just between active developers. Many projects also have significant user groups that are not involved in the coding, and in the case of EMR systems this is healthcare workers, and members of regulatory agencies and/or governments. These users must have a strong line of communication back to the developers, to ensure that the final product remains able to meet the practical needs of all user groups to a high degree. Failure to include healthcare workers in systems design has often led to implementation failures [21].

Both OpenEMR and OpenMRS have passed the critical test of time, and retain active communities after multiple generations of software releases. Both also meet the 5 key factors above, and show strong collaborative links between developers and the broader user groups. It is interesting to note the distinct collaborative strengths of the two packages; OpenEMR between developers with strong ties to the commercial software world and medical practice managers; OpenMRS between university and NGO-based coders with a strong history in medical concept coding and users with experience in the stringent implementation requirements of low and middle income nations. Strong diversity is also seen in the support list of OpenMRS (Table 2).

Table 2 - List of Key Supporters of OpenMRS

AMPATH	Regenstrief Institute (Univ. Indiana)
NIH (Fogarty International Center)	Rockefeller Foundation
Google	Salesforce
Harvard Medical School	SolDevelo
International Development Research Centre	ThoughtWorks
Jembi Health Systems	UC San Francisco
Medical Research Council South Africa	University of Washington
Millennium Villages Project	World Health Organisation
Partners in Health	…..and many others

In keeping with the large Sourceforge survey's findings, many open-source EMR projects also do not make it in the long-term. This is evident in the EMR projects that had active communities in the mid-2000s (such as FreeMed and Care2X) that no longer appear to be evolving and releasing new versions.

3.2. Technical Features of Successful Open-Source EMR Systems

Technical features also play a strong role in the probability of long-term success for open-source EMR systems.

- Scalable and Sustainable: systems must be able to scale from dozens to millions of patients, and remain sustainable as the demands of care delivery increase over time

- Flexible: readily adapted to the wide range of clinical scenarios e.g., direct patient care in clinics and hospitals, preventive care, research and epidemiology, and emergency situations (e.g. OpenMRS in the Ebola outbreak [25])

- Rapid Form Design: allows clinician's to design data entry and decision support interfaces appropriate to their needs, without resorting to coding changes. This functionality is facilitated by Concept Dictionary structure of OpenMRS [22]

- Uses Standards for Medical Concepts and Interoperability: adaptable and expandable concept dictionary infrastructure that is mapped to standards such as SNOMED® CT, ICD-10, LOINC®, RxNORM; meets data-exchange standards such as HL7, FHIR [23]

- Mobile Connectivity: allows immediate paperless entry and review of records at all point-of-care locations; should also support situations with intermittent connectivity, as may occur in remote locations

- Free or Low Cost: to ensure all populations have access; does not exclude private enterprise investment

- Clinical Usefulness: the system must facilitate the processes of recording data and informing caregivers and providers. If not clinically useful and able to improve efficiency of operational workflows the system will not be used.

3.3. Comparing OpenEMR with OpenMRS

As introduced earlier, these two systems were conceived in different environments, with different initial goals and visions, and then developed by a coding community with distinct set of background knowledge. The net result is that although the two systems share some similarities, they also differ significantly in their key strengths.

Both systems share features such as being free and open source, implemented in dozens of countries worldwide, and available in many languages. They have each gone through multiple stages of development over more than 15 years.

Both systems also share strong development communities that continue to improve and evolve their respective systems. For example from the 2016 OpenMRS annual report, we see that it was active in over 60 countries, at more than 1800

sites (+60% vs 2015), has an annual conference with over 400 attendees (+20%), has played a significant part in the Google Summer of Code for 10 years, and had more than 1100 new members join its community in 2016 (+75% vs 2015 new members) [26].

OpenEMR's strength lies firmly within its practice management features. These are billing, scheduling, integration with external providers (such as lab testing), insurance provider integration, prescription management and compliance with key US legislation (originally HIPAA confidentiality, and more recently MACRA rules for Medicare billing and other EMR-based incentive payments such as Meaningful Use).

These management and compliance strengths are mirrored by a relatively weak standardised coding system in its medical record database. The system was not developed around a medical concept dictionary or archetype library, and as a result does not capture data with a high level of standardisation and repeatability. Similarly it also supports the storage of scanned PDF documents, which result in medical data being stored outside a coded database, which greatly impedes the generation of summary reports and data analysis.

It has also been observed that the source code of OpenEMR is mixed in some places (with SQL queries next to HTML) showing that there is not complete separation of database operations from the user interface [27].

The core strength of OpenMRS is its rich and continually evolving concept dictionary. It ensures that all elements of a patient's interaction with the care system are captured in a predefined, standardised set of database entries [28]. This allows the creation of accurate patient summaries, reports, and data analysis on the entire data set, without missing aspects that may be contained in free-text descriptions or other document formats (such as PDF, or image scans).

A central international reference version of the concept dictionary is maintained at the Columbia International eHealth Laboratory (CIEL) [29]. This group oversees the ongoing evolution of the dictionary, which adds new medical concepts (e.g. observations/tests/drugs), and also enables quick adaptability and expansion of the dictionary for wholly new situations, such as the Ebola outbreak in 2011 [25]. Having a centrally-maintained version ensures that all new additions are consistent with existing structures, and avoids the inevitable inconsistencies and overlaps that develop in systems developed by many parties over an extended period.

A further technical advantage of OpenMRS is its strictly modular structure, and easily accessible API. This structure ensures a strict separation of the user interface from the underlying database back-end, permits the expansion of the system without affecting the running of an established system, and also enables most developers simply to work with routine java objects and the API, without having to gain familiarity with the complex data model.

OpenMRS alone can be expanded by many modules, including options for scheduling and billing. However it has not been developed to integrate with US-based healthcare legislation, and is not a feature rich billing platform. OpenMRS can also be significantly expanded (for example to cover entire hospital implementations) through integration with OpenELIS (lab information system) and OpenERP (enterprise resource planning). Bahmni is one such integration, which is currently active at 25 sites across several countries [30].

4. Future for Open-Source EHR Software

Proprietary EHR software retains its dominant position in most hospitals and medical practices. However poor compatibility, low flexibility, and often high purchase an implementation costs (sometimes exceeding $US1Bn) have created many cases of dissatisfaction [9 – 10]. The continuing market consolidation also leads to reduced competitive pressure, slowing rates of innovation.

Dissatisfaction and limitations such as these contrast with the inherent advantages of open source (innovation, agility, interoperability, running cost). As a result, when returning to the original question of this article "Is Open Source a Better Way for EHR Systems?" it seems on current evidence that the answer is yes, for all the same strengths and benefits that have driven Open Source to become a leading player in the broader enterprise software market.

However the inherent strengths and benefits of Open Source are not a guarantee of a successful software development and implementation, and as with any complex project, a set of sizable challenges must be overcome. Successful OSS development projects have been found to have a specific set of features (see 3.1), and in addition an experienced commercial software partner may be necessary to orchestrate the software customisation, project implementation and ongoing technical support required in a healthcare setting [31].

The observation that OSS strengths and benefits outweigh the challenges has also been recognised by multiple governments including Australia, UK, Brazil and Norway. These countries are now starting to specify open source standards for data storage and exchange in their ongoing or upcoming nation-wide EHR implementations [32].

Considering the features, interoperability, and cost advantages of OSS, several kinds of implementations immediately stand out as ideal candidates:

1. Regional areas in developed countries facing acute budgetary limitations: these regions have often been unable to consider installation and maintenance of costly proprietary software which can easily exceed $100m for mid-size systems. Open-source systems developed for resource-restricted areas (such as OpenMRS) are ideally suited to such situations, and have an established track record at all scales from single-practice up to nation-wide.

2. Remote regions that are poorly served by a distant health service: Remote islands or states which have suffered from poor connectivity with distant health services can now implement their own system at low cost, tailor it to their precise needs, and then use it as an expandable framework to capture all current and future healthcare services.

3. Allied health systems, including aged and disability care: operating outside established hospital settings and often struggling with very limited funding, and particularly complicated medical histories spanning many providers. Many still struggle with inefficient paper-based systems, poor communication and interoperability, and systems that are unable to reliably capture and summarise large, complex and mixed medical records.

An example project from Australia which is now investigating open-source software for regional allied health providers (combining #1 and #3 above) is the My Connected Health project. Feedback from multiple providers has confirmed the acute needs of regional providers for IT systems that allow more accurate and efficient data capture and management, and their dependence on low-cost solutions due to funding constraints. Existing OSS packages have the capacity to meet both these key criteria.

The bright future for open-source EHR also stems from its fundamentally open- and interchangeable nature. When developers identify specific beneficial features in different systems, they are free to take the corresponding code sections and integrate them in a new system. An example of this has recently been seen in the EMR space, where key developers from OpenEMR have started a new fork of the system (known as LibreHealth), which is specifically designed to allow more innovation and freedom to incorporate some of the strengths of OpenMRS [33]. This group is still young, but has the benefit of an experienced initial developer community. With a clear vision and good management, this group also has the potential to make a valuable contribution to the open-source EMR software space.

So in conclusion we have seen that the same set of intrinsic benefits that have propelled OSS to its leading position in the broader enterprise software market are just as beneficial for EHR systems. Furthermore, these benefits will be essential assets in the next phase of health IT development, where new innovations and continuing refinement will start to lower costs, increase efficiency, and most importantly, improve patient outcomes. With several well tested open-source EHR systems immediately available, all the pieces are in place for open-source to significantly increase its market share and impact on patient outcomes.

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openEHR Approach to DCM Development: Lessons Learnt from the International Review of the Tobacco Smoking Summary Archetype

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Abstract

Data modelling for electronic health records (EHRs) is complex, requiring technological and cognitive sophistication. The openEHR approach leverages the tacit knowledge of domain experts made explicit in a model development process aiming at interoperability. Our research aim was to explore the data modelling process for a tobacco smoking summary archetype and its implications on information systems development with specific reference to interoperability. The first author became a member of the OpenEHR Clinical Knowledge Manager review platform and observed a set of reviews of the tobacco smoking summary archetype, and the editors' discussions following each iterative review, and made field notes. The first author also interviewed eight reviewers. The data were analysed using a general inductive thematic approach. The success of the openEHR approach was mostly attributed to a very large and active community of relevant domain experts, the insightful coordination and guidance of the editors, and a well-defined process with excellent tooling support by the openEHR CKM.

1. Introduction

The rising burden of diseases has presented a challenge for public health and healthcare systems worldwide. The fundamental challenge of addressing this issue is a result of the complex interaction of the biological, behavioural, physiological, and environmental factors that surround and influence the individual. To add to the challenge, disagreement among stakeholders along with limited access to resources often create contention, and obscures the general sense of direction as to how the rising burden of diseases should be addressed [1]. In essence, the development of health information technology (IT) solutions can be just as difficult. In this paper, the authors offer an insight to the findings surrounding the openEHR approach to detailed clinical model (DCM) development. Exploring the process that enabled the aggregation of tacit knowledge of domain experts from different walks within the same field of interest. Whereby the development of the DCM not only met their individual expectations, but also ensured its adoptability among the diversity of needs within health and healthcare.

Aspects that contributed to the success of the DCM development stems primarily from the features of openEHR, but more so, the potential for domain experts to collaborate and cooperate. It is on this basis, the understanding of the complex interaction of multiple factors associated with the rise in the burden of diseases can be achieved, whereby tacit knowledge of individuals can build on one another [2]. In light of these concepts, this paper aims to focus on the relevance of these findings to the development of health information systems, particularly for software maintenance, and future-proofing of systems and data.

2. Background

The incorporation of electronic health records (EHRs) has significantly improved the way in which patient health data is stored and retrieved [3]. Moreover, the widespread adoption of EHRs has created the opportunity to facilitate population-based studies of medical records, where the aggregation of patient data from disparate sources enables a better understanding of a population's health characteristics relevant to a specific health condition [4]. In reference to public health surveillance, the ability to accurately and efficiently capture longitudinal population health information is a feature that makes EHRs so outstanding. However, as technology is consistently advancing, the time and effort required to evaluate them in accordance with expectations of an organisation can be very costly and time consuming, and can often result in the adoption of systems that may not be entirely interoperable with one another. Furthermore, due to the changeability of clinical requirements, traditional software development can take a lot of time and effort to develop IT solutions, which in turn can be very difficult and expensive to maintain over time.

2.1. openEHR

The openEHR foundation is an open standard organisation that strives to achieve universal interoperability and reusability of all electronic patient health data [5]. Features of openEHR responsible for efficacious development of DCMs are the two-level modelling paradigm, and the clinical knowledge manager.

2.1.1. Detailed Clinical Models

In healthcare, DCMs are computable and manageable representations of domain content models documented in EHRs [6]. The health information is structured through the combination of expert knowledge, data specifications and terminologies, and various technical applications [7]. In this aspect, the constructs of DCMs are most applicable to addressing complex health cases; where multiple factors need to be taken into consideration to formulate an accurate diagnosis. In openEHR, the CKM operates as a platform for domain experts to collaborate, cooperate, and contribute to the review and maintenance of DCMs. The development of DCMs begins with the author(s) and editors creating a draft clinical model, and inviting domain experts from all walks within the field of interest to review the model; a process known as crowdsourcing [8, 9]. The aggregation of tacit knowledge provides fresh perspectives to the editors, and ensures the DCM is developed in a manner that enables it to meet the ever-shifting health demands of populations [5, 10]. The review of the DCM continues until all of the domain experts involved agree that the model has satisfied all their expectations, and thus, fit for publication [11].

2.1.2. Two-Level Modelling Paradigm

The two-level modelling is a fundamental paradigm attributing to the success of openEHR DCMs. The first level of modelling comprises of a stable reference model (RM), and the second level of modelling comprises of a formal definition of clinical content in the form of archetypes and templates [12]. The RM is the base information model for all openEHR systems, and defines the invariant semantics of EHR, EHR extracts, and demographic models. The archetype provides a place to formally define reusable data points and data group definitions. The archetype is a structured and constrained combination of entities of a RM that characterises particular clinical concepts such as blood pressure measurements or laboratory analysis results [10, 12]. The template is a logical representation of case-specific datasets, such as data items making up a patient's discharge summary [10]. Its construct is built by referencing relevant items from a number of archetypes, and must therefore, also abide to the semantics from which they are built.

In model-driven development (MDD) methodology, the term *model* refers to the visual representation of simplified abstractions, each one specifying a different view of a complex domain, and codes are then generated from these models in the development of the software [13, 14]. In openEHR, the archetype itself can be seen as a model, whereby the template can be seen as a complex domain; made up of different datasets from different archetypes, customised to the specific needs of an EHR system. In reference to the two-level modelling paradigm, this feature is made possible through the RM; the information model that defines the invariant semantics, which all EHR data in any openEHR system must obey [15]. In light of this, the reviewers and editors are not required to have a prior understanding of software development in order to contribute to the development of an archetype. As a result, more time and effort can be invested into developing the clinical content of the archetype [16, 17]. The MDD methodology empowers developers and end-users by enabling them to focus specifically on relevant aspects of the software development, while ignoring other aspects that are irrelevant [13]. Furthermore, MDD enables individuals with different levels of experience to collaborate, cooperate, and contribute towards the archetype development, which in turn, increases the quality of the developed archetype [18].

2.1.3. Clinical Knowledge Manager

The openEHR CKM is an online collaborative e-health knowledge asset-management application and repository of clinical knowledge resources, such as archetypes, templates and clinical terminology subsets [19]. It is designed to enable the development of knowledge assets through various intermediate forms, leading to a concrete artefact that can be disseminated to a large audience [5, 19]. The knowledge assets are developed through the voluntary contributions of interested and motivated individuals with the common aim to furthering an open and international approach to clinical informatics. The features of openEHR CKM incorporates web-based governance, documentation, and review of standard specifications for health information in a form independent of the technical standards in use [19, 20]. Furthermore, other systems are able to query for and obtain artefacts matching any criteria, and searchable metadata to be added to each archetype, template, or other assets required by users [20, 21]. These aspects of the openEHR CKM create an environment that simplifies the typically error-prone manual operations and complex workflows, and ensure the efficient and effective online governance of e-health knowledge assets [5, 21].

3. Methods

The methods of data collection included in the study consisted of observations and interviews, with the additional use of field notes in conjunction with each respective method, as shown in Figure 1. The first author followed the international openEHR CKM review of the tobacco smoking summary archetype up to the stage of publication. Two perspectives of

the openEHR approach of particular interest to the study were the mechanics and the human cognition. The perspective of the mechanics was understood through participatory observation on the content and editorial reviews of the archetype development, where the review documentation was analysed with a summative approach to content analysis. The perspective of human cognition was understood through interviewing the reviewers and editors, where they shared their thoughts, knowledge, and experiences about the openEHR approach. The interviews were digitally recorded, transcribed, and analysed using the conventional approach to content analysis [22].
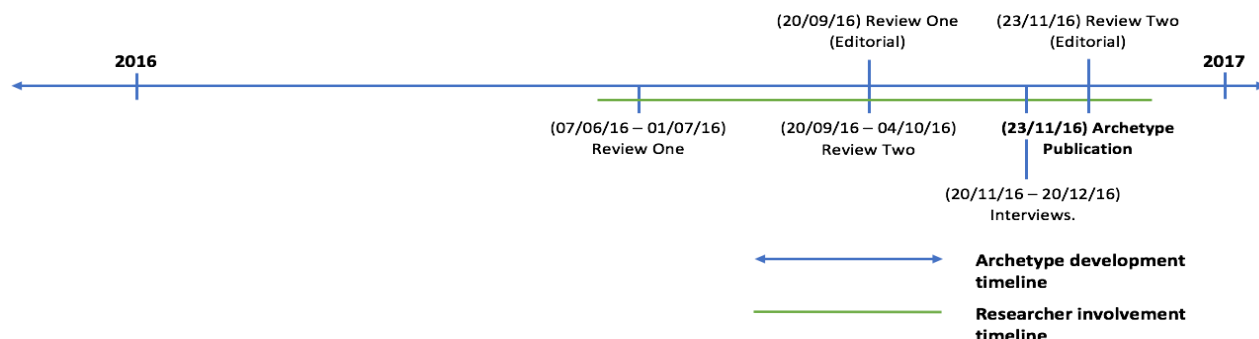
Figure 1 Chronology of the study

In Figure 1, the green arrow without directionality indicates that this study was only a snapshot of the entirety of the tobacco smoking summary archetype development, which has been an ongoing process. Keeping in mind that as time progresses, the applicability of the archetype to meet the demands of different stakeholders may be resubmitted for review, whereby further development and refinement may be recommended to better achieve the intended purpose of the archetype; in other words, the development of any openEHR archetype is a continuous process.

4. Findings

Findings from the study indicated that both the socio-technical (technical and human cognition) aspects of the openEHR approach were key to the successful development of DCMs. In conjunction with the features of openEHR, the developed DCM was able to accurately capture patient health data with an appropriate depth of detail, whilst achieving data interoperability and reusability. More importantly, the crowdsourcing of domain experts not only broadened the perspectives of editors, but ensured the maintainability of the DCM to meet the current expectations of the healthcare system, and thus, future-proofing it.

The concept data interoperability is a key underlying factor to the success of all health information systems, however, the degree at which it can be achieved is largely dependent on time and location/demography. As a targeted population (and use-case) increases, the number of health variables needing to be captured also increases, but as a population increases, we find that there are distinct characteristics among different demographics. In this instance, some health variables that may be applicable to one population, may not be applicable to another. A health information system developer will then have to decide whether to capture all the health variables, or select only those that are applicable to the population as a whole; meaning some demographics may not be accurately represented. For this reason, achieving meaningful data interoperability at an international level is a significantly complicated task. Moreover, it raises the question of whether there is an incentive to invest in a system where the captured data is relatively general, as compared to a more detailed system that is well-suited to the needs of a specific demographic.

In health IT development, there is often a tendency to start anew; however, this approach of reinvention is a poor investment of a health informatician's time and effort [23]. Following the science and practice of health informatics, one should assess whether similar scenarios have been captured before, and use existing knowledge and experience as a foundation to learn and build on. With this approach, any of the preliminary steps leading up to the development of a health information system can be bypassed, where more time and effort can be invested on the quality of its content. To the best of our knowledge, there is currently no system developed with this feature, nor is there any attempts to create one. The potential for developers to search for specific use-cases along with the corresponding solutions, highlights a promising concept that could vastly benefit the future of health information systems development.

5. Discussion and Conclusion

5.1. Aspects of the openEHR Approach

The openEHR approach to archetype development is a complex process that incorporates a number of aspects that are all interdependent in determining the success of the archetype to accurately capture patient data, and achieve data

interoperability and reusability, as shown in Figure 2. Key aspects contributing to the success of the openEHR approach are the availability of the openEHR community of domain experts, the MDD methodology, and the reviewers' tacit knowledge, and the editor's vision and synthesis. The literature and the findings have indicated that these four aspects cover the socio-technical characteristics of the archetype development, linking the human cognition (tacit knowledge of reviewers and editors) to the mechanics of the archetype development.
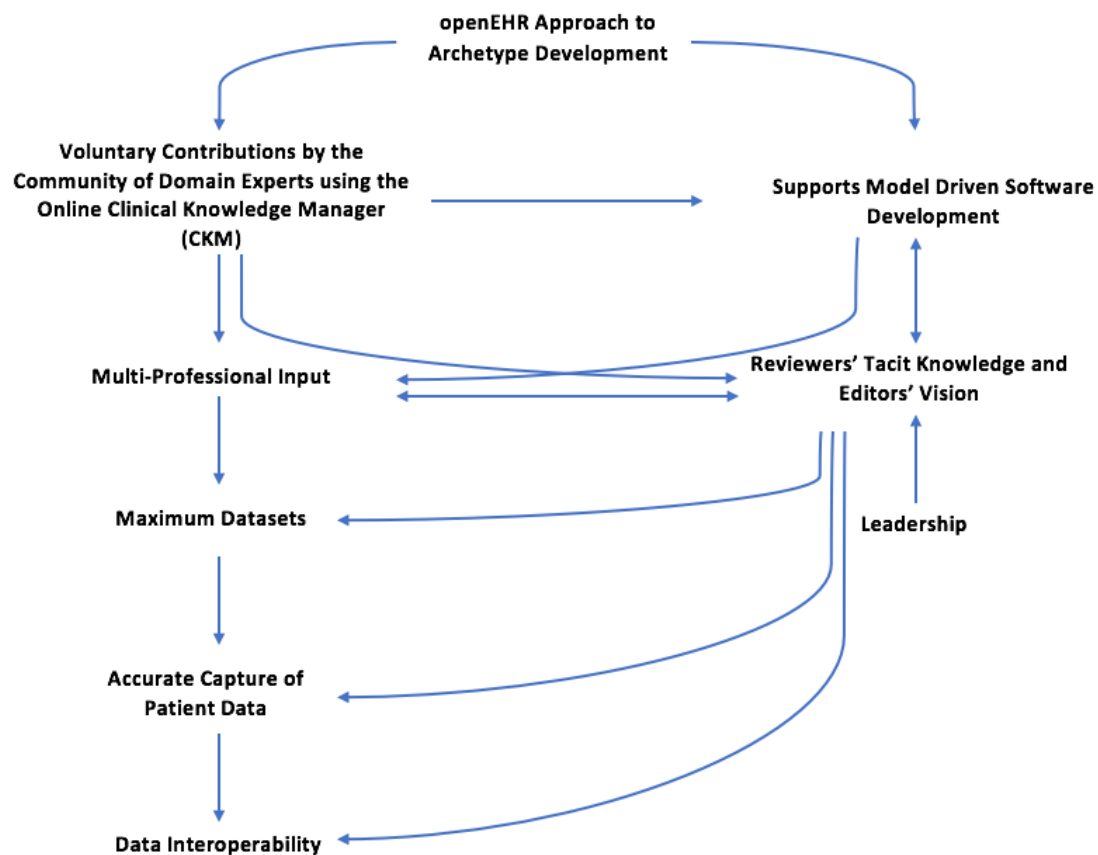
Figure 2 Aspects of the openEHR approach to archetype development

In the development of health information systems, there often lies the challenge of meeting the expectations of end-users, all of whom possess a diverse spectrum of requirements. To overcome this challenge, the openEHR DCM is designed to be a maximal dataset, where it aims to address all the characteristics surrounding a specific clinical concept. In this aspect, the end-users are empowered with the option to determine the depth of detail of patient data captured. For example, the depth of detail a general practitioner needs to know about their patient's smoking history in order to deliver adequate care may be relatively minimal compared to that of a respiratory physician. In this instance, the two healthcare professionals are able to adopt the same health information system, thus meeting their individual expectations whilst overcoming the challenge of data interoperability and reusability. The applicability of this concept to the development of health information systems is particularly important in uniting healthcare professionals in addressing the rising burden of disease. As all healthcare professionals have a story to tell, the ability to aggregate their knowledge and experiences not only ensures the success of the developed health IT system, but also paints a clearer direction as to how the rising burden of diseases should be addressed.

5.2. Investing in Knowledge and Experience – Aligning the Culture of Knowledge Sharing

The interoperability of health information technology is primarily determined by the interdependence of the system, technology, and the individual users. Figure 3 illustrates the different tiers of data interoperability ordered in their respective complexity. The bottom tier is most readily dependent on the technology and system aspects of health IT development (least complex), whereas the top tier is most readily dependent on the individual aspects of health IT development (most complex).
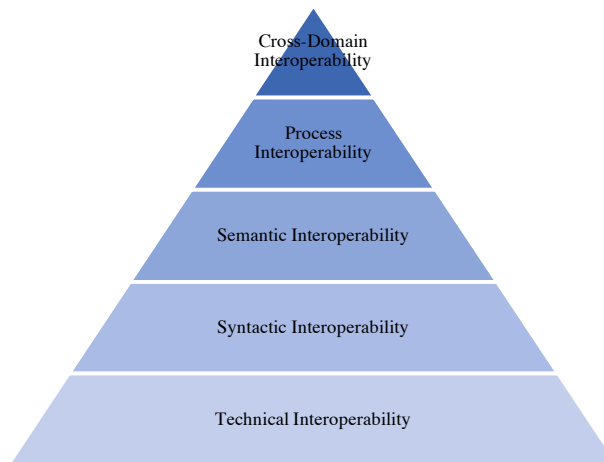
Figure 3 Tiers of data interoperability

It goes without saying that the development of health IT is dependent on the individual, in the sense that the individual believes that the developed health IT best aligns with their needs, and their perception of data interoperability. However, not all needs within healthcare are the same, nor is the perception of data interoperability, and it is because of this individual aspect, that health information systems, which may not be entirely interoperable, are developed. In openEHR, the aggregation of tacit knowledge was drawn from different walks within the field of interest, which in turn, implies different sectors of healthcare. As a result, the contribution towards the archetype development may not entirely align with the editors' vision at times, but this is due to the differences in perspectives. On a larger scale, the aggregation of diverse viewpoints is a step towards achieving mutual standards and protocols, thereby broadens the landscape in which the developed DCM could be applied. Furthermore, this process creates the potential to accelerate the rate at which the healthcare system shifts in order to align with the ever-changing health demands of the population. As by sharing a common perspective towards data interoperability, the development of future health IT is likely to become more interoperability with one another. The seamless access of patient health data between different sectors of healthcare, creates a system that is able to continuously reform and adapt to meeting the ever-changing health demands of the population. However, as not all domains of healthcare share the same perception towards data interoperability, suggests that there is still untapped potential to be exploited if only they can align their perspective of data interoperability with the larger sector.

5.3. Preventing the Reinvention in Health IT

Addressing the rising burden of diseases is a daunting task for many public health and health systems worldwide. With the appropriate application of approaches, each individual within the healthcare system can contribute to its reform, thus, meeting the ever-changing expectations of the population. By creating an environment where we build on the success and achievement of our predecessors, not only do we maintain data interoperability and reusability, but we also ensure the survivability of these health information systems. In this aspect, we reduce reinvention in health IT, and instead, we progress by investing more of our time as health informaticians in improving the quality of existing systems.

This paper has highlighted the potential of aggregating tacit knowledge of domain experts from different walks, as it not only expands the perception of health IT developers, but it also allows for the understanding of multitude of standpoints within the healthcare landscape. In turn, this approach aligns the perceptions held by different sectors in determining the general sense of direction as to addressing the rising burden of diseases.

6. Acknowledgement

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Supporting older adults to age in place using technology: Findings from a workshop of experts.

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Abstract

This paper presents findings from an ongoing project which explores how the use of innovative technologies can be used to distribute information and knowledge throughout an older person's formal and informal networks to better support them to live independently in their own home. The project examines the requirements of different stakeholder groups if technologies such as social media, digital devices and Smart home technologies are used to integrate healthcare providers more closely with the informal social support network of an older person. This paper presents the finding from a workshop of experts conducted at the HINZ Conference in 2016. We find that this approach will result in changes in relationships between different stakeholder groups and will require ongoing negotiation and adaptation of boundaries and responsibilities in the provision of care and support.

Keywords: Aged Care; E-Health; Telehealth; Social Media

1. Introduction

Like other developed countries, New Zealand is experiencing an ageing population, often with complex health problems, placing an unsustainable demand on healthcare services [1]. The New Zealand Ministry of Health has strongly directed a move to new models of care, away from the traditional models of care based around hospital/residential based care to a more patient-focused integrated system within an expanded primary care where the person is supported to remain in their community [2]. For the older person, this would usually be either in their own homes or with family, or in supported community accommodation - otherwise known as 'ageing in place' [3]. A key enabler of new models of care is the use of enhanced information and communication technology (ICT) [4].

This paper presents some preliminary findings from a project that is investigating a novel use of ICT to support this approach by integrating social media, digital devices and Smart House technologies to support older people to live longer in their communities, not just a more sustainable model of care but one with improved health quality and safety for older people. The project is currently funded by the New Zealand Health Research Council.

Smart House technologies (sensors, recording devices, etc) create an intelligent environment that can monitor and control the environment, track activities of daily living, and recognise significant departures from normal behaviour [5]. These technologies and the processing of the data provided by them have been the subject of much research and development for several years, but leading reviews of the field [6,7] have indicated that Smart Houses have not been adopted into new models of care yet due to the lack of research into the requirements of the various stakeholder groups and into the societal and economic issues surrounding the utilisation of smart house technology, such as privacy and confidentiality, accessible design and reimbursement for services [6]. Furthermore, existing systems of transferring data from Smart Home technologies rely on one-to-one relationships, for example blood pressure readings to the clinic nurse. Social media networks offer the

option of many-to-many relationships between the older person, family/friends and health providers, widening and individualising the support network of the older person. The focus of the project is to explore how the use of innovative technologies can be used to distribute information and knowledge throughout an older person's formal and informal networks to better support them to live independently in their own home. It is anticipated that this approach will result in changes to the boundaries and relationships between different groups.

The project has taken a socio-technical systems approach to the development of healthcare technologies, as advocated by Coiera [8], which recognises that the adoption of new technological involves interaction between society's complex infrastructures and human behaviour. It has started with a focus on user-requirements and system implications rather than the more technology-driven approach found in most telemedicine and smart house projects. In this paper we present our current interpretation of how these technologies can be integrated and explore some of the implications for support networks. The findings are based on the outcome of a workshop which aimed to gather feedback on our theoretical models from a range of professionals and academics working in the areas of healthcare and health informatics, which was conducted at the Health Informatics New Zealand (HINZ) 2016 conference.

The analysis of the discussions of the workshop identified three major themes:

1. The complexity of the changing roles and responses,
2. The complexity of the flows and interpretation of information and
3. Emergent issues of management and control.

The findings emphasise the need to gain a clear understanding of the perspectives of all stakeholders to obtain a good organisational design before undertaking the technical design.

2. Project structure

The research project is structured into the following four phases; this paper will focus on the first two phases.

2.1 Phase 1: Exploration of literature and development of initial models.

The initial phase of the project involved a review of existing literature which:

a) identified an initial draft list of stakeholders who would be involved with using smart house technology and environment monitoring for healthcare and wellbeing, and
b) consolidated prior research into user requirements, and key issues/barriers to the adoption smart home technologies in general and for the care of the elderly in particular.

This work informed the development of our conceptual models of how the system might work in terms of actors and processes, these models are explained below.

2.2 Phase 2 Exploration and validation of models with expert user group.

The conceptual models were then partially validated by a group of experts at a workshop. Details of this process are presented in the next section of this paper.

2.3 Phase 3. Exploration of requirements with stakeholder groups.

The validated models will be used to explore the draft requirements and key issues/barriers using focus groups and individual interviews with representatives of various stakeholder groups such as healthcare providers in both primary and hospital services, other home-based service provides, and potential smart house residents and their friends and family involved in their care and support.

This phase is currently in progress. The outcome of this phase will be a series of service requirements, documented as a series of scenarios which illustrate the needed functionality.

2.4 Phase 4 detailed modelling and refinement of requirements using prototyping

The requirements will then be used to develop and define a high level architectural model of a system which would be appropriate to support the communication patterns identified by the respondent groups. Prototypes of the system will be developed to provide a concrete representation of the way in which users would interact. The iterative feedback from the stakeholders will be used to further develop and refine these models, within the limitations of the budget, time and participant engagement.

The final outcome of the project will be a better understanding of the individual and organisational issues surrounding the development and use of such services.

2.5 Conceptual Models

Our conceptual model of the structure of the support network for an older person is presented in figure 1 below. The model emphasises the concept of individualised care by placing the older person at the centre, and surrounding them by two layers of support services; an inner informal support layer comprised of family, friends and other social organisations, and an outer layer of more formal support from healthcare and social service providers. The inclusion of the informal support ring emphasises the increased complexity of these new models of care in comparison with more traditional dyadic patient-professional situation. It concretely recognises the changing roles and relationships and information exchanges which take place, including those between the formal and informal support groups.

In the conceptual model of the processes and information flows, information from multiple sources in captured, processed and interpreted and then distributed via the social media environment into the social environment or support networks. Information can also flow the other way to provide feedback for the system.

Figure 1: Structural model of actors

3. Method

The process of expert consultation was used to assess the validity of the conceptual model by running an open invitation workshop at the Health Informatics New Zealand (HINZ) 2016 conference. HINZ is a large international conference on health informatics and telehealth with over 220 speakers from 14 countries, and the workshop was featured as a formal event within the programme. 24 people participated in the workshop, of which 7 identified as clinicians, 8 as academics, with smaller numbers identifying with other roles.

The session began with presentation about the purpose and format of the workshop and a presentation and discussion of the structural model of the actors, as presented in figure 1 above. The audience was then divided

into four groups. Each group then considered each of four key questions in a round-robin style. Each question was managed by a facilitator/note-taker who recorded key issues and comments on large sheets of paper, each group could see and elaborate on comments made by previous groups. Finally, the facilitators provided feedback and summarised the key points raised about their question and the session ended with some general discussion. Overall the workshop lasted about 90 minutes.

The four key questions which were discussed were derived from figure 2, the process model, but were structured so that they could be tackled in any order. The four questions were:

1. How could information on the older adult's health be collected?
2. When would information on the older adult's health be processed and received?
3. Who would receive what type of information?
4. What are the ethical issues?

After the workshop, the notes were transcribed and thematic analysis was conducted by the research team.

4. Findings

Analysis of the comments from the workshop identified three major themes, relating to people (in terms of roles and responses), information (in terms of collection and interpretation) and system management and control (in terms of defining and maintaining appropriate configurations). Some of the comments made were suggested requirements, but many comments raised new issues that needed to be considered.

4.1 Peoples' Roles and Responses

Network membership was a key subtheme relating to people. Many comments and discussion related to the issues of who should be a part of the support group and have access to any information and resources. The general consensus was that the system should build on current support networks and include family, friends and healthcare professionals; however, different people would have to have different rights and responsibilities.

Issues of network quality and size were raised. A reasonably large network is desirable to facilitate sharing of responsibilities and to avoid burnout of support people, but what is an appropriate or optimum size? Network quality was also an issue; can network members be relied on? Will they work together? What if there are dysfunctional relationships within the network?

Another issue was how to manage the education and training of the support network, especially in relation to any particular health issues of the older person.

Notification and responses was another key subtheme relating to people. The key issue is how to design a system to ensure that issues are dealt with in a timely and appropriate manner without overloading the support network. It was felt that information about the older person's health and wellbeing should be available to clinicians and others in some easily assimilatable form such as a 'dashboard'.

However, there also needs to be some kind of alert or notification system to flag abnormal events which might need a response. Such a system would need to define appropriate response times for events, escalation plans and alternative routes for notifications if matters were not dealt with, there is also a need to identify appropriate emergency response procedures. Overall people felt that systems needed to be 'overdesigned' for safety.

4.2 Information Collection and Interpretation

Platforms for data collection was one subtheme relating to information. New platforms are becoming available and it is important that components and systems are compatible and easy to integrate and configure.

With the development of the internet of things (IoT), it is possible to unobtrusively collect information about the elder person's activities of daily living (ADL) from many devises around the home as well as from assistive technologies that they might use. In addition, aspects of their health can be monitored with wearable devices. Furthermore, levels of social interaction using communications tools can also be monitored easily.

It is likely that each person will wish to have their own individualised set up and it is important to avoid being locked in to a single service provider.

Storage and interpretation was another subtheme. In general, assessments of the older person should be based on multiple measures. It is also important for the system to allow for both random and predictable variations in behaviour without generating unnecessary alerts.

When analysing information, it is important to compare information against the individual's own baseline information, rather than generalised data derived from large datasets. It is also important to maintain patterns of individual historical data in order to detect gradual variations over time.

Issues relating to the safe storage of data and the appropriateness of contributing information to anonymised data sets also need to be considered.

4.3 System Management and Control

The third theme concerns the need to initially configure and personalise the system, and then to maintain the configuration in the event of changing circumstances related to the people and their roles and access to information.

Configuration and control. When the system is initially set up it will be necessary to identify who should be included and what roles they might play. It will also be necessary to configure the system to respond to alerts, to define appropriate response times and to define escalation procedures.

Furthermore, once the system is established, there will be an ongoing need to maintain and update the configuration in response to changes to in the circumstances of the members of the support network as people move or take on other responsibilities or when the circumstances of the older person change.

Security and access. Again, when the system is initially set up it will be necessary to define what data is collected, how it is to be processed and how to interpret deviation from normal behaviour. It will also be necessary to establish what information should be available to the various members of the support network.

There will also be an ongoing need to maintain and update the system as devices and data sources change, and also when people's roles and relationships change. This also raises the issue of how much control the older person should have over the system, to what extent should they have the power to maintain their privacy and dignity by restricting access or even by switching off the system completely.

Finally, *a number of legal and social* issues were raised. The system will have to be established to it complies with the local legislation related to privacy and access to personal information, especially health information and with local codes of conduct for healthcare providers.

Consideration will also need to be given the implications if the older person assigns a power of attorney to someone else, and what happens to the data on their death. These issues may need to be treated differently for different cultural groups.

5. Conclusions and discussion

This paper has reported some initial findings from ongoing project which is exploring the possibilities and implications of integrating new technologies to better support older people to age in place. In particular we have considered the integration of smart house technologies with social networking systems. Using social networking systems it is possible to expand the older persons support network by integrating their informal support group with their healthcare professionals. As a result, the project has moved away from the 1 to 1 relationships found in traditional telemedicine situations to much more complex nexus of many to many relationships. The introduction of these innovative technologies and processes will require the renegotiation of professional boundaries and relationships as informal support networks become increasingly integrated into the provision of care. Furthermore, these relationships are likely to evolve over time, thus introducing the need for systems management and reconfiguration.

6. Acknowledgements

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The Internet of Things and Big Data: Benefits and the Risks to Confidentiality and Privacy in the Era of Connected Health Devices

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Abstract

The Internet of Things (IoT) and big data analytics are creating new opportunities in all industrial sectors and healthcare is not immune from this data tsunami. The benefits include improved patient care, lowered healthcare costs, faster research and development of new drugs, and more rapid responses to public health risks. In the headlong rush to acquire these benefits however, the privacy of the patient and the confidentiality of their data are at risk of taking a back seat to progress. This article outlines the benefits arising from the use of IoT and analytics in healthcare and describes the risks to patient confidentiality and privacy that healthcare providers, from individual clinicians to healthcare administrators, meet when working within this new paradigm.

Keywords: Big data, Internet of Things, Privacy, Confidentiality

1. Introduction

The term "Internet of Things" (IoT) was coined in 1999 by technology pioneer Kevin Ashton who founded the Auto-ID Centre at MIT (https://en.wikipedia.org/wiki/Kevin_Ashton). Defined [1] as "a global network infrastructure, linking physical and virtual objects through the exploitation of data capture and communication capabilities", it includes existing and evolving Internet and network developments. IoT has made possible interaction between humans and things and, as important, between things and things, without human intervention. No one would have ever imagined that clothes, furniture, cars, household lights or even our coffee pots will have their own Twitter accounts, interact with social networks, and send data to the cloud, enabling aggregation of data from different devices. The need in healthcare for the real-time capture of data, is among the reasons for the drive towards IoT [2].

While IoT could be a game changer for healthcare services, concerns have been raised that these devices are pervading our privacy and even our bodies. Smart meters deduce when we shower, mobile apps know how we feel, cars know when we do not go to work, and wearable devices know when we do not adhere to prescribed medications. According to Yin et al [3] the success or failure of this revolution will be determined by two key challenges: security and privacy.

With IoT comes big data. Big data is described as having the following characteristics: large data amounts generated (volume); multiple types of data (variety); rapid generation of data (velocity); inconsistency in data sets (variability); and variations in the quality of the data generated (veracity) [4]. The dynamic and ever-growing rise in healthcare data collected from the IoT devices has contributed to the use of big data in this domain.

As will be seen, the growing use of connected devices combined with big data analytics represents an area of great benefits within the healthcare industry. With benefits however, come risks.

This paper provides insight into some potentially key benefits, outlines broad concepts in privacy and confidentiality and highlights potential risks that healthcare leaders will need to deal with as we enter the era of connected health devices.

2. Methodology

The methodology for this review utilized a combination of literature survey and case study extrapolation. First, papers on the overarching elements of IoT and big data were searched for primarily using the Google Scholar database. Results were restricted to English language papers from 2005 onwards and patents and citations were excluded. Search terms included IOT, Internet of Things, connected devices, big data and big data analysis.

Second, the results were sub-searched to find risks and benefits for each term. These risks and benefits were then applied to health scenarios using subject knowledge. Case studies were then searched for using the scenarios as search terms. Examples included: data theft, health data breaches, anonymised data re-identification and health device hacking.

Finally, a case study review of acknowledged privacy breaches and IoT security intrusions validated the scenarios and brought the issues of privacy and confidentiality into focus. The ransomware events in Europe and the well-highlighted issues within the Australian Department of Social Security, were used to apply an up-to-the minute analysis. A review of the relevant legislation in New Zealand and its relationship to the risks uncovered, provided a New Zealand-specific alignment.

3. Benefits

The Internet of Healthcare Things (IoHT) helps medical resources to connect with each other and provide improved access to care, increase the quality of care, and reduce the cost of care. For example, IoT-enabled healthcare devices allow real-time patient monitoring, which cuts down unnecessary visits by doctors, hospital stays, and re-admissions. They are being used in areas such as agreed care, patient flow and rehabilitation services, while embedded technologies are applied in applications like telehealth systems to deliver care to people in remote locations. The supply of continuous data helps provide critical clinical information and supports the decision making process [5]. Hospitals are using IoHT not only to track inventory but also to optimize healthcare workflows with medical device integration [3]. IoHT, when assisted by virtual infrastructure, and the use of big data, helps in making critical information accessible to care givers at the point of care for informed decision making and evidence-based care. This ensures timely healthcare from managing chronic diseases at one end of the spectrum to preventing disease at the other [6].

A wide range of data can be captured from patients in real-time using advanced radio-frequency identification (RFID) and sensor systems. RFID is a wireless communications technology that consists of a reader to identify electronic tags from a distance and read and write data from and to them. Incorporating sensors with RFID tags, allows the transmission of dynamic and real-time information about their surroundings. Wearable sensor devices are used to capture vital signs data such as an ECG, heart rate, blood pressure, body temperature and other bio-signals [7-9]. These devices are used in a variety of care environments, including hospitals, residencies and outdoors whilst integrated smart systems [10] are used in homes not only to capture vital signs data but also monitor movement of people and environmental variables such as light, temperature, presence of smoke and moisture.

Sensors capture the data, data is analysed by complex algorithms, and medical professionals access the information wirelessly and make diagnoses and treatment recommendations. Real-time monitoring of patients is possible to detect subtle changes, and adverse events such as drug interactions can be avoided.

IoT devices collect data unattended, hence removing the limitation of manual data entry, and make it available to clinicians at the point of care, while automation reduces the risk of error and costs associated with data collection, thereby improving efficiency and data quality. This can be critical in healthcare, where human error and the lack of information during critical times, can literally be the difference between life and death.

Improved data and collection of data from a greater variety of sources has led to a greater abundance of data for use in analytics. This has the potential for providing benefits from improved research and development in the area of drug design to identifying patients who are becoming critically ill.

The use of big data analytics offers tantalising rewards to the healthcare industry. FastText by Facebook Research, the same algorithms used to determine which Facebook groups you should join, or which advertisements to show, based on the text within your posts, holds the promise of real-time analysis of unstructured text content, such as that found in progress notes for example [11]. Data mining of massive clinical databases such as the PhysioNet Critical Care database [12] is being used to find predictors of poor clinical outcomes in critically ill patients and precursors of readmission to Intensive Care Units [13].

Raghupathi and Raghupathi [14] identify eight areas where big data and analytics could benefit healthcare.

Table 1 – Potential Healthcare Benefits of Big Data and Analytics (Ref 14)

Area of Potential Benefit	Example
Clinical operations	Analysing data to identify improved efficiencies in healthcare delivery
Research and development	using data more efficiently, in clinical trials for example
Public health	Identifying disease outbreaks before they take hold
Evidence based medicine	Analysing treatments and outcomes or predicting at-risk patients
Genomic analysis	Making the genomic sequence of an individual part of their medical record to provide targeted treatments or identify risk of disease
Fraud analysis	Identifying fraudulent insurance claims
Remote monitoring	Evaluating data from wearable devices or in-home monitors to detect adverse events or monitor safety
Patient profiling	Identifying those who would benefit from pro-active care or increased disease monitoring

Big data sets, applicable to public health planning, delivery and research at the population level, are frequently formed by the consolidation of discrete patient datasets, and these much smaller sets are used for the direct care of individuals in their own right. Similarly, many of the IoT instances noted above apply equally to the areas and examples shown in Table 1. Thus, the automated collection of unit-level data, both clinical and administrative, lowers error, increases efficiency, and reduces patient travel and inconvenience. Telehealth is effective at reducing costs and resources when hospital treatment is replaceable by home care. Remote monitoring can help clinicians identify patients at risk and pre-empt possible deterioration in their medical condition. Data from wearable sensors can be used to create patient profiles that lead to personalised care targeting more effective medication and/or interventions. Other sensors could alert public health authorities of the progress of an infectious disease so that they can respond appropriately. And so on.

Like the benefits, the risks to data confidentiality and misuse also apply to patient data whether captured at unit level or scaled to big data level.

4. Risks

Confidentiality and privacy have been a source of concern, controversy, and debate since medical records were first kept, due to numerous views and somewhat differing laws and regulations. Health-related data taken from human subjects are always regarded as confidential and any misuse of them as an invasion of privacy. Individuals' trust in their healthcare providers to keep their transmitted or stored health records confidential tends to impact how, when, and whether they share their medical data. For instance, a survey done in the UK showed that 79% of the participants are worried about the security of their health records and 71% thought the UK National Health Service (NHS) could not guarantee the safety and security of electronic health record systems [15]. Privacy regarding use of patient health data or records is also a major concern. As noted [16], the contrast between the rights of an individual and the aims of researches and public health activities such as better understanding of diseases and improving healthcare, have been fuelling continuous debate.

There is a balancing act required in the relationship between big data and privacy. On one side, big data, and the analytics that it supports, provides critical assistance in solving real world, clinical problems. However, when the data becomes so intrusive that it interferes with the privacy of the individual, the practical application of IoHT may be placed in jeopardy. Patient data is growing each day and in some quarters, is viewed as a new form of currency and commodity. Big data analytics can aid informed decision-making processes, beneficially impacting people's lives but the same methodologies that hold out this potential benefit, accentuate concerns related to patient privacy and pose a potential dark side, including identity-theft, re-identification, and the possibility of individual discrimination.

In light of the changes and rapid growth in health technology, perhaps values and current legal concepts regarding privacy, need to be re-examined and more clearly defined. As mentioned earlier, controversies often arise because of the vagueness of the appropriate laws, which include regulations regarding practitioner responsibility and accountability of health data. Striking a balance between patient privacy protection and the use of patient health data for the "greater good" is always likely to cause concerns if these areas are not clearly defined.

Glenn and Monteith [17] state that privacy concerns are more sensitive in the digital age in which we live than in the past when healthcare processes were manual and paper-based. Similar sentiments have been expressed [18] suggesting that storing patient health information electronically on computers and connecting to the Internet makes patient data more vulnerable to hostile security issues than paper-based systems. For example, in the United States, security breaches of unsecured protected health information affecting at least 500 individuals has been on the rise and are well documented since 2009. These security breaches include hacking/IT incidents, unauthorized access/disclosure, theft of computers containing patient information, and others [19]. In their analysis of 949 security breaches between 2012 and 2013 alone, Liu, Musen and Chou [20] found that 29 million patient health records were affected and that most of these security breaches occur via portable electronic devices.

Despite continuous efforts by experts and companies in ensuring better security in computer networks, major threats and challenges remain. Denial of service, attacks on information in transition, sinkhole attacks and wormhole attacks are some of the major security issues threatening health information [21]. The recent May 2017, ransomware attacks seen in Europe and in particular, the UK, where large parts of the National Health Service were affected [22], bring sharp focus to the ever-growing threat. In healthcare wireless sensor applications, security threats often make patient privacy vulnerable as attackers can potentially eavesdrop patient data during transmission [23].

Kumar and Lee [24] state that security breaches in healthcare applications could lead to leakage of patient health data, potentially resulting in a person losing his/her employment or making it impossible for them to acquire insurance protection [18].

Peppet [25] meanwhile outlines three facts about IoT that are at the heart of privacy issues relating to IoT and big data analytics. First, that IoT devices have poor, if any, legal regulation. That is, the devices are often marketed as "fitness devices" rather than medical devices, which means that they are not subject to scrutiny by regulatory bodies such as the

US Food and Drug Administration (FDA) and the data is not subject to medical data laws such as HIPAA. As a result, large amounts of highly personalized biometric data are being collected and, as pointed out above, can be combined with data from other devices to reveal a range of identifiable information. Second, he posits that the data collected from daily IoT use, could be used to discriminate against people otherwise protected by anti-discrimination laws, using the combination of data from diverse IoT devices such as fitness monitors and in-car driving monitors. Third, that IoT devices offer poor security, highlighting a November 2013 attack in which attackers took control of over 100,000 connected devices. As previously described, when the IoT devices under attack are critical to patient care, the results could be nothing less than catastrophic.

Who can access the data and with whom it should be shared has always be the dilemma when it comes to security of data. While existing protocols are used to investigate the authentication and authorization issues outside the constrained environments, solutions to these issues remain in their infancy in constrained environments. As time passes, the addition of requirements to the existing protocols will be a challenge for maintaining security standards [6].

Communication between devices is one of the major challenges in implementing IoT. Even though IoT devices have sensors that talk to servers in their own language, manufacturers have their own proprietary protocols making it difficult for sensors to communicate with different servers. Moreover, the bureaucratic tendency to accumulate all the data, coupled with privacy issues and fragmentation of the software environment, challenges the very concept of the IoT. The need for multiple identifiers for a single object and accommodating the changes of identities to maintain the integrity of smart devices after reconfiguration is a major challenge as it needs to be balanced with security concerns [26].

Any device connected to the Internet is vulnerable to attack, however, attacks on IoT devices in healthcare are potentially more lethal than many other cybercrimes as they can have a direct impact on the life of a patient. For example, this risk was spectacularly demonstrated in 2016 in an attack on Johnson and Johnson's Animas One Touch Ping insulin pump [27]. The pump functions by the use of a remote control to provide a dose of insulin to the patient. In spite of the encrypted wireless connection between the pump and remote, the hacker took control of the pump and triggered unauthorized insulin injections. This incident highlights how deadly the repercussions of an attack on IoHT devices can be, as death as a result of insulin overdose is well documented. The hacker was able to enter the network via the device thereby threatening the safety of the patient, the integrity of the specific device, and the security of the entire hospital network.

In the area of big data analytics, the potential benefits found, can just as easily become risks if applied indiscriminately. One example of this benefit / risk dichotomy can be seen in the search for cost-efficiencies within health using big data analytics. Cost-effective though may not equal best value and clinical relevance may not equal best practice at an individual level. As an example, Schousboe et al. [28] found that annual mammography for women was "not cost-effective…regardless of age or breast density", for those women who did not carry the BRCA1 or BRCA2 gene. If applied broadly as a policy setting by a medical insurance company however, the result could be a substantial increase in the cost of additional screening for individuals, or a potentially catastrophic result if a breast cancer is not found in time. The US Preventative Service [29] recommendations for example, states that breast screening should be every one to two years, noting that the American Medical Association, American College of Radiology, and the American Cancer Society, all recommend annual screening. A woman undergoing an increased schedule of screening, would not only be liable for increased costs associated with non-covered additional screenings, but could by inference be determined to have some sort of increased risk of breast cancer, for example, have the BRCA1 or BRCA2 gene mutation.

This inference-based risk to the individual is highlighted by Tene and Polonetsky [30], who state that "it is often not the data but rather the inferences drawn from them that give cause for concern".

Information analysed in the interests of public health, can lead to the erroneous "outing" of individuals. A clear example of this is seen in the case of Gaétan Dugas, a Canadian who in the 1980s, was portrayed as "patient zero" (a theory since debunked [31]), at the beginning of the then new HIV epidemic. The fact that this label, together with his photograph, was reproduced in provocative articles including by Time and New York Post [31], no doubt had a devastating social and psychological effect, at a time when there were public calls for the mass internment of HIV positive people and criminal sanctions were being debated [32].

Re-identification of an individual from anonymized data, either through poor anonymization techniques or through the combination of data from disparate sources, is another area of concern. El Eman et al. [33] for example, recount the case of a patient who died as the result of a drug adverse effect being re-identified from anonymized adverse event data, based on cross matching with obituary data. They caution that anonymizing patient data is not enough in cases where the source medical data can be matched with data from non-medical sources such as other publicly held databases or social media that increase the probability of a match being extracted. This is particularly true where a widely reported event such as death (obituaries, social media etc.) occurs.

Genomic research, while holding the potential for advancement in areas such as personalized medicine and disease research, increases the risk of personal identity disclosure as the genome is unique to each individual. For example, the

combination of information from genealogical databases and analysis of the Y chromosome resulted in the prediction of individual surnames [34].

Fraud analysis while a priority for medical insurance companies, poses risks to individuals as seen with the Australian Government's "robo-debt" cross-analysis of social security benefit payments data with Tax Office return data, resulting in a reported error rate of 1 in 5 [35].

The problems highlighted above, are particularly at the fore when the data from IoT is considered. It is not just what a single data source may reveal but also what a number of data sources reveal in combination. Peppet [25] states that "on the Internet of Things, 'every thing may reveal everything'" and gives as an example, the real possibility that a fitness monitor measuring heart rate and respiration rate may reveal more than just exercise regimes but also drug and alcohol use due to the specific biometric indicators that can be found within this data.

As can be seen, the emergence of connected devices which measure everything from how often an individual brushes their teeth to a highly detailed analysis of their urine [25] represents the availability of data on a massive scale, one which is rapidly evolving and from multiple sources. This epitome of "big data" does not yet necessarily come under the protection of medical data and privacy laws and as such represents privacy and confidentiality issues for consumers and ethical issues for researchers.

5. Implications for New Zealand Health

In New Zealand, the privacy of patients is governed by the Privacy Act 1993 [36, 37]. The Act contains 12 information privacy principles. Of particular importance to the confidentiality of patient health data are Principles 4 and 5. Principle 4 is concerned with the manner of collecting personal information and states that an agency wanting to collect personal information shall not do so in a manner that is unlawful, unfair or unreasonably intrusive [37 (p17)]. Principle 5, governs the storage and security of personal information. It stipulates that an agency that holds personal information must protect it by necessary security safeguards to prevent loss, unauthorized access, use, modification, disclosure and other misuse [37 (p18)].

The Health Information Privacy Code 1994 (HIPC), based on the Privacy Act 1993, further establishes specific rules for health-sector organizations [38]. While the HIPC, together with its published commentary, ensures that health sector agencies provide necessary security means to maintain confidentiality of patient data stored in EHRs and central repositories, it appears that little is said regarding security of patient data transmitted from IoHT and wireless devices. In other words, the commentary provided for the HIPC does not include specific security rules that healthcare organizations must comply with when using IoHT and wireless devices [39].

Current New Zealand privacy law requires agencies (with a few exceptions, any public or private entity) to have valid reasons for collecting personal information, have obtained the consent of the person prior to collection, not share that data except with the consent of the person, and to store and maintain that data in a manner which is secure [39]. In the era of connected devices however, the current laws may not be enough to protect the private health data of New Zealand citizens.

There is little cause for complacency. A Google Scholar literature search[1] to discover the number of articles published since 2012 with both of the terms "Internet of Things' and "Health" in the title returns 167 papers. Adding "New Zealand" as a keyword in the title reduces the count to 2. A search with the title keywords "Privacy" and "Internet of Things" yields 307 papers but adding "Health" as a keyword in the title reduces the count to a single paper from China. Far smaller paper numbers are found when "confidentiality" is substituted for "privacy" in the searches.

These figures suggest that whilst researchers (and the general public) are alerted to the privacy and confidentiality risks associated with IoT, the level of awareness is much lower in the health sector almost certainly due to the lower penetration of IoT compared with other spheres. Awareness will undoubtedly increase as IoHT applications become more common but the current negligible level of concern apparent in New Zealand is cause for some disquiet. For example:

(i) *What role do mobile phone applications play in the storage realm?*

If they are on the phone of an individual but created and their security and other settings controlled through mechanisms unknown and inaccessible to the user, where does the responsibility lie for the secure storage of data? This is a major issue in regards to devices such as Fitbit. Goyal et al. [40], for example, found that neither the Fitbit Charge nor the Jawbone UP Move fitness trackers, encrypted the data stored in the associated phone application database.

(ii) *What constitutes "Consent"?*

Is a long and overly legalese "Privacy policy" that gives no option to consumers, except to allow the indiscriminate use and sharing of their data (often with unknown third parties), or not to use the fitness device after they have already purchased it, in keeping with the spirit of the law? As Peppet [25] asserts, device

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[1] The authors would like to thank one of the reviewers of the paper for this insight.

manufacturers often "confuse notice and choice". Further, these devices often do not take into account the person's age and so may run into problems regarding the ability of a child to consent to their health information being recorded.

(iii) *Is there a policy gap between consumer protection law and health information law?*

The data that is recorded on "fitness" and other semi or actual health devices requires an urgent determination of type. If it is deemed to be "health information" then protections regulating the use of the data must be strengthened. Likewise, if these devices are deemed to be no more than a toy, there could still be a case mounted to develop a specific Product Safety Standard for these devices.

6. Conclusion

The Internet of (Health) Things and big data analytics are having a revolutionary impact on the way healthcare is delivered with many potential benefits ranging from increased efficiency and quality in care delivery to personalised patient treatment and improvements in population and public health planning at local and national levels. This paper has endeavoured to paint a picture of the current state of affairs and likely developments whilst drawing attention to some inherent risks notably those associated with personal privacy and data confidentiality.

We outline how some of these risks have already manifested themselves in real world situations, from the revealing of highly personal information even from anonymized data, to device hacking attacks with potentially catastrophic consequences. Reasons why these risks propagate include poor scrutiny by government bodies, poor legal regulation, unsecured or unknown communication between the devices, and responsibility opaqueness when a security breach occurs.

Focusing on New Zealand, we have highlighted gaps in the legal protection of individuals, from the categorization of fitness devices, which puts them outside the reach of medical device law, to the limited extent of data storage and privacy laws that ignore storage on mobile applications and pose key questions to be asked by policy makers.

As the world moves further into an always-connected era, the urgency with which these issues need to be addressed will only increase. The new technologies are advancing rapidly and the general low level of awareness in New Zealand of their healthcare roles sends a strong message that more needs to be done on the technology, educational, and legal fronts to manage their consequences and preserve the rights of individuals.

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