

Open Source Software in Dentistry

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Abstract

Electronic Patient Records are regularly used and highly advantageous for dentists working in a range of clinical settings. Open source software has been used as an effective alternative to proprietary systems in a range of healthcare settings, however the extent of its use in dentistry is poorly understood. A comprehensive literature search identified three uses of open source software across the dental academic literature. Each example was used in separate niche settings and none of these examples were for patient records systems. A wider search identified two different open source dental patient record systems. No evidence relating to any potential advantages or efficacy of this software was found, however, theoretical benefits to the use of open source software in dentistry could be hypothesised. Though no published studies on use of this software in patient records in a dental setting were found, open source software could theoretically overcome some of the problems with the most commonly utilised dental software packages. There are theoretical long-term advantages to use of this open source software which have been demonstrated in other healthcare settings. Further research is needed which could investigate the use of available but infrequently utilised open source software dental patient record systems.

1. Introduction

A significant proportion of dental practices use electronic patient records software (EPR) [1]. These systems offer a range of advantages over conventional paper-based records including, but not limited to, improved legibility of notes [2], improved compliance with legal requirements [3], consistent recording of crucial data [4], increased efficiency [5] and the ability more readily carry out audit of procedures and protocols [3].

Current available software packages have been studied and compared: a small number of software packages have a significant proportion of the market share [5,6]. Utilisation of these systems comes usually with a long-term subscription fee alongside a support package which for smaller practices, can be a significant financial burden. There are deficiencies and limitations with the available software packages: notably much of the data and patient information a dentist wishes to record cannot be recorded appropriately on the available software [7]. This mirrors earlier findings [5] that dental EPRs are unusually complex compared to other medical software; this reflects the high level of variation in patients, presentation and procedures in all settings of clinical dentistry.

Open Source Software (OSS) has been defined as *"a model of computer software development where the source code is available for programmers to view, read, modify and re-distribute without the property right restrictions of proprietary software"* [8]. OSS has been utilised in a range of healthcare settings such as optometry [9], primary medical care [10] and paramedics [11], as well as in certain government organisations [12] due to the benefits it can offer over proprietary systems [13,14,15]. Of great importance to healthcare settings, especially those receiving public funding, is that OSS is said to have a reduced cost of ownership [15,16]. Furthermore, its use eliminates 'vendor lock-in' whereby an organisation is committed and restricted to using a particular

software provided by a particular company [10, 17]. Additionally, the source code can be audited, quality assured and modified to enable customisation of software [17]. Summarising these benefits, Kantor, et al. [10] declare that OSS “*fits naturally our scientific model of shared, peer-reviewed knowledge in medicine*”. The potential for these benefits to apply to computerised patient records in dentistry worthy of consideration. Due to the benefits OSS offers to healthcare providers, this review aimed to assess all the published research related to OSS in dentistry in order to greater understand the current status of this software and its potential for use in the future.

2. Method

The following databases were comprehensively searched for terms relating to open source software and dentistry: Medline (from 1966), Embase (from 1980), Cochrane Database of Systematic Reviews and CINAHL. Articles were then reviewed to ensure they met the simple inclusion criterion of discussing open source software in any aspect of dentistry. Though EPR systems are the most commonly used software systems in dental settings, the search was not limited to this type of software. A search of the ‘grey’ literature was also conducted to assess any non-academic references to open source software being utilised in any dental setting.

3. Results

The literature search identified four papers meeting the selection criteria. Three mentioned open-source software but in relation to a niche use. OSS was discussed in dental radiology [18], dental education [19] and dental implantology [20] but not in relation to dental patient records. There was a fleeting mention of OSS in an article discussing dental informatics as a potential future development [21]. None of the articles discussed OSS itself: they all used OSS as a component of their methods without discussing the rationale or reasons for using this type of software. The studies identified [18,19,20,21] offer minimal insight into OSS as a whole and only show the implications of a particular piece in a single setting.

Wider searching identified two currently available open source dental electronic patient systems: OpenMolar (<http://openmolar.com>) and OpenDental (<http://www.opendental.com>). OpenMolar was developed in the UK and has two versions both running on a GPLv3 public license: the developer of this software specifies that version 1 is available for use by others if they wish, but it has been tailored specifically to a single practice, whilst version 2 is not yet complete for wider adoption. OpenDental runs on an GN General Public Licence and appears to have a more substantial user base, though far less than the aforementioned proprietary systems. OpenDental has an active online community of users and developers: this gives it a potential for wider use in dental settings: no literature relating to the use of these open-source software packages was found.

4. Discussion

Despite multiple academic references to OSS in other settings, the use of OSS in dental settings, seems very limited. Though two open-source programmes are used by dentists, neither has a significant proportion of the market share and the awareness about them appears to be minimal. There could be many reasons for the current status of OSS in dentistry, but the lack of research on this area means only theoretical reasons can be deduced.

It is very possible that the barriers to use of EPR systems also explain the limited uptake and use of other dental software packages, including those which are open source. OSS is still software hence

those not wishing to use IT or EPR at all are unlikely to be interested in deployment of a potentially more complex software type, even if it could be beneficial to said user.

Without open-source packages being widely promoted like their proprietary alternatives, many dentists may be unaware of open-source software and the ability to take and adapt the source code of this to customise software. Alongside lack of awareness amongst dental practitioners, there may be a further lack of awareness in leadership positions [15] and it is noteworthy that health informatics leadership is reportedly highly conservative [13 14]. In terms of Information Technology, Murray et al. [22] identified issues with OSS adoption beyond simple IT complications including lack of knowledge in executives, complications with the licences of the software, deficiency functionality and wrong perceptions of software limitations by all users. In wider organizations, such as hospital or secondary care dentistry, the wider leadership and management teams may also prevent OSS usage for numerous potentially unfounded reasons [13]. Adoption of OSS has been investigated in larger organisations, not limited to healthcare: 112 papers were examined [23] and the conclusion was drawn that OSS can be appropriately adopted when desired though that adoption of OSS is a greater task than simply using OSS software: there are many additional hurdles to overcome than simply installing a software package.

Unlike with proprietary software, the OSS code is available for anyone to investigate and hence independent assessment is possible [15, 14, 24]. This means that any problems that one finds can be easily adjusted presuming an appropriately skilled individual can provide this service. It has been stated that time for fixing any 'bugs' in the software is shorter with OSS than with proprietary software as whoever identifies the bug is often appropriately skilled to fix it [16]. This same feature of open source enables modification and adaptation of the published code to meet individual users' requirements, which inspires innovation and improvement [17]. Furthermore, with a published source code, software developers are encouraged to a greater extent to optimise the quality of their code [15,25]. Theoretically, if open source software proliferated into dental practices, the more it were adopted, the larger the community of contributors to development. This could facilitate widespread peer-review of code which can theoretically enable enhanced reliability [16, 26, 27] and security [14,25,28] of the systems in place. This could ultimately lead to improvements in the ability for dentists to record the information they wish to about their patients' ongoing care or at least, improved efficiency in recording of this [15] in a more secure, reliable and appropriate software package.

With proprietary software, which in dental settings usually operates under a subscription service, the end-user may be left without a service if the providing company ceases business or ends utilisation of the service in use. Though these services offer a convenient and supported approach to dental software, migration to an alternative platform can be impossible or incredibly laborious. The more committed a dental practice or organisation is to use of an EPR software, the harder it can be to migrate: both of these issues lead to risk for those using them known as 'vendor lock-in'. OSS eliminates this risk [1, 17] and enables alternative users, groups of users, or companies to take on support for the software and its ongoing troubleshooting and modification. Consequently, there is hence increased, or potentially infinite longevity of software [14] as failure of a servicing company does not necessarily mean an alternative system has to be considered [10]. The compatibility of OSS with proprietary systems is important to enable it to compete with the more widely used systems [29].

The reduced cost of ownership is of vital importance when OSS is considered: this is a common theme in literature related to OSS usage in healthcare and non-healthcare settings. Publicly fund-

ed services have a duty to be cost effective and hence OSS, which often requires either no, or a small fee, can help with cost-effectiveness [16]. It should be noted that open-source does not necessarily mean 'free': sometimes one can purchase the source code, and it is possible to pay for support packages for use of OSS: this is the case with OpenDental. It is worth noting that considerable expertise is required for effective modification of the source code if and when this may be required: clearly this attracts a separate cost, which could initially be a deterrent to OSS consideration.

There are no published data or studies detailing the long term cost-benefit model of open source software. A study examining this, potentially using the available software OpenDental or OpenMolar could assess if there is a potential for cost-saving in dental settings. As a component of improved efficiency in larger health services, 'textomics' could be integrated to enable text mining and biomedical data to be integrated into a data set which could be used for service planning and healthcare research [14,21]: there is the potential, therefore, for cost-savings from a planning, research and audit perspective. If integrated into dental OSS on a large scale, this data would be substantially beneficial if utilised appropriately and ethically.

The potential intrinsic disadvantages of OSS cannot be ignored. Notably no single person retains responsibility for errors that may occur in the software's code. Additionally, version proliferation can occur where multiple versions of software released at different times can be present on different pieces of equipment used in the same setting: this can cause incompatibility issues and other end-user problems [8]. Furthermore, software licences can be confusing and complex [17] and implementation, as discussed, can be troublesome and costly, to the extent users can be deterred from even attempting their usage [8].

A balanced decision on an organization-by-organization basis has to be made to balance the advantages and cost saving of an open source approach vs the disadvantages. The lack of good quality research in this area provides little sound basis on which practices can make informed decisions as to whether OSS is suitable for their setting. This search has shown how the potential of OSS is limitless if the code can be adequately amended to suit user needs however many dental professionals will not be able to adjust software without substantial knowledge and training in this area.

There is much scope for further research on OSS in relation to dentistry. As EPR is so widely used and open source EPR is available, these could be used to initially assess various factors related to OSS use in dentistry. A cost-benefit analysis could be advantageous [17] to promoting OSS use and an assessment of efficiency and clinical outcomes could be compared between OSS and a proprietary alternative to assess whether the customizability of software helps patient care. These are just examples which could aid uptake of OSS however it must be considered that OSS may never find its place in the dental setting due the size of the barriers to doing so.

5. Conclusion

Despite the substantial benefits of OSS for the dental community and the sizeable barriers, the future of OSS in dentistry may not be bleak. With available systems' potential to improve, a package may be able to break into a more mainstream position. If existing systems such as OpenDental are more widely used and the community of developers remains active, the benefits of OSS may be realised and utilised in a wider range of dental settings. These, or similar programmes could

become an effective component of dental informatics and record-keeping. In the absence of research documenting use of OSS in dental settings for record-keeping or other technological benefits, the advantages of OSS in this setting can only be theorised and hence its use at present could be considered a gamble in the dental setting. There could be many reasons for the poor-uptake of OSS but again, these remain theoretical. Further research is needed to address acceptance of OSS and the impact of OSS on software expenditure, efficiency and patient outcomes [17] to enable dentists to make more informed decisions on the use of proprietary or open source software.

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