Pharma Chk

Testing the quality of medicines in the field

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Engineering for Social Impact

• Active engagement from local stakeholders
• Multidisciplinary approach
• Working in the field
• Focus beyond the technology
  • Cultural barriers to adoption
  • Policy aspects
  • Field testing and feedback
Counterfeit and Substandard Medicines: A Global Challenge

• Poor quality medicines make up **10 – 30%** of drug sales worldwide
  • Causes over 100,000 preventable deaths annually

• Poor quality medicines account for US$ 75 billion of US$ 962 billion global pharmaceutical market

• Poor quality medicines contribute to drug-resistant infection and disease
  • Artemisinin resistant malaria on Thailand-Cambodia border
PharmaChk: The Mission

Improve access to good quality medicines and raise the quality of life around the world

- **Needs assessment** – understand and address the current gaps and bottlenecks in field-based testing

- **Technology innovation** – develop a user-friendly, accurate, and portable tool to address key challenges

- **Policy development** – work with local health authorities to develop and implement continuous monitoring

- **Long term goal** – reduce adverse health outcomes and support economic development of people living in areas with limited pharmaceutical regulatory oversight
Pharma Chk: The Device

Accurately and affordably test the quality of medicines in the field:

- Quantification of active ingredient
- Analysis of API kinetic release

Key Challenges:

- Reducing/eliminating sample preparation
- Bringing quantitative results to field
- Rapid, portable testing for high-throughput
PharmaChk

- Portable platform
- Optical quantification
- Specific chemistry
- No sample preparation
Pharma Chk: Prototype II

- High precision pumping
  Accurate and repeatable dilution and fluid delivery

- Versatile CCD imaging
  Flexible signal detection and multichannel imaging

- Tunable ultrasonic disintegration
  Automated disintegration and dissolution

- Precision CNC plastic cartridges
- Improved signal detection
- Integrated waste containment
- Simplified tubing connection

More robust disposable
PharmaChk: Assay Development

- Fluorescent and luminescent assays are being developed to target highly specific chemistries for each API

\[
\text{NH}_2\text{NH} + \text{HO-OH} \xrightarrow{\text{OH}_2\text{cat.}} \text{NH}_2\text{O}^* \xrightarrow{\text{light}} \text{NH}_2\text{O}^{-}
\]

- Currently targeting antimalarial medication – able to test 5 front-line medications

- Developing aptamer chemistries for improved specificity and stability
Capture-SELEX

Process

- Large initial pool of random DNA sequences
- Cyclic enrichment of high affinity binders
  - Incubation with target molecule
  - Separation of bound and unbound DNA

Advantages

- Target does not need to be immobilized
- Short cycle times (2-3 days)
Stochastic Modeling Efforts

\[ [SA_i] = \frac{1}{K_S}(A_i^f - [SA_i] - [TA_i])S_{free}^f, \]
\[ [TA_i] = \frac{1}{K_{D,i}^f}(A_i^f - [SA_i] - [TA_i])T_{free}^f, \]
\[ S_{tot}^i = \sum_{i=1}^{M_B} [SA_i] + S_{free}^f, \]
\[ T_{tot}^i = \sum_{i=1}^{M_B} [TA_i] + T_{free}^f, \]

- Existing models and protocol designs do not account for random events
- Protocol parameters can be very sensitive
- Many parameters exhibit bimodal behavior
- Modeling is important for identifying key protocol parameters
Current Assays

**Chemistry-based**
- Artesunate
- Amodiaquine
- Artemether
- Lumefantrine
- Dihydroartemisinin

**Aptamer-based**
- Tetracycline
- Under development

- Linear signals and minimal-to-no impact from common excipients
- Additional excipient testing ongoing
## Pharma Chk: Field Results

### Artesunate (AS)

![Molecule Structure of Artesunate](image)

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Pharma Chk: Beyond the Lab

- Working extensively with USP and Ghanaian FDA to understand local logistical and policy challenges
- Involving local stakeholders in development to improve adoption
Current supply chain

Suppliers → Drug Manufacturer → Primary Distributors → Central Warehouse limited → Secondary Distributors

Limited testing

GENERAL OVERSIGHT

Medicine Regulatory Authorities → Consumers limited → Hospitals Pharmacies

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Policy Development
Supply chain with PharmaChk

Suppliers → Drug Manufacturer → Primary Distributors → Central Warehouse → Secondary Distributors

GENERAL OVERSIGHT

Expansive Testing

Medicine Regulatory Authorities

Consumers

District Warehouses

Hospitals Pharmacies
**Pharma Chk:** The Impact

**Access to quality medicines, for all people, in all places, at all times.**

- Improve morbidity and mortality caused by ineffective treatment
- Suppress development of drug resistance pathogens
- Support local capacity building and economic development