Computing and Global Health
Lecture 7
Treatment support and mobile devices

Winter 2015

Richard Anderson

Today's topics

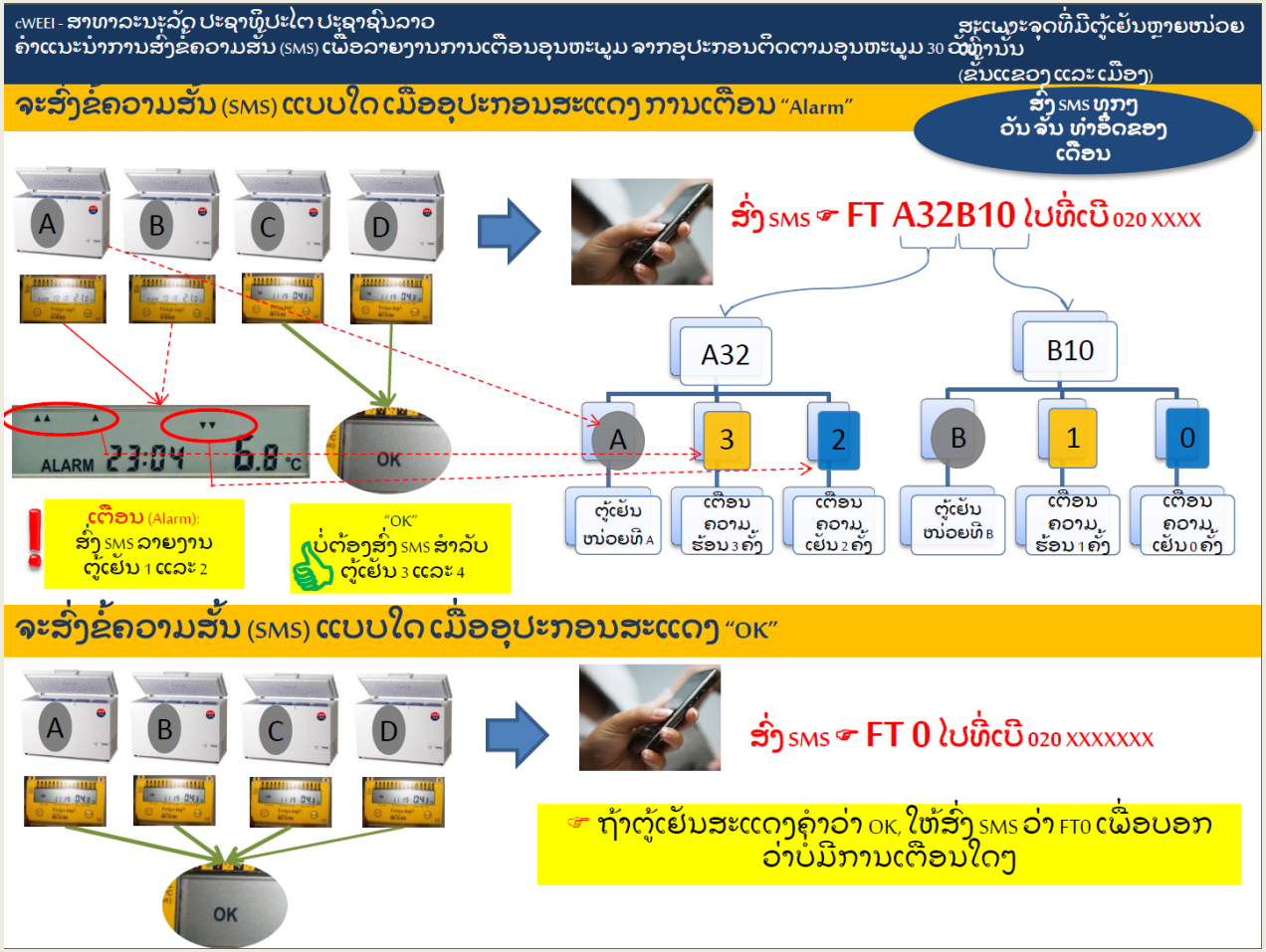
- Aditya Vashistha
  - Voice based messaging
- Treatment Support
  - Adherence
  - Protocol Support
  - Diagnostics
- Gadgets
  - Hijack
  - ODK Sensors
  - FoneAstra
  - Partopen
  - CellScope
  - ColdTrace

Readings and Assignments

- Readings
  - eIMCI
  - CellScope
  - Hijack
- Homework 6
  - Design an SMS syntax for cold chain reporting
- Homework 7
  - Paper prototype of medical protocol
    - Details TBD
- Homework 8
  - Open Data Kit

Date	Topic
Jan 7, 2015	Overview
Jan 14, 2015	Surveillance
Jan 21, 2015	Tracking
Jan 28, 2015	Medical records
Feb 4, 2015	Logistics
Feb 11, 2015	Patient support
Feb 18, 2015	Treatment support
Feb 25, 2015	Health worker support
Mar 4, 2015	Behavior change
Mar 11, 2015	Finance

Homework 7: SMS Reporting



Homework 7: Solutions

```
OneCharId::= [a-zA-Z]
TwoCharId::= (OneCharId)(OneCharId)
FacilityId::= '@'(TwoCharId)(TwoCharId)(TwoCharId)
VaccineId::= (OneCharId)
RefrigeratorId::= (OneCharId)
TemperatureDeviceId::= '*'RefrigeratorId
Ref_Alarm_Count::= [1-5]
Ref_Status_Val::= (RefrigeratorId)(Ref_Alarm_Count)
Ref_Status::= 'ST'(Ref_Status_Val)
Stock_Val::= [1-9]+
Stock_Status_Val::= (VaccineId)(Stock_Val)
Stock_Status::= 'SS'(Stock_Status_Val)
Status_Emergency::=(VaccineId|RefrigeratorId|
                    TemperatureDeviceId) [!]+
Query_Temp::= (FacilityId)'QT'(Ref_Status_Val)
Query_Stock::= (FacilityId)'QS'(Stock_Status_Val)
Hashtag::= '#'(all visible characters)+
HashtagSeq::= Hashtag+
ccSeq::= '/cc:'(FacilityId)+
MessageValue::= (Ref_Status|Stock_Status|
                 Status_Emergency|Query_Stock|
                 Query_Temp)
Message::= (FacilityId)(MessageValue+)
           (HashtagSeq)(ccSeq)
```

Data Record	Symbol	Complete Syntax	Example
Monthly temperature	MT	MT (mm yy|mm yyyy) [[Fridge letter] H [0-5] C [0-5]]+	MT a H 3 C 4 f H 0 C 0 c H 1 C 0
Monthly Stock	MS	MS (mm yy|mm yyyy) [[vaccine short code] [0-999]]+	MS pcv13 33 rv5 2
Stock Out	SO	SO [[vaccine short code]]+	SO pcv13
Refrigerator Failure	RF	RF [[fridge letter]]+	RF a b c
Refrigerator Repair	RR	RR [[fridge letter]]+	RR a b c
Temperature failure	TF	TF [[fridge letter]]+	TF d

SUBMIT DATA

These commands submit data to a central database. They all follow the same pattern: Command ID (CID), Facility ID (FID), Command Data (CDATA), and Terminator ("#"):

[CID] [FID] [CDATA] #

FACILITY IDENTIFIER (FID)

All data submissions require a prefix which identifies the province, district, and facility number in the form of:

[PP][DD][FF]

For example, for facility 3 in district 17 in province 8, the FIP would be: 081703

[help] OR

[optional 6 digit facility code] followed by
- [digit: days high] [digit: days low] [character: a-z fridge ID]
- [digit: quantity] [stock prefix non-digit character, e.g pen for pentavalent vaccine]
- [query] [stock or fridge prefix; e.g a-z or pen for pentavalent vaccine]
- [emergency] followed by
  - [any stock prefix]
  - [refrigerator]
  - [temperature]

Medication Adherence

- TB and HIV
  - Concerns about drug resistant strains
- Adherence obstacles
  - Side effects, inconvenience, perceived cure, stigma

Adherence

- Direct Observation Therapy
  - Health worker observes daily medication
    - Home or clinic
    - Considered burdensome
  - Variations
    - Family member observes
    - Pick up medication every few days

WHO TB Strategy
Pursue high-quality DOTS expansion and enhancement

1. Secure political commitment, with adequate and sustained financing
2. Ensure early case detection, and diagnosis through quality-assured bacteriology
3. Provide standardized treatment with supervision, and patient support
4. Ensure effective drug supply and management
5. Monitor and evaluate performance and impact

TB Drug Distribution

- Fingerprint scanning in drug distribution
  - Reduce record keeping and increase accuracy
  - Verification of drug pick up
  - Allow follow up of non-compliant

SMS Reporting

- Send confirmation code associated with each pill to a given number

4387

Pill box notifications

- Pill box records openings
- Dispense a fixed amount each day
- SimPill – built in SMS modem and simcard
  - Automatic notifications
  - Initial development for low resource settings but commercialized for developed world

Delivery of health services

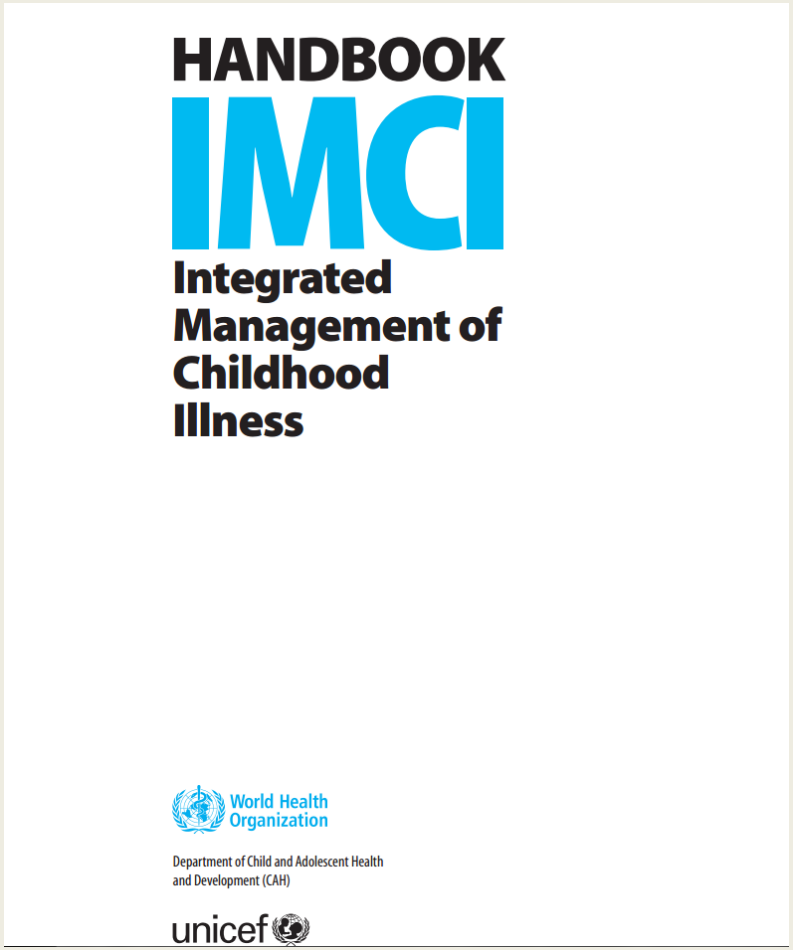
- Routine care delivered by Nurses or CHWs

- Problems to solve
  - Consistent delivery of services
    - Standards based
    - Competent
  - Availability
  - Appropriate escalation and referal

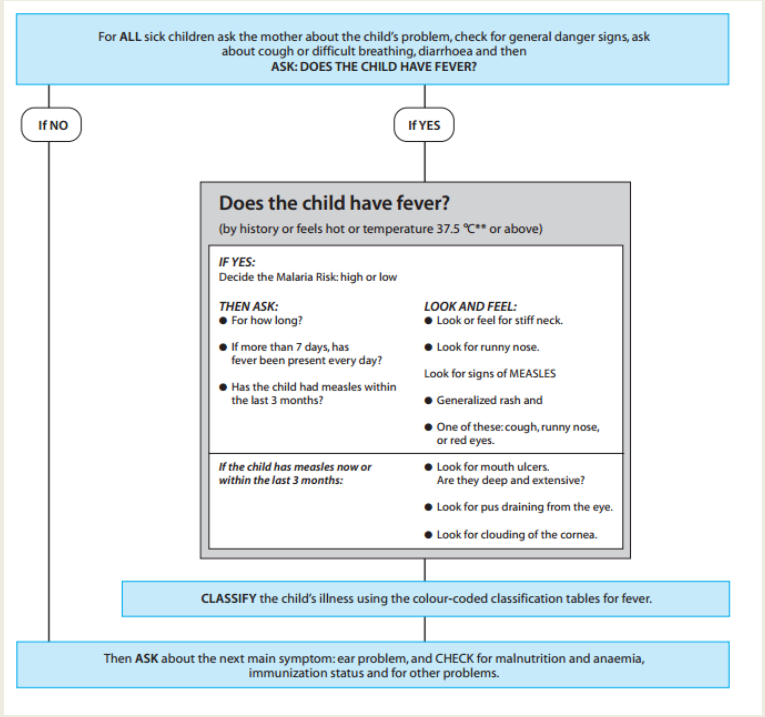
Vision versus reality

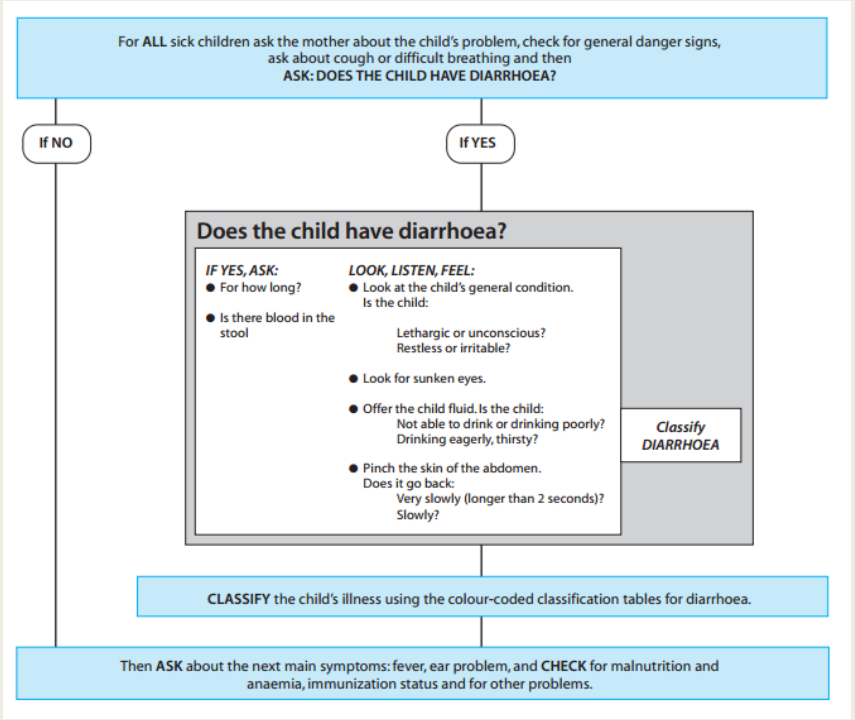
IMCI

- WHO Designed protocol on diagnosing/treating childhood illness
- Step through diseases with flow chart
- Target nurses/health workers
- Standardize care



IMCI





EXAMPLE 11: CLASSIFICATION TABLE FOR LOW MALARIA RISK AND NO TRAVEL TO A HIGH RISK AREA

SIGNS	CLASSIFY AS	IDENTIFY TREATMENT (Urgent pre-referral treatments are in bold print.)
• Any general danger sign • Stiff neck	VERY SEVERE FEBRILE DISEASE	➤ Give quinine for severe malaria (first dose). ➤ Give first dose of an appropriate antibiotic. ➤ Treat the child to prevent low blood sugar. ➤ Give one dose of paracetamol in clinic for high fever (38.5° C or above). ➤ Refer URGENTLY to hospital.
• NO runny nose and NO measles and NO other cause of fever.	MALARIA	➤ If NO cough with fast breathing, treat with oral antimalarial. OR If cough with fast breathing, treat with cotrimoxazole for 5 days ➤ Give one dose of paracetamol in clinic for high fever (38.5° C or above). ➤ Advise mother when to return immediately. ➤ Follow-up in 2 days if fever persists. ➤ If fever is present every day for more than 7 days, REFER for assessment.
• Runny nose PRESENT OR • Measles PRESENT OR • Other cause of fever PRESENT.	FEVER—MALARIA UNLIKELY	➤ Give one dose of paracetamol in clinic for high fever (38.5° C or above). ➤ Advise mother when to return immediately. ➤ Follow-up in 2 days if fever persists. ➤ If fever is present every day for more than 7 days, REFER for assessment.

EXAMPLE 6: CLASSIFICATION TABLE FOR DEHYDRATION

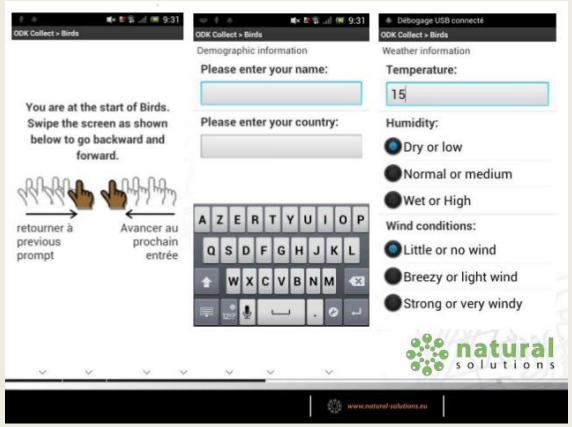
SIGNS	CLASSIFY AS	IDENTIFY TREATMENT (Urgent pre-referral treatments are in bold print.)
Two of the following signs: • Lethargic or unconscious • Sunken eyes • Not able to drink or drinking poorly • Skin pinch goes back very slowly	SEVERE DEHYDRATION	➤ If child has no other severe classification: — Give fluid for severe dehydration (Plan C). OR If child also has another severe classification: — Refer URGENTLY to hospital with mother giving frequent sips of ORS on the way. Advise the mother to continue breastfeeding ➤ If child is 2 years or older and there is cholera in your area, give antibiotic for cholera.
Two of the following signs: • Restless, irritable • Sunken eyes • Drinks eagerly, thirsty • Skin pinch goes back slowly	SOME DEHYDRATION	➤ Give fluid and food for some dehydration (Plan B). ➤ If child also has a severe classification: — Refer URGENTLY to hospital with mother giving frequent sips of ORS on the way. Advise the mother to continue breastfeeding ➤ Advise mother when to return immediately. ➤ Follow-up in 5 days if not improving.
Not enough signs to classify as some or severe dehydration.	NO DEHYDRATION	➤ Give fluid and food to treat diarrhoea at home (Plan A). ➤ Advise mother when to return immediately. ➤ Follow-up in 5 days if not improving.

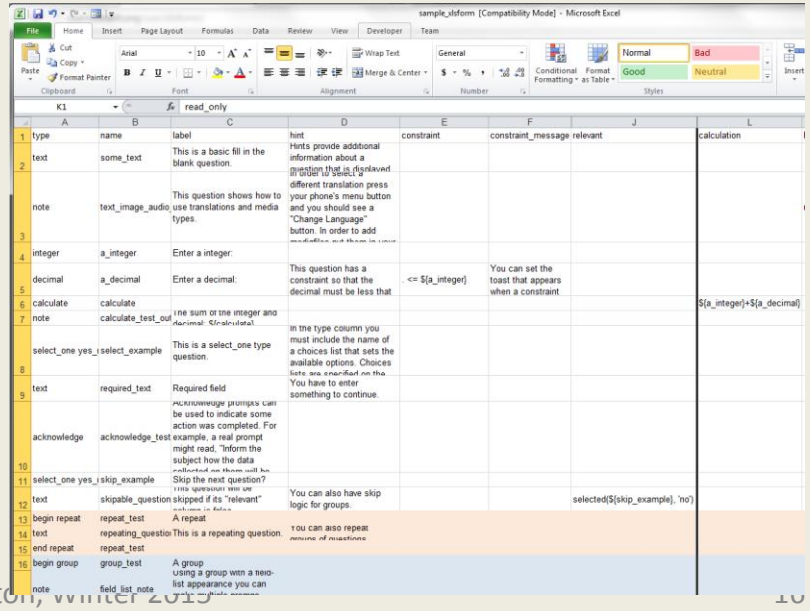
Tanzania e-IMCI Study

- Implement IMCI on a PDA
- Goal:
  - Demonstrate improved compliance to IMCI protocol
  - No increase in time of visits

Open Data Kit 1.0

- Collect
  - Forms based data collection application running on Android device
- XLSForm
  - Form creation tool reading in Excel spreadsheet
- Aggregate
  - Backend server to receive data





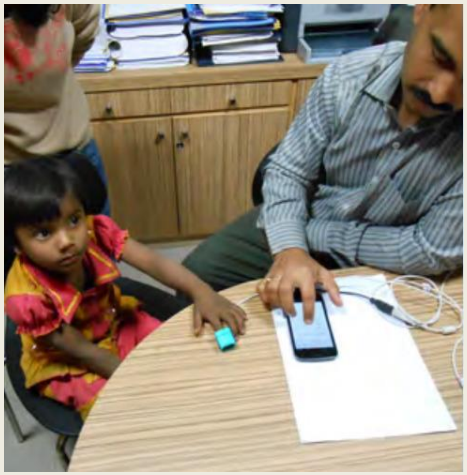
IMCI to ODK

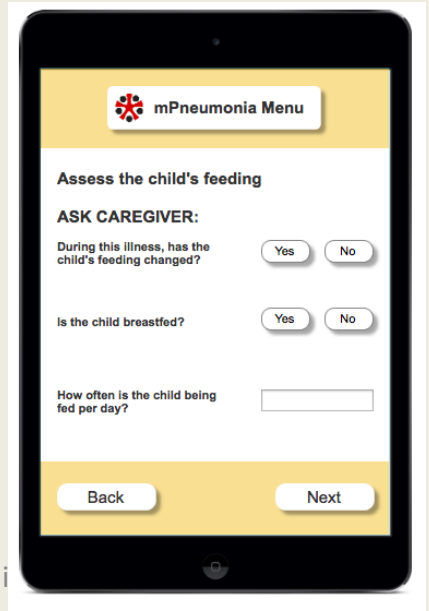
- Convert IMCI Protocol to decision tree
- Encode in forms
- Establish branching logic
- Implement in spreadsheet
  - Compile to ODK

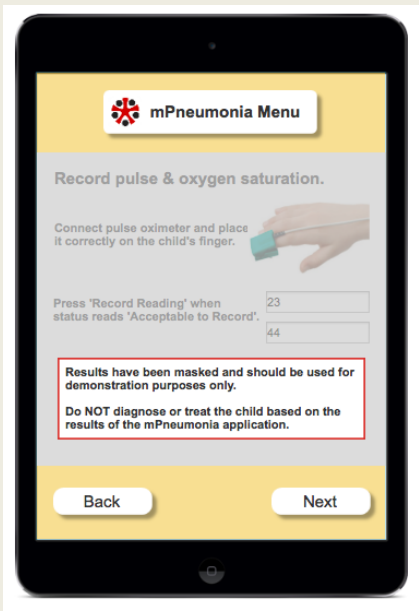
- Challenges
  - Extracting the decision tree
  - Verification of wording and workflow
  - Usability
- Medical review of IMCI
  - Difficulty in adapting protocol
  - Official approval of protocol
  - Determining correspondence of electronic and paper version

IMCI + Pulse Oximetry

- Measure blood oxygen level
- Low oxygen levels can indicate pneumonia
- Add blood oxygen level into pneumonia questions
- Pulse oximeter connected to mobile phone so readings entered automatically

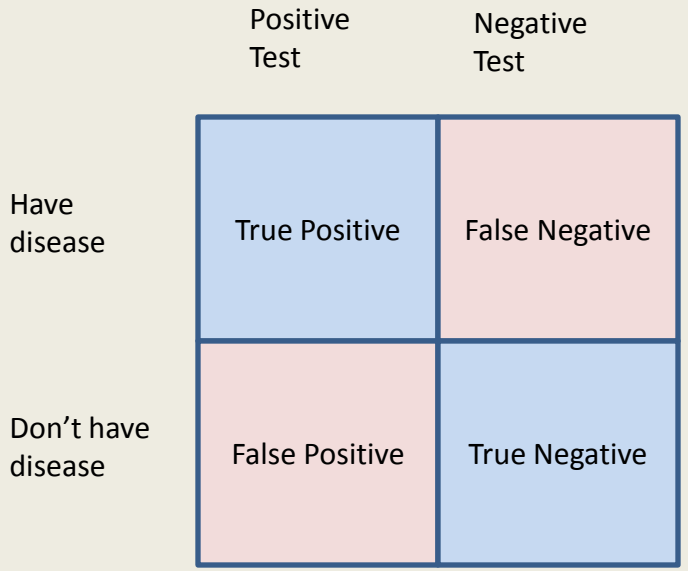


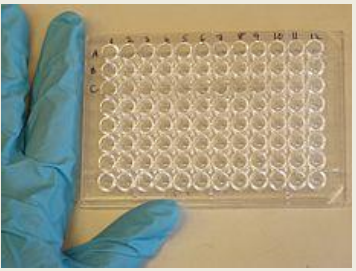




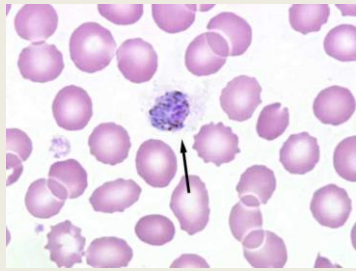
Diagnostics

- Issues
  - Cost of test
  - Precision of test
  - Accuracy of test
    - Error profile
  - Action on positive test
  - Action on negative test
  - Goals
    - Individual treatment
    - Public health goals

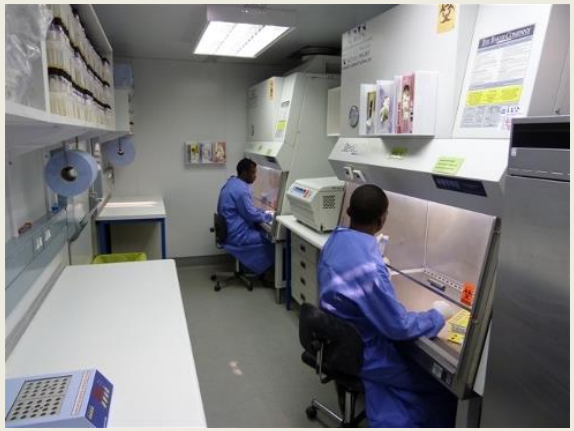




Lab Diagnostics

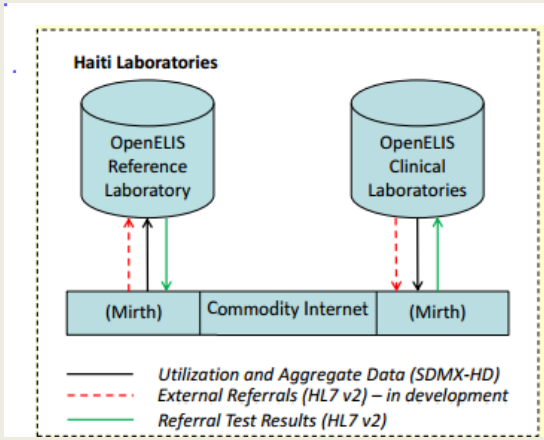


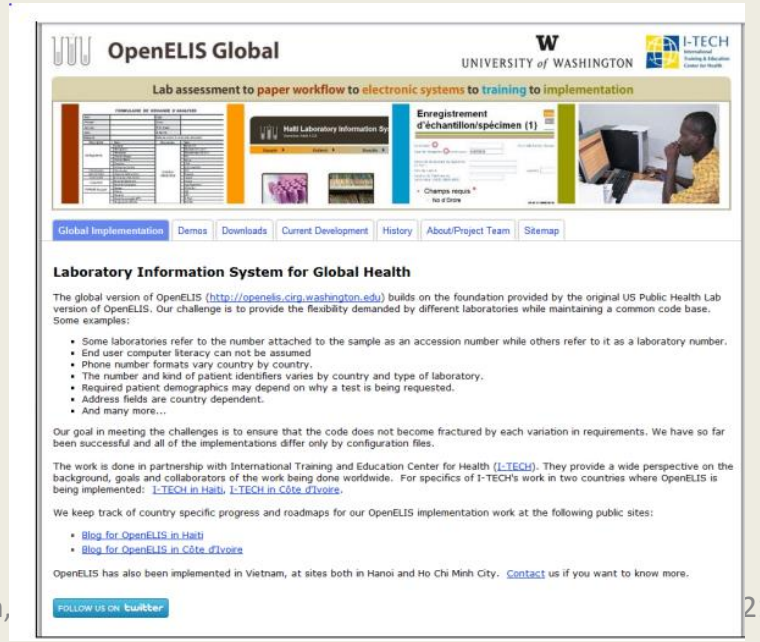
- Highly accurate tests
  - E.g., Enzyme-linked immunosorbent assay (ELISA)
  - Microscopy
- Requires infrastructure, trained staff, equipment
- Issues
  - Costs
  - Transport of samples
  - Delays in processing or notification



Lab Information System

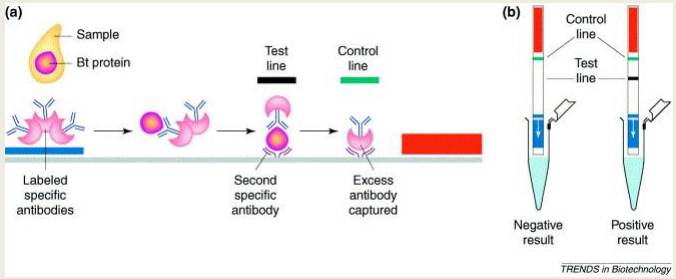
- Internal lab management
- Tracking of samples and tests
- Interoperability with medical records
- Notifications
- Probably not much difference between developed and developing world





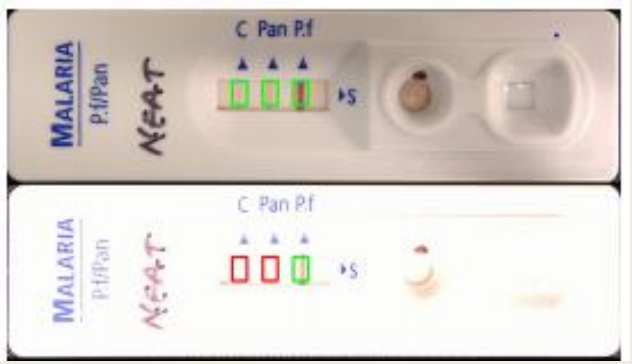
Rapid Diagnostic Tests

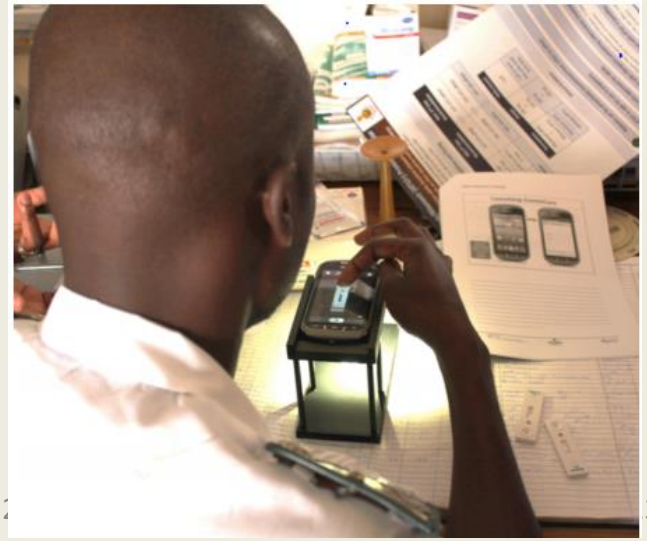
- Point of Care Tests
  - Deliver results without sending test to lab
  - Fast turn around
  - Limited test preparation
- Lateral flow immunochromatographic assays
- Large number of tests available
  - Blood, Urine
  - HIV, Malaria, Syphilis



ODK Diagnostics

- Nicki Dell, Gaetano Borriello
- Image analysis on SmartPhone to read RDT
  - Computation done locally
  - Template to adapt to multiple tests
- Use cases
  - Enable lesser trained health workers to conduct tests
  - Support tests which are not frequently used
  - Supervision
  - Quality control
- Field trials
  - Zimbabwe





Gadgets

Hijack

- Sensor interface through audio jack
- EKG Interface
- Soil temperature monitor
- UBC Pulse Oximeter for iPhone
- HIV Diagnostic

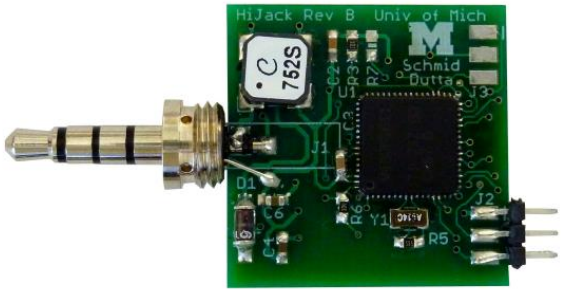
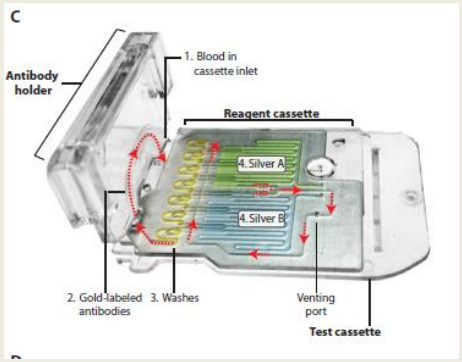
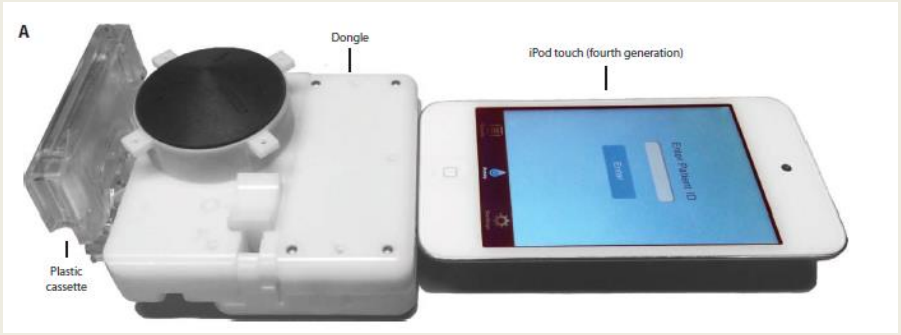


Figure 14: The HiJack base platform, with a 1" x 1" footprint, offers power (>5 mW), analog (2x 12-bit), digital (1x GPIO), and serial (1x I2C and 1x UART) interfaces, exported via connectors, and all multiplexed over the headset port. This board provides the functionality needed to build a variety of external sensor interfaces for the mobile phone.

Smartphone for point of care diagnosis

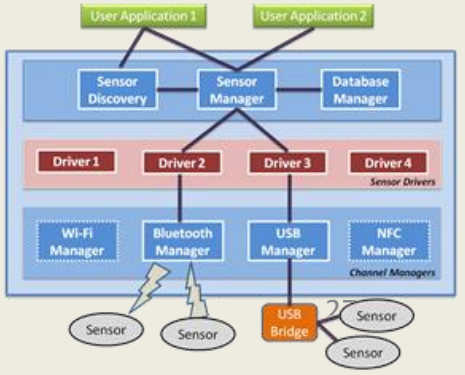
- Recent press attention on HIV/Syphilis diagnosis by Columbia University
- Laboratory quality immunoassay
- Ultra low power
- Power from cell phone
  - iPhone = Battery
  - Signal processing on cell phone to generate results





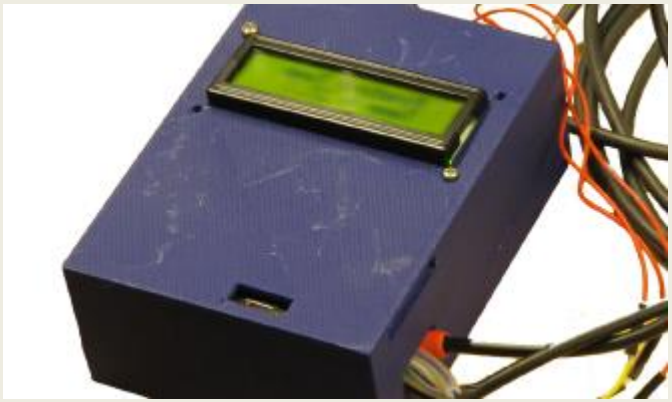
ODK Sensors

- Build a user-level sensing framework with sensor drivers
  - No operating system modifications
  - Allows convenient reuse between applications
- Create a single sensor interface
  - Access wired, wireless, and built-in sensors
  - Support multiple sensors over multiple channels
- Focus on ease of deployment and development
  - Distribution through existing app store model
  - Reduce complexity
  - Without adverse effects on performance



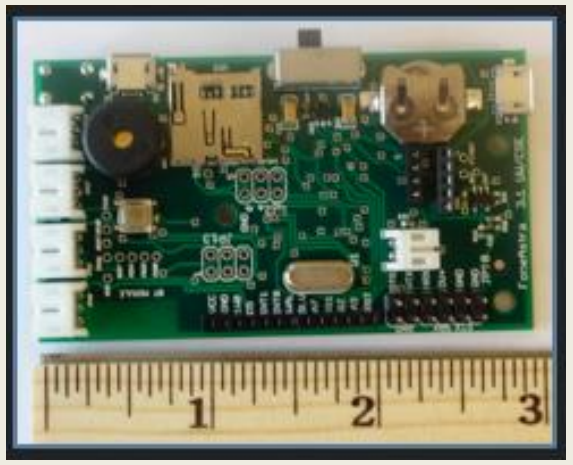
Fone Astra

- Sensor connection to low cost phone
  - Phone for communication and output
- $25 board + $25 phone
- Temperature monitoring



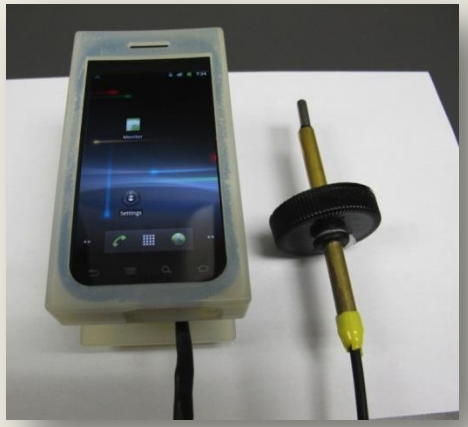
Android Fone Astra

- Version 2 of FoneAstra replaced basic phone with Android phone
- Communication by bluetooth or USB
- Separate power for FoneAstra device
- Programmability and UI on phone



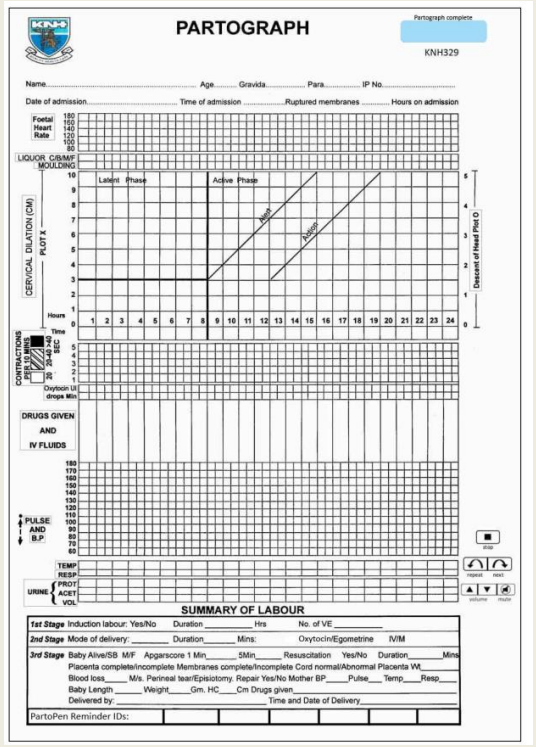
Milk Pasteurization

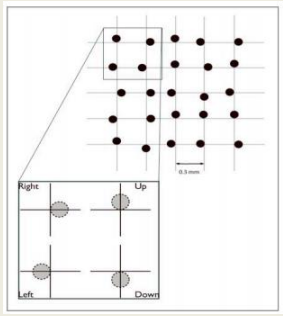
- Human milk pasteurization
- Replace high price pasteurizer with hotplate
- Temperature monitoring to ensure proper heating and verify quality



PartoPen

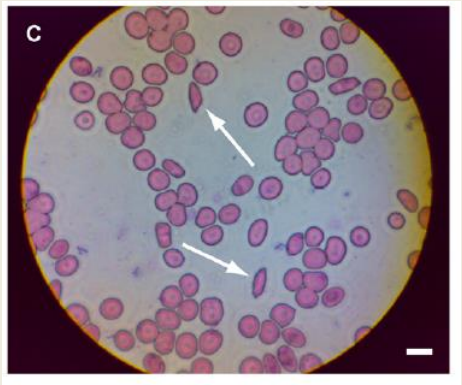
- Paper record of birth progress
  - Plot dilation versus time
  - Too slow, issue an alert
- Idea
  - Implement using a LiveScribe digital pen
- Deployment
  - Nurses in Kenya, in both training and practice





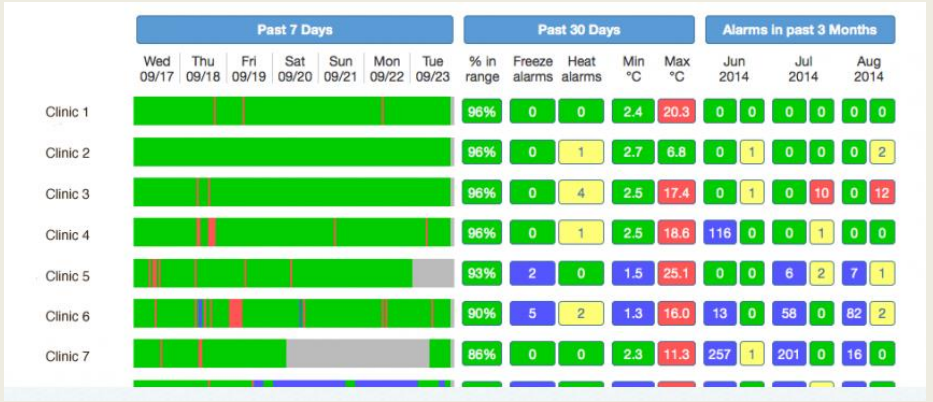
Cell Scope

- UC Berkeley project
  - Dan Fletcher, Bioengineering
  - Build a cheaper microscope for diagnostics



Cold Trace

- Remote temperature monitoring
- Connection through audio port to Android phone
- Deployments now rely on a single model of low cost Android phone
- Well engineered product with substantial support
- Need for multi sensor device



Next week

- Supporting the health worker