

Biometric Monitoring as a Persuasive Technology: Ensuring Patients Visit Health Centers in India's Slums

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The Problem of Medication Adherence

- WHO: In developed countries, 50% having chronic disease take medication as directed
- In US, non-adherence causes:
 - \$300 billion annual cost to healthcare system
 - 10% of hospital admissions
 - 23% of nursing home admissions
- Globally, non-adherence claims millions of lives and poses threat of untreatable diseases



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Indian TB cases 'can't be cured'

Tuberculosis which appears to be totally resistant to antibiotic treatment has been reported for the first time by Indian doctors.

Concern over drug-resistant strains of TB is growing, with similar 'incurable' TB emerging in Italy and Iran.

Doctors in Mumbai said 12 patients had a "totally drug resistant" form of the infection, and three have died.

The Indian Health Ministry is investigating the cases and has sent a team of doctors to Mumbai.

TB is one of the world's biggest killers, second only to HIV among infectious diseases.



Some strains are becoming resistant to antibiotics

Related Stories

[Plan to tackle drug-resistant TB](#)

[TB vaccine provides 'double hit'](#)

Reasons for Non-Adherence

- (Drugs expensive or unavailable)
- Patient does not understand illness or benefit of treatment
- Complexity of regimen
- Poor provider-patient relationship
- Perceived side effects
- Psychological problems (e.g., depression)
- Forgetfulness



Sometimes Reasons are Justified

- Condition mis-diagnosed
- Inappropriate prescription
- Experience of side effects
- Cost/benefit ratio of drugs



Extensive Research to Improve Adherence, with Mixed Results

BMC Health Services Research



Research article

Open Access

Patient adherence to medical treatment: a review of reviews

Sandra van Dulmen*¹, Emmy Sluijs¹, Liset van Dijk¹, Denise de Ridder², Rob Heerdink³ and Jozien Bensing¹

“The study is a review of 38 systematic reviews”

“Although successful adherence interventions do exist, half of interventions seem to fail”

“Non-adherence rates have remained nearly unchanged in the last decades”

Interventions with Long-Term Success are Usually Multi-Faceted

- Encompassing several of the following:
 - convenient & supportive care
 - information and education
 - reminders
 - self-monitoring
 - reinforcement
 - counselling
 - family therapy
 - psychological therapy
 - crisis intervention
 - telephone follow-up
- Difficult to replicate and scale

What About Technology?

- Several successful pilots, but few taken to scale
- One thrust: medication monitors



MEMS



SIMPill



Vitality



uBox

– Due to high cost, mostly limited to clinical trials

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- Due to high cost, mostly limited to clinical trials
- Another thrust: text message reminders
 - Recent review: 20 of 25 controlled trials (spanning 40K people) had significant result

Focus: Tuberculosis in India

- TB in India: 350,000 deaths per year
- Completely curable by taking free drugs from the government
- To ensure medication adherence:
 - “Directly Observed Therapy”
 - Every ingested dose is observed by a medication “provider”
 - Providers receive about \$5 per successful treatment outcome



Directly Observed Therapy is Difficult to Administer at Scale

- Relies on paper records that are routinely fudged

Revised National Tuberculosis Control Programme
Treatment Card

State: Madhya Pradesh
Name: Shrinani
Sex: M F
Complete Address:
Name and Address:
Initial home visit to:
Disease Classified:
 Pulmonary
 Extra Pulmonary site:
Has previous Anti-TB treatment? Yes No
New Case Relapse Retreatment Breakthrough

Prescribed regimen and Dosages:
Category I 2 times / week
Category II 3 times / week
Category III 3 times / week

Enter X on date when the first dose of drugs has been swallowed under direct observation and draw a horizontal line (-----) to indicate the period during which medicines will be self-administered.

Month / Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
January																															
February																															
March																															
April																															
May																															

Treatment outcome with date: _____ Signature of MO with date: _____

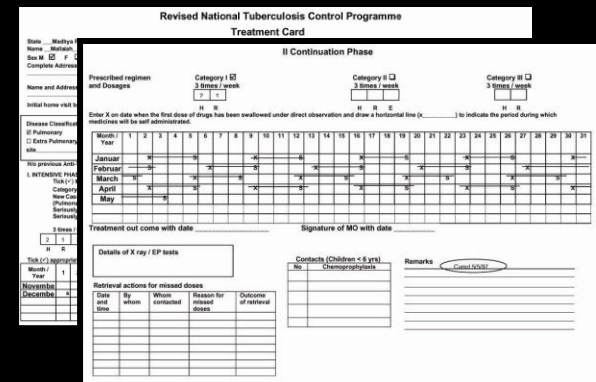
Details of X ray / EP tests:
Tab (C) approved: _____
Month: _____ Year: _____
November: _____
December: _____

Details of X ray / EP tests:
Date and time: _____ By whom: _____ When consumed: _____ Reason for missed doses: _____ Outcome of retrieval: _____

Contacts (Children < 6 yrs):
No. of Chemoprophylaxis: _____
Remarks: _____

Directly Observed Therapy is Difficult to Administer at Scale

- Relies on paper records that are routinely fudged
- Even diligent workers have trouble connecting with patients



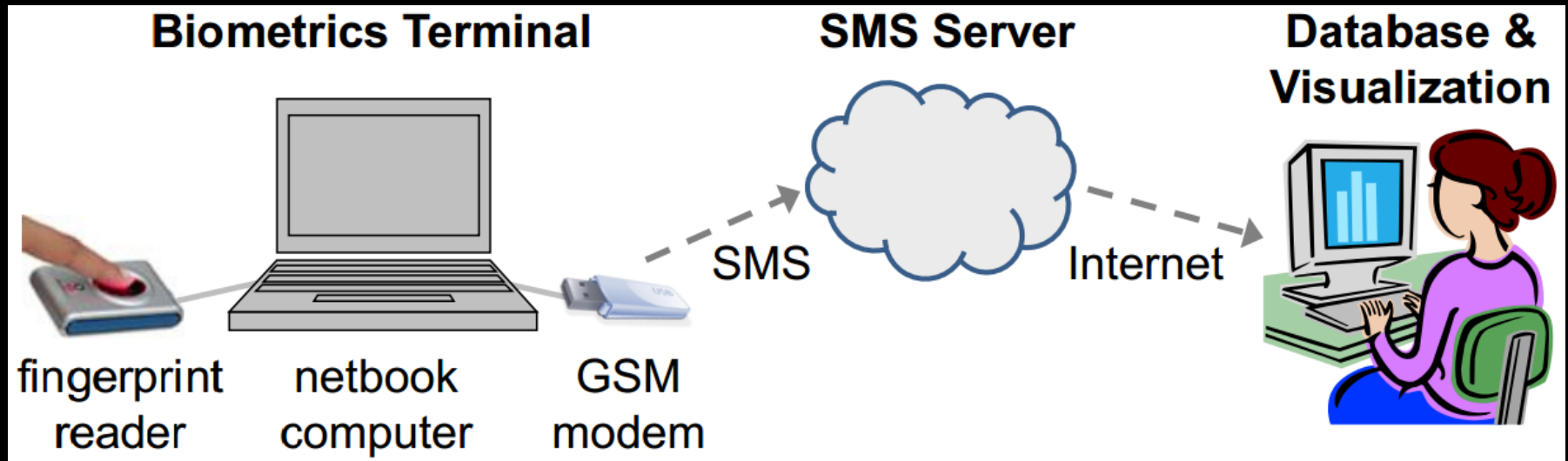
The image shows a 'Revised National Tuberculosis Control Programme Treatment Card'. It is a form for recording patient treatment progress. The card includes fields for patient details (Name, Address, Sex, Age, etc.), prescribed regimen (Category I, II, or III), and a grid for tracking treatment status by month and day. The grid has columns for days 1-31 and rows for months from January to May. A horizontal line is drawn across the grid to indicate the period of direct observation. Below the grid, there are sections for 'Treatment outcome with date', 'Details of X ray / EP tests', 'Retrieval actions for missed doses', and 'Remarks'. The card is titled 'II Continuation Phase'.

“Many patients want unsupervised doses and when I refuse they even offer me money. They don’t want to come to the center, but send someone else in their place.”

— Health worker with Operation ASHA

A Biometric Terminal for TB Clinics

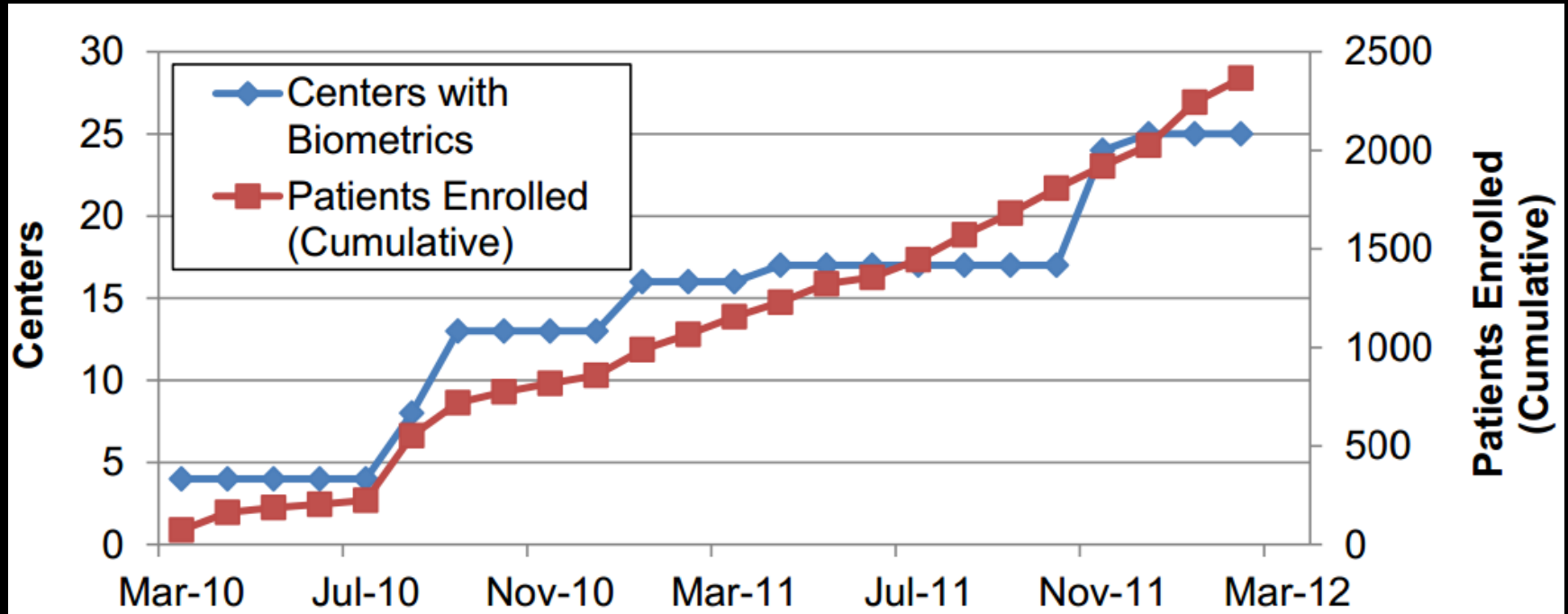
Developed with Operation ASHA and Innovators In Health



- **Benefits:**
 - Immediate response to missed doses
 - Incentives for workers, accountability to donors
 - Cost: \$500 / terminal → \$2.50 / patient

Large-Scale Deployment in TB Clinics

with Operation ASHA in Delhi



Catering to low-income patients in slum communities

Annual household income ~ USD 2,000 / year

Challenges Overcome

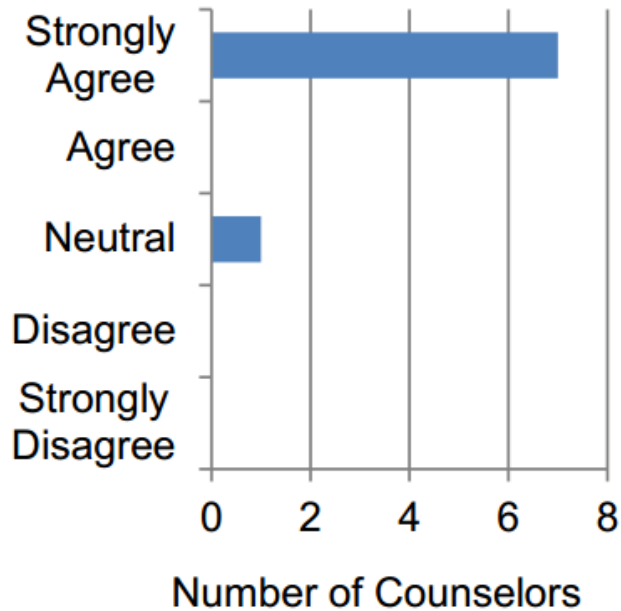
- Initial apprehension of health workers
- Occasional hesitancy to provide thumb print
- Mis-recognition
- Computer viruses



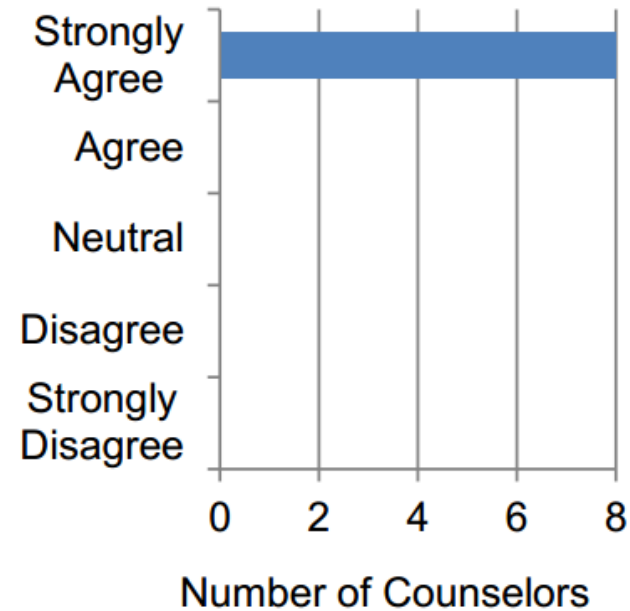
Impact Assessment

- Ideal assessment: randomized controlled trial
 - Our aspiration in the future!
- Next best: quantitative assessment
 - We compared missed doses, patient outcomes over time and across clinics, spanning over 50,000 dosage records
 - No significant effect found (small sample size, many confounds)
- Focus for now: qualitative assessment
 - We interviewed 8 health workers, 4 clinic owners, 23 patients
 - Rich anecdotal evidence for importance of biometrics

Feedback from Health Workers



“Patients are more likely to visit a center which has biometrics.”



“I am less likely to send medication home with a proxy (other than the patient) due to the biometric terminal.”

Changing Patient Behavior

“All patients come to the DOTS center, some out of consideration for me as I have told them that I get scolded if scans are not taken.”

— *Health worker with Operation ASHA*

Patient Perceptions

- Varied understanding of purpose of biometrics
 - 61% explained system well; others could not
- Half of patients confirmed behavioral change

“Without the laptop I may not have come to the center so regularly but would have sent my husband.”
- Other half were neutral towards technology

“I don’t know [if it helps me]. I would have come even if this device wasn’t there because I want to get well.”

Changing Health Worker Behavior

“There is a handicapped patient who is unable to come to the center. And he wants unsupervised doses. Since I can’t give it to a proxy but still I want to give him DOTS, I go myself every time and take his fingerprint.”

— *Health worker with Operation ASHA*

Incentives for Health Workers

- Respect

“Now that I have this laptop the patients give me double respect. When I go into the field even the neighbors of the patient flock around and think I am coming from a big hospital because I carry a laptop.”

- Record-keeping

“I would be lost without biometrics. I would not know how many patients to expect that day, how many and who have already visited the center.”

Limitation: Participant Response Bias

- Interviews were conducted by a known champion of the biometrics program
- We repeated the survey with a different interviewer; one worker changed her reply:
“If I have the option, I don’t want the netbook. The earlier answer to Nupur Mam was incorrect. I was little scared telling her that I don’t need the netbook.”
- Follow-up study: “Yours is Better! Participant Response Bias in HCI”, Dell et al., CHI 2012

The Road Ahead

- Released as open-source from MSR India
- Wellcome Trust awarded funding to OpASHA for further development of the terminal
 - For mobile interface, text-free UI, expansion
- Replications of system underway in:
 - Uganda
 - Cambodia
 - Rajasthan and 5 other Indian states
- Still looking for opportunities to evaluate

Conclusions

- Medication adherence remains a central challenge in global public health
- Non-technical innovations (such as DOTS) have had major impact at scale
- Technology interventions have shown positive results in pilots, but have yet to be scaled up
- With increasing penetration of technology, new opportunity to strengthen DOTS, and adherence