

# 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\*<sup>1</sup>, Emmy Sluijs<sup>1</sup>, Liset van Dijk<sup>1</sup>, Denise de Ridder<sup>2</sup>, Rob Heerdink<sup>3</sup> and Jozien Bensing<sup>1</sup>

**“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

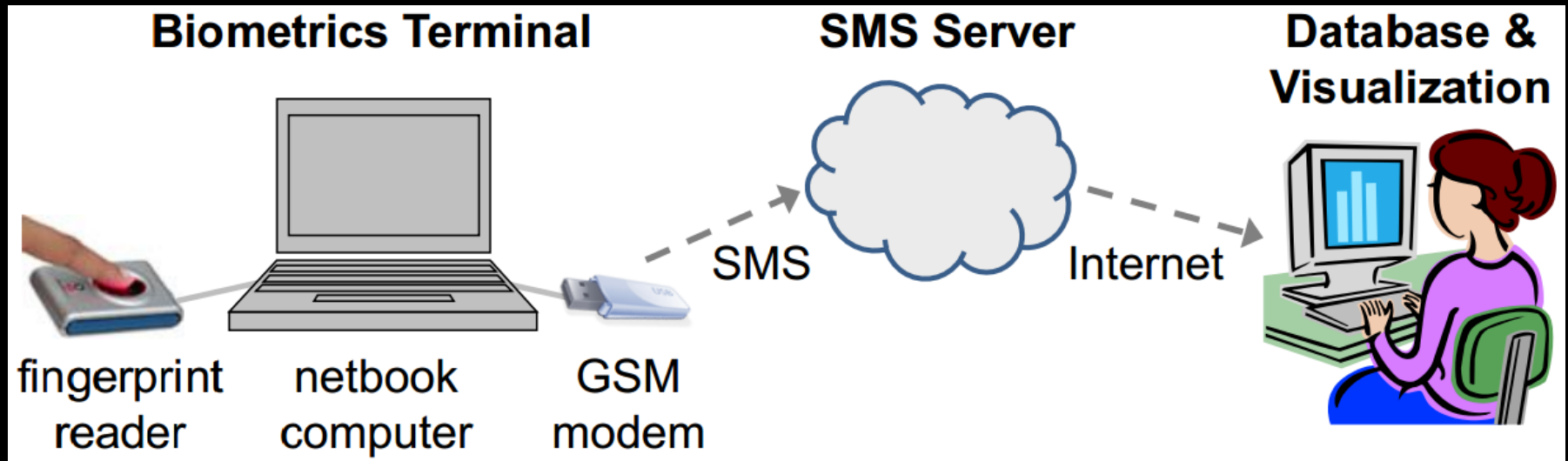






# A Biometric Terminal for TB Clinics

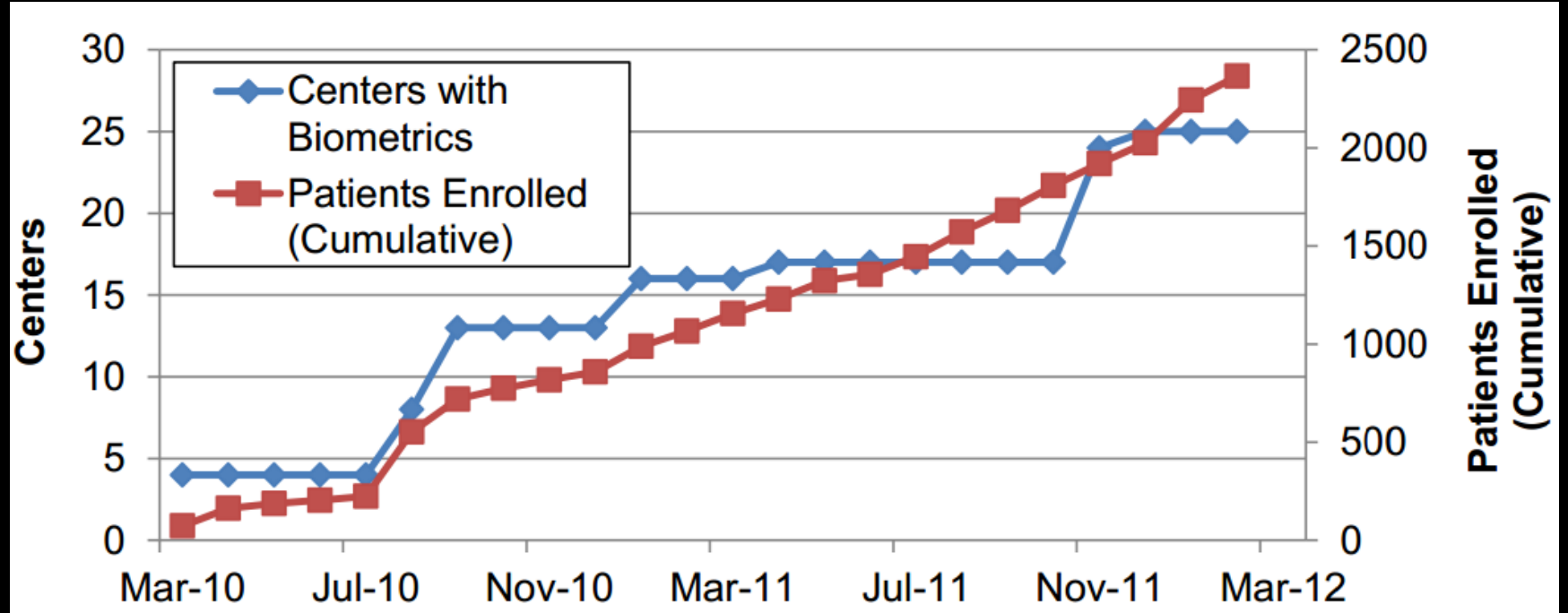
*Developed with Operation ASHA and Innovators In Health*



- **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

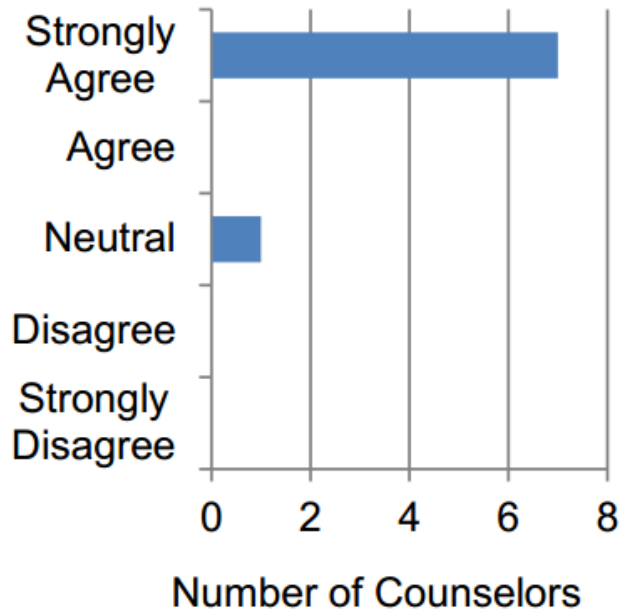


# Impact Assessment

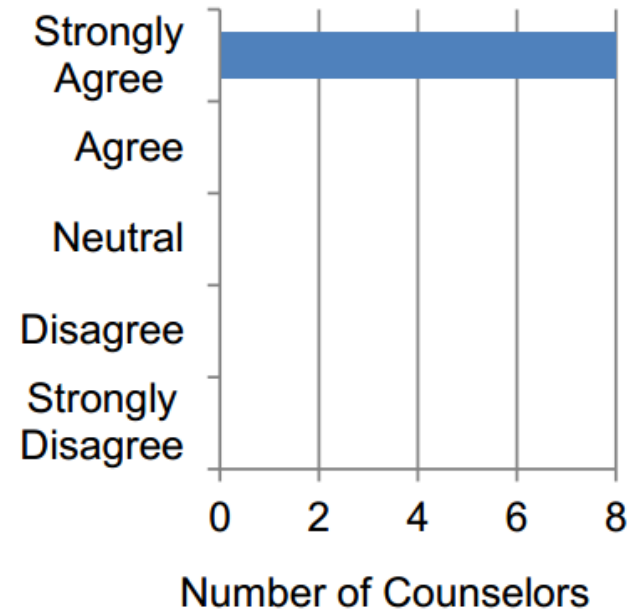
- Ideal assessment: randomized controlled trial
  - Our aspiration in the future!
- Next best: quantitative assessment
  - We compared missed doses, patient outcomes over time and across clinics, spanning over 50,000 dosage records
  - No significant effect found (small sample size, many confounds)
- 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