“I want you to find a bold and innovative way to do everything exactly the same way it’s been done for 25 years.”
The Evidence Gap

• Is there evidence to show that mHealth strategies lead to improved health?

• How strong is that evidence?
mHealth is not monolithic:

This impacts -- evaluation, indicators, business models, opportunities and strategies for scale.

**Education and Awareness**
Messaging in support of public health and behavioral change campaigns.

**Diagnostic and Treatment Support**
Mobile phones to support provider decisions and as a point-of-care device.

**Disease and Epidemic Outbreak Tracking**
Sending and receiving data on disease incidence, outbreaks and public health emergencies.

**Supply Chain Management**
Using mobile solution to improve stock-outs and combat counterfeiting.

**Remote Data Collection**
Collecting real-time patient data with mobile applications.

**Remote Monitoring**
Maintaining care giver appointments or ensuring medication regime adherence.

**Healthcare Worker Communication and Training**
Connecting health workers with sources of information.
mHEALTH: A Health Systems Catalyst

Shift focus from “Does mHealth work?” to “Does mHealth optimize what we know works?”

Distribution of issues examined in Mobile Health research between 2000 and 2010

Relevance of issue:
- Low (66%)
- High (34%)
2011:
< 13% of primary evidence = High Strength
41% “inconclusive”

Source: PubMed, GSMA Literature Review of State of Evidence on mHealth 2011
Scaling Up mHealth: Where Is the Evidence?

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What Is the Problem?

There are over 6 billion mobile phone subscribers and 75% of the world has access to a mobile phone [1]. Service and care providers, researchers, and national governments are excited at the opportunities mobile health has to offer in terms of improving access to health care, engagement and delivery, and health outcomes [2]. Interventions categorized under the rubric “mobile health” or “mHealth”—broadly defined as medical and public health practice supported by mobile devices [2]—span a variety of applications ranging from the use of mobile phones to improve point of service data collection [3], care delivery [4], and patient communication [5] to the use of alternative wireless devices for real-time medication monitoring and adherence support [6].

A recent World Bank report tracked more than 500 mHealth studies, and many donor agencies are lining up to support the “scaling up” of mHealth interventions [7]. Yet, after completion of these 500 pilot studies, we know almost nothing about the likely uptake, best strategies for engagement, efficacy, or effectiveness of these initiatives. Currently, mHealth initiatives lack a foundation of basic evidence [8], let alone a foundation that would permit evidence-based scale up. For example, in Uganda in 2008 and 2009 approximately 23 of 36 mHealth initiatives did not move beyond the pilot phase [9]. The current enthusiasm notwithstanding, the scatter-shot approach to piloting mHealth projects in the absence of a concomitant programmatic implementation and evaluation strategy may dampen opportunities to truly capitalize on the technology. This article discusses a number of points pertinent to developing a more robust evidence base for the scale up of mHealth interventions.

Summary Points

- Despite hundreds of mHealth pilot studies, there has been insufficient programmatic evidence to inform implementation and scale-up of mHealth.
- We discuss what constitutes appropriate research evidence to inform scale up.
- Potential innovative research designs such as multi-factorial strategies, randomized controlled trials, and data farming may provide this evidence base.
- We make a number of recommendations about evidence, interoperability, and the role of governments, private enterprise, and researchers in relation to the scale up of mHealth.

The issues related to evidence are complex, and we make no attempt to recapitulate the evidence. Instead, we focus on what needs to be done to develop this evidence, and we make recommendations to improve attendance at health-care appointments [13,14].


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Abbreviations: DI, evidence-based intervention; LMIC, low- and middle-income country; mHealth, mobile health; MOST, Multiple Optimization Strategy.

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Provenance: Not commissioned; externally peer reviewed.
Letter to the Editor

Hope for mHealth: More “y” or “o” on the horizon?

Results: We identified 215 unique mHealth studies that were registered in the clinicaltrials.gov database, of which 8.4% (n=18) were observational in nature while the remaining 91.6% (n=197) were interventional. Of the 215 studies, 81.8% (n=176) studies used a classical randomized trial design and 40 new studies were added to the database between May and November 2012 alone. Based on these results, we posit that the field is entering a new ‘era’ where a body of rigorous evaluation of mHealth strategies is rapidly accumulating.
The Effectiveness of Mobile-Health Technologies to Improve Health Care Service Delivery Processes: A Systematic Review and Meta-Analysis

Caroline Freer, Gemma Phillips, Louise Watson, Leandro Galli, Lamberti Felix, Phil Edwards, Wihanu Patal, Andy Haines

Abstract

Background: Mobile health interventions could have beneficial effects on health delivery processes. We aimed to conduct a systematic review of controlled trials of mobile technology interventions to improve health care delivery processes.

Methods and Findings: We searched for all controlled trials of mobile technology-based health interventions using MEDLINE, EMBASE, PsycINFO, Global Health, Web of Science, Cochrane Library, UK NHS, HTA, (Jan 1960-Sep 2010). Two authors independently extracted data on allocation concealment, allocation sequence, blindness, completeness of follow-up, and measures of effect. We calculated effect estimates and used random-effects meta-analysis to give pooled estimates. We identified 43 trials. None of the trials had low risk of bias. Seven trials of health care provider support reported 26 outcomes regarding appropriate disease management, of which 11 showed statistically significant benefits. One trial reported a statistically significant improvement in communication using mobile phones. Two trials reported no statistically significant differences in appointment attendance using SMS reminders versus no reminders and no statistically significant differences. One trial reported an increase in appointment attendance using SMS reminders versus no reminders was not statistically significant. There was no difference in attendance using SMS reminders versus other reminders in any trial. The conclusion was that mobile health interventions can improve health care delivery processes, and further research is needed to determine their effectiveness.

Conclusions: The results for health care provider support interventions on diagnosis and management outcomes are generally consistent with modest benefits. Trials using mobile technology-based photos reported reductions in correct diagnosis when compared to the gold standard. SMS appointment reminders have modest benefits and may be appropriate for implementation. High quality trials measuring clinical outcomes are needed.

Figure 1. PRISMA 2009 flow diagram.
doi:10.1371/journal.pmed.1001363.g001
mHealth Technical Evidence Review Group for RMNCH

“m-TERG”

“Providing governments and implementing agencies objective, evidence-based guidance for the selection and scale of mHealth strategies across the reproductive, maternal, newborn and child health continuum”
Two Initial Areas Selected

Do mHealth strategies:

- improve provider adherence to care and treatment guidelines?

- reduce stockouts of essential maternal health drugs and commodities?
Bridging the Evidence Gap - Methods

1. Document Search “beyond the peer-reviewed”: articles, reports, blogs, presentations using extended strategy, ‘sleuthing’ references and links

2. Included documents which describe:
   - Implementation of an mHealth intervention
   - Systematic Evaluation Methodology

3. Tag document using WHO mTERG taxonomy

4. Grade document quality using WHO mTERG instrument

5. Summary / Synthesis of overall direction, magnitude and consistency of effect
Grading quality of evidence

• A flexible approach that allows the grading of reporting and methodology for varied study designs

• **Domain 1:** Reporting and Methodology – This is indicative of the quality of methodological rigor employed by the studies under consideration, as well as the reporting standards that have been adhered to.

• **Domain 2:** Essential mHealth criteria – Classifies the studies under consideration based on the quality of information presented about the mHealth intervention.
Two Initial Areas Selected

Do mHealth strategies:

- improve provider adherence to care and treatment guidelines?

- reduce stockouts of essential maternal health drugs and commodities?
Provider Competence, Accountability, Effectiveness.

Client Knowledge and Self-Efficacy

System

- Improved Information about individuals, populations, providers, facilities, outcomes,
- Availability of Commodities, Health Workers, Equipment
- Improved Efficiency + Coverage
- Improved Quality of Care
- Improved Health Behaviors

Client

- Provider to Provider Communication
- Disease Prevention
- Point of Care Diagnostics
- Disease Management
- Referrals
- Health Education or Promotion
- Hotlines and Information Services
- Appointment Reminders
- Treatment Adherence
- Mass Messaging Campaigns

System

- Provider Training and Education
- Provider Work Planning and Scheduling
- Human Resource Management
- Electronic Decision Support
- Electronic Health Records
- Registries/Vital Events Tracking
- Payment for Services
- Savings Accounts
- Insurance
- Performance Based Incentives
- Cold Chain Management
- Stock Out Prevention
- Counterfeit Prevention
- Maintenance of Equipment
- Commodity Tracking
Provider Competence, Accountability, Effectiveness.

Client Knowledge and Self-Efficacy

Improved Information about individuals, populations, providers, facilities, outcomes,

Availability of Commodities, Health Workers, Equipment

Improved Quality of Care

Improved Efficiency + Coverage

Improved Health Behaviors

Improved HEALTH Outcomes

System

Provider

Client

Data Collection and Reporting
- Electronic Health Records
- Registries/Vital Events Tracking
- Payment for Services
- Savings Accounts
- Insurance
- Performance Based Incentives
- Cold Chain Management
- Stock Out Prevention
- Counterfeit Prevention
- Maintenance of Equipment
- Commodity Tracking

Provider Training and Education
- Provider Work Planning and Scheduling
- Human Resource Management
- Electronic Decision Support
- Provider to Provider Communication
- Remote Client to Provider (Telemedicine)
- Disease Prevention

Referrals

Health Education or Promotion
- Hotlines and Information Services
- Appointment Reminders
- Treatment Adherence
- Mass Messaging Campaigns
Search Strategy

**Identification**
- Articles identified through database search and use of search engines using a combination of search terms n=1,499
- Potentially eligible articles remaining n=1,459

**Screening**
- Titles and abstracts of 1,459 potentially eligible articles screened
  - 1,406 articles excluded
    - 161 were not mobile health related
    - 1,117 did not meet health domain criteria
    - 105 did not meet mHealth application criteria
    - 11 did not meet target user criteria
    - 12 only briefly mentioned the use of mHealth for decision support

**Eligibility**
- Application of inclusion and exclusion criteria to 1,459 articles
  - 53 articles tagged using the taxonomy tool
  - 21 articles graded using the grading tool
  - 32 articles did not meet grading criteria
    - 7 did not provide description of evaluation of mHealth program
    - 2 did not provide description of implementation of mHealth program
    - 13 did not provide description of evaluation or implementation of mHealth program
Quality of Information

Completeness of description of methodology
Completeness of description of technology, intervention

% Score for each domain

- Domain 1: Study reporting and methodology
- Domain 2: Reporting of essential mHealth criteria
Can mHealth strategies be used to improve provider adherence to care and treatment guidelines?

- Domain 1 score ranged from 5 to 37 points out of a maximum 47-point score (11 to 79%) suggesting large variations in quality and methodology of reporting.

- Only three of the 21 graded studies achieved a score >75% for Domain 2 (essential mHealth criteria), which indicates that most studies do not adequately describe the mHealth intervention they are reporting on.
<table>
<thead>
<tr>
<th>Authors</th>
<th>Type of study</th>
<th>Findings</th>
<th>Grade scores for strength of evidence (%)</th>
</tr>
</thead>
</table>
| DeRenzi et al       | Non-Experimental: quantitative | • The investigation in rural Tanzania suggests that e-IMCI is almost as fast as the common practice and potentially improves care by increasing adherence to the IMCI protocols.  
• Additionally, the authors found clinicians could quickly be trained to use e-IMCI and were very enthusiastic about using it in the future.                                                                                   | Domain 1: Reporting and Methodology 58%  
Domain 2: Reporting of essential mHealth criteria 93% |
| Zurovac et al       | Experimental: quantitative | • The study found that for health workers who received the SMS reminders, correct management of pediatric malaria increased by almost 25% at both 6 months and 12 months--an increase 2.5 times higher than more complex methods of improving protocol adherence.                                                 | 88%  
50% |
| Bogan et al         | Non-Experimental: mixed methods | • CHWs were able to use CommCare quickly and easily and indeed is based on the specific functions they request, rather than making a product that tries to do it all.  
• The authors found many unexpected problems (like battery swapping) and some things we would expect to be problems (such as phone literacy or learning to navigate the program) were not.  
• Perhaps the most important lesson learned is to form a true partnership with the users throughout the design process.                                                                                          | 21%  
50% |
| Chib                | Experimental: mixed methods | • The study found that results on midwives’ knowledge of standard delivery procedures were mixed.  
• The intervention group’s knowledge scores were significantly higher for two questions (p=0.01 and p=0.06) but lower for one question (p=0.03). However, Chib concluded that the demonstrated potential for knowledge improvement suggests that introducing targeted messages about standard procedures delivered by mobile phone could be effective.          | 79%  
100% |
| DeRenzi et al (2)   | Non-Experimental: qualitative | • The results suggest that electronic implementations of protocols such as IMCI can reduce training time and improve adherence to the protocol.  
• They also highlight several important challenges including varying levels of education, language and expertise, which could be most adequately addressed by implementing novel intelligent user interfaces and systems. | 61%  
71% |
| Florez-Arango et al | Experimental: quantitative | • The automated guidelines increased protocol adherence by an average of 30.18% (p<0.001) and reduced errors by an average of 33.15% (p=0.001) overall.  
• The authors concluded that the IMCI tool effectively simplified a complex set of guidelines, reduced the health workers’ cognitive workload, and eliminated the need to recall specific guidelines or patient information during patient visits while providing a high level of clinical care. | 92%  
43% |
The studies that were methodologically sound showed significant improvement of HW performance when using mHealth

**Examples:**

- In South Africa, Rhode and colleagues randomized 24 primary care nurses to be trained in IMCI using traditional paper-based guidelines, and concluded that nurses who used the IMCI decision-support tool were significantly more likely to make an accurate diagnosis (p<0.001).

- In rural Kenya, Zurovac et al randomized outpatient health workers with mobile phones to receive text message reminders about national pediatric malaria guidelines to improve and sustain protocol adherence. For health workers who received the SMS reminders, correct management of pediatric malaria increased by almost 25% at both 6 months and 12 months.

The use of mHealth varied: e-training, peer to peer, SMS reminders, decision support
Two Initial Areas Selected

Do mHealth strategies:

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- reduce stockouts of essential maternal health drugs and commodities?
Improved Information about individuals, populations, providers, facilities, outcomes,
Availability of Commodities, Health Workers, Equipment

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Remote Client to Provider (Telemedicine)
Disease Prevention
Point of Care Diagnostics
Disease Management
Referrals

Health Education or Promotion
Hotlines and Information Services
Appointment Reminders
Treatment Adherence
Mass Messaging Campaigns

Improved HEALTH Outcomes
**Search Strategy**

**STOCKOUTS**

- Articles identified through database search and use of search engines using a combination of search terms $n=916$
  - 279 duplicate articles removed

- Potentially eligible articles remaining $n=637$
  - 587 articles excluded
    - No mention of use of mobile phones
    - Not addressing any mHealth intervention
    - No mention of use of mHealth interventions to address drug stock outs

- Titles and abstracts of 637 potentially eligible articles screened
  - 50 full text articles reviewed for eligibility

- Application of inclusion and exclusion criteria to 50 articles
  - 24 articles excluded after application of criteria

- 26 articles tagged using the taxonomy tool
  - 16 articles did not meet grading criteria

- 10 articles graded using the grading tool
Completeness of description of methodology
Completeness of description of technology, intervention
<table>
<thead>
<tr>
<th>Author/mHealth Program</th>
<th>Type of study</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Domain 1</td>
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</table>
| **Barrington et al**   | Experimental: Quantitative | • Proportion of health facilities that reported no stock-outs of >=1 anti-malarial drug fell from 78% to 26% over 21 weeks of follow-up.  
• In one district, stock-outs were eliminated by week 8. | 54% | 50% |
| **Githinji et al**     | Experimental: Quantitative | • 79% of the stock-out parameters were accurately reported.  
• Over 26 weeks, percentage of facilities reporting stock-out of Artemether-Lumefantrine reduced by 38%.  
• Of the 176 stock-out alerts, district managers initiated redistribution of stocks in response to 44% alerts. | 69% | 36% |
| **Banks**              | Case Study (News service) | • FrontlineSMS was used to validate, consolidate, and transmit stock-out data to Ushahidi - a software that displays crowd-sourced information on an online map.  
• Bigger “hotspots” represented greater number of drug stock-outs and allowed collation of stock out information | 0 | 21% |
| **mTrac**              | Case study | • 57 districts in Uganda have received mTrac training  
1000 are submitting stock-outs data | 0 | 35% |
| **cStock**             | Experimental: Quantitative (Webinar presentation) | • Piloted in 6 districts in Malawi  
• 94% Health Surveillance Assistants (HSAs) use cStock to request drugs from local facilities.  
• Reporting rates for cStock remained over 80% during 5 months of follow-up. | 0 | 21% |
| **Asiimwe et al**      | Experimental: Quantitative and qualitative | • Study suggests that SMS-based stock-outs reporting can improve timeliness in the flow of data | 53% | 64% |
| **Rui Xue**            | Case Study | • Study suggests that the inventory system in Uganda optimized ordering of stocks | 46% | 64% |
| **Shao et al**         | Non-Experimental | • Mobile-based data collection can potentially improve visualization of data in a web-interface and has applications to prevention of stock-outs | 45% | 64% |
| **Supply Chains for CCM** | Program Report | • Supply Chain for Community Case management (SC4CCM) aims to improve availability of CCM products at the lowest level of the supply chain in Rwanda. | 40% | 57% |
| **PBS**                | News report | • By using mobile technology, health workers are able to send a text message about their drug supply needs  
• This system can potentially reduce stock-out of drugs | 0 | 21% |
Overall, a majority of the evidence was anecdotal and the evidence to suggest effectiveness of use of mHealth strategies to prevent stock-outs is weak.

A number of projects are being currently implemented but have limited published results on effectiveness.
The Evidence Gap - Overall

- Across both domains, there are many interventions but most are incompletely described
- Almost none have design that allow rigorous evaluation
- Almost none have control groups
- It is impossible to compare or combine study results due to lack of standardization
- The nature of the exact interventions differs
- Differing indicators make meta-analyses difficult