The effectiveness of mobile health (mHealth) technologies to train healthcare professionals in developing countries: a review of the literature

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ABSTRACT

Mobile health (mHealth) approaches for medical education in developing countries may be particularly useful given the number of mobile phone subscription rates and the challenges faced by medical educators. The evidence to support its effectiveness has not been critically reviewed. The electronic databases PubMed, Scopus and MEDLINE were searched to retrieve English language articles published in international academic journals between January 2007 and September 2014. Two reviewers independently reviewed citations using predetermined inclusion and exclusion criteria. Only articles addressing the use of mobile or tablet technologies and that met a prespecified keyword strategy were selected for review. The original search returned 583 results, of which only seven pertained to medical education in developing countries and had full text available. There was significant variation between the studies reviewed, in terms of intended audience, intervention design, assessment method and outcome. Three studies assessed the integration of mHealth solutions into the training of allied healthcare professionals, three assessed resident doctors, and another assessed undergraduate medical students. Six of the seven studies used mobile phones as the intervention tool. The majority of studies pointed towards mHealth as a promising tool for education and training of healthcare professionals, yet due to the limited size of the studies definite conclusions were limited. The results of this review suggest that more studies with larger sample sizes and more quantitative methods of evaluation are needed in order to demonstrate that mHealth holds more than mere potential.

INTRODUCTION

The WHO estimates that there is a global healthcare workforce shortage of 7.5 million physicians, pharmacists, nurses and other basic healthcare professionals that will grow to 12.9 million in the coming decades.¹ To try and solve this shortage of healthcare professionals in developing nations, new medical schools have been established and an emphasis has been placed on community-based healthcare programmes delivered through Community Healthcare Workers (CHWs), laypeople who live in the community and serve as a critical link between these communities and the primary healthcare system.²

One of the key factors that must be considered when training healthcare professionals is high quality and sustainable and effective education, yet medical education faces unique challenges in the developing world. In formal university settings, government funding has become increasingly limited, forcing universities to require more students to pay larger fees to ensure their programme's financial solvency.³ The decrease in government funding has led to larger class sizes and a consequent expansion of student-to-faculty ratios, with less one-to-one teaching as a result.⁴ Medical education is further hindered by the migration of highly skilled healthcare professionals to more affluent countries.^{3 5} Consequently, there are fewer experienced faculty available to teach students.⁶ In combination, larger class sizes with a less experienced faculty have led to rushed and unprepared clinical teaching.⁴

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Furthermore, training of allied healthcare professionals, such as CHWs, is not standardised and varies greatly from region to region and country to country; some receive as little as 2 days' training, while others, such as Pakistan's Lady Health Workers, receive a year's training.⁷ In order for them to be effective, they require high quality continuing education.²

Recent advances in education technology offer a potential solution to the ongoing challenges facing medical education in the developing world, and one potential solution is the use of mobile health (mHealth) as a tool to deliver education to healthcare professionals. mHealth can be defined as 'mobile computing, medical sensor, and communications technologies for healthcare'.⁸ It has many potential applications including, but not limited to, training and education, disease management, point of care documentation and patient communication and is already widely used in many medical fields.⁸ According to the International Telecommunication Union (ITU), global mobile phone subscriptions for the year 2013 reached almost 6.6 billion, driven mainly by an increase of subscribers from developing countries, which contributed to almost 80% of this figure.⁹ By 2015, mobile phone subscription is expected to exceed the world population, which represents the enormous potential these technologies might have for educational purposes in resource-limited environments.⁹

The present study looks at mHealth as the use of mobile phone and tablet technology to enable training and education of healthcare professionals in developing countries. The main objective of this study is to analyse the effectiveness of mHealth implementations in the field of medical education since 2007.

Our specific research questions are:

- A. Is mHealth effective for medical education in developing countries?
- B. What are the factors limiting or challenging the implementation of mHealth projects in developing countries?

Significance of this study

mHealth is an emerging topic and there are few studies assessing the effectiveness of mHealth as an educational tool. Most published work focuses on developed nations; however, there is now emerging evidence that mHealth projects are being used for education in developing nations. Given the challenges faced in medical education in the developing world and the high number of mobile subscriptions, mHealth as a tool for teaching has enormous potential. This review, focusing on the educational applications of mHealth, will hopefully help the reader better understand effectiveness, limitations and challenges and future directions in this field.

METHODS

The systematic literature search included the PubMed, Scopus and MEDLINE databases and was performed

in September 2014 by two authors (JO and CO). Journal articles published between 1 January 2007 and 1 September 2014 were included. Search exclusion criteria included articles not in the English language, those not specific to the medical field and those not defined as a journal article. Search terms used included: 'mHealth', or 'Mobile phone', or 'cell phone', or 'smartphone', or 'iPhone', or 'android tablet', or 'iPad', and 'education'.

RESULTS

A systematic literature search of PubMed, Scopus and MEDLINE databases generated 583 articles in total. All duplicated articles were removed automatically using endnote and a manual revision was done for verification (JO). Two authors (JO and CO) then reviewed the abstract text. Articles were excluded if they were a review, there was no abstract or if the abstract did not pertain to education of healthcare professionals (eg, those that focused on the education of patients were excluded). Full-text articles were searched manually in digital sources and studies were excluded when access to full-text articles was not available. This review process identified seven studies and the manuscripts were reviewed in full by all three authors (JO, CO and AB).

DISCUSSION

While the developing infrastructure to support E-learning and mobile technology within the health sphere holds profound promise, it also raises equally significant questions. The myriad ways that these technologies can be harnessed, and the seemingly endless possibilities that they produce, prompt us to wonder: are all mHealth solutions created equal? Indeed, as investment in mHealth continues to surge, rigorous evaluations of the efficacy and functionality of these platforms must be demanded. mHealth approaches for medical education are no exception. The stakes in this realm are particularly high from both an economic and health outcomes perspective, because they are primarily being created for and utilised in developing countries. Thus, reviewing the literature on employing mobile health technologies to train healthcare professionals in resource-limited settings can help to inform future policy and intervention design.

There was significant variation between the studies reviewed, both in terms of intended audience, intervention design, assessment method and outcome. The first theme to emerge from the analysis concerned who the targeted participants were in each of the articles. Three studies assessed the integration of mHealth solutions into the training of allied healthcare professionals,^{10–12} three assessed resident doctors,^{13–15} and another assessed undergraduate medical students.¹⁶ Therefore, depending on the users, some interventions aimed to deliver supplementary information for

purposes of professional development while others were intended for point of care or workflow support.

One study introduced the low-cost Android tablet, *connecTAB*, to deliver video tutorials and remote online peer-tutoring for clinical skills training to Malaysian students.¹⁶ The *connecTAB* was specifically developed for areas with low bandwidth and videos were preloaded in order to circumvent the issue of streaming in areas with slow internet speeds, which was indicated as a barrier in several of the other studies reviewed, particularly Zolfo *et al.*¹¹ The *connecTAB*, which is significantly less expensive than internet-enabled smartphones, could be one potential solution that might be useful for developing countries. The remaining studies used mobile phones as the medium through which to facilitate learning, with two studies requiring internet-enabled smartphones.^{11 14} Interventions using mobile phones included short message service (SMS), smartphones with internet access and preloaded relevant applications, an electronic dosing tool and a module-based clinical training programme. The final study assessed the incorporation of educational technology in a formal medical curriculum more broadly rather than focusing on the impact of a particular intervention.¹⁵ Indeed, this study gathered focus groups of students from two Nepalese teaching hospitals to explore the use and impact of educational technology in medical education, enabling the participants to drive the conversation rather than the interviewer. This methodology allowed several salient themes to be revealed, including the central role that social network sites play in educational attainment, among others. One of the most important things that Pimmer *et al.*¹⁵ touch on is the concern among leaders in medical education that information and communication technology sacrifices quality of instruction and instead promotes a 'copy and paste mentality' whereby students search the internet for immediate answers to their questions rather than learning the content in its entirety. Some of the technologies reviewed, particularly the web-based applications, may be susceptible to similar criticism. This will be one of the pivotal obstacles that mHealth will be forced to grapple with.

Six of the studies utilised questionnaires to evaluate the knowledge acquired by participants, with five recruiting pre-post knowledge tests. Within these monitoring and evaluation schemes, though, there was much variance. The study that employed the *connecTAB* for clinical skills training,¹⁶ for example, utilised standardised Observed Structured Clinical Examination (OSCE) scores to assess outcomes. However, there was no control group with which to compare the changes in scores because all of the study's participants were given the technology. By contrast, one of the studies conducted in Tehran, Iran, "Comparison of Teaching about Breast Cancer via Mobile or Traditional Learning Methods in Gynecology Residents," opted to use a pretest and a post-test to examine the efficacy of their SMS method compared to the traditional method by

having a single cohort rather than distinct intervention and control groups.¹³ Not only did the mobile method have a better effect on learning compared to the traditional training, but participants also indicated that the former generated more interest in the subject. Surely the latter data, which are equally valuable, could not have been yielded without this single cohort methodology. Perhaps this study design merits further investigation, particularly because of its potential to capture things like functionality and user-friendliness, which are critical to gaining local buy-in for and the success of mHealth interventions. Also, since many of the technologies were intended to be pedagogical adjuncts to more traditional curriculums, it is often difficult to determine the extent to which the intervention is contributing to the results that we observe. This is also true of multipronged interventions. That being the case, it may prove useful to adopt more quantitative methods to determine the educational benefit of mHealth tools.

The studies were also quite diverse in terms of geography, ranging in location from Iran to Peru. Only one study, however, was carried out in Africa.¹⁴ This is striking for several reasons. First, the poor health outcomes that plague much of the continent, coupled with pervasive poverty and budget restraints, make Africa a seemingly perfect candidate for mHealth utilisation. Further, the number of cellphone subscribers and cellphone coverage in sub-Saharan Africa, more than that in the USA or Europe, suggests that these approaches would most likely be embraced and integrated into existing medical education with relative ease.⁹ Third, it is important to recognise that innovations in mHealth need to be developed with end-user stakeholders in mind and a one-size-fits-all approach is not appropriate. Technology and education developments need to be made so that they are targeted towards and relevant for the intended audience. To be sure, while the iPhone may prove a powerful tool in places like Peru, as Zolfo *et al.*¹¹ examine, the high investment cost for the Smartphones' purchase could present a limitation and may not be a viable option in the context of countries with very low income per capita.

It would also be interesting to observe in greater detail the effect mHealth has on the training of allied healthcare professionals, including nurses and community healthcare workers. Health workers are inequitably distributed throughout the world, with severe imbalances between developed and developing countries. Sub-Saharan Africa faces the greatest challenge; with 11% of the world's population and 24% of the global burden of disease, it has only 3% of the world's health workers.¹⁷ To solve this healthcare worker shortage, community-based interventions have been proposed. It has been shown that a well-implemented community health programme can (1) reduce infant and child mortality and morbidity; (2) improve healthcare seeking behaviour and (3) provide low-cost interventions for common maternal and paediatric health problems.

These community-based healthcare programmes are delivered through Community Healthcare Workers (CHWs), laypeople who live in the community and serve as a critical link between these communities and the primary healthcare system.¹⁸ CHWs perform a variety of roles including home visits, first aid, health education, family planning activities and referrals. Despite their importance, CHWs still have an ambiguous role within the healthcare system. More specifically, in a review, Delacollette *et al* observed that CHWs wanted to be more than symbolically remunerated for their services; they were eager to receive further training to expand their scope of practice.² It is important to consider the training of these allied healthcare professionals, with the mHealth model being one potential way to ensure standardised, high-quality training. This is one critical direction that future studies should take as there is currently a lack of them.

CONCLUSION

In their investigation of mobile learning in resource constrained environments, Pimmer *et al*¹⁵ articulate what has threatened the legitimacy and uptake of mHealth for medical training since its inception: “the evidence appears to suggest potential rather than achievement.” Indeed, while the potential of mHealth in medical education has been well established, the primarily qualitative modes of evaluation make the mHealth approaches vulnerable to critique from policymakers and medical institutions who increasingly rely on more quantitative data to inform new investment or changes in strategy. This vulnerability is exacerbated by the fact that there are so few studies concerning this topic. Further, of those few studies that do exist, they are relatively small in scope. While individual small-scale studies can often provide insight that their larger counterparts cannot, the validity of the topic of interest can be compromised when the majority of the literature is modest in reach. The results of this review suggest that more studies with larger sample sizes and more quantitative methods of evaluation are needed in order to demonstrate that mHealth holds more than mere potential.

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Competing interests JO was the lead author of one of the papers that was reviewed in this study.

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