WHO GUIDELINE

RECOMMENDATIONS ON DIGITAL INTERVENTIONS FOR HEALTH SYSTEM STRENGTHENING

WEB SUPPLEMENT 2

UNPUBLISHED SYSTEMATIC REVIEWS AND GRADE TABLES

World Health Organization

Web Annex A: Healthcare providers' perceptions and experience on using mHealth technologies to deliver primary healthcare services: qualitative evidence synthesis (unpublished review)

Link to published protocol:

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Abstract

Background

Mobile health (mHealth) refers to medical and public healthcare practices supported by mobile devices, such as mobile and smart phones, client-monitoring devices, personal digital assistants, and tablets. It also refers to these technologies' capabilities to create, store, retrieve, and transmit information between users. mHealth relies mainly on the mobile phone's utility of voice, short messaging services (SMS) and multimedia message services (MMS), but also includes more complex applications, such as global positioning systems, bluetooth technology, and third and fourth generation mobile communications (3G and 4G systems).

These technologies leverage the reach and speed of mobile networks and mobile computing power to improve the reach of healthcare delivery, including the capturing, processing, and exchange of information, and are transforming the health sector. Its uptake is reflected in 17 effectiveness reviews, of which 10 are Cochrane reviews. These reviews vary in the type and purpose of the technology, from the use of email for clinical communication between healthcare professionals, to the use of mobile phones for healthcare appointment reminders. The evidence on the effectiveness of mHealth cited in these reviews ranges from having no or only a small effect, to evidence that it significantly improved targeted health behaviours. The most common areas to which mHealth is applied are information management, clients' self-management of health and illness, clinical decision support, communication, and service delivery.

Objectives

The review has the following two objectives:

1. To identify, appraise and synthesise qualitative research evidence on healthcare providers' perceptions and experiences regarding their use of mHealth technologies to provide and support the delivery of primary healthcare services; and

2. To identify hypotheses, for subsequent consideration and assessment in effectiveness reviews, about why some technologies are more effective than others.

Search methods

We searched PDQ-Evidence (http://www.pdq-evidence.org) for related reviews in order to identify studies for inclusion. We also searched, MEDLINE, Ovid, CINAHL, EbscoHost, Global Health, Ovid, Science Citation Index and Social Sciences Citation Index, ISI Web of Science, for eligible primary studies. Our search also included the following grey literature resources: Eldis: http://www.eldis.org, The Grey Literature Report: http://www.greylit.org, mHealth Database: http://www.africanstrategies4health.org/mhealth-database.html, mHealth Evidence: https://www.mhealthevidence.org, mHealth Knowledge: http://mhealthknowledge.org, mPowering: http://mpoweringhealth.org, and OpenGrey: http://www.opengrey.eu. All searches were conducted up until November 2015, without language, date, or geographic restrictions.

Selection criteria

We included studies that (a) used qualitative methods for data collection and analysis; (b) focused on the views and experiences of (i) all cadres of healthcare providers (i.e. professionals, paraprofessionals and lay health workers) who are involved in providing primary healthcare (PHC) services to patients, and (ii) any other individuals or groups involved in delivering and managing mHealth programmes which aim to provide or support PHC services to patients; and (c) were from any country, irrespective of income status, where mHealth is used to provide said services. For the purposes of this review, we defined PHC services as one or any combination of the following:

- the first contact point of healthcare [27];
- all rehabilitative, therapeutic, preventive and promotive healthcare [28];
- being delivered at an individual and/or community level [29]; and
- bringing healthcare services to where people work and live, which in particular applies to low-income settings [29].

These services could be implemented in public or private PHC primary healthcare facilities, in the community, or the homes of clients.

Data collection and analysis

The data coding, extraction and synthesis process was iterative, and aligned with a thematic synthesis process. As a first step, the study characteristics of the included studies was extracted by two review authors. Thereafter two review authors independently read each study as a whole, including the background, methods, results, discussion, and conclusion sections, to get a sense of their meaning and their contribution to answering the review question. As one full text was coded, these codes were recorded for use across the studies, thus beginning the process of translating the data from one study into the other studies. New codes that emerged from subsequent studies were also recorded, and the already coded studies were returned to, so as to determine if these codes applied to that data too. The coded extracts were then organised into broad themes. Using the thematically coded data, two review authors jointly wrote up discreet findings. Since many of the extracts did not neatly fit within any theme, we continued the iterative process of trying to make sense of the extracts, by regrouping them with other extracts from which similar underlying issues had emerged, and eventually synthesised all the extracted data into findings. We also constantly evaluated each extract against our inclusion criteria and review objectives, deciding up until the very end, whether or not it was an appropriate fit. The findings thus represent the final translation of the coded data across all the included studies. Thereafter two review authors independently assessed the quality of the included studies, using an adapted Critical Appraisals Skills Programme (CASP) tool. Finally, two review authors independently assessed the confidence in the findings by using the

GRADE-CERQual approach. High confidence findings suggest that it is highly likely that the review finding is a reasonable representation of the phenomenon of interest, while very low confidence indicates that it is not clear whether the review finding is a reasonable representation of the phenomenon.

Main results

We included 23 studies, of which 19 were from low - and middle income countries. This review confirms many issues that are well reported in the mHealth literature; including, but not limited to, the following: mHealth allows healthcare providers to better coordinate the delivery of care through being connected with their peers and higher level workers (moderate confidence); it facilitates two-way communication between them and patients which leads to the immediacy of care (high confidence); the level of their techno-literacy shapes their perceptions and experiences about mobile health (high confidence); and that mHealth technologies help mitigate the challenging conditions for those working in remote areas (moderate confidence). This review also includes findings on less well established issues, of which the following may be of use to decision makers and those aiming to use these technologies in PHC services: healthcare providers have mixed reactions to being contacted outside of working hours, with some seeing it as useful in emergency cases, and others suggesting boundaries to protect themselves (moderate confidence). Some workers find it difficult to communicate information to patients that is provided to them via their mobile devices when this information is beyond their clinical capacity, or when the support needed to follow up on this information is absent (low confidence). Whilst some workers find treatment algorithms loaded onto the devices useful, others have negative perceptions on this as they see it as too prescriptive, and are concerned that they may lose their clinical competencies by blindly following treatment algorithms (moderate confidence). Healthcare providers perceive that mobile health interventions impacts positively on patients' health behaviours (low confidence). Healthcare providers have concerns about using their personal phones for work purposes when not being reimbursed for airtime and charging costs (low confidence). Contextual issues within the broader health system in which the mobile technologies are used, for instance staff shortages, impacts healthcare providers' perceptions and experiences of mHealth (high confidence).

Authors' conclusions

Many of the included studies are implemented as pilot and/or small scale studies. Findings from large scale programmes may differ given that such programmes are often less well-resourced and with less intense in-field management and support, compared to pilot and small scale studies. Mobile health technologies are no panacea for poor performing healthcare providers and health systems, but may enhance the delivery of PHC services by well performing healthcare providers in functional health systems. More studies are needed from high-income countries that meet this review's inclusion criteria, as this may strengthen the evidence for very low and low confidence findings. Policy makers and practitioners alike should consider including healthcare providers in the planning stages of mHealth programmes, as this may improve the uptake and use of these technologies.

Summary of qualitative findings table

Review finding		Studies contributing to the review	Overall CERQual assessment
F1	Healthcare providers appreciated that mobile health technologies allowed them to better coordinate the delivery of care, which includes client care and logistical arrangements, through being connected to other persons and sectors of the health system, as well as with clients, communities and peers. This is primarily for LHWs and lower cadre health professionals and in LMICs.	Barnabee 2014; Chang 2011; Hampshire 2016; Henry 2016 Huq 2014; Khan 2015; Madon 2014; Quinn 2013	**Moderate confidence** Due to moderate concerns about methodological limitations and minor concerns about adequacy.
F2	Some lower level healthcare providers valued being able to reach higher level healthcare providers, through mobile health technologies. Through this exchange, they received advice, which they perceived as improving the quality of the care they offered, improving health care outcomes, and as satisfying clients. The exchange also broke the hierarchy between healthcare provider levels, when previously unreachable health professionals could now more easily be reached. In one study healthcare providers perceived direct contact as improving relationships. In contrast, when higher level professionals responded in anger, it made lower level healthcare providers reluctant to call them.	Ayiasi 2015; Chang 2011; Hampshire 2016; Huq 2014; Khan 2015; Madon 2014; Quinn 2013	**Moderate confidence** Due to moderate concerns about methodological limitations.
F3	Mobile health technologies were not experienced as supportive when those assigned to offer clinical support via these technologies were not responsive to those seeking the support.	Huq 2014; Quinn 2013	**Low confidence** Due to serious concerns regarding adequacy, and moderate concerns regarding methodological limitations and relevance.
F4	Some of the supervised healthcare providers felt that mobile health technology-facilitated supervision changed how they worked and that it made their work more visible. Those being supervised perceived it as positive or negative. Some of those who supervised lower level healthcare providers, expressed that this allowed them to be more aware of their staff's work, in particular when the latter experienced problems. Some supervisors perceived this as positive as they could address these problems.	Barnabee 2014; Chang 2011; Hampshire 2016; Henry 2016 Madon 2014; Medhanyie 2016; Valaitis 2005	**Low confidence** Due to serious concerns regarding methodological limitations, and moderate concerns regarding relevance and adequacy.
F5	Automated text messages about illness management, sent to healthcare providers' mobile phones, were perceived by some as a type of supervision, and some perceived it as improving performance and care. Some felt motivated by this, whereas others felt guilty for not providing correct care.	Jones 2012	**Very low confidence**

			Due to serious concerns regarding relevance and adequacy.
F6	Using mobile health technologies allowed some healthcare providers to feel connected to their peers within their respective organisations, with some perceiving this as supportive. In one study, healthcare providers still felt the need for face-to-face connection with their peers.	Barnabee 2014; Hampshire 2016; Henry 2016; Jennings 2013; Madon 2014; Valaitis 2005	**Low confidence** Due to moderate concerns regarding methodological limitations, relevance and adequacy.
F7	Mobile health technologies facilitated two-way communication between healthcare providers and clients, and kept healthcare providers informed about the client's conditions. This was perceived by some healthcare providers to lead to immediacy of care, following up missing clients, informed care, and advice and emotional support to clients, even when physical contact was not possible. However, it was felt that some cases still warrant face-to-face contact.	Barnabee 2014; Chang 2011; Hampshire 2016; Hirsch-Moverman 2017; Huq 2014; Jennings 2013	**High confidence** -
F8	Healthcare providers had mixed reactions to being contactable via mobile health technologies outside of working hours. Where they made their contact numbers available to clients, it was possible for clients to contact them at all hours. Some healthcare providers felt it was useful in emergency cases, some were ambivalent about it, and others felt negative about being contacted outside working hours. Some suggested that they set boundaries to protect themselves from working outside of working hours.	Chang 2011; Hampshire 2016; Huq 2014; Jennings 2013; Valaitis 2005	**Moderate confidence** Due to moderate concerns regarding adequacy, and minor concerns regarding relevance.
F9	Through the use of mobile health technologies, healthcare providers were able to expand their current range of tasks, at their own level, as well as take on tasks previously assigned to higher level workers, and conduct tasks independently. This was experienced as satisfying and fulfilling, both for those to whom tasks were shifted, as well as to those from whom tasks were shifted. Some health professionals reported that clients with mobile phones first contacted lay health workers before contacting them. When this happened, these health professionals felt that this allowed them the time to focus on geographical areas in which clients did not have mobile phones.	Barnabee, 2014; Chang 2011; Khan 2015; Praveen 2014	**Moderate confidence** Due to moderate concerns regarding methodological limitations and relevance.
F10	Healthcare providers may find it difficult to communicate or explain information to the patient that is provided to them via their mobile devices when this information is beyond their clinical capacity or when the support needed to follow up on this information is absent.	Orchard 2014; Praveen 2014	**Low confidence** Due to serious concerns regarding relevance and moderate concerns regarding methodological limitations and adequacy.
F11	Healthcare providers perceived the use of mobile health technologies to be more efficient because of the increased speed with which it allowed them to work. A few participants in one study did not experience it as efficient as it did not reduce their workload, and still others felt it increased their workload.	Ayiasi 2015; Barnabee 2014; Chang 2011; Hampshire 2016; Hao, 2015; Huq 2014; Jennings 2013; Jones 2012; Madon 2014;	**Moderate confidence** Due to moderate concerns regarding methodological limitations.

		Medhanyie 2015; Praveen 2014; Surka 2014; Valaitis 2005	
F12	The use of mobile health technologies for record keeping was perceived by healthcare providers and their managers as helpful for decision making and information sharing.	Khan 2015; Madon, 2014; Murray 2011	**Low confidence** Due to serious concerns regarding adequacy of the supporting data.
F13	Healthcare providers working in rural and geographically challenging contexts, appreciated the efficiency of mobile health technologies in allowing them to offer a service despite these circumstances. Using these technologies also saved traveling time in an urban setting which allowed the healthcare providers more time with their clients.	Chang 2011; Hampshire 2016; Hirsch-Moverman 2017 Quin; Valaitis 2005	**Moderate confidence** Due to moderate concerns regarding methodological limitations and adequacy.
F14	Healthcare providers had positive views and experiences about the portability of mobile health technologies. This allowed flexibility in doing their work, working when convenient, and not having to be office-bound to access information.	Hampshire 2016; Murray 2011; Orchard 2014; Valaitis 2005	**Low confidence** Due to serious concerns regarding relevance and adequacy, and moderate concerns regarding methodological limitations.
F15	Healthcare providers expressed dissatisfaction with aspects of mobile health technologies, which included when technology changes were too rapidly introduced, or when their expectations of the technologies were not met.	Hao, 2015; Valaitis 2005	**Low confidence** Due to serious concerns regarding adequacy and moderate concerns regarding relevance.
F16	Healthcare providers reported that mobile health interventions may require the registration of clients onto the system. Some health professionals perceived this as a menial task that is not appropriate for their job level. This lead to dissatisfaction and the perception that the mobile health intervention is adding to their workload.	Hirsch-Moverman 2017; Medhanyie 2015; Wolf-Piggot 2017	**Very low confidence** Due to serious concerns regarding methodological limitations, relevance, and adequacy.
F17	Several mobile health interventions had treatment algorithms loaded onto the devices. Healthcare providers often found it useful because it guided and simplified delivering care, which was also experienced as reassuring. Contrary to the experiences of these healthcare providers, others held a negative perception of using algorithms, as they felt it too prescriptive, and were concerned that they may lose their clinical competencies by blindly following treatment algorithms.	Mitchell 2012; Orchard 2014; Shao 2014; Surka 2014	**Moderate confidence** Due to serious concerns regarding methodological limitations and moderate concerns regarding relevance.
F18	Some healthcare providers experienced anxiety in understanding and using mobile health technologies. Healthcare providers and trainers felt that training and familiarity with these technologies helped overcome this anxiety. Some healthcare providers felt hampered in learning to use mobile health technologies if it were not also used by their clinical mentors.	Hirsch-Moverman 2017; Madon 2014; Mitchell 2012; Murray 2011; Praveen 2014; Vedanthan 2015	**Moderate confidence** Due to moderate concerns regarding methodological limitations.
F19	Healthcare providers, lay and professional, required technical support when having difficulties in navigating mobile health technologies. In some instances,	Hao, 2015; Madon 2014; Murray 2011; Vedanthan	**Low confidence**

	it was provided by higher level staff, and in other cases peer-to-peer support solved users' technical problems.		Due to serious concerns regarding adequacy and moderate concerns regarding methodological limitations.
F20	The level of healthcare providers' techno-literacy, that is how versed they were in using mobile health technologies, shaped their perceptions and experiences about mobile health. Those who managed well, had positive views about mobile health. When healthcare providers struggled using these technologies, they held negative perceptions about its usefulness. Those who struggled with techno-literacy were also anxious that this may result in additional errors, and not understanding the information generated by these technologies. In some instances, poor techno-literacy threatened job security. There was also the perception that when healthcare providers are introduced to one mobile health intervention, it may enhance their techno-literacy and therefore increase their willingness to use other mobile health interventions.	Hao, 2015; Hirsch-Moverman 2017; Madon 2014; Mitchell 2012; Murray 2011; Praveen 2014; Quinn 2013; Shao 2014; Surka 2014; Valaitis 2005; Vedanthan	**High confidence** -
F21	Healthcare providers were conscious of protecting clients' confidential information when using mobile health technologies, in particular when the information concerned stigmatised conditions such as HIV/AIDS. There were a range of measures, negotiated between healthcare provider and client, to keep client information confidential.	Hirsch-Moverman 2017; Valaitis 2005; Wolf-Piggot 2017	**Low confidence** Due to serious concerns regarding relevance and adequacy.
F22	It was reported that in some primary healthcare programmes, healthcare providers, across the cadre spectrum, used their personal mobile phones and Internet access, for work purposes. Having to sponsor their own airtime, was a concern for healthcare providers. One instance was reported where workers were negative about using their personal mobile phones given the associated costs to purchase airtime and to charge their phones. Other healthcare providers felt a moral imperative to assist their clients using their own mobile phones.	Hampshire 2016; Jennings 2013; Quinn 2013; Wolf-Piggot 2017	**Low confidence** Due to serious concerns regarding adequacy and moderate concerns regarding methodological limitations.
F23	Healthcare providers consistently mentioned advantages to their use of mobile health technologies, in comparison to using paper-based systems. These advantages included quicker recording of their work, easier access to client data, easy correction of recording mistakes, and not having to carry paper registers. Being able to work quicker and avoiding the cumbersome processes of using a paper-based system, applied when healthcare providers compared a digital algorithm with a paper-version. In one instance, a few healthcare providers complained when they had to maintain both a mHealth and paper-based system, and in one instance, preferred the paper-based system.	Madon 2014; Mitchell 2012; Shao 2014; Surka 2014; Valaitis 2005; Vedanthan	**Moderate confidence** Due to serious concerns regarding methodological limitations and relevance.

F24	Healthcare providers perceived that mobile health interventions impacted positively on clients' health behaviours. They felt that some clients became more responsive to healthcare delivered via mobile health technologies after receiving a linked health promotion intervention. Healthcare providers also perceived that adherence to treatment improved for some clients. In another instance, healthcare providers believed that the graphic display on a device helped clients to better understand their condition.	Barnabee 2014; Chang 2011; Huq 2014; Jones 2012; Madon 2014; Praveen 2014	**Low confidence** Due to serious concerns regarding adequacy and moderate concerns regarding methodological limitations and relevance.
F25a	Some healthcare providers also report that mHealth technologies raise their social status and increase the trust and respect they receive from clients and communities. This is in part due to the devices themselves, but is also because they use these devices to access higher level care. Lay health workers in particular also feel that the devices increase the respect they receive from health professionals.	Ayiasi 2015; Barnabee 2014; Jones 2012; Khan 2015; Madon 2014; Mitchell 2012	**Moderate confidence** Due to moderate concerns regarding methodological limitations and relevance.
F25b	Some healthcare providers are concerned that the use of these expensive devices will emphasise inequity between themselves and their colleagues as well as themselves and their clients and that it may create a social gap.	Valaitis 2005	**Very low confidence** Due to serious concerns regarding relevance and adequacy.
F26	According to healthcare providers, clients saw healthcare providers' use of digital devices as leading to better patient care. Some healthcare providers described how clients believed this made the healthcare provider more thorough, for instance that the healthcare provider would ask many questions, and would be given the answers through the digital device.	Jones 2012;Khan 2015;Mitchell 2012;Shao 2014; Valaitis 2005;Vedanthan	**Moderate confidence** Due to moderate concerns regarding methodological limitations.
F27	Healthcare providers had mixed views on the increase of their workload that resulted from the mobile health interventions. Some held negative feelings towards using mobile health technologies when it meant maintaining two systems or when there were staff shortages. They also felt negative when the addition of the mobile health intervention to current work was not understood and appreciated by supervisors, or when they themselves perceived the intervention as peripheral to their work. Some healthcare providers did not object to the additional work, whilst others expected to be remunerated for the additional work.	Hao, 2015; Praveen 2014; Shao 2014; Wolf-Piggot 2017	**Low confidence** Due to moderate concerns regarding methodological limitations, coherence, and adequacy.
F28	Contextual issues impacted healthcare providers' experiences of using mobile health technologies. These issues included language differences when consulting with higher level cadres, client poverty, gender discrimination amongst clients in the use of mobile phones, and staff shortages. Some healthcare providers felt these contextual issues impeded optimising the benefits of mobile health technologies.	Chang 2011; Huq 2014; Khan 2015; Praveen 2014; Shao 2014; Wolf-Piggot 2017	**Low confidence** Due to moderate concerns regarding methodological limitations, coherence, and relevance.

F29	Healthcare providers felt that mobile health interventions could be improved, and offered a range of recommendations related to mobile health interventions. These included being consulted as end-users during the planning and implementation of the intervention, being included in decisions about changes to the system, being given money for airtime, simplified software installation, and improving connectivity. They also recommended sturdy devices, colour displays, and solar charges. In one instance healthcare providers suggested that raising awareness of the mobile health intervention would increase clients' use and trust in such interventions. There were recommendations that those collecting routine data using mobile health technologies, should be informed how the data is put to use. Healthcare providers also felt that the use of these technologies could be expanded to other settings, services, and illnesses than what they were using it for.	Barnabee 2014; Hao, 2015; Henry 2016; Khan 2015; Madon 2014; Medhanyie 2015; Mitchell 2012; Praveen 2014; Quinn 2013	**High confidence** -
F30	Healthcare providers were challenged by logistical issues that they experienced when using mobile health technologies to provide primary healthcare services. The most frequent problems were poor network connectivity, and no easy access to electricity to charge their mobile phones. In some instances, poor connectivity resulted in client dissatisfaction because it created delays in receiving healthcare. In one instance not having an airtime vendor was mentioned as being a problem in using mobile health technologies.	Chang 2011; Hampshire 2016; Hao, 2015; Khan 2015; Madon 2014; Praveen 2014; Quinn 2013	**High confidence** -
F31	Healthcare providers discussed challenges, beyond network and electricity issues, in using mobile health technologies. These included the risk of damaged and stolen phones, proficiency with English and unavailability of local language characters, small screens, and having to carry both a personal and work mobile phone. In contrast, when these technologies were easy to use, and they could access what they needed, healthcare providers perceived it as enhancing their quality of care.	Chang 2011; Hao, 2015; Medhanyie 2015; Praveen 2014; Quinn 2013; Valaitis 2005	**Low confidence** Due to serious concerns regarding adequacy and moderate concerns regarding methodological limitations.
F32	For mobile health interventions that required communication between healthcare providers and clients, healthcare providers identified several challenges on the part of the clients, that impacted negatively on this communication. These challenges included clients who regularly changed their phone numbers without informing the healthcare provider, clients who did not have phones, money to buy airtime or access to electricity, and clients who were afraid of being robbed of their phones. There were also clients who did not know how to use their phones.	Chang 2011; Hirsch-Moverman 2017; Wolf-Piggot 2017	**Low confidence** Due to serious concerns regarding relevance and adequacy, and moderate concerns regarding methodological limitations.

F33	Healthcare providers reported that their owning of mobile health technologies was beneficial to clients who were too poor to have such technologies. This enabled them to access higher level care on behalf of these clients.	Chang 2011	**Very low confidence** Due to serious concerns regarding relevance and adequacy and moderate concerns regarding methodological limitations.
F34	Some healthcare providers used the Internet to access medical information. They found the quick access to such information useful, in particular when they were with clients and needed more information about a particular condition and its treatment.	Hampshire 2016	**Very low confidence** Due to serious concerns regarding relevance and adequacy and moderate concerns regarding methodological limitations.
F35	Some healthcare providers were positive about receiving automated text messages containing treatment guidelines and motivational content, and found its conciseness and up-to-date information, as useful reminders to provide correct treatment. Concerns about the text messages included it being too repetitive and that motivational messages on its own were less meaningful.	Jones 2012	**Very low confidence** Due to serious concerns regarding relevance and adequacy.
F36	Some healthcare providers felt that their concentration on the mobile health technologies during the period they were learning to use it, may have distracted them to the detriment of their interaction with the clients during consultations.	Vedanthan 2015	**Very low confidence** Due to serious concerns regarding relevance and adequacy and moderate concerns regarding methodological limitations.
F37	Healthcare providers in one study perceived no difference in using either a smart phone or tablet to deliver health care services.	Shao 2014	**Very low confidence** Due to serious concerns regarding relevance and adequacy and moderate concerns regarding methodological limitations.
F38	Some healthcare providers valued the use of WhatsApp (instant messaging) because it was perceived to be a cheaper way to communicate, compared to using short messaging services (SMS), and it allowed posting photos about their work. Healthcare providers used WhatsApp for a range of activities, including notifications on drug stock-outs, supervision and keeping informed about work-related issues. Some created different interest groups on WhatsApp.	Hampshire 2016; Henry 2016	**Very low confidence** Due to serious concerns regarding methodological limitations, relevance and adequacy.

Web Annex B: Health professionals' mobile digital education: a systematic review of factors influencing implementation and adoption (unpublished review)

Link to pre-print for publication: http://preprints.jmir.org/preprint/12895

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Abstract

Background

In the past five decades, electronic learning has increasingly been used in health professional education. Mobile learning (mLearning), an emerging form of educational technology using mobile devices, has been used to supplement learning outcomes through enabling conversations, the sharing of information and knowledge with other learners; and, aiding support from peers and instructors regardless of geographic distance.

Objectives

This review synthesises findings from qualitative or mixed methods studies to provide insight into factors facilitating or hindering implementation of mLearning strategies for medical and nursing education.

Methods

A systematic search was conducted across a range of databases. Studies were selected on the basis that they were examining mLearning in medical and nursing education, employed a mixed methods or qualitative approach, and were published in English after 1995. Findings were synthesised using a framework synthesis approach.

Main results

A total of 1946 citations were screened and 47 studies were selected for inclusion. Most evaluated pilot mLearning interventions. Synthesis identified valued aspects of mobile devices related to efficiency and interactive and reflective learning. Also identified were challenges to do with device functionality, learning how to use a device, learning as a professional and within a clinical setting, and the importance of institutional infrastructure and policies.

Conclusion

The portability of mobile devices makes mLearning unique among forms of eLearning for health professionals; it can enable interactions between learners and educational material, fellow learners

and educators in a way that is particularly applicable to health professional education, where students are expected to merge training with clinical practice. As with any complex tool used for educational purposes however, devices need to be appropriately incorporated into the structures of academic and medical institutions. Furthermore, learners and educators need support so that they fully comprehend the functions of each mobile device or app used for learning. This study points to strategies to complete these two objectives, such as developing procedural guidance for practice settings, and device training and maintenance services on campus.

Systematic review registration

This review is registered with PROSPERO – an international prospective register of systematic reviews (record number CRD42016035411).)

Summary of Qualitative Findings

Summary of review finding	
Device usability	
Portability means efficiency but also vigilance	
PL-F1	Enthusiasm for mobile device often centred around time saving that could lead to improved learning, and was more than once summed up with the phrase 'efficient and effective' (35, 48). Participants emphasised the speed with which reference material could be retrieved for various purposes (27, 34, 56), but also the quick enabling of dialogue with others (face-to-face as well as virtually), and the rapid storage of material in varied forms (e.g. text and images) for later use (54). In clinical settings students valued being able to reduce their reliance on memory, both of things that needed to be recalled, and of gaps in knowledge that needed to be remedied (39, 49). As one put it, 'it's a lot easier [to] look up things there and then instead of trying to remember to go back and read up on it.' (39) (p927)
PL-F2	The portable nature of the mobile device was, also, referred to as a source of vigilance by students and their tutors, who discussed the need for care in surgical or post-operation scenarios and possible electromagnetic interference from devices or the risk of contamination (44, 57, 60). Other potential threats to the device were voiced in terms of loss (11, 39, 59, 68), damage if it was on loan (39) or theft (11), especially as there was a concern that mobile usage itself could "attract thieves" (11, 68).
Fit for purpose hardware, software and data	
PL-F3	Reports of problems attributed to hardware and software were seen in a range of studies. Reported criticisms of hardware included a screen being too small for reading documents (36, 39, 61), devices being ill suited for note taking (24, 32, 38, 60-62) and screens having a poor resolution (51, 61). Size and weight were also emphasised as important for portability (32, 61).
PL-F4	Software was not always judged as sufficiently intuitive (11, 26), or could interfere with an important learning task, such as self-assessment (39). The ability of software to transfer and synchronize data or files with a desktop computer or between platforms (27, 61) was given importance in more than one study, as were experiences with technical issues. The latter included devices freezing or stopping (11, 26), the loss of information with system crashes (11, 26, 37), difficulties with attachments or scanning (26, 37) and system incompatibility with platforms or applications (44, 65).
Ownership, personalisation and sense of self	
PL-F5	Despite costs, some students preferred to own devices because this provided opportunities to engage with technology in an informal manner (33, 37), or at times that suited them (27). In one study where devices were provided, learners who already owned a device preferred to continue to use their own (32). Across several studies participants emphasised the value of being able to personalise the learning content (24, 27, 35, 36, 49, 50, 68) or programme layout (26) within mobile devices to suit their own needs.
PL-F6	The perceived personal significance of mobile devices for learning is intimated by students using phrases to sum-up PDA or smartphone use such as, 'a way of life' (65) pADD) and 'it is part of my life now' (53) (:1401), as well as others' concerns about developing over dependency on their device (11, 27, 32, 33, 56, 59). Linking their device use to their own cognitive capacity, some were concerned about technology failure (11, 59) or that their loss of recall ability would be problematic during exams (32).

Social Technology	
Devices can impact on care and learning relationships	
PL-F7	Although students (32) and tutors (47) noted that use of mobile devices could potentially strengthen communication between clinicians and patients; both these groups expressed a diversity of concerns related to the perceived inhibiting effects of the devices on interactions with patients. Use of mobile devices was seen by trainee doctors and nurses as interfering with activities at the bedside (56, 57), specifically with medical consultations, clinical observations (56), and teamwork (57). Some voiced reservations in using mobile devices in front of patients (11, 40, 56) as they felt 'rude' (36, 56, 58), 'awkward' (30, 58), were wary of appearing 'insincere or disingenuous' (56), or felt discomfort due to a lack of technological skills (24). Not being able to maintain good eye contact with patients was reported as causing difficulties with conversation (56, 58). Consequently, mobile device use presented a challenge to student building of relationships between themselves and other actors (30, 56). Reluctance for device use could remain, despite encouragement from senior clinical staff for device use while with patients (40)- learners in one study described it as a 'discretionary dilemma' (67).
Devices raise issues of professionalism and practice boundaries	
PL-F8	Some students feared they would be viewed as unprofessional by either patients or colleagues because devices were perceived as being purely for leisure (11, 30, 33, 39, 56). Some reported concerns that mobile devices were actually being used for non-work-related and recreational purposes during worktime (56, 57). Others, however, perceived that use of mobile devices could strengthen their own professional identity or that of their institution (32) or saw others as competent if they used devices to retrieve information (34)
PL-F9	In terms of practice boundaries, there was some discussion of how mobile technology may blur the boundaries between clinicians' personal and professional spaces through the increased availability of work-related information. One student described colleagues as 'actual prisoners to their phones' (56).
Negotiating the social aspect of mobile technology	
PL-F10	Students described how it could help if patients were given explanations for device use (30, 39, 47) and this was also described as helpful for managing the responses of clinical supervisors (32). Some students described how it was possible to actively negotiate digital device use (29, 56, 60), e.g. through asking patients' permission before using a device (39, 50, 56). Some described jointly looking up information with patients (24, 30, 47).
Interaction Learning	
Facilitated interaction and learning	
PL-F11	As many of the studies were of devices mainly aimed at supporting information retrieval and storage- students' accounts often focused upon interactions between themselves and information supplied by their respective institution, or creatable by a device. Valued content included: textbooks, up to date medical literature (27) and clinical guidelines (11, 25, 27, 30, 36, 44, 62, 68). This type of content enabled to student to seek information via mobile devices which was supportive of clinical practise, especially in the absence of more senior advisors (9). Students also reported making notes for subsequent review (31).
PL-F12	In a few cases, students accessed online study groups developed by tutors through social media messaging applications, e.g. WhatsApp (53, 63), or platforms (62). Students valued these online study groups because they enabled them to discuss details of cases, as well as post and respond to clinical questions (53, 62, 63). Group members valued the opportunity to immediately resolve complex cases when separated geographically (53), and in one case felt encouraged to participate when enabled to anonymously post queries without fear of judgement (68).
PL-F13	Students' use of internet-linked devices to ask questions and discuss clinical issues in a group was also reported from students in institutions that were not formally directing mLearning. Here participants reported value in both large and open, and selective and closed social media-facilitated groups (53). Views were also shared on structured co-operative peer assessment approaches. Students in one study were positive about the exchanges enabled by use of open source software for the production of sharable eportfolios (26). Here students could make comments on each others' learning portfolios and could rate each others' comments. In two studies, junior and more experienced students were asked to do pair work at a distance using Skype-enabled devices. Here, both work on case studies in real time (65) and peer-evaluation of clinical skills (53) were described favourably – in one study more so by the junior students (65).

PL-F14	Explanatory or contextual detail of these experiences of co-operative mLearning was described in two studies. In one study, students reported being able to form social groups with a sense of cohesion and belonging through learning with smartphones when in remote settings (53). In another study, some students felt phones could 'keep you connected' when on clinical assignments (38).
PL-F15	In terms of interactions with teaching staff, students reported particularly valuing being able to instantly contact their supervisors remotely on a variety of topics ranging from discussion of patients' symptoms (11, 63) to queries on workplace schedules (35, 43, 45, 66) through text and chat. Some reported also being provided with emotional support through these means (45, 53, 56, 62, 66). There were reports, on the other hand, that some clinicians preferred to use alternative means than smartphones for their teaching work, including PCs for assessments (39), or paper (56).
Organising learning using mobile devices	
PL-F16	Students and staff described using mobile devices to help them organise their learning, for example to access information on learning activities when in a clinical setting (26, 33, 44, 46, 61, 62, 66). Value was placed on devices that could help organise demands from both clinical practise and academic institutions, with mention of PDAs for tracking the completion of both academic and clinical tasks (24) and for accessing lesson timetables (44). During and away from clinical practice, students also described how device portability allowed them to better organise their working time, for example using blocks of time between patients or when waiting for senior staff for learning in (30, 39, 44, 46, 48, 51, 62). Students made favourable comparisons with 'cumbersome' text books (60).
Reflective learning for clinical practice	
PL-F17	Students reported using mobile devices to guide their own learning within a clinical context through reflection on learning materials. They described repeatedly viewing medical texts (11, 24, 36, 38, 44, 64) to consolidate their learning or update their knowledge (11, 27, 34). Both learners and those teaching them described how these activities enabled students to prepare immediately before encounters or achieve more immediate, or more long-lasting insights into a clinical issue (9, 37, 39, 57). The potential mechanisms for enhanced learning (e.g. authentic problem solving, increased access to immediately relevant or difficult to access clinical cases) were described by both students and staff (9, 44, 53).
PL-F18	Some reported, though, that they were 'too busy' to incorporate devices into their learning activities during practice (24, 38, 58, 60, 62). For example some commented they had little time to input clinical activities for the purposes of reflection (38); while others found they had insufficient time to view online videos of lectures (62).
Mobile Learning Processes	
Changes in pedagogy and learning	
PL-F19	Some students reported a shift in the nature of tutor-student relations, in that they felt more able to generate discussion with senior colleagues because of easier access to information (9, 47, 56). Tutors described a process of learning alongside their students (44, 49).
PL-F20	Enthusiasm for mlearning approaches, however, was far from universal, with some students articulating a preference for traditional pedagogical approaches (24, 29, 33, 37, 39, 46, 47, 52, 56, 61, 65, 66). Emphasis here was given to the value of paper-based learning (24, 49, 61) and face-to-face communication (52, 66), with some students expressing reluctance to invest time integrating a mobile device into their daily schedule (29).
Learning to mlearn	
PL-F21	Some students and lecturers expressed frustration and impatience in the process of learning how to use a device (40, 46, 61). Even students who were perceived by authors as technologically capable (33) were seen only to have knowledge of a small number of apps or platforms that they used for their own needs. Study participants described a reliance on others, in particular peers and friends, but also clinical tutors (32, 33, 36, 53). Students in several studies described how they had become more comfortable with mobile devices over time (26, 35, 39, 49, 64), with some claiming that trial and error were key (29, 36, 68). Technologically more competent users, however, also reported the need for support and repeat training to gain sufficient device familiarity (38). Others reported subtle changes in their learning behaviours over time (36, 61), e.g. ensuring they always recharged their device battery so it would be ready for work use (36).

PL-F22	In a number of studies, either students or tutors expressed insights into the need for evaluation of mLearning opportunities. Uncertainty was voiced over the trustworthiness or reliability of information being distributed through mLearning apps or websites (27, 34, 35, 46, 54, 55, 59, 67, 68). Students described seeking recommendations for apps from their peers or instructors (35).
The implementation of mlearning in clinical contexts	
Institutional infrastructure and resources	
PL-F23	The importance of network connectivity was emphasised by both tutors and students (69). The availability of this particular resource was variable as participants in several studies described how Wifi hotspots were unavailable in the educational institutions or hospitals they were working in (34, 39, 59), or that access could be inconsistent, slow, or otherwise poor (37, 39, 41, 51), in particular for video streaming. Both tutors and students reported delays to the roll-out of mLearning programmes due to insufficient Wifi (29, 34, 46). The use of mobile data plans in place of Wifi was seemed as problematic in some studies (34, 38, 68) due to the associated costs for students.
PL-F24	When students were loaned mobile devices as part of the study, it was noted that such devices were old, or ill-suited mobile technology (11, 32, 44) or in some cases did not work (28, 61). These studies indicated that institutions may not have the resources to provide students with mobile devices; in one such study, students complained about sharing devices (28).
mLearning training and technical support	
PL-F25	Students expressed satisfaction with training in a small number of studies (38, 39, 49, 55, 59, 68). In a few instances, they reported feeling empowered enough to incorporate mLearning techniques into their daily activities (55, 59, 68). Features of these training formats were that they were delivered in an experiential format (49, 59) or were provided throughout the course (38, 68). Where there was no training, learners reported having insufficient time to familiarise themselves with the device and so to use it for learning (24). Students and staff in several studies, however, described still being unfamiliar with device functions despite training (33, 37, 40, 58, 60, 68).
PL-F26	Assistance after training was identified as lacking, for example when learners forgot the functions covered during orientation (33, 40, 58, 60, 68). Technical support was described by teaching staff (44) and learners (40) as helpful during learning activities and later as part of a routine (46). Students without such a service, described feeling helpless or even panicking. Local technical support, however was described by some learners as fragmented or uncoordinated (32), with a prolonged turn-around time (68). In one study, a situation was described where support staff might offer software support yet be unable to resolve hardware issues, with this resulting in users being directed to the device manufacturer (32).
mLearning leadership and policy	
PL-f27	The use of mLearning strategies did not always appear to have been planned with course content or pedagogy in mind, or with consideration of the attributes required by teaching staff. In terms of learning structure, participants in two studies complained of poor timing (33, 62). In one of these they noted that an mLearning module providing sleep education had been introduced during rotation, when medical students often are too busy to view course content online (62). Students also reported device content that was not congruent with the rest of their curriculum or reflective of their practice (39, 40, 62). Students in several studies reported they were offered little guidance on how to integrate mobile devices into their learning activities (29, 33, 37). Others noted their clinical instructors' lack of device knowledge (36, 37, 39, 56).
PL-F28	There were, also, several references to disapproval for device-use among supervising staff in clinical settings, resulting in students being hesitant to use the device openly.(11, 39, 53, 54, 59) (e.g. 48, 49, 62, 64). In one study students reported active discouragement from some supervisors (11). A range of proposals for guiding practice were made across the studies. In one, senior teaching staff emphasised the importance of clear policies and of improving staff awareness about the value of portable devices (42). Tutors in another recommended the development of 'ground rules' 'to legitimise… use and ensure entrustability' (62). The need for 'behavioural etiquette', or 'appropriate, informal codes of conduct' for digital communication was found to be a consistent discussion theme in one study where students, administrative professionals and tutors all participated (33, 53) ~~(64)~~.

Web Annex C: Patients' and clients' perceptions and experiences of targeted client communication accessible via mobile devices for reproductive, maternal, newborn, child and adolescent health: A qualitative evidence synthesis (unpublished review)

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Abstract

Background

In response to the needs of government decision-makers globally, the World Health Organization (WHO) Department of Reproductive Health and Research (RHR) has initiated guidelines to inform government-led investments of digital health strategies for strengthening of reproductive, maternal, newborn, child or adolescent health (RMNCAH) essential interventions. The WHO has commissioned a series of systematic reviews to inform these guidelines, including the current review. This review complements one of the other WHO-commissioned reviews that focuses on the effectiveness of targeted digital communication via mobile device for RMNCAH.

Objectives

To identify, appraise and synthesize qualitative studies exploring patients' and clients' perceptions and experiences of targeted digital communication via mobile device in the areas of reproductive, maternal, newborn, child or adolescent health.

Search methods

We searched the following electronic databases for eligible studies:

- MEDLINE (OvidSP)
- MEDLINE In-process and Other Non-Index Citations (Ovid SP)
- WHO Global Health Library
- POPLINE
- EMBASE

The first commercial SMS message was sent in December 1992 so our search period was 1993 to present. Our searches were carried out on 06.07.2017. We also hand searched mHealthEvidence.org for studies that met our inclusion criteria. Finally, we asked WHO guideline panel members to identify studies that fit our inclusion criteria.

Selection criteria

Type of studies: We included primary studies that used qualitative methods for data collection and data analysis. Mixed methods studies were included if it was possible to extract data gathered through qualitative methods.

Type of interventions: We included studies exploring patients' and clients' experiences and perceptions of targeted digital communication accessible via mobile device. This could include perceptions and experiences of the content of the message, the delivery mechanism itself, the sender, or other aspects tied to this form of communication. By "targeted client communication" we mean the transmission of targeted health content to a specified population or individuals within a predefined health or demographic group.

Type of populations: We included studies that focused on the perceptions and experiences of one or more of the following groups: adolescent and youth populations (ages 10-24 years) that are potential users of sexual and reproductive health (SRH) services; adult users / potential users of SRH services (age 18 +); pregnant and postpartum women living with HIV and their partners or others who support them up to six weeks, with the exception of breastfeeding in which it will be 6 months; and parents and caregivers of children under five years of age.

Data collection and analysis

Three authors independently assessed titles and abstracts to identify their potential eligibility. The full text of all the papers that were likely to be relevant were retrieved and assessed independently by two review authors. We purposively sampled from the articles that met our inclusion criteria. A sampling frame was developed that took into consideration the target group, data richness and closeness of the study findings to the review objective.

We used a data extraction form to extract key themes and categories relevant to the synthesis objective. We also extracted information about first author, date of publication, language, country of study, context, participant group, theoretical or conceptual framework, and research methods.

To assess the methodological quality of included studies, we used an adaptation of the Critical Appraisal Skills Programme (CASP) quality assessment tool for qualitative studies. We carried out a framework analysis using the Supporting the Use of Research Evidence (SURE) framework to identify themes in the data. We used CERQual (Confidence in the Evidence from Reviews of Qualitative research) to assess the confidence that may be placed in each of the review findings.

Main results

Forty-eight studies met our inclusion criteria. We sampled 35 studies for analysis. All of the sampled studies were published between 2009 and 2017. All of the included studies were published in English. Sampled studies were from (Australia (1), Cambodia (1), Cameroon (2), Canada (2), Ghana (1), India (2), Kenya (2), Lesotho (1), Nigeria (2), Peru (3), Sierra Leone (1), South Africa (2), Uganda (2), United Kingdom (4), USA (9)).

Feelings of familiarity, convenience and control, support and connectiveness: Overall most participants were positive to receiving health information via their mobile phones (low confidence). Some participants felt that mHealth programmes provided them with feelings of support and connectedness and in some cases, that someone was interested in their situation, invested in their wellbeing and cared about them. A few participants felt that in some cases the sense of caring and support from healthcare providers through mHealth programmes had a positive influence on their relationship with their healthcare provider (moderate confidence). Participants described how they shared mHealth messages with friends, family and community members (moderate confidence).

Varying degrees of access to network services and phones: Some participants felt that mHealth programs could save them time and money, especially participants who faced barriers in attending health care because of distance and a lack of time and/or funds (low confidence). However, participants reported varying degrees of access to network services and to electricity (high confidence). Participants also reported varying access to mobile phones (moderate confidence). Some participants, particularly women and adolescents, who had to share or borrow a phone or had their access to phones controlled or restricted, complained that this made it difficult to receive messages and keep them private (moderate confidence). People's ability to access mHealth messages could also be limited by language, literacy and/or ICT literacy (moderate confidence).

Confidentiality issues: Some participants who were dealing with health conditions that are often seen as stigmatised or very personal worried that their health information would be disclosed or their identity traced due to their participation in a mHealth program. People's perceptions of information delivery channels were influenced by how confidential they felt the delivery channels were (high confidence). Some participants proposed strategies to address these concerns, including neutral, coded or discreet language, pass codes, not disclosing the sender, coming from a trusted sender, and the ability to tailor and control content, timing and frequency of their messages (high confidence).

Impact on behaviour: Some participants thought that participating in a mHealth programme had influenced their behaviour. Reasons they gave included receiving new knowledge; receiving specific strategies for instance how to initiate discussion with a partner or healthcare provider; being motivated or reassured; and being reminded for example to take medication or make an appointment. However, other participants believed that the intervention did not have any influence on their behaviour because the mHealth programmes was not relevant to their situation (low confidence).

Communication content preferences: Participants had preferences regarding the content they receive through mHealth programmes and messages. They wanted varied information that provided new knowledge and reminders; as well as explanations, solutions and suggestions about health issues. They were interested in content related to health, illness and treatments and practical topics such as clinic location and transportation. They wanted this information to be relevant and acceptable to their personal circumstances and local setting (moderate confidence). Some participants felt that including elements in the mobile-based platform in which participants are asked for a response (e.g., via knowledge quizzes or a practical tool allowing access to additional information, such as a nutrition calculator) could increase the engagement of users with the programme (low confidence).

Participants perceptions' of who the sender of the message was could influence their trust in and perception of program credibility. Participants said they wanted a known, identified phone number; messages sent from a reliable, trusted, credible source; and in some cases to feel like the messages were sent by a person (even if sent from an automated service) (moderate confidence).

Communication format preferences: Participants described preferred mHealth message format characteristics, including short, concise, and personalized messages in a language they could understand and in full text not "text speak" (low confidence). Participants also said that the tone of the message mattered to them. Preferences varied but included a tone that was motivational, friendly, encouraging, polite and positive. Some participants highlighted that they did not like feeling pressured, lectured, shamed or frightened by mHealth messages (low confidence). Participants appreciated personalized and tailored information, including messages that used an individual's name, allowed participants to choose the content, topic and language of their messages, provided

information relevant to the participants setting, allowed them to select the timing and frequency of the message, and allowed them to have control over privacy settings (low confidence).

Communication delivery preferences: Participants believed that participating in mHealth programmes should be free or very low cost in relation to joining the program or sending and receiving SMS/phone calls (high confidence). Participants often had preferences for how often mHealth messages were sent, the time of day they were sent and the duration of the programmes. However, there was variation in what most participants felt was appropriate timing and frequency (moderate confidence). Participants also had preferences for different delivery channels (for example SMS, interactive voice recording or speaking with a health care provider). These preferences were influenced by factors including cost, convenience, the ability to store messages and re read them, familiarity with the channel, what content was being delivered, the nature of the topic, language and literacy considerations and the ability to discuss with a person (moderate confidence).

Summary of Qualitative Findings

	Summary of review finding	Studies contributing to the review finding	Methodological limitations	Adequacy	Relevance	Coherence	Overall CERQual assessment of confidence in the evidence
F1	Participants reported varying degrees of access to network services including cell networks (for calls and SMS) and internet. In addition, some had poor access to electricity to charge their phones. These factors were reported to be barrier to using the mHealth programs.	Akinfaderin-Agarau 2012; Cornelius 2009; Flax 2017; Hirsch-Moverman 2017; Jalloh-Vos 2014; Mbuagbaw 2012; Mbuagbaw 2014; Smilie 2014	**Minor concerns about methodological limitations** (Due to poor reporting of sampling (unclear how participants were recruited in several studies) and researcher reflexivity)	**No or very minor concerns about adequacy**	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**No or very minor concerns about relevance** (Studies from a range of different settings and target groups)	**High confidence** (Eight studies with minor concerns regarding methodological limitations.)
F2	Participants reported varying degrees of access to mobile phones. For instance, some had no phone, some had lost or broken their phone, some could not afford to purchase airtime, some changed their number or sim card, or for some access to the phone was controlled by another person. These factors were reported to be barrier to using the mHealth programs.	Akinfaderin-Agarau 2012; Entsieh 2015; Flax 2017; Hirsch-Moverman 2017; Jalloh-Vos 2014; Jennings 2013; Menacho 2013; Missal 2016; Rana 2015; Smilie 2014;	**Minor concerns about methodological limitations** (Due to poor reporting of sampling (unclear how participants were recruited in several studies) and researcher reflexivity)	**No or very minor concerns about adequacy**	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**Minor concerns about relevance** (Due to a focus on study populations that may have limited access to mobile phone ownership for example, due to age, gender, SES, or health condition. (Partial relevance))	**Moderate confidence** (Due to minor concerns regarding methodological limitations and relevance)

F3	Some participants, particularly women and adolescents, who had to share or borrow a phone or had their access to phones controlled or restricted by another person, complained that this made it difficult to keep messages and conversations private or to receive their messages at all. These factors were reported to be barrier to using the mHealth programs.	Akinfaderin-Agarau 2012; Flax 2017; Jalloh-Vos 2014; Rana 2015	**Minor concerns about methodological limitations** (Due to poor reporting of sampling strategies and lack of researcher reflexivity)	**Minor concerns about adequacy** (Due to a limited number of studies)	**Minor concerns about coherence** (As the majority of participants in one study did not see phone sharing as a problem)	**Minor concerns about relevance** (Due to a focus on study populations that may have limited access to mobile phone ownership for example, due to age, gender, SES, or health condition. (Partial relevance))	**Moderate confidence** (Due to minor concerns regarding methodological limitations, coherence, adequacy and relevance)
F4	Some participants who were dealing with health conditions that are often seen as stigmatised or very personal (for example HIV, family planning and abortion care) worried that their confidential health information would be disclosed or their identity traced due to their participation in a mHealth program. People's perceptions of information delivery channels (SMS, IVR, Voice call) were influenced by how confidential they felt the delivery channels were.	Akinfaderin-Agarau 2012; Calderon 2017; Cates 2015; Curioso 2009; Evans 2016; French 2016; Goldenberg 2015; Greaney 2014; Jalloh-Vos 2014; Jennings 2013; Mbuagbaw 2012; Mbuagbaw 2014; Mitchell 2016; Menacho 2013; Nachega 2016; Odeny 2014; Perry 2012; Rana 2015; Rodrigues 2017; Smith 2017; Willoughby 2017	**Minor concerns about methodological limitations** (Due to poor reporting of researcher reflexivity)	**No or very minor concerns about adequacy**	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**No or very minor concerns about relevance** (Studies from a range of different settings and target groups)	**High confidence** (Due to minor concerns regarding methodological limitations)

F5	Some participants proposed strategies to address their concerns regarding confidentiality and privacy. These strategies included neutral, coded or discreet language, pass codes, not disclosing the sender, coming from a trusted sender, and the ability to tailor and control content, timing and frequency of their messages.	Calderon 2017; Curioso 2009; Evans 2016; French 2016; Goldenberg 2015; Greaney 2014; Mbuagbaw 2012; Menacho 2013; Odeny 2014; Rana 2015; Rodrigues 2017; Smith 2017; Willoughby 2017	**Minor concerns about methodological limitations** (Due to poor reporting of participant voices in the findings and of researcher reflexivity)	**No or very minor concerns about adequacy**	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**No or very minor concerns about relevance** (Studies from a range of different settings (HIV are the majority of the participants. however, no concerns due to limited participant group))	**High confidence** (Due to minor concerns regarding methodological limitations)
F6	Participants believed that the cost to participate in mHealth programs should be free or very low. There should be little or no charge in relation to mHealth program costs such as joining the program or downloading apps as well as charges related to sending and receiving SMS/phone calls.	Akinfaderin-Agarau 2012; Calderon 2017; Cornelius 2009; Mitchell 2016; Menacho 2013; Perry 2012; Rana 2015; Smith 2017	**No or very minor concerns about methodological limitations**	**No or very minor concerns about adequacy**	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**Minor concerns about relevance** (Due to partial relevance in relation to participant group (adolescents focus) and/or in LMIC settings where cost may be particularly important)	**High confidence** (Due to minor concerns regarding relevance)

F7	Some participants felt that mHealth programmes could save them time and money by giving them access to health care via their mobile phones. This was especially relevant to participants who faced barriers in attending health care because of distance to the health facility and a lack of time and/or funds.	Calderon 2017; Smith 2017	**Minor concerns about methodological limitations** (Due to poor reporting of participant voices in the findings, researcher reflexivity and unclear ethical considerations in one study)	**Moderate concerns about adequacy** (Due to a limited number of studies)	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**Moderate concerns about relevance** (Due to partial relevance of setting and populations who may be particularly affected by lack of time and funds and distance)	**Low confidence** (Due to minor concerns regarding methodological limitations and moderate concerns regarding adequacy and relevance)
F8	Participants described how they shared mHealth program messages more broadly with friends, family and community members.	Calderon 2017; Cornelius 2009; Flax 2017; French 2016; Gold 2010; Jennings 2013; Perry 2012; Smith 2017; Wright 2011	**Minor concerns about methodological limitations** (Due to poor reporting of participant voices in the findings and researcher reflexivity)	**No or very minor concerns about adequacy**	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**Moderate concerns about relevance** (Due to a fair number of studies where participants did not experience an mHealth intervention but were asked to comment about their preferences regarding a hypothetical intervention)	**Moderate confidence** (Due to minor concerns regarding methodological limitations and moderate concerns regarding relevance)

F9	A participant's ability to access mHealth messages was sometimes limited by their language skills and their personal level of literacy and/or ICT literacy	Akinfaderin-Agarau 2012; Calderon 2017; Curioso 2009; Greaney 2014; Hirsch-Moverman 2017; Jalloh-Vos 2014; Mbuagbaw 2014; Rodrigues 2017; Smillie 2014	**Moderate concerns about methodological limitations** (Due to poor reporting of sampling, participant voices in the findings and researcher reflexivity)	**No or very minor concerns about adequacy**	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**Minor concerns about relevance** (Due to partial relevance of study population (populations that are more likely to have literacy and language challenges))	**Moderate confidence** (Due to minor concerns regarding relevance and moderate concerns regarding methodological limitations)
F10	Overall most participants seemed to accept and were positive to the idea of receiving health information through mHealth interventions via their mobile phones due to factors such as; familiarity with the technology, convenience, control, being able to save and re read messages later, cost, it was a simple way of providing a reminder for medication or appointments and the sense that someone was thinking about them and cared enough to send a message.	Akinfaderin-Agarau 2012; Brown 2014; Calderon 2017; Cates 2015; Cornelius 2009; Curioso 2009; Evans 2016; French 2016; Gold 2010; Greaney 2014; Hirsch-Moverman 2017; Jalloh-Vos 2014; Jennings 2013; Lau 2014; Mbuagbaw 2012; Mbuagbaw 2014; Menacho 2013; Missal 2016; Munro 2017; Naughton 2013; Odeny 2014; Perry 2012; Rana 2015; Rodrigues 2017; Sloan 2017; Smillie 2014; Smith 2017; Willoughby 2017; Wright 2011;	**Moderate concerns about methodological limitations** (Due to poor reporting of participant voices in the findings and researcher reflexivity)	**No or very minor concerns about adequacy**	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**Moderate concerns about relevance** (Due to a fair number of studies where participants did not experience an mHealth intervention but were asked to comment about their preferences regarding a hypothetical intervention)	**Low confidence** (Due to moderate concerns regarding methodological limitations and relevance)

F11	Participants perceptions' of who the sender of the mHealth message was could influence their trust in and perception of mHealth program credibility and value. Participants said they wanted a known, identified phone number; messages sent from a reliable, trusted, credible source; and in some cases to feel like the messages were sent by a person (even if sent from an automated service).	Akinfaderin-Agarau 2012; Brown 2014; Calderon 2017; Cates 2015; Evans 2016; Greaney 2014; Lau 2014; Mbuagbaw 2012; Menacho 2013; Missal 2016; Naughton 2013; Rana 2015; Rodrigues 2017; Smillie 2014; Willoughby 2017	**Minor concerns about methodological limitations** (Due to poor reporting of participant voices in the findings and researcher reflexivity)	**No or very minor concerns about adequacy**	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**Moderate concerns about relevance** (Due to a fair number of studies where participants did not experience an mHealth intervention but were asked to comment about their preferences regarding a hypothetical intervention)	**Moderate confidence** (Due to minor concerns regarding methodological limitations and moderate concerns) regarding relevance
F12	Participants often had preferences for how often m Health messages were sent, the time of day they were sent and the duration of mHealth programs. However, there was variation in what most participants felt was appropriate timing and frequency. Participants were particularly concerned about being bombarded with too many messages, whether the timing of the messages was convenient for them and/or whether messages arrived in connection with the behaviour the message was trying to target.	Calderon 2017; Cornelius 2009; Evans 2016; French 2016; Gold 2010; Greaney 2014; Jennings 2013; Mbuagbaw 2012; Menacho 2013; Missal 2016; Mitchell 2016; Munro 2017; Naughton 2013; Odeny 2014; Rana 2015; Rodrigues 2017; Sloan 2017; Smillie 2014; Smith 2017; Ware 2016; Willoughby 2017; Wright 2011	**Minor concerns about methodological limitations** (Due to poor reporting of researcher reflexivity)	**No or very minor concerns about adequacy**	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**Moderate concerns about relevance** (Due to a fair number of studies where participants did not experience an mHealth intervention but were asked to comment about their preferences regarding a hypothetical intervention)	**Moderate confidence** (Due to minor concerns regarding methodological limitations and moderate concerns regarding relevance)

F13	Participants mentioned various mHealth message format characteristics that they preferred. These included a preference for short, concise, personalized, clear and direct messages in a language they could understand and in full text rather than "text speak".	Akinfaderin-Agarau 2012; Calderon 2017; Cates 2015; Curioso 2009; Evans 2016; French 2016; Gold 2010; Greaney 2014; Lau 2014; Menacho 2013; Missal 2016; Munro 2017; Naughton 2013; Odeny 2014; Perry 2012; Rana 2015; Smillie 2014; Willoughby 2017	**Minor concerns about methodological limitations** (Due to poor reporting of participant voices in the findings and researcher reflexivity)	**No or very minor concerns about adequacy**	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**Serious concerns about relevance** (Due to partial relevance of study population (several of the studies were among adolescents) and a fair number of studies where participants did not experience an mHealth intervention but were asked to comment about their preferences regarding a hypothetical intervention)	**Low confidence** (Due to minor concerns regarding methodological limitations and serious concerns regarding relevance)
F14	Participants said that the tone of the mHealth message mattered to them. Their preferences varied but included a tone that was; motivational, friendly, encouraging, polite, congratulatory, personalized, upbeat, positive, humorous and relatable. Some participants highlighted that they did not like feeling pressured, lectured, shamed or frightened by mHealth messages.	Cates 2015; Curioso 2009; Evans 2016; French 2016; Gold 2010; Jennings 2013; Menacho 2013; Munro 2017; Naughton 2013; Odeny 2014; Perry 2012; Rana 2015; Sloan 2017; Wright 2011	**Minor concerns about methodological limitations** (Due to poor reporting of researcher reflexivity)	**No or very minor concerns about adequacy**	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**Serious concerns about relevance** (Due to partial relevance of study population (several of the studies were among adolescents) and a fair number of studies where participants did not experience an mHealth	**Low confidence** (Due to minor concerns regarding methodological limitations and serious concerns regarding relevance)

						intervention but were asked to comment about their preferences regarding a hypothetical intervention)	
F15	Participants appreciated personalized mHealth information and discussed their preferences for tailored or customized mHealth programs and messages. This could include sender based personalization or receiver based options. Reasons for these preferences included engaging the user, enhancing credibility, increasing feelings of ownership, control over their personal information and feelings of privacy. Preferences for tailoring included making mHealth messages personalized by using an individual's name, allowing participants to choose the content, topic and language of their messages, providing information relevant to the participants setting (local information), allowing them to select the timing and frequency of the message, providing personalized reminders (for example for vaccination or medication) and allowing participants to have control over privacy settings.	Calderon 2017; Evans 2016; French 2016; Goldenberg 2015; Hirsch-Moverman 2017; Jennings 2013; Munro 2017; Naughton 2013; Odeny 2014; Sloan 2017; Ware 2016; Willoughby 2017	**Minor concerns about methodological limitations** (Due to poor reporting of researcher reflexivity)	**No or very minor concerns about adequacy**	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**Serious concerns about relevance** (Due to a large number of studies where participants did not experience an mHealth intervention but were asked to comment about their preferences regarding a hypothetical intervention)	**Low confidence** (Due to minor concerns regarding methodological limitations and serious concerns regarding relevance)
F16	Participants had preferences regarding the content they receive through mHealth programmes and messages. They wanted varied information that	Brown 2014**;** Calderon 2017**;** Cornelius 2009**;** Entsieh 2015**;** French	**Minor concerns about methodological limitations**	**No or very minor concerns about adequacy**	**No or very minor concerns about coherence**	**Moderate concerns about relevance**	**Moderate confidence** (Due to minor concerns regarding

	provided new knowledge and reminders; as well as explanations, solutions and suggestions about health issues. They were interested in content related to health, illness and treatments and practical topics such as clinic location and transportation. They wanted this information to be relevant and acceptable to their personal circumstances and local setting.	2016; Greaney 2014; Gold 2010; Jalloh-Vos 2014; Jennings 2013; Mbuagbaw 2014; Missal 2016; Mitchell 2016; Munro 2017; Nachega 2016; Odeny 2014; Perry 2012; Sloan 2017; Smith 2017	(Due to poor reporting of researcher reflexivity)		(Good fit between data from primary studies and the review finding)	(Due to a fair number of studies where participants did not experience an mHealth intervention but were asked to comment about their preferences regarding a hypothetical intervention)	methodological limitations and moderate concerns regarding relevance)
F17	Participants had preferences for different delivery channels, (for example SMS, interactive voice recording (IVR) or speaking with a health care provider), for information shared through mHealth programmes. These preferences were influenced by a number of factors including cost, convenience, the ability to store messages and re read them, familiarity with the channel, personal preference, what content was being delivered, the nature of the topic, language and literacy considerations and the ability to discuss with a person.	Akinfaderin-Agarau 2012; Cates 2015; Curioso 2009; Greaney 2014; Jennings 2013; Mitchell 2016; Missal 2016; Naughton 2013; Odeny 2014; Rana 2015; Rodrigues 2017; Smillie 2014; Willoughby 2017	**Minor concerns about methodological limitations** (Due to poor reporting of researcher reflexivity)	**No or very minor concerns about adequacy**	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**Moderate concerns about relevance** (Due to a fair number of studies where participants did not experience an mHealth intervention but were asked to comment about their preferences regarding a hypothetical intervention however they may still have had experience with the communication channel outside of an mHealth programme that	**Moderate confidence** (Due to minor concerns regarding methodological limitations and moderate concerns regarding relevance)

						they could draw on)	
F18	Participants said that they liked the ability to engage with a health care provider and receive answers to their questions through mHealth programmes. However, some participants felt that for some topics they would feel uncomfortable talking to a health care provider due to issues related to shyness and privacy.	Akinfaderin-Agarau 2012; Calderon 2017; Cates 2015; Jennings 2013; Rana 2015; Rodrigues 2017; Smillie 2014; Smith 2017; Willoughby 2017	**Moderate concerns about methodological limitations** (Due to poor reporting of sampling, ethical considerations and researcher reflexivity)	**Moderate concerns about adequacy** (Due to thin data)	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**Serious concerns about relevance** (Due to a large number of studies where participants did not experience an mHealth intervention but were asked to comment about their preferences regarding a hypothetical intervention)	**Very low confidence** (Due to moderate concerns regarding methodological limitations and adequacy and serious concerns regarding relevance)
F19	Participants discussed advantages and disadvantages of mHealth programmes in relation to meeting with a health care provider. Some participants perceived interacting with a health care provider as preferable, warmer and something they were accustomed to. Perceptions of mHealth programmes were that people could receive a faster response and the messages were more convenient and less judgemental.	Calderon 2017; Nachega 2016; Naughton 2013; Sloan 2017; Smillie 2014	**Minor concerns about methodological limitations** (Due to poor reporting of researcher reflexivity)	**Serious concerns about adequacy** (Due to thin data from a small number of studies)	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**Serious concerns about relevance** (Due to a fair number of studies where participants did not experience an mHealth intervention but were asked to comment about their preferences regarding a hypothetical interventionand partial relevance of the target group)	**Very low confidence** (Due to minor concerns regarding methodological limitations and serious concerns regarding adequacy and relevance)

F20	Some participants felt that mHealth programmes provided them with feelings of support and connectedness as someone was taking the time to send them messages. In some cases, this made participants feel like someone was interested in their situation, invested in their wellbeing and cared about them. For some, this lead them to feel encouraged, have increased self-confidence and feelings of self-worth. For others, the messages provided support, guidance and information, often giving a sense of direction, reassurance and motivation to those participating. A few participants felt that in some cases the sense of caring and support that they received from healthcare providers through mHealth programmes had a positive influence on their relationship with their healthcare provider.	Brown 2014; Calderon 2017; Entsieh 2015; Jalloh-Vos 2014; Lau 2014; Mbuagbaw 2014; Munro 2017; Nachega 2016; Rana 2015; Rodrigues 2017; Sloan 2017; Smillie 2014; Smith 2017; Ware 2016; Wright 2011	**Moderate concerns about methodological limitations** (Due to poor reporting of participant voice in the findings, ethical considerations and researcher reflexivity)	**No or very minor concerns about adequacy**	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**Moderate concerns about relevance** (Due to a fair number of studies where participants did not experience an mHealth intervention but were asked to comment about their preferences regarding a hypothetical intervention)	**Moderate confidence** (Due to moderate concerns regarding methodological limitations and relevance)
F21	Participants were concerned about over-reliance on digital reminders which might create dependency on mHealth programmes and messages and, in the absence of these reminders, poor adherence to care plans.	Jalloh-Vos 2014; Mbuagbaw 2012; Rana 2015	**Minor concerns about methodological limitations** (Due to poor reporting of methods in one study)	**Serious concerns about adequacy** (Due to thin data from a small number of studies)	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**Moderate concerns about relevance** (Due to the fact that all of the studies are from one region, two focus on one health issue (HIV) and one is hypothetical)	**Low confidence** (Due to minor concerns regarding methodological limitations, moderate concerns about relevance and serious concerns about adequacy)
F22	Some participants thought that participating in a mHealth programme had influenced their behaviour while	Brown 2014; French 2016; Gold 2010; Greaney 2014;	**Moderate concerns about**	**Minor concerns about adequacy**	**No or very minor concerns about coherence**	**Minor concerns about relevance**	**Low confidence** (Due to minor concerns regarding

	others did not. Reasons that they gave for potentially altering their behaviour included receiving new knowledge; receiving specific strategies for instance how to initiate discussion with a partner or healthcare provider; being motivated or reassured by the programme; and being reminded for example to take medication or make an appointment. Some participants who believed that the intervention did not have any influence on their behaviour found the mHealth programmes to not be relevant to their situation.	Hirsch-Moverman 2017; Jalloh-Vos 2014; Jennings 2013; Lau 2014; Missal 2016 Munro 2017; Rodrigues 2017; Sloan 2017; Smillie 2014; Smith 2017; Entsieh 2015; Rodrigues 2017; Ware 2016	**methodological limitations** (Due to poor reporting of participant voice in the findings, ethical considerations and researcher reflexivity)	(Due to thin data in some studies)	(Good fit between data from primary studies and the review finding)	(Due to the fact that a large group of the studies were tied to pregnancy and childbirth which can in itself have an influence on behaviour change)	relevance and adequacy and moderate concerns regarding methodological limitations)
F23	Some participants felt that including elements in the mobile-based platform in which participants are asked for a response (e.g., via knowledge quizzes or multiple choice questions or a practical tool allowing access to additional information, such as a nutrition calculator) could increase the engagement of users with the programme and provide additional information. In one study, participants suggested that it would be helpful if the response was quick, simple and convenient.	Cornelius 2009; Munro 2017; Naughton 2013; Wright 2011	**Minor concerns about methodological limitations** (most studies were fairly well conducted and reported (the lack of reflexivity in 3 of the studies is not a serious concern because of the focus of the finding)	**Moderate concerns about adequacy** (Due to the small number of studies and thin data)	**No or very minor concerns about coherence** (Good fit between data from primary studies and the review finding)	**Serious concerns about relevance** (Due to a fair number of studies where participants did not experience an mHealth intervention but were asked to comment about their preferences regarding a hypothetical intervention, all of the studies were conducted in HICs and most of the studies are with adolescent	**Low confidence** (Due to minor concerns regarding methodological limitations, moderate concerns regarding adequacy and serious concerns regarding relevance)

and youth
populations)

Web Annex D: Tracking health commodity inventory and notifying stock levels via mobile devices (unpublished review)

Link to published protocol:

https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD012907/full

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Abstract

Background

Timely and reliable availability of essential medicines and health commodities is foundational to a responsive health system, and an area that is of much interest to governments, especially in low and middle income countries. The rapid expansion of mobile technologies offers potential low-cost solutions to the challenge of drug distribution and commodity availability in primary health care settings. However, the evidence on the use of mobile devices to address commodity shortages is sparse, and offers no clear way forward. To respond to this need, the World Health Organization (WHO) is establishing guidelines that aim to inform investments of digital health applications for strengthening tracking of health commodity inventory and stock notification.

Objectives

Primary objective

- To assess the effects of strategies for notifying stock levels and digital tracking of healthcare-related commodities and inventory via mobile devices.

Secondary objectives

- To describe what mobile strategies are currently being used to improve reporting and digital tracking of health commodities
- To identify factors influencing the implementation of mobile interventions targeted at reducing stock-outs of health commodities

Search methods

We searched Cochrane Central Register of Controlled Trials; (CENTRAL) in the Cochrane Library; MEDLINE Ovid; Embase Ovid; Global Health Library WHO; and POPLINE K4Heath on August 15, 2017. We searched the World Health Organization International Clinical Trials Registry Platform; and the US National Institutes of Health Ongoing Trials Register. We also searched Epistemonikos for related systematic reviews and potentially eligible primary studies. We conducted a grey literature search using mHealthevidence.org and issued a call for papers through popular digital health communities of practice. Finally, we conducted citation searches of included studies. We searched for studies published after 2000. We searched for studies in any language.

Selection criteria

Study design: For the primary objective we included individual and cluster-randomised trials; controlled before-after studies, provided they have at least two intervention sites and two control sites; and interrupted time series studies, if there is a clearly defined time point when the intervention occurred and at least three data points before and three after the intervention. For the secondary objectives: we included any study design, either quantitative, qualitative, or descriptive, that aimed to describe current strategies for commodity tracking or stock notification via mobile devices; or aimed to explore factors that influence the implementation of these strategies, including studies of acceptability or feasibility.

Types of participants: we included studies of all cadres of healthcare providers, including lay health workers and others involved in the distribution of health commodities (administrative staff, managerial and supervisory staff, dispensary staff); and all other individuals involved in stock notification who may be based in a facility or a community setting and involved with the delivery of primary healthcare services

Types of interventions: We included interventions aimed at improving the availability of health commodities using mobile devices in primary healthcare settings. By mobile devices, we mean mobile phones of any kind (but not analogue landline telephones), as well as tablets, personal digital assistants, and smartphones. Laptops are not included in this list. For the primary objectives, we included studies that compared health commodity tracking or stock notification via mobile devices with standard practice (i.e. non-digital and non-mobile, paper-based processes for stock management). For the secondary objectives, we included studies of health commodity tracking and stock notification via mobile device as long as we could extract data relevant to our secondary objectives.

Data collection and analysis

For the primary objective, two authors independently screened all records, extracted data from the included studies and assessed the risk of bias. For the analyses of the primary objective, we reported means and proportions where appropriate. We used the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach to assess the certainty of the evidence and we prepared a Summary of Findings table. For the secondary objective, two authors independently screened all records, extracted data from the included studies and assessed methodological limitations using the WEIRD tool. Results were summarized under key themes identified through a review of the data. We used the GRADE-CERQual (Confidence in the Evidence from Reviews of Qualitative research) approach to assess our confidence in the evidence and we prepared a Summary of Qualitative Findings table.

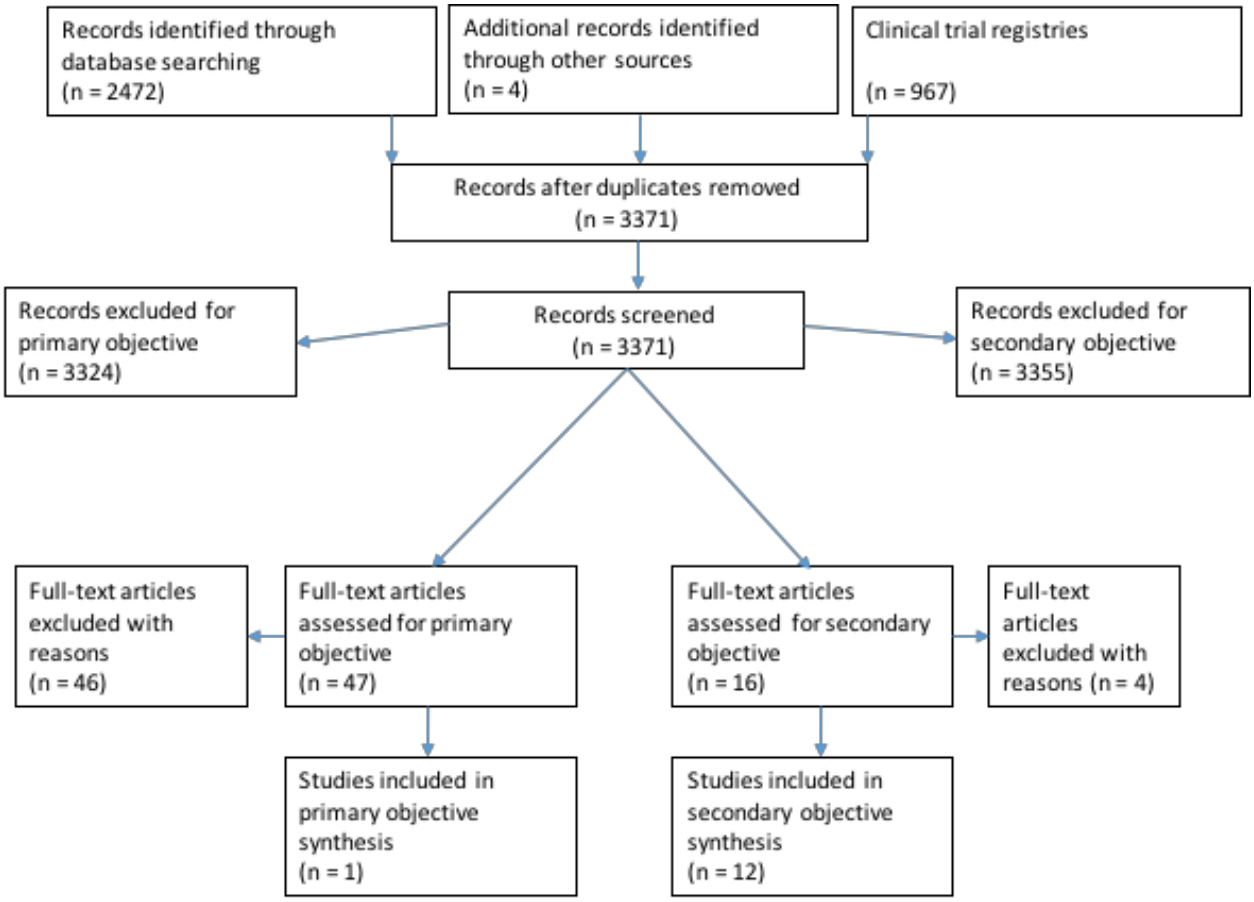
Main results

For the primary objective, we included one study, which used a controlled before-after study design and assessed the effect of a mobile system for stock notification and tracking. The study was conducted in Malawi and assessed outcomes related drug stock-outs, quality of data about stock management, time between stock level reporting and appropriate action and provider acceptability/satisfaction with the mobile system for stock notification. However, we are uncertain of the effect of the intervention on these outcomes because the certainty of this evidence was assessed as very low. The included study did not assess resource use or unintended consequences.

For the secondary objective, we included 12 studies that described a total of eight interventions. All studies were conducted in African countries (Tanzania, Kenya, Malawi, Ghana, Cameroon, Zambia, Liberia, Uganda and South Africa) and one was conducted in India. Most of the interventions aimed to make data about stock-levels and potential stock-outs visible to managers, who could then take corrective action to address it. We identified a number of factors that may influence the implementation of stock notification and tracking via mobile device. These include challenges tied to infrastructural issues such as poor access to electricity or internet (moderate confidence); and broader health systems issues such as drug shortages at the national level which cannot be mitigated by interventions at the primary health care level (low confidence). Several factors were identified as important, including availability of stock-level data at all levels of the health system

(low confidence); familiarity and training of healthcare providers in the use of the digital devices (moderate confidence); availability of technical programming expertise for initial development and ongoing maintenance (low confidence); Easy-to-use systems built with user participation (moderate confidence); data availability in a easy-to-use format such as an interactive dashboard (moderate confidence); and supportive supervision for effective adoption of the digital system (moderate confidence).

Figure 1: Study flow diagram



Authors' conclusions

We need more well-designed studies on the effect of using mobile devices for stock notification and on the factors that may influence the implementation of such interventions.

Summary of Findings A: Mobile stock notification with enhanced management

Mobile stock notification with enhanced management compared to standard care in primary healthcare settings

Patient or population: Healthcare providers and other health professionals involved in commodity/stock management
Setting: Primary healthcare setting in Malawi
Intervention: Mobile stock notification with enhanced management which involved quality improvement teams that were tasked with using the data supplied by the stock notification system
Comparison: Standard care involved routine stock management with mobile stock notification or any other digital intervention

Outcomes	**Standard care**	**Mobile stock notification with enhanced management**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Availability of commodities						
Stock-out of drugs in the last 30 days - Stock-out of Cotrimoxazole (to treat bacterial infections)	167 per 1,000	**160 per 1,000** (82 to 317)*	**RR 0.96** (0.49 to 1.90)*	171 (1 non-RCT) Malawi[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on stock-out of Cotrimoxazole because the certainty of this evidence was assessed as very low.**
Stock-out of drugs in the last 30 days - Stock-out of Artemether-Lumefantrine 2X6 (to treat malaria caused by Plasmodium facilparum)	189 per 1,000	**136 per 1,000** (68 to 272)*	**RR 0.72** (0.36 to 1.44)*	171 (1 non-RCT) Malawi[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on stock-out of Cotrimoxazole because the certainty of this evidence was assessed as very low.**
Stock-out of drugs in the last 30 days - Stock-out of oral rehydration salts (ORS) (to treat dehydration)	256 per 1,000	**258 per 1,000** (156 to 432)*	**RR 1.01** (0.61 to 1.69)*	171 (1 non-RCT) Malawi[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on stock-out of Cotrimoxazole because the certainty of this evidence was assessed as very low.**
Stock-out of drugs in the last 30 days - Stock-out of Zinc 20 mg (to treat diarrhea)	211 per 1,000	**209 per 1,000** (118 to 376)*	**RR 0.99** (0.56 to 1.78)*	171 (1 non-RCT) Malawi[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on stock-out of Cotrimoxazole because the certainty of this evidence was assessed as very low.**
Quality and timeliness of stock management						
Quality of data about stock management	On average, 85% (n=393) of the intervention group participants who managed relevant medicines reported on stock-levels completely[c]. (Only intervention group assessed for this outcome thus non-comparable.)			N[2] (1 non-RCT) Malawi[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on quality of data about stock management because the certainty of this evidence was assessed as very low.**

Mobile stock notification with enhanced management compared to standard care in primary healthcare settings

Patient or population: Healthcare providers and other health professionals involved in commodity/stock management
Setting: Primary healthcare setting in Malawi
Intervention: Mobile stock notification with enhanced management which involved quality improvement teams that were tasked with using the data supplied by the stock notification system
Comparison: Standard care involved routine stock management with mobile stock notification or any other digital intervention

Outcomes	**Standard care**	**Mobile stock notification with enhanced management**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Time between stock-level reporting and appropriate action	Health facilities took an average of 12.8 days to fulfil an order requested by the health surveillance assistants (lead time)[d]. (Only intervention group assessed for this outcome thus non-comparable.)			N[2] (1 non-RCT) Malawi[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on quality of data about stock management because the certainty of this evidence was assessed as very low.**
Satisfaction and acceptability						
Provider acceptability/satisfaction	The proportion of intervention group participants who reported using the digital intervention (cStock) as the primary means for ordering health products was 97% (n=81). (Only intervention group assessed for this outcome thus non-comparable.)			N[2] (1 non-RCT) Malawi[1]	⨁◯◯◯ VERY LOW [e]	**We are uncertain of the effect of this approach on provider satisfaction with stock management because the certainty of this evidence was assessed as very low.**
Resource use						
Resource use	No studies were identified that reported on this outcome					**We are uncertain of the effect of this approach on resource use because no direct evidence was identified.**
Unintended consequences						
Unintended consequences	No studies were identified that reported on this outcome					**We are uncertain of the effect of this approach on unintended consequences because no direct evidence was identified.**

*The 95% confidence interval (CI); **RR:** Risk ratio; **RCT:** Randomised controlled trial

GRADE Working Group grades of evidence. **High certainty:** We are very confident that the true effect lies close to that of the estimate of the effect. **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect. **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations

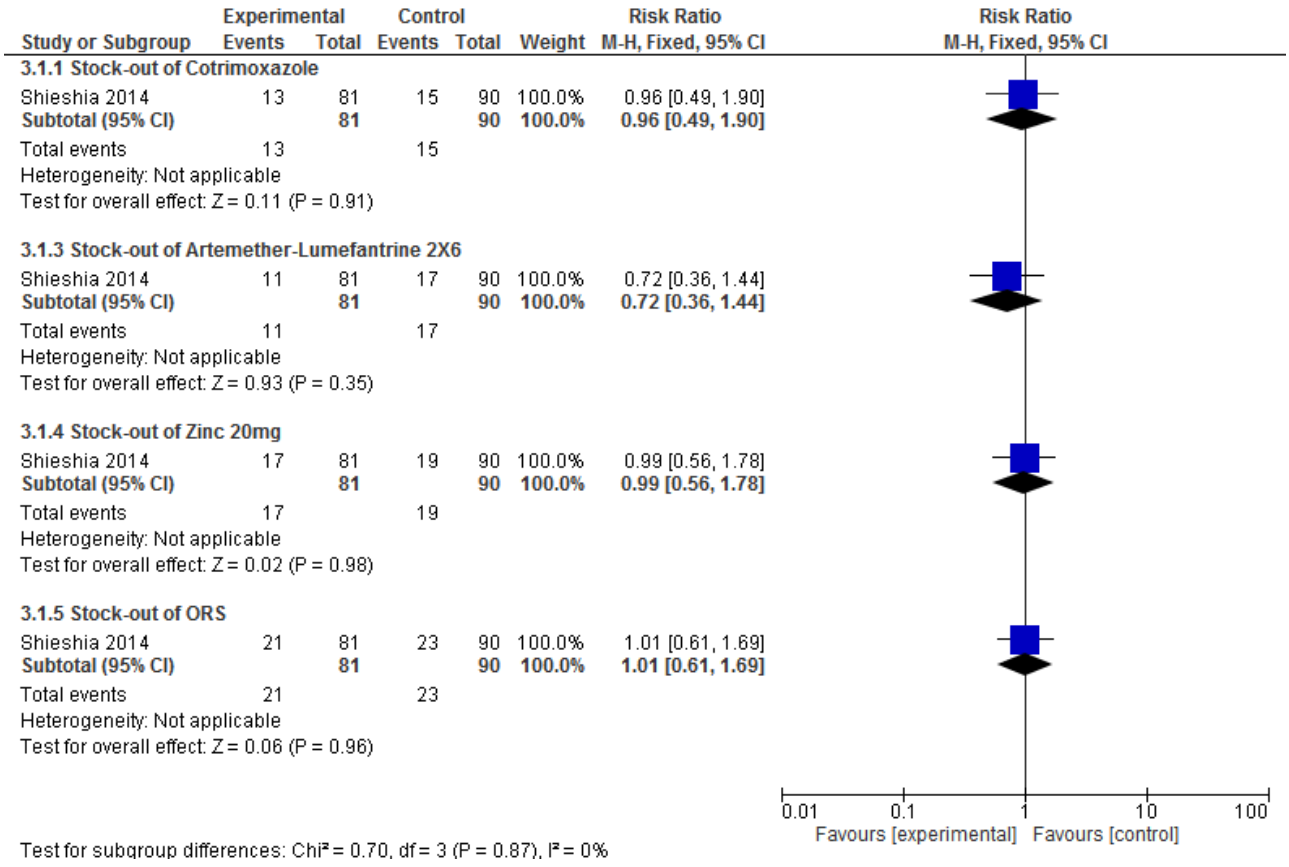
a. Downgraded two steps for very serious risk of bias concerns: Unclear random sequence generation, allocation concealment and blinding of participants not feasible given the intervention, unclear blinding of outcomes and incomplete outcome reporting
b. Downgraded one step for imprecision: Small sample size
c. Reporting completeness was assessed by the extent to which health surveillance assistants (intervention group participants) send messages about the stocks on-hand for all the products they managed.
d. Measured over a 18 month period (January 2012-June 2013)
e. Non-comparable results, thus downgraded to very low

References and notes

1. Shieshia M, Noel M, Andersson S, Felling B, Alva S, Agarwal S, Lefevre A, Misomali A, Chimphanga B, Nsona H, Chandani Y. Strengthening community health supply chain performance through an integrated approach: Using mHealth technology and multilevel teams in Malawi. Journal of global health. 2014 Dec;4(2). Published and unpublished data
2. For this outcome the number of study participants is based on another study sample than for the other outcomes. These data come from ongoing data (backend data in a digital system) and comprise of ALL the health care providers who ever reported on stock-levels

Analyses

Stock-out of drugs in the last 30 days



Summary of Findings B: Mobile stock notification with effective product transport

Mobile stock notification with effective product transport compared to standard care in primary healthcare settings

Patient or population: Healthcare providers and other health professionals involved in commodity/stock management
Setting: Primary healthcare settings in Malawi
Intervention: Mobile stock notification with effective product transport which involved providing health surveillance assistants with training and tools for bicycle maintenance
Comparison: Standard care involved routine stock management with mobile stock notification or any other digital intervention

Outcomes	**Standard care**	**Mobile stock notification with effective product transport**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Availability of commodities						
Stock-out of drugs in the last 30 days - Stock-out of Cotrimoxazole (to treat bacterial infections)	167 per 1,000	**218 per 1,000** (117 to 407)*	**RR 1.31** (0.70 to 2.44)*	168 (1 non-RCT) Malawi[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on stock-out of Cotrimoxazole because the certainty of this evidence was assessed as very low.**
Stock-out of drugs in the last 30 days - Stock-out of Artemether-Lumefantrine 2X6 (to treat malaria caused by Plasmodium facilparum)	189 per 1,000	**270 per 1,000** (153 to 472)*	**RR 1.43** (0.81 to 2.50)*	168 (1 non-RCT) Malawi[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on stock-out of Cotrimoxazole because the certainty of this evidence was assessed as very low.**
Stock-out of drugs in the last 30 days - Stock-out of oral rehydration salts (ORS) (to treat dehydration)	211 per 1,000	**129 per 1,000** (63 to 260)*	**RR 0.61** (0.30 to 1.23)*	168 (1 non-RCT) Malawi[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on stock-out of Cotrimoxazole because the certainty of this evidence was assessed as very low.**
Stock-out of drugs in the last 30 days - Stock-out of Zinc 20 mg (to treat diarrhea)	256 per 1,000	**281 per 1,000** (171 to 465)*	**RR 1.10** (0.67 to 1.82)*	168 (1 non-RCT) Malawi[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on stock-out of Cotrimoxazole because the certainty of this evidence was assessed as very low.**
Quality and timeliness of stock management						

Mobile stock notification with effective product transport compared to standard care in primary healthcare settings

Patient or population: Healthcare providers and other health professionals involved in commodity/stock management
Setting: Primary healthcare settings in Malawi
Intervention: Mobile stock notification with effective product transport which involved providing health surveillance assistants with training and tools for bicycle maintenance
Comparison: Standard care involved routine stock management with mobile stock notification or any other digital intervention

Outcomes	**Standard care**	**Mobile stock notification with effective product transport**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Quality of data about stock management	On average, 65% (n=253) of the health surveillance assistants who managed relevant medicines in the intervention group reported on stock-levels[c]. (Only intervention group assessed for this outcome thus non-comparable.)			N[2] (1 non-RCT) Malawi[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on quality of data about stock management because the certainty of this evidence was assessed as very low.**
Time between stock-level reporting and appropriate action	Health facilities took an average of 26 days to fulfil an order requested by the health surveillance assistants (lead time)[d]. (Only intervention group assessed for this outcome thus non-comparable.)			N[2] (1 non-RCT) Malawi[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on quality of data about stock management because the certainty of this evidence was assessed as very low..**
Satisfaction and acceptability						
Provider acceptability/satisfaction	The proportion of intervention group participants who reported using the digital intervention (cStock) as the primary means for ordering health products was 91% (n=78). (Only intervention group assessed for this outcome thus non-comparable.)			N[2] (1 non-RCT) Malawi[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on provider satisfaction with stock management because the certainty of this evidence was assessed as very low.**
Resource use						
Resource use	No studies were identified that reported on this outcome					**We are uncertain of the effect of this approach on resource use because no direct evidence was identified.**
Unintended consequences						
Unintended consequences	No studies were identified that reported on this outcome					**We are uncertain of the effect of this approach on unintended consequences because no direct evidence was identified.**

Mobile stock notification with effective product transport compared to standard care in primary healthcare settings

Patient or population: Healthcare providers and other health professionals involved in commodity/stock management
Setting: Primary healthcare settings in Malawi
Intervention: Mobile stock notification with effective product transport which involved providing health surveillance assistants with training and tools for bicycle maintenance
Comparison: Standard care involved routine stock management with mobile stock notification or any other digital intervention

Outcomes	**Standard care**	**Mobile stock notification with effective product transport**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?

*The 95% confidence interval (CI); **RR:** Risk ratio; **RCT:** Randomised controlled trial

GRADE Working Group grades of evidence. **High certainty:** We are very confident that the true effect lies close to that of the estimate of the effect. **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect. **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations

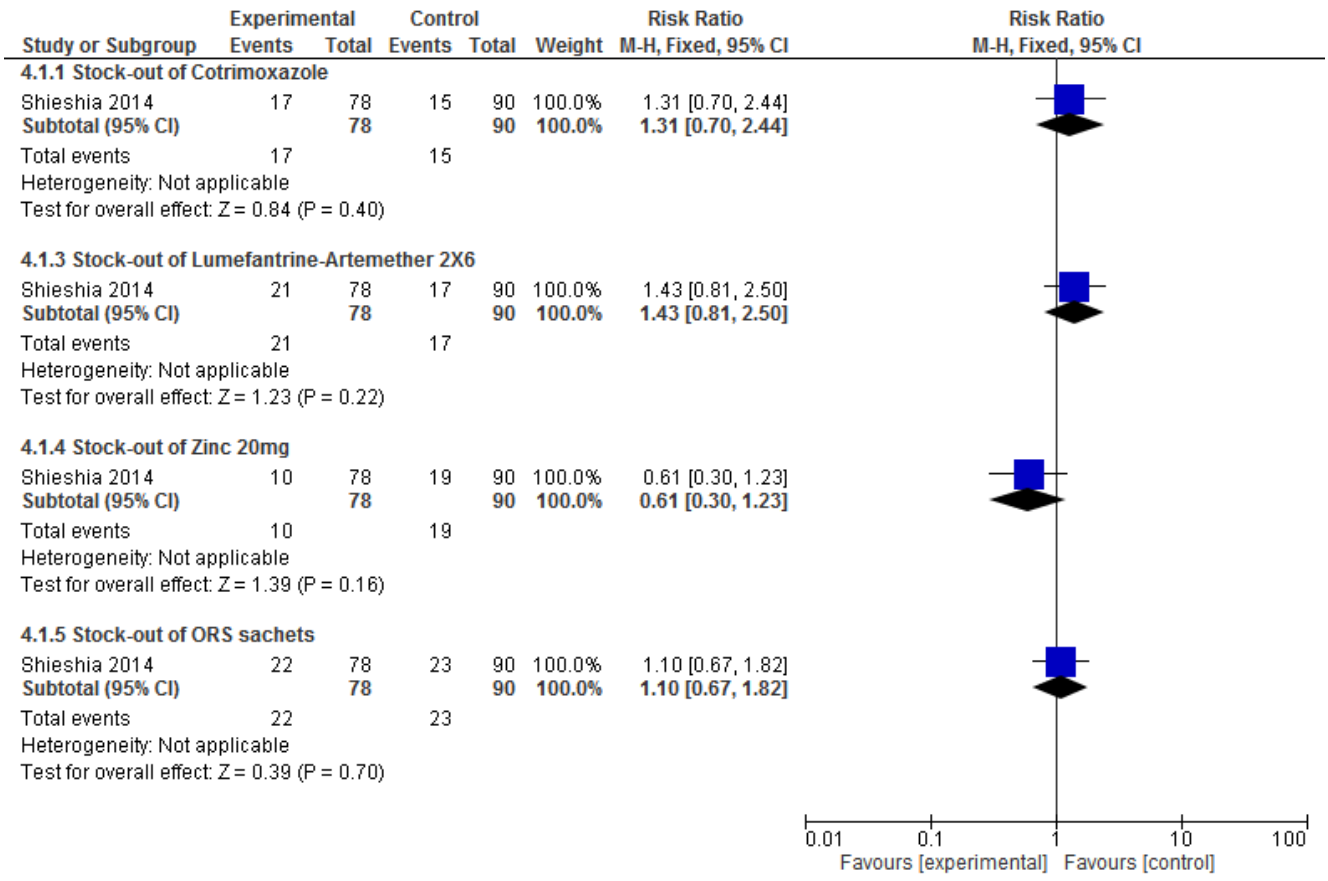
a. Downgraded two step for very serious risk of bias concerns: Unclear random sequence generation, allocation concealment and blinding of participants not feasible given the intervention, unclear blinding of outcomes and incomplete outcome reporting
b. Downgraded one step for imprecision: Small sample size
c. Reporting completeness was assessed by the extent to which health surveillance assistants (intervention group participants) send messages about the stocks on-hand for all the products they managed.
d. Measured over a 18 month period (January 2012-June 2013)

References and notes

1. Shieshia M, Noel M, Andersson S, Felling B, Alva S, Agarwal S, Lefevre A, Misomali A, Chimphanga B, Nsona H, Chandani Y. Strengthening community health supply chain performance through an integrated approach: Using mHealth technology and multilevel teams in Malawi. Journal of global health. 2014 Dec;4(2). Published and unpublished data
2. For this outcome the number of study participants is based on another study sample than for the other outcomes. These data come from ongoing data (backend data in a digital system) and comprise of ALL the healthcare providers who ever reported on stock-levels

Analyses

Stock-out of drugs in the last 30 days



Summary of Qualitative Findings

Summary of the review finding		Studies contributing to the review finding	Overall CERQual assessment of confidence in the evidence
F1	Authors identified infrastructural issues such as challenges in charging phones, uploading and transmitting data and loss of data due to poor network as key barriers to implementation.	Negandhi 2016; Stanton 2016; Shieshia 2014; Asiimwe 2011; Sanabria 2010	**Moderate confidence** Due to methodological limitations as all source material does not include empirical data.
F2	Study authors were concerned that digital stock notification systems used at facility level cannot mitigate a number of broader health system problems, including an underlying lack of stock at national or district level, and a mismatch between national ordering routines and local needs.	Mikkelson-Lopez 2013; Githinji 2013	**Low confidence** Due to methodological limitations, and concerns about adequacy as conclusions are based on two studies.
F3	Study authors suggested that the availability and use of data on stock-levels at all levels of the health system allowed health care officials to respond to anticipated shortages.	Barron 2016; Stanton 2016; Shieshia 2014; Asiimwe 2011	**Low confidence** Due to methodological limitations and concerns about coherence of the data.
F4	The extent to which healthcare providers are familiar with smartphones and are given adequate training in using the digital system influence adoption of the system.	Stanton 2016; Shieshia 2014; Negandhi 2016; Githinji 2013; Barrington 2010; Asiimwe 2011	**Moderate confidence** Due to concerns about methodological limitations.
F5	Study authors considered the availability of technical programming expertise for initial development and ongoing maintenance of the digital system an important implementation factor.	Sanabria 2010; Asiimwe 2011	**Low confidence** Due to concerns about methodological limitations and adequacy as conclusions are based on two studies.
F6	User-friendly systems built with user participation with easy-to-use interfaces were considered important to implementation.	Negandhi 2016; Shieshia 2014; Namisango 2016	**Moderate confidence** Due to concerns about methodological limitations.
F7	Authors emphasized that mangers should have access to data in an easy-to-use format such as an interactive dashboard.	Shieshia 2014; Negandhi 2016; Sanabria 2010	**Moderate confidence** Due to concerns about methodological limitations.
F8	Authors emphasized the role of supportive supervision for effective adoption of a digital system.	Negandhi 2016; Shieshia; Barrington 2010	**Moderate confidence** Due to concerns about methodological limitations.

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2. Stanton, M.,Molineux, A.,Mackenzie, C.,Kelly-Hope, L. (2016). Mobile Technology for Empowering Health Workers in Underserved Communities: New Approaches to Facilitate the Elimination of Neglected Tropical Diseases JMIR Public Health and Surveillance, 2(1), e2
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Web Annex E: Birth and death notification via mobile devices (unpublished review)

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Link to published protocol: https://www.cochrane.org/CD012909/EPOC_birth-and-death-notification-mobile-devices

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Abstract

Background

Ministries of health, donors, and decision-makers now face opportunities to harness mobile technology to acquire accurate and timely statistics on births and deaths. There is high demand from these stakeholders for evidence-based guidance on the value of this technology. In response to this global need, the World Health Organization is developing guidelines to inform investments on digital health approaches that use mobile phones for birth and death notifications.

Objectives

Primary objectives:

- To assess the effects of birth notification via a mobile device, compared to standard practice.
- To assess the effects of death notification via a mobile device, compared to standard practice.

Secondary objectives:

- To describe the range of strategies used to implement birth and death notification via mobile devices.
- To identify factors influencing the implementation of birth and death notification via mobile devices.

Search methods

We searched Cochrane Central Register of Controlled Trials; (CENTRAL) in the Cochrane Library; MEDLINE Ovid; Embase Ovid; Global Health Library WHO; and POPLINE K4Heath on August 12, 2017. We searched the World Health Organization International Clinical Trials Registry Platform; and the US National Institutes of Health Ongoing Trials Register on August 22, 2017. We also searched Epistemonikos for related systematic reviews and potentially eligible primary studies. We conducted a grey literature search using mHealthevidence.org and issued a call for papers through popular digital health communities of practice. Finally, we conducted citation searches of included studies in Scopus, Web of Science, and Google Scholar. We searched for studies published after 2000. We searched for studies in any language.

Selection criteria

Study design: For the primary objectives we included individual and cluster-randomised trials; cross-over and stepped-wedge study designs; controlled before-after studies, provided they have at least two intervention sites and two control sites; and interrupted time series studies, if there is a clearly defined time point when the intervention occurred and at least three data points before and three after the intervention.

For the secondary objectives: we included any study design, either quantitative, qualitative, or descriptive, that aimed to describe current strategies for birth and death notification via mobile devices; or aimed to explore factors that influence the implementation of these strategies, including studies of acceptability or feasibility.

Types of participants: we included studies of all cadres of healthcare providers, including lay health workers; administrative, managerial, and supervisory staff; focal individuals at the village or community level; children whose births are being notified and their parents/caregivers; and individuals whose deaths are being notified and their relatives/caregivers.

Types of interventions: By birth or death notification, we mean the transmission of information via a mobile device to a centralised system or focal individual(s) to report a birth or death event. By mobile devices, we mean mobile phones of any kind (but not analogue landline telephones), as well as tablets, personal digital assistants, and smartphones. Laptops are not included in this list. For the primary objectives, we included studies that compared birth and death notification via mobile devices with standard practice (i.e. non-digital and non-mobile, paper-based processes, and workflows for notifying birth and death events).

For the secondary objectives, we included studies of birth and death notification via mobile device as long as we could extract data relevant to our secondary objectives.

Data collection and analysis

For the primary objectives, two authors independently screened all records, extracted data from the included studies and assessed the risk of bias. For the analyses of the primary objectives, we reported means and proportions where appropriate. We used the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach to assess the certainty of the evidence and we prepared a Summary of Findings table.

For the secondary objectives, two authors independently screened all records, extracted data from the included studies and assessed methodological limitation using the WEIRD tool. We carried out a framework analysis using the Supporting the Use of Research Evidence (SURE) framework to identify themes in the data. We used the GRADE-CERQual (Confidence in the Evidence from Reviews of Qualitative research) approach to assess our confidence in the evidence and we prepared a Summary of Qualitative Findings table.

Main results

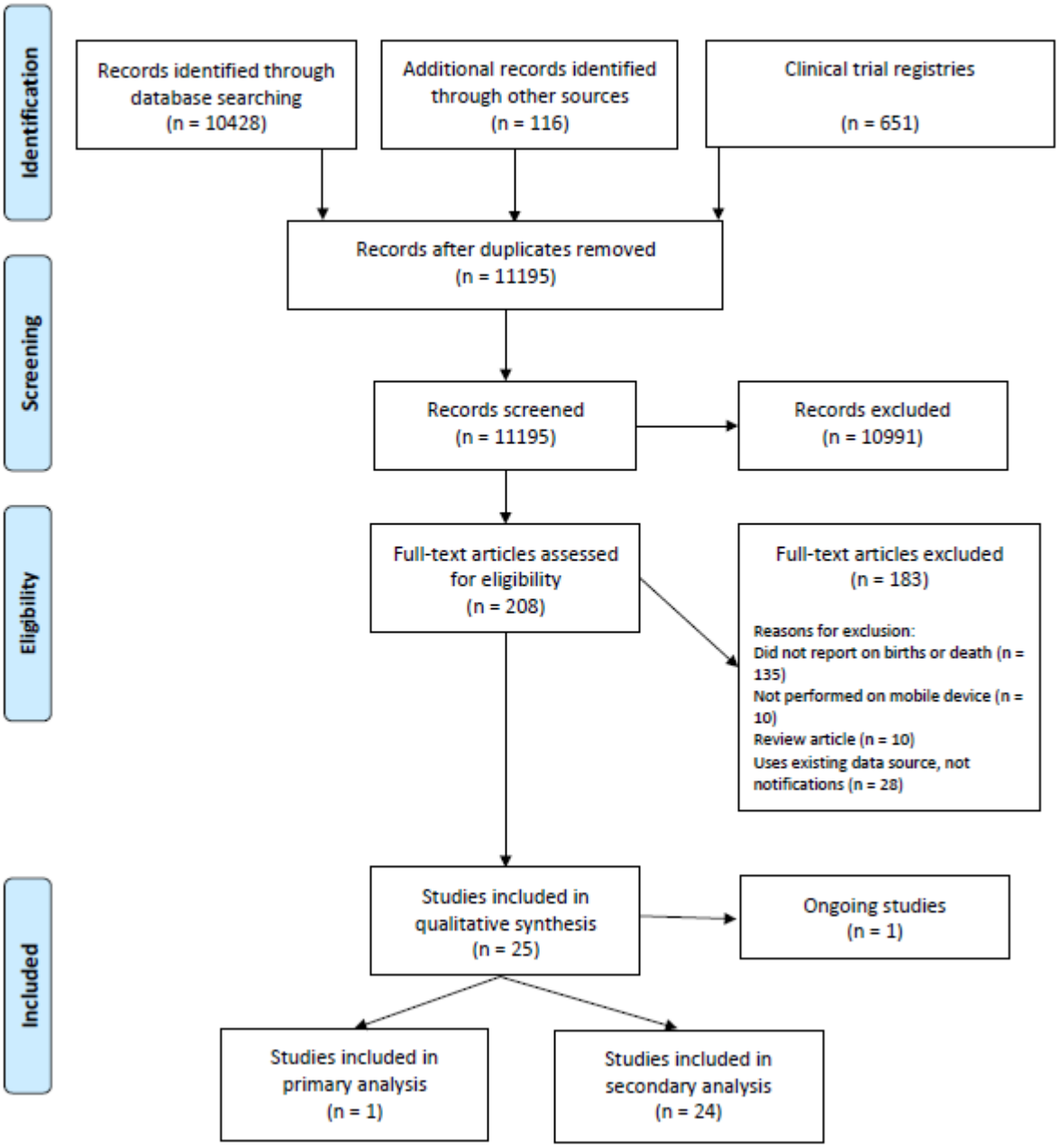
For the primary objectives, we included one study, which used a controlled before-and-after study design and assessed the use of mobile devices for birth notification. The study was conducted in Lao People's Democratic Republic. The study assessed outcomes related to coverage and timeliness. However, we are uncertain of the effect of the intervention on these outcomes because the certainty of this evidence was assessed as very low. The included study did not assess resource use or unintended consequences. We did not identify any studies using mobile devices for death notification.

For the secondary objectives, we included 19 studies. All studies were conducted in low- or middle income settings including five studies in Asia (Lao People's Democratic Republic, Bangladesh, Pakistan and India), and 14 studies in sub-Saharan Africa (Kenya, Mozambique, Tanzania, Zambia, Liberia, Ghana, Uganda, Rwanda, South Sudan and Senegal). No studies were identified from high-income settings. With the exception of one study from Lusaka, Zambia, all included studies focused on identification of births and deaths in rural, remote, or marginalized populations who are typically under-represented in civil registration processes or traditionally seen as having poor access to health services. The mTika study implemented a birth notification intervention in Dhaka, but focused on populations in urban slums.

We identified a number of factors that may influence the implementation of birth-death notification via mobile device. These include the importance of government commitment, legal frameworks and underlying health and civil registration systems (low confidence); geographic barriers (moderate confidence); challenges tied to network connectivity (moderate confidence), the cost and maintenance of the system and data security (low confidence); access to human resources (moderate confidence); healthcare provider factors, including costs they may incur and access to adequate training, support and incentives (moderate confidence); factors related to families, including costs and socio-cultural norms (low confidence); and possible inequities in the implementation of this intervention (moderate confidence).

Authors' conclusions

We need more, well-designed studies of the effect of birth and death notification via mobile device and on factors that may influence its implementation.


Identification
Screening
Eligibility
Included
Records identified through database searching (n = 10428)
Additional records identified through other sources (n = 116)
Clinical trial registries (n = 651)
Records after duplicates removed (n = 11195)
Records screened (n = 11195)
Records excluded (n = 10991)
Full-text articles assessed for eligibility (n = 208)
Full-text articles excluded (n = 183)
Reasons for exclusion:
Did not report on births or death (n = 135)
Not performed on mobile device (n = 10)
Review article (n = 10)
Uses existing data source, not notifications (n = 28)
Studies included in qualitative synthesis (n = 25)
Ongoing studies (n = 1)
Studies included in primary analysis (n = 1)
Studies included in secondary analysis (n = 24)

Summary of Findings

Birth notification via mobile device compared to standard care in community settings

Patient or population: Health Care Workers (HCPs), Village Health Workers (VHVs), newborn children

Setting: Community setting in Lao People's Democratic Republic

Intervention: Provision of mobile phone and credit to HCPs and VHVs to facilitate birth notification

Comparison: Standard care, i.e., no provision of mobile phone or credit to HCPs and VHVs to facilitate birth notification

Outcomes	**Standard care**	**Birth notification via mobile device**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Coverage of birth notification						
Proportion of HCPs who reported receiving a notification from VHV about deliveries or birth using mobile phones	8 per 13	**17 per 17** (100%)		30 (1 non-RCT) Lao People's Democratic Republic[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on coverage of notification about birth because the certainty of this evidence was assessed as very low.**
Proportion of VHVs who reported notifying a HCP about deliveries or births using mobile phones	37 of 44 (84%)	**43 of 45** (96%)		89 (1 non-RCT) Lao People's Democratic Republic[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach coverage of notification about birth because the certainty of this evidence was assessed as very low.**
Number of legal birth registrations	No studies were identified that reported on this outcome					**We are uncertain of the effect of this approach on coverage of legal birth registration because no direct evidence was identified.**
Timeliness of birth notification						

Birth notification via mobile device compared to standard care in community settings

Patient or population: Health Care Workers (HCPs), Village Health Workers (VHVs), newborn children

Setting: Community setting in Lao People's Democratic Republic

Intervention: Provision of mobile phone and credit to HCPs and VHVs to facilitate birth notification

Comparison: Standard care, i.e., no provision of mobile phone or credit to HCPs and VHVs to facilitate birth notification

Outcomes	**Standard care**	**Birth notification via mobile device**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Proportion of HCPs who reported receiving a notification from VHV about imminent deliveries or within 1 day of birth using mobile phones	8 per 13	**17 per 17** (100%)		30 (1 non-RCT) Lao People's Democratic Republic[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on timeliness of receiving a notification because the certainty of this evidence was assessed as very low.**
Proportion of VHVs who reported notifying HCPs either during labor or within 1 day of birth using mobile phones	32 of 49 (65%)	**43 of 52** (83%)		101 (1 non-RCT) Lao People's Democratic Republic[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach timeliness of sending notification because the certainty of this evidence was assessed as very low.**
Timeliness of legal birth registration	No studies were identified that reported on this outcome					**We are uncertain of the effect of this approach on timeliness of legal birth registration because no direct evidence was identified.**
Coverage of newborn or child healthcare services						
Number of births where HCP made postnatal care visit to home	After: 88/308 (28%) Before: 57/260 (19%)	**After: 132/418 (30%)** **Before: 62/353 (11%)**		1,339[2] (1 non-RCT) Lao People's Democratic Republic[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on the number of births where HCP made postnatal care visit to home because the certainty of this evidence was assessed as very low.**

Birth notification via mobile device compared to standard care in community settings

Patient or population: Health Care Workers (HCPs), Village Health Workers (VHVs), newborn children

Setting: Community setting in Lao People's Democratic Republic

Intervention: Provision of mobile phone and credit to HCPs and VHVs to facilitate birth notification

Comparison: Standard care, i.e., no provision of mobile phone or credit to HCPs and VHVs to facilitate birth notification

Outcomes	**Standard care**	**Birth notification via mobile device**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Number of births for which HepB birth dose vaccination was provided within 30 days	After: 257/347 (71%) Before: 135/309 (39%) 32% increase	**After: 348/463 (70%)** **Before: 95/406 (15%)**		1,525[2] (1 non-RCT) Lao People's Democratic Republic[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on the number of births for which HepB birth dose vaccination was provided within 30 days because the certainty of this evidence was assessed as very low.**
Timeliness of newborn or child healthcare services						
Number of births where HepB vaccine was administered within 0-1 day	After: 232/257 (90%) Before: 114/135 (83%)	**After: 287/348 (81%)** **Before: 63/95 (74%)**		835[2] (1 non-RCT) Lao People's Democratic Republic[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on the number of births where HepB vaccine was administered within 0-1 day because the certainty of this evidence was assessed as very low.**
Number of births where HepB vaccine was administered within 2-7 days	After: 22/257 (9%) Before: 14/135 (11%)	**After: 55/348 (17%)** **Before: 29/95 (24%)**		835[2] (1 non-RCT) Lao People's Democratic Republic[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on the number of births where HepB vaccine was administered within 2-7 days because the certainty of this evidence was assessed as very low.**

Birth notification via mobile device compared to standard care in community settings

Patient or population: Health Care Workers (HCPs), Village Health Workers (VHVs), newborn children

Setting: Community setting in Lao People's Democratic Republic

Intervention: Provision of mobile phone and credit to HCPs and VHVs to facilitate birth notification

Comparison: Standard care, i.e., no provision of mobile phone or credit to HCPs and VHVs to facilitate birth notification

Outcomes	**Standard care**	**Birth notification via mobile device**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Number of births where the HCP made a postnatal care home visit with 24 hours of notification	At least 50% of the time: 10/13 (77%) Less than 50% of the time: 3/13 (23%)	**At least 50% of the time: 10/17 (59%)** **Less than 50% of the time: 7/17 (41%)**		30 (1 non-RCT) Lao People's Democratic Republic[1]	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on the number of births where the HCP made a postnatal care home visit with 24 hours of notification because the certainty of this evidence was assessed as very low.**
Timeliness of legal birth registration	No studies were identified that reported on this outcome					**We are uncertain of the effect of this approach on timeliness of legal birth registration because no direct evidence was identified.**
Resource use						
Resource use	No studies were identified that reported on this outcome					**We are uncertain of the effect of this approach on resource use because no direct evidence was identified.**
Unintended consequences						
Unintended consequences	No studies were identified that reported on this outcome					**We are uncertain of the effect of this approach on unintended consequences because no direct evidence was identified.**

RCT: Randomised controlled trial

Birth notification via mobile device compared to standard care in community settings

Patient or population: Health Care Workers (HCPs), Village Health Workers (VHVs), newborn children

Setting: Community setting in Lao People's Democratic Republic

Intervention: Provision of mobile phone and credit to HCPs and VHVs to facilitate birth notification

Comparison: Standard care, i.e., no provision of mobile phone or credit to HCPs and VHVs to facilitate birth notification

Outcomes	**Standard care**	**Birth notification via mobile device**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?

GRADE Working Group grades of evidence. **High certainty:** We are very confident that the true effect lies close to that of the estimate of the effect. **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect. **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

HCPs: Healthcare Providers; **VHVs:** Village Health Workers

Explanations

a. Downgraded two steps for very serious risk of bias concerns: Unclear random sequence generation, allocation concealment and blinding of participants not feasible given the intervention, unclear blinding of outcomes and incomplete outcome reporting
b. Downgraded one step for imprecision: Small sample size and scarce reporting

References and notes

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2. The study had different respondent number for different follow-up times and the respondent number varied according to who they were (HCP, VHV, women/parents etc)

Analyses

No meta-analyses performed.

Summary of Qualitative Findings

Summary of the review finding		Studies contributing to the review finding	Overall CERQual assessment of confidence in the evidence
A. Health system constraints in the implementation of birth and death notification via mobile devices			
A.1	Geographic barriers hamper timeliness of birth and death notification conducted via mobile devices, as well as post-notification services or processes (e.g., certification of birth or death).	Xeuatvongsa 2016; ANISA 2016; Pascoe 2012; MOVE-IT 2013; Ngabo 2012; MBRT 2017, mVRS 2017	**Moderate confidence** Serious concerns related to methodological limitations. Few or no concerns related to coherence, relevance and adequacy.
A.2	Notification of birth and death data using mobile phones, alone or in conjunction with other non-mobile strategies, may facilitate provider and health system accountability for collection of vital data and post-notification service delivery.	Moshabela 2015; MBRT 2017; ANISA 2016;	**Low confidence** Serious concerns related to methodological limitations and adequacy. Few or no concerns with coherence and relevance.
A.3	Local capacity to train future cadres of notifiers can be strengthened though "train the trainer" approaches.	Ngabo 2012; MBRL 2011	**Low confidence** Serious concerns related to methodological limitations and adequacy. Few or no concerns with coherence and relevance.
A.4	Mechanisms for continuous monitoring and supportive supervision are important for ensuring quality and timeliness of birth and death data collected via mobile devices.	Mosabela 2015; Andreatta 2011; mTika 2016; Ngabo 2012; MOVE-IT 2013; Yugi 2016; ImTECHO 2015; Pascoe 2012	**Moderate confidence** Moderate concerns related to methodological limitations and adequacy. Few or no concerns with coherence and relevance.
A.5	There is inadequate attention to legal frameworks governing civil registration. These may need to be modified to allow new notification modalities (i.e. via mobile-cellular channels) and the inclusion of new cadres of notifiers.	Mozambique 2017; MVRS 2017; MBRP 2015	**Low confidence** Serious concerns related to methodological limitations and adequacy. Few or no concerns with coherence and relevance.
A.6	Availability of adequate human resources to conduct birth and death notification via mobile devices may be facilitated by hiring new cadres of notifiers or recruiting existing cadres of healthcare providers for provision of notification.	Andreatta 2011; MBRL 2011; Gisore 2012; Pascoe 2012; MOVE-IT 2013; Xeuatvongsa 2016; Yugi 2016; ANISA 2016; mVRS 2016; Mozambique 2017; MBRT 2017	**Moderate confidence** Serious concerns related to methodological limitations. Few or no concerns with coherence, relevance, and adequacy.
A.7	Implementation of birth and death notification via mobile devices may be influenced by underlying health and civil registration system infrastructure, resources, and processes.	Ngabo 2012; MBRL 2011; MOVE-IT 2013; Moshabela 2015; ANISA 2016; mVRS 2017; Gisore 2012; ImTeCHO 2015	**Low confidence** Serious concerns related to methodological limitations. Minor concerns related to adequacy. Few or no concerns with coherence, and relevance.
B. Factors related to individuals providing birth and death notification via mobile devices			
B.1	Costs incurred by healthcare providers sending notification using personal mobile phones may need to be reimbursed to facilitate sustained use of these technologies for notification.	Ngabo 2012; Pascoe 2012; M-SIMU 2017; Yugi 2016; Xeautvongsa 2016; Gisore 2012	**Moderate confidence** Moderate concerns related to methodological limitations and adequacy. Few or no concerns related to coherence or relevance
B.2	The use of mobile phones for notification is acceptable to health providers, and seen as supportive of job responsibilities.	Ngabo 2012; Pascoe 2012; m-SIMU 2017, Van Dam 2015; Yugi 2016; ImTeCHO 2015	**Moderate confidence** Moderate concerns related to methodological limitations and adequacy. Few or no concerns related to coherence and relevance

Summary of the review finding		Studies contributing to the review finding	Overall CERQual assessment of confidence in the evidence
B.3	Rigorous training on how to use mobile devices, and provision of post-training support may be necessary for facilitating digital birth and death notification by notifiers who lack familiarity with, or prior experience using mobile technologies.	Andreatta 2011; Gisore 2012; Ngabo 2012; M-SIMU 2017; Yugi 2016 mTika 2016; Xeautvongsa 2016; MBRT 2017; van Dam 2015; MBRL 2011; MOVE-IT 2013	**Moderate confidence** Moderate concerns related to methodological limitations. Few or no concerns related to coherence, relevance, and adequacy.
B.4	Successful adoption of mobile birth and death notification strategies by healthcare providers may be affected by competing priorities and lack of adequate incentives	MOVE-IT 2013; M-SIMU 2017; mTika 2016	**Moderate confidence** Minor concerns related to methodological limitations. Serious concerns related to adequacy. Few or no concerns related to coherence and relevance.
C. Factors related to families for whom birth and death is notified via mobile devices			
C.1	For some families, costs may be a barrier to completing birth and death registration post-notification.	MOVE-IT 2013, MBRP 2015, MBRT 2017	**Low confidence** Serious concerns related to methodological limitations and adequacy. Few or no concerns related to coherence, relevance, and adequacy.
C.2	There may be a need for targeted demand generation activities in communities with low awareness for the need of birth and death registration, concurrent to the use of mobile phones for birth and death notification.	MOVE-IT 2013; MBRG 2017; mVRS 2017; MBRT 2017; ImTeCHO 2015	**Low confidence** Serious concerns related to methodological limitations. Moderate concerns related to adequacy. Few or no concerns related to coherence and relevance.
C.3.	Socio-cultural norms may influence the timely identification of births and deaths, and should be taken into consideration when developing mobile phone interventions for notification.	MOVE-IT 2013; MBRG 2017; MBRP 2015; ANISA 2015	**Low confidence** Serious concerns related to methodological limitations and adequacy. Few or no concerns related to coherence and relevance
D. Factors related to stakeholders involved in birth and death notification via mobile devices			
D.1	Study authors reported strong government commitment as a key factor in the successful implementation of birth and death notification via mobile devices.	MBRL 2011; Ngabo 2012; Yugi 2016 mVRS 2017; Mozambique 2017; MBRT 2017; MBRP 2015	**Low confidence** Serious concerns related to methodological limitations. Moderate concerns related to adequacy. Few or no concerns related to coherence or relevance.
E. Factors related to technologies used for birth and death notification via mobile devices			
E.1	Study authors reported cost as an important consideration in the purchase, set up, and scaling of mobile technologies needed for birth and death notification.	Ngabo 2012; Xeuatvongsa 2016; Gisore 2012; mTika 2016; ImTeCHO 2015 Pascoe 2012; van Dam 2015; Yugi 2017; mVRS 2017	**Low confidence** Serious concerns related to methodological concerns. Moderate concerns related to adequacy. Few or no concerns related to coherence and relevance.
E.2	Study authors reported challenges with maintaining mobile phones and associated technologies (e.g., servers) for notifying births and deaths.	Ngabo 2012; ImTeCHO 2015; MBRL 2011; Pascoe 2012; Gisore 2012; MBRP 2015; MBRT 2017	**Low confidence** Serious concerns related to methodological concerns. Moderate concerns related to adequacy. Few or no concerns related to coherence and relevance.

	Summary of the review finding	Studies contributing to the review finding	Overall CERQual assessment of confidence in the evidence
E.3	Study authors reported availability of network connectivity as a key factor in the successful implementation and scale-up of birth and death notification via mobile devices.	Ngabo 2012; Pascoe 2012; MOVE-IT 2013; Yugi 2016; ANISA 2016; M-SIMU 2017; van Dam 2015; mVRS 2017; MBRT 2017, MBRP 2015, ImTeCHO 2015	**Moderate confidence** Serious concerns related to methodological limitations. Few or no concerns with coherence, relevance, and adequacy.
E.4	Study authors described varying data security and encryption measures to preserve confidentiality of birth and death information notified via mobile devices.	ImTeCHO 2015; van Dam 2015; MBRT 2015; Ngabo 2012	**Low confidence** Serious concerns with methodological limitations and adequacy. Few or no concerns with coherence and relevance
F. Equity considerations in the implementation of birth and death notification via mobile devices			
F.1	While birth and death notification via mobile devices was seen as a way to reach under-registered populations, study authors reported inequities in the implementation of this strategy related to availability of supportive infrastructure (network coverage, roads, human resources), human factors (age, gender, literacy, poverty), and selective funding priorities of donors.	Gisore 2012; MBRP 2015; MBRT 2017; Andreatta 2011; Ngabo 2012; MOVE-IT 2013 M-SIMU 2017; mTika 2016; Yugi 2016; Xeuatvongsa 2016; mVRS 2017	**Moderate confidence** Serious concerns related to methodological limitations. Few or no concerns related to coherence, relevance, and adequacy.

Web Annex F: Factors influencing the acceptability, feasibility and implementation of interactive telemedicine: an overview of reviews (unpublished overview)

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Abstract

Background

In response to the needs of government decision-makers globally, the World Health Organization (WHO) Department of Reproductive Health and Research (RHR) has initiated guidelines to inform government-led investments of digital health strategies for strengthening RMNCAH essential interventions. The WHO has recently commissioned a series of systematic reviews to inform these guidelines as well as the current overview. This overview complements two other WHO-commissioned reviews that focus on the effectiveness of mobile-based technologies to support client-to-healthcare provider and healthcare provider-to- healthcare provider communication and management of care.

Objectives

To identify, appraise and synthesize systematic reviews exploring factors that influence the acceptability, feasibility and implementation of telemedicine interventions.

Search methods

We searched MEDLINE Ovid on July 10th 2017 and the Epistemonikos database on October 14th 2017 for reviews published in 2000 and later. We included reviews in any language.

Selection criteria

Type of reviews: We included reviews that fulfilled the PRISMA definition of a systematic review and that aimed to explore factors influencing the acceptability, feasibility or implementation of telemedicine. Eligible reviews needed to have fulfilled the following criteria:

- A clearly stated set of objectives
- An explicit, reproducible methodology (Had the review authors clearly described the methods they had used to extract and synthesis data?)
- A systematic search that attempts to identify all studies that would meet the eligibility criteria
- An assessment of the validity of the findings of the included studies
- Systematic presentation, and synthesis, of the characteristics and findings of the included studies. We operationalized this item by assessing whether the review authors had presented information about the included studies, including a full reference to each study and the study

design used in each study; and whether they had presented a synthesis of the study results, as opposed to a simple listing of the results from each study.

We included reviews that included qualitative studies, surveys or mixed methods. We excluded reviews that primarily aimed to assess the effectiveness or cost effectiveness of telemedicine; primarily aimed to describe the use or distribution of telemedicine, but did not aim to synthesise the results; or only included surveys assessing patient satisfaction.

Type of interventions, populations and settings: We included reviews that had telemedicine as their primary focus. We defined telemedicine as the provision of healthcare services at a distance, in which communication is conducted between healthcare providers seeking clinical guidance and support from other healthcare providers; or in which communication is conducted between remote healthcare users seeking health services and healthcare providers. We focused exclusively on interactive telemedicine, where the person's inquiry receives a response in real-time or response is as immediate as clinically appropriate. Where reviews focused on broader sets of digital or non-digital interventions, we included these reviews if it was possible to extract those findings that specifically concerned telemedicine. We included reviews where telemedicine is delivered through a variety of channels. However, as telemedicine through mobile devices is the main focus of the WHO guideline that this overview aims to inform, we excluded reviews if mobile devices had been excluded. We included reviews that explored telemedicine among any population group or healthcare condition, any healthcare provider cadre; and in any setting.

Data collection and analysis

Two authors independently assessed titles and abstracts of the identified records to identify their potential eligibility. The full text of all the papers that are likely to be relevant were retrieved and assessed independently by two review authors. Once papers were included, we extracted data about author, publication date, language, review inclusion criteria, and results. We extracted data on the methodological quality of the included reviews based on the five main domains of the ENTREQ statement criteria. The adapted criteria were:

- Is there a clear description of the review objective? If so, does it aim to explore factors influencing the acceptability, feasibility or implementation of telemedicine?
- Is there a clear description of the methods used to extract and synthesize data?
- Was a systematic search carried out to identify all studies that would meet the eligibility criteria?
- Is there an assessment of the validity of the findings of the included studies?
- Is there a systematic presentation, and synthesis, of the characteristics and findings of the included studies?

Three authors analysed the data using a thematic analysis approach. We used an adapted version of the GRADE-CERQual approach to assess the confidence of each of the overview findings.

Main results

Six reviews fulfilled our inclusion criteria. The reviews were published between 2003 and 2017, and included individual studies published between 1993 and 2016. One of the reviews only included the review authors' own studies. The reviews only assessed papers published in English. Four reviews explored the use of telemedicine and staff members' and clients' perspectives and experiences of telemedicine in a range of areas including COPD/CHD, cancer, long-term conditions, psychiatry, internal medicine and dermatology. Most of the studies in these four reviews were from Europe, with the remaining studies from North America, Australia and Asia. These reviews included qualitative studies or qualitative, quantitative and mixed methods studies. One review focused on factors that hinder or support the implementation of cross-border services. The majority of services

were delivered through collaborations between high income countries and low or middle income countries. The studies included in this review were primarily programme descriptions, case reports, and pilot or feasibility studies. One review focused on security issues associated with telemedicine. However, this review did not contribute data to any of the findings.

The overview highlights a number of issues that can potentially influence the acceptability, feasibility and implementation of telemedicine programmes. Healthcare workers want easy-to-use, reliable equipment and ongoing technical support. However, they often experience installation and usability issues, poor integration with other systems, and problems with electricity, bandwidth and connectivity (high confidence). The impact of telemedicine on healthcare providers' workload is likely to influence their acceptance of these programmes (moderate confidence), as is their access to training (high confidence). The collaboration between healthcare workers that provider-to-provider telemedicine implies is often appreciated and can reduce professional isolation. But for some healthcare providers, collaboration can be challenging or cause resistance because of a lack of trust, loss of control, power conflicts, disagreements about roles, and cultural and linguistic differences (moderate confidence). With regard to client-to-provider telemedicine, healthcare providers have concerns about the impact that this may have on the healthcare worker – client relationship and on quality of care (moderate confidence); and may also have concerns about the impact on their professional identity and credibility (very low confidence).

Some clients see client-to-provider telemedicine services as offering reassurance and a sense of safety and appreciate the increased access, consistency and continuity of care (low confidence). Some clients appreciate the convenience of telemedicine as it saves time and money and reduces the burden of travel, although others may see it as difficult to engage with or too time consuming (low confidence). Some clients also appreciate being able to communicate with healthcare workers from their home environment, while others miss face-to-face contact (low confidence). Some clients believe that telemedicine has increased their independence and self-care, but some healthcare workers may be concerned about clients' ability to manage their own conditions (low confidence). Telemedicine services can give clients who speak minority languages access to providers who speak these languages. However, access may be difficult for others to achieve, for instance because of hearing impairments, poor computer literacy or technical issues (high confidence).

Other issues raised by healthcare providers, clients and other stakeholders include concerns about the data confidentiality and security (moderate confidence); challenges in achieving informed consent for sharing records and images in settings with low literacy or computer literacy levels (moderate confidence); and concerns that the population will see telemedicine as a cost-cutting exercise (low confidence). Stakeholders also highlight the importance of involving staff and patients in service design (moderate confidence); clarifying liability issues for healthcare workers providing care through telemedicine (low confidence); integrating telemedicine systems into existing healthcare systems (low confidence); and ensuring institutional support and using local champions to support this integration (low confidence), but also highlight problems in achieving these goals.

Summary of Qualitative Findings

Summary of overview finding		Reviews contributing to the overview finding	Methodological limitations	Relevance	Adequacy	Coherence	Overall CERQual assessment of confidence in the evidence
F1	Some healthcare workers are concerned that loss of face-to-face communication will change the healthcare worker – patient relationship and could lead to poorer quality care	Brewster 2013[1]; May 2003[3]	Moderate concerns about methodological limitations in May 2003 (no assessment of quality of included studies)	No or very minor concerns	No or very minor concerns	No or very minor concerns	**Moderate confidence** (due to moderate concerns about methodological limitations).
F2	Healthcare workers want easy-to-use, reliable equipment and ongoing technical support. However, they often experience installation and usability issues, poor integration with other systems, and problems with electricity supplies, bandwidth and connectivity	Brewster 2013[1]; Saliba 2012	No or very minor concerns	No or very minor concerns	No or very minor concerns	No or very minor concerns	**High confidence**
F3	Healthcare workers may be concerned that telemedicine could undermine their professional identify and credibility	Brewster 2013[1]	No or very minor concerns	No or very minor concerns	Serious concerns because of thin data	Moderate concerns - it was hard to tell if the data really supported this finding because of vague descriptions	**Very low confidence** (due to serious concerns about adequacy and moderate concerns about coherence)

F4	Healthcare workers are less likely to accept telemedicine services if they are perceived as increasing or not reducing their workload (moderate confidence)	Brewster 2013[1]; May 2003[3]; Saliba 2012	Moderate concerns about the methodological quality of May 2003 (no assessment of the quality of the included studies)	No or very minor concerns	No or very minor concerns	No or very minor concerns	**Moderate confidence** (due to moderate concerns about methodological limitations)
F5	Collaboration between different healthcare workers is often appreciated and can reduce professional isolation. But for some healthcare providers, collaboration can be challenging or cause resistance because of a lack of trust, loss of control, power conflicts, disagreements about roles, and cultural and linguistic differences	Brewster 2013[1]; May 2003[3]; Saliba 2012	Minor concerns because of methodological limitations with May review, but this review only contributed to a small part of finding)	No or very minor concerns	Minor concerns about number of studies	No or very minor concerns	**Moderate confidence** (because of minor concerns about methodological limitations and adequacy)
F6	Staff training is considered important for staff acceptance and system use	Brewster 2013[1]; Saliba 2012	No or very minor concerns	No or very minor concerns	No or very minor concerns	No or very minor concerns	**High confidence**

F7	Some clients may believe that telemedicine has increased their independence and self-care, but healthcare workers may be concerned about this transfer of responsibilities	Brewster 2013[1]; Cox 2017[2]; Raphael 2016[4]	No or very minor concerns	Moderate concerns because of partial relevance. Healthcare provider perspectives are from review of cancer patients only, while client perspectives are from COPD and from adults over 65.	Moderate concerns because of thin data	No or very minor concerns	**Low confidence** because of concerns about partial relevance and data adequacy
F8	Some clients may appreciate being able to communicate with healthcare workers from their home environment, while others may miss face-to-face contact	Cox 2017[2]	No or very minor concerns	Serious concerns about partial relevance as clients were all cancer patients	No or very minor concerns	No or very minor concerns	**Low confidence** because of serious concerns about partial relevance
F9a	Some clients may see telemedicine as offering reassurance and a sense of safety and may appreciate the increased access, consistency and continuity of care.	Cox 2017[2]	No or very minor concerns	Serious concerns about partial relevance as clients were all cancer patients	No or very minor concerns	No or very minor concerns	**Low confidence** because of serious concerns about partial relevance
F9b	Telemedicine services can give clients speaking minority languages access to providers who speak their mother tongue. However, access may be difficult for others to achieve, for instance because of hearing impairments, poor computer literacy or technical issues	Cox 2017[2]; Saliba 2012[5]	No or very minor concerns	No or very minor concerns	Minor concerns about number of studies for part of the finding (use of healthcare providers speaking mother tongue)	No or very minor concerns	**High confidence**

F10	Some clients, particularly those with caring or work responsibilities, may appreciate the convenience of telemedicine as it saves time and money and reduces the burden of travel, although others may see it as difficult to engage with or too time consuming	Cox 2017[2]	No or very minor concerns	Minor concerns about partial relevance as the review focuses on cancer patients only (they may have different needs and different amount of services than others)	Moderate concerns about small number of studies and thinness of data for second part of finding	No or very minor concerns	**Low confidence** because of minor concerns about relevance and adequacy
F11	Some stakeholders may be concerned that the population will see telemedicine primarily as a cost-cutting exercise	Saliba 2012[5]	No or very minor concerns	Moderate concerns about partial relevance (the participants were from UK only)	Moderate concerns about thin data	No or very minor concerns	**Low confidence** because of moderate concerns about relevance and adequacy
F12	Some stakeholders are concerned about the confidentiality of medical information and data security	Saliba 2012[5]	No or very minor concerns	Moderate concerns because of partial relevance (all data comes from review on cross-border telemedicine)	No or very minor concerns	No or very minor concerns	**Moderate confidence** because of concern about partial relevance
F13	Informed consent needs to be ensured but can be challenging to achieve in settings with low levels of literacy or computer literacy	Saliba 2012[5]	No or very minor concerns	No or very minor concerns	Minor concerns about data thinness and small number of studies	No or very minor concerns	**Moderate concerns** because of data adequacy

F14	Liability issues for healthcare workers providing care through telemedicine systems may need to be clarified	Saliba 2012[5]	No or very minor concerns	Serious concerns because of partial relevance (the review focuses on cross-border telemedicine)	No or very minor concerns	No or very minor concerns	**Low confidence** because of serious concerns about relevance
F15	Where telemedicine systems begin as pilot systems, stakeholders argue that they need to be integrated into existing healthcare systems to be acceptable and sustainable. However, this may require many changes and can be difficult to achieve	Brewster 2013[1]; May 2003[3]; Saliba 2012[5]	Moderate concerns because one of the reviews (May 2012) does not meet all PRISMA criteria (no assessment of quality of included studies)	Moderate concerns about partial relevance (one of the reviews focuses on cross-border telemedicine) and one of the review includes studies that are relatively old (May 2003)	No or very minor concerns	No or very minor concerns	**Low confidence** because of moderate concerns about methodological limitations and relevance
F16	The involvement of staff and patients in service design is considered important for acceptability, but not always done	Brewster 2013[1]; Cox 2017[2]	No or very minor concerns	No or very minor concerns	Minor concerns because of thin data and few studies	No or very minor concerns	**Moderate confidence** due to minor concerns about data adequacy
F17	Institutional support and local champions may be important for ensuring integration into existing systems, although staff re-organisation can undermine this	Brewster 2013[1]; May 2003[3]; Saliba 2012[5]	Moderate concerns because one of the reviews (May 2003) did not meet PRISMA criteria	No or very minor concerns	Minor concerns because of thin data	No or very minor concerns	**Low confidence** because of concerns about methodological limitations and data adequacy

[1] Brewster, L., et al. (2014). *Factors affecting front line staff acceptance of telehealth technologies: a mixed-method systematic review*. J Adv Nurs 70 (1): 21-33

[2] Cox A, et al. *Cancer Survivors' Experience With Telehealth: A Systematic Review and Thematic Synthesis*. J Med Internet Res. 2017 Jan; 19(1): e11.

[3] May C, et al. *Understanding the normalization of telemedicine services through qualitative evaluation*. JAMIA, Vol 10, No 6, Nov/Dec 2003

[4] Raphael, D, et al. *Telephone communication between practice nurses and older patients with long term conditions - a systematic review*. Jf Telemed Telecare 2016, 23(1): 142-148.

[5] Saliba V, et al. *Telemedicine across borders: A systematic review of factors that hinder or support implementation*. Int J Med Inform. 2012 Dec;81(12):793-809.

Web Annex G: Targeted client communication via mobile phones for sexual, reproductive, maternal, neonatal and child health (unpublished review)

Link to protocols:
https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=87234&VersionID=1136179
https://www.crd.york.ac.uk/PROSPEROFILES/87124_PROTOCOL_20180221.pdf

Melissa Palmer[1], Caroline Free[1], Nicholas Henschke[3], Claire Glenton[4], Simon Lewin[4], Marita Fønhus[4], Tigest Tamrat[2], Garrett Mehl[2], Gemma Villanueva[3], Nicola Maayan[3], Hanna Bergman[3].

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Abstract

Objective

The overall aim of this review was to assess the effects of targeted client communication (TCC) via mobile devices on people's: behaviour, health and wellbeing, and health service use in the areas of reproductive, sexual, maternal, newborn and child health focusing on MRNCH priorities in LMIC relating to the WHO essential interventions for reproductive, maternal, newborn and child health (PMNCH, 2011).

Search strategy

We searched the following electronic databases: The Cochrane Central Register of Controlled Trials (CENTRAL, *The Cochrane Library, latest issue*); MEDLINE (OvidSP) (*2010* to present); EMBASE Classic + Embase (OvidSP) (*2010* to present); POPLINE; WHO Global Health Library. We searched for ongoing trials in the following trial registries: WHO ICTRP (World Health Organization International Clinical Trials Registry Platform; www.who.int/ictrp); and US National Institutes of Health Ongoing Trials Register ClinicalTrials.gov (www.clinicaltrials.gov). We also searched Epistomonikos (https://www.epistemonikos.org/). Additionally, the WHO issued a call for papers through popular digital health communities of practice to identify additional primary studies as well as grey literature. On completion of screening, we ran a search for all relation citations of the included studies.

Selection criteria

Publication dates: We searched for studies published since 2010.
Study design: Randomised trials.
Type of participants:

- Pregnant and postpartum women up to six weeks after birth, and their partners or others who support them
- Pregnant and postpartum women up to six weeks after birth living with HIV, and their partners or others who support them
- Parents and caregivers of children under five years of age

• Adolescent and youth populations (ages 10-24 years) as potential users of sexual and reproductive health (SRH) services.
• Adult users / potential users of sexual and reproductive health services (SRH)

Types of interventions: Trials that assessed targeted client communication delivered via mobile devices, where the content of the communication is intended to improve reproductive, sexual, maternal, newborn, and/or child health. By 'targeted client communication' we mean the transmission of targeted health content to a specified population or individuals within a predefined health or demographic group. By mobile devices, we mean mobile phones of any kind (but not analogue landline telephones), as well as tablets and personal digital assistants, which facilitate communication via different multimedia channels including Short Message Service (SMS), voice calls, interactive voice response (IVR), multimedia Message Service (MMS), and smartphone applications (apps) when used for instant messaging purposes.

We included studies in which the intervention delivered to mobile phone is the primary intervention component under evaluation. We included studies in which the intervention was compared to either standard care; or targeted, non-digital communication (e.g. letters, face-to-face communication to clients); or non-targeted, digital communication via mobile devices.

Data collection and analysis

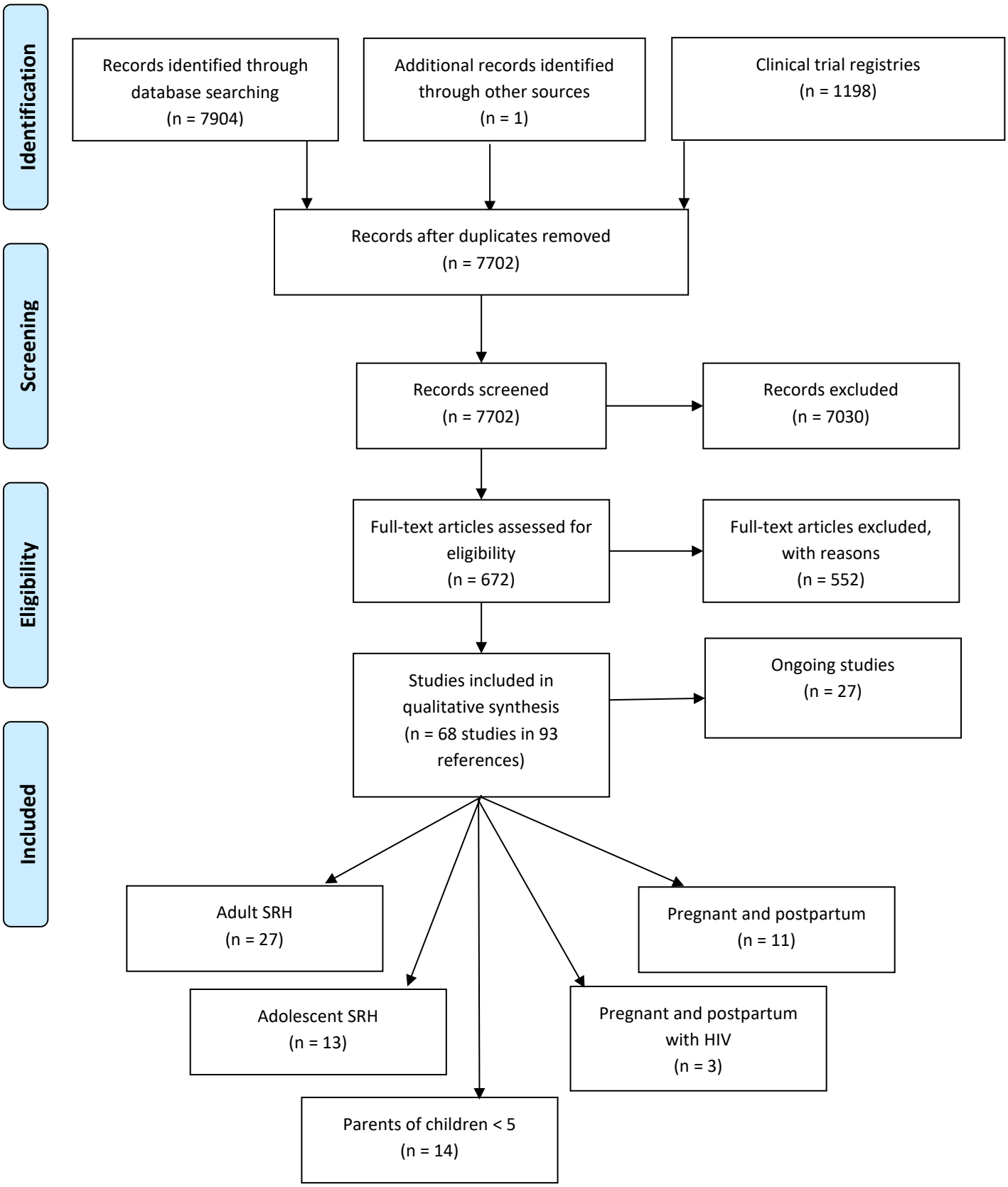
Two authors independently screened search results. One review author extracted data from included studies, and this was cross-checked by a second reviewer. We assessed methodological risk of bias of included studies in accordance with the Cochrane Handbook and the guidelines of the Cochrane Consumers and Communication Review Group. We assessed the certainty of the evidence using GRADE.

Main results

- *TCC via mobile phones for sexual and reproductive health (adults):* 27 studies met the inclusion criteria – eight were carried out in high income countries, eight in upper middle income countries, nine in lower middle income countries, one in a low income country, and one trial was conducted in two countries (South Africa – a upper middle income country, and Uganda – a low income country).
- *TCC via mobile phones for sexual and reproductive health (adolescents):* 13 studies met the inclusion criteria. With the exception of one trial conducted in a lower middle income country (Ghana), all other trials were carried out in high income countries.
- *TCC via mobile phones for pregnant and post-partum women:* 11 studies met the inclusion criteria - four were conducted in high income countries, two in upper middle income countries, four in lower middle income countries, and one in a low income country.
- *TCC for pregnant and post-partum women living with HIV:* Three studies met the inclusion criteria – all of which were carried out in Kenya (a lower middle income country).
- *TCC for parents and carers of children under 5 years:* Fourteen studies met the inclusion criteria, six of which were conducted in high income countries, seven in lower middle income countries, and one in a low income country.

See the Summary of Findings tables for the results of the review.

Prisma flow diagram



Summaries of Findings A: Adolescent users of sexual and reproductive health services

A.1 Summary of Findings table with plain language summary

Digital, targeted client communication for adolescents compared to standard care in primary healthcare settings

Patient or population: Adolescents aged 14-24 years
Setting: Community settings in high-income countries (Australia, USA [3])
Intervention: Targeted client communication (reminders and/or information/education via SMS and/or voice calls)
Comparison: Standard care / no intervention

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Utilization of healthcare services						
Clinic attendance for STI testing (self-report) Follow-up: 12 months	91 per 1.000	**136 per 1.000** (77 to 241)	**RR 1.50** (0.85 to 2.65)	385 (1 RCT) Australia	⨁◯◯◯ VERY LOW [a,c,e]	**We are uncertain of the effect of the intervention on clinic attendance for STI testing among adolescents because the certainty of this evidence was assessed as very low.** (Studies conducted in community settings [4]).
Timeliness of information and services	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on providers' acceptability/ satisfaction because no direct evidence was identified.**
Health behavior, status and well-being						
Behavior – condom use (self-report) Follow-up: 12 months	234 per 1.000	**188 per 1.000** (127 to 277)	**RR 0.80** (0.54 to 1.18)	385 (1 RCT) Australia	⨁◯◯◯ VERY LOW [a,c,e]	**We are uncertain of the effect of the intervention on condom use among adolescents because the certainty of this evidence was assessed as very low.** (Studies conducted in community settings [4]).
Behavior – oral contraception use (self-report) Follow-up: 6 months	540 per 1.000	**643 per 1.000** (567 to 729)*	**RR 1.19** (1.05 to 1.35)*	683 (1 RCT) USA	⨁⨁◯◯ LOW [b,d]	**The intervention may increase the contraception use at 6 months among adolescents** (Study conducted in community setting [2]).
Adherence - Adherence to anti-retroviral medication (self-report) Follow-up: up to 12 months	409 per 1.000	**847 per 1.000** (205 to 1.000)*	**RR 2.07** (0.50 to 8.51)*	123 (2 RCTs) USA (2)	⨁◯◯◯ VERY LOW [b,f,g,h]	**We are uncertain of the effect of the intervention on adherence to anti-retroviral medication among adolescents because the certainty of this evidence was assessed as very low.** (Studies conducted in community settings [1, 3]

Digital, targeted client communication for adolescents compared to standard care in primary healthcare settings

Patient or population: Adolescents aged 14-24 years
Setting: Community settings in high-income countries (Australia, USA [3])
Intervention: Targeted client communication (reminders and/or information/education via SMS and/or voice calls)
Comparison: Standard care / no intervention

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Log HIV viral load among adolescents[1] Follow-up: 12 months	The mean HIV viral load ranged from **2.2 to 4.2**	The mean log HIV viral load in the intervention groups was **0.47 lower** (1.45 lower to 0.51 higher)*		74 (2 RCTs) USA (2)	⨁◯◯◯ VERY LOW b,g,h,i	**We are uncertain of the effect of the intervention on HIV treatment success (assessed using log viral load suppression) among previously non-adherent adolescents because the certainty of this evidence was assessed as very low.** (Studies conducted in community settings [1, 3]).
Satisfaction and acceptability						
Client acceptance of and satisfaction with the approach/ intervention	Two studies[2, 4] were identified that reported on acceptability and satisfaction with the intervention. One study[2] reported that most participants (>90%) were satisfied with the number, content, and length of the messages received. Another study[4] reported at 12 months that 24% found the SMS annoying.			1859 (2 RCTs) Australia USA	⨁◯◯◯ VERY LOW j	**We are uncertain of the effect of the intervention on satisfaction with the approach/ intervention among individuals because the certainty of this evidence was assessed as very low (non-comparable).** (Studies conducted in community settings [2,4]).
Knowledge and attitudes about sexual health and STIs –above cut-off knowledge score Follow-up: 6 months	380 per 1.000	**449 per 1.000** (357 to 555)	**RR 1.18** (0.94 to 1.46)	459 (1 RCT) Australia	⨁◯◯◯ VERY LOW a,c,e	**We are uncertain of the effect of the intervention on knowledge and attitudes about sexual health and STIs among adolescents because the certainty of this evidence was assessed as very low.** (Studies conducted in community settings [4]).
Providers' acceptability/satisfaction	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on providers' acceptability/ satisfaction because no direct evidence was identified.**

[1] The panel should note that WHO has defined viral failure as follows: 'Viral failure is defined by a persistently detectable viral load exceeding 1000 copies/mL (two consecutive viral load measurements within a 3-month interval with adherence support between measurements) after at least 6 months of using ART' (page xiii). Evidence of treatment success is defined as two consecutive viral load measurements below 1000 copies/mL (Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Recommendations for a public health approach. 2016. Geneva: WHO)

Digital, targeted client communication for adolescents compared to standard care in primary healthcare settings

Patient or population: Adolescents aged 14-24 years
Setting: Community settings in high-income countries (Australia, USA [3])
Intervention: Targeted client communication (reminders and/or information/education via SMS and/or voice calls)
Comparison: Standard care / no intervention

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Resource use						
Resource use	No studies were identified that reporting this outcome					**We are uncertain of the effect of the intervention on resource use because no direct evidence was identified**.
Unintended consequences						
Unintended consequences	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on unintended consequences because no direct evidence was identified.**

*The 95% confidence interval (CI); **RR:** Risk ratio; **MD:** Mean difference; **RCT:** randomised controlled trial; **SMD:** standardised mean difference

GRADE Working Group grades of evidence. **High certainty:** We are very confident that the true effect lies close to that of the estimate of the effect. **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect. **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

ARV: anti-retroviral medication; **HBV:** hepatitis B virus; **HIV:** human immunodeficiency virus; **HPV:** human papilloma virus; **IVR**: interactive voice response; **MMS**: multimedia messaging service; **RCT:** randomized controlled trial; **SMS:** short message service; **SRH**: sexual and reproductive health; **STIs:** Sexually transmitted infections; **TCC:** targeted client communication; **QoL:** quality of life

Explanations

a. Downgraded one level for indirectness: Single study from one high income country
b. Downgraded one level for indirectness: All studies from high income countries
c. Downgraded one level for imprecision: Few events and a 95% confidence interval that encompasses both a potential small harmful effect and a potential large beneficial effect of intervention
d. Downgraded one level for risk of bias: Lack of participant and provider blinding, incomplete outcome data, and baseline imbalances
e. Downgraded one level for risk of bias: Unclear allocation concealment, lack of participant and provider blinding, incomplete outcome data
f. Downgraded two levels for imprecision: Few events and a 95% confidence interval that encompasses both a potential small harmful effect and a potential large beneficial effect of intervention
g. Downgraded one level for risk of bias: One study with unclear randomisation sequence generation and allocation concealment, both studies lack blinding of participants and providers, one study with high attrition and only per-protocol analysis
h. Downgraded one level for inconsistency: High statistical heterogeneity ($I^2 > 50\%$)
i. Downgraded two levels for imprecision: Small sample size resulting in wide confidence intervals that encompass harm, no effect, and benefit of the intervention
j. Non-comparable results, thus downgraded to very low

References and notes

1. Belzer, M. E.,Kolmodin, MacDonell,Clark, L. F.,Huang, J.,Olson, J.,Kahana, S. Y.,Naar, S.,Sarr, M.,Thornton, S.,Adolescent Medicine Trials Network, for,H. I. V. Aids Interventions. Acceptability and Feasibility of a Cell Phone Support Intervention for Youth Living with HIV with Nonadherence to Antiretroviral Therapy. AIDS Patient Care & Stds. 2015. 29:338-45
2. Castano, P. M.,Bynum, J. Y.,Andres, R.,Lara, M.,Westhoff, C.. Effect of daily text messages on oral contraceptive continuation: a randomized controlled trial. Obstetrics & Gynecology. 2012. 119:14-20
3. Garofalo, R.,Kuhns, L. M.,Hotton, A.,Johnson, A.,Muldoon, A.,Rice, D.. A Randomized Controlled Trial of Personalized Text Message Reminders to Promote Medication Adherence Among HIV-Positive Adolescents and Young Adults. AIDS & Behavior. 2016. 20:1049-59
4. Lim, M. S.,Hocking, J. S.,Aitken, C. K.,Fairley, C. K.,Jordan, L.,Lewis, J. A.,Hellard, M. E.. Impact of text and email messaging on the sexual health of young people: a randomised controlled trial. Journal of Epidemiology & Community Health. 2012. 66:69-74

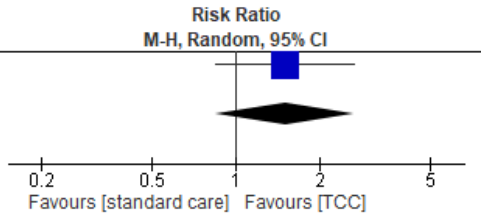
Analyses

Utilisation of health services

STI/HIV testing outcomes

Study or Subgroup	TCC Events	TCC Total	Standard care Events	Standard care Total	Weight	Risk Ratio M-H, Random, 95% CI
Lim 2012	24	176	19	209	100.0%	1.50 [0.85, 2.65]
Total (95% CI)		**176**		**209**	**100.0%**	**1.50 [0.85, 2.65]**
Total events	24		19			

Heterogeneity: Not applicable
Test for overall effect: Z = 1.40 (P = 0.16)

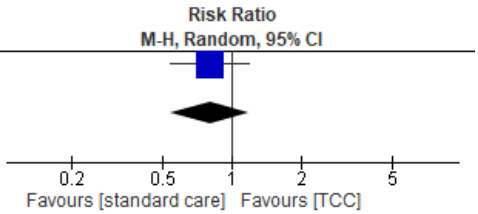


Health behavior, status and well-being

Health behaviour – condom use outcomes

Study or Subgroup	TCC Events	TCC Total	Standard care Events	Standard care Total	Weight	Risk Ratio M-H, Random, 95% CI
Lim 2012	33	176	49	209	100.0%	0.80 [0.54, 1.18]
Total (95% CI)		**176**		**209**	**100.0%**	**0.80 [0.54, 1.18]**
Total events	33		49			

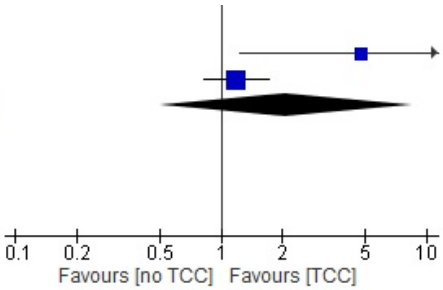
Heterogeneity: Not applicable
Test for overall effect: Z = 1.11 (P = 0.27)



Health behaviour – STI/HIV treatment outcomes

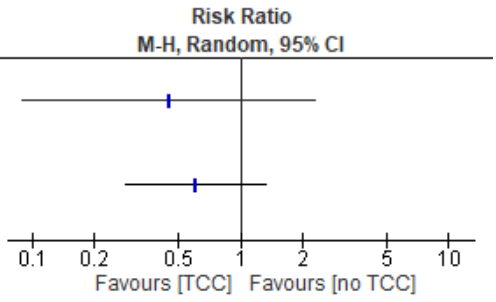
1.1.2 STI/HIV treatment						
Belzer 2014	8	14	2	17	39.5%	4.86 [1.22, 19.28]
Garofalo 2016	26	43	25	49	60.5%	1.19 [0.82, 1.71]
Subtotal (95% CI)		**57**		**66**	**100.0%**	**2.07 [0.50, 8.51]**
Total events	34		27			

Heterogeneity: Tau² = 0.83; Chi² = 4.12, df = 1 (P = 0.04); I² = 76%
Test for overall effect: Z = 1.01 (P = 0.31)

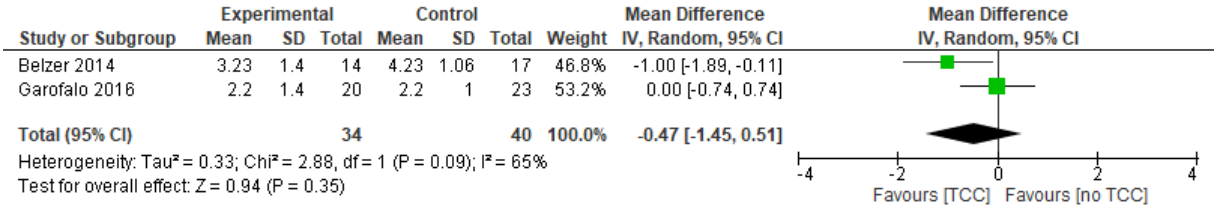


Conception and STI incidence

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Risk Ratio M-H, Random, 95% CI
1.4.1 Conception					
Rokicki 2016	2	31	4	28	0.45 [0.09, 2.28]
1.4.2 STI incidence (chlamydia)					
McCarthy 2016	9	99	15	101	0.61 [0.28, 1.33]

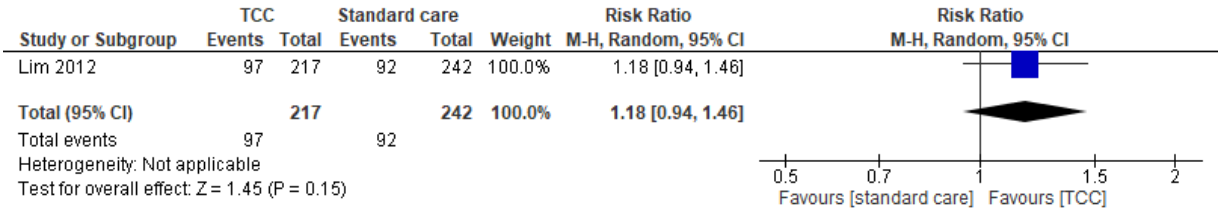


HIV viral load



Satisfaction and acceptability

Knowledge and attitudes about sexual health and STIs



A.2 Summary of Findings table with plain language summary

Digital, targeted client communication for adolescents compared to non-digital, targeted communication in primary healthcare settings

Patient or population: Adolescents aged 14-24 years
Setting: Community settings in high-income country (USA)
Intervention: Targeted client communication (reminders and/or information/education via SMS)
Comparison: Non-digital targeted client communication (teen outreach program, 1 study [1])

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Utilization of healthcare services						
Accessed contraceptive services or STI care in the past 9 months (self-report) Follow-up: 25 weeks	84 per 1.000	**58 per 1.000** (33 to 103)*	**RR 0.69** (0.39 to 1.23)*	624 (1 RCT) USA	⨁◯◯◯ VERY LOW [a,b,c]	**We are uncertain of the effect of the intervention on whether adolescents accessed contraceptive services or to STI care because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [1]).
Timeliness of information and services	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on providers' acceptability/ satisfaction because no direct evidence was identified.**
Health behavior, status and well-being						
Behavior – condom use in the past 3 months (self-report) Follow-up: 25 weeks	The mean condom use was **92.7%**	The mean condom use in the intervention group was **1.4 higher** (3.05 lower to 5.85 higher)*		500 (1 RCT) USA	⨁◯◯◯ VERY LOW [a,c,d]	**We are uncertain of the effect of the intervention on condom use among adolescents because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [1]).
Behaviour – contraceptive use (type not specified) in the past 3 months (self-report) Follow-up: 25 weeks	The mean contraceptive use was **95.9%**	The mean contraceptive use in the intervention group was **1.6% higher** (1.43 lower to 4.63 higher)*		500 (1 RCT) USA	⨁◯◯◯ VERY LOW [a,c,d]	**We are uncertain of the effect of the intervention on contraception use among adolescents because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [1]).
Ever pregnant (women) or caused a pregnancy (men) among adolescents Follow-up: 25 weeks	39 per 1.000	**31 per 1.000** (13 to 78)*	**RR 0.80** (0.32 to 1.99)*	511 (1 RCT) USA	⨁◯◯◯ VERY LOW [a,c,e]	**We are uncertain of the effect of the intervention on adolescents ever being pregnant or causing a pregnancy because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [1]).
Satisfaction and acceptability						
Providers' / Clients' acceptability/satisfaction	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on clients' or providers' acceptability/ satisfaction because no direct evidence was identified.**
Resource use						

Digital, targeted client communication for adolescents compared to non-digital, targeted communication in primary healthcare settings

Patient or population: Adolescents aged 14-24 years
Setting: Community settings in high-income country (USA)
Intervention: Targeted client communication (reminders and/or information/education via SMS)
Comparison: Non-digital targeted client communication (teen outreach program, 1 study [1])

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Resource use	One study was identified that reported on resource use associated with the intervention. It reported that the intervention cost an additional US$126 per participant compared to the control group, or a 10.6% cost increase (95% CI: US$101 to US$153).			852 (1 RCT) USA	⨁◯◯◯ VERY LOW [f]	**We are uncertain of the effect of the intervention on resource use because the certainty of the evidence was assessed as very low.** (Study conducted in community setting [1]).
Unintended consequences						
Unintended consequences	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on unintended consequences because no direct evidence was identified.**

*The 95% confidence interval (CI); **RR:** Risk ratio; **MD:** Mean difference; **RCT:** randomised controlled trial; **SMD:** standardised mean difference

GRADE Working Group grades of evidence. **High certainty:** We are very confident that the true effect lies close to that of the estimate of the effect. **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect. **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

ARV: anti-retroviral medication; **HBV:** hepatitis B virus; **HIV:** human immunodeficiency virus; **HPV:** human papilloma virus; **IVR**: interactive voice response; **MMS**: multimedia messaging service; **RCT:** randomized controlled trial; **SMS:** short message service; **SRH**: sexual and reproductive health; **STIs:** Sexually transmitted infections; **TCC:** targeted client communication; **QoL:** quality of life

Explanations

a. Downgraded one level for indirectness: All studies from high income countries
b. Downgraded two levels for imprecision: Few events and a 95% confidence interval that encompasses both a potential harmful effect and a potential beneficial effect of intervention
c. Downgraded one level for risk of bias: Unclear randomisation sequence generation and allocation concealment, lack of participant and provider blinding, incomplete outcome data and selective outcome reporting
d. Downgraded one level for imprecision: A 95% confidence interval that encompasses both a potential small harmful effect and a potential small beneficial effect of the intervention
e. Downgraded two levels for imprecision: Small sample size resulting in wide confidence intervals that encompass harm, no effect, and benefit of the intervention
f. Non-comparable results, thus downgraded to very low

References and notes

1. Bull, S., Devine, S., Schmiege, S. J., Pickard, L., Campbell, J., & Shlay, J. C. (2016). Text messaging, teen outreach program, and sexual health behavior: A cluster randomized trial. American journal of public health, 106(S1), S117-S124.

Summaries of Findings B. Adult users of sexual and reproductive health services

B.1 Summary of Findings table with plain language summary

Digital, targeted client communication for adult users of SRH services, compared to standard care in primary healthcare settings

Patient or population: Adult users / potential users of sexual and reproductive health services (SRH)
Setting: Community settings in high- (Australia, UK, USA) and middle- (Bangladesh, Cameroon, Kenya, India, Cambodia, South Africa, Brazil, Colombia, China, Uganda) countries.
Intervention: Targeted client communication (reminders and/or information/education via SMS, MMS, IVR, instant messaging, app instant messaging or voice calls)
Comparison: Standard care / no intervention

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Utilization of healthcare services						
Clinic attendance for STI/HIV testing (objective) Follow-up: 2 to 12 weeks	278 per 1.000	**545 per 1.000** (287 to 1.000)	**RR 1.96** (1.03 to 3.75)	752 (3 RCTs) Australia, Kenya, United Kingdom	⨁◯◯◯ VERY LOW [g,h,k,r]	**We are uncertain of the effect of the intervention on clinic attendance for STI/HIV testing among adults because the certainty of this evidence was assessed as very low.** (Studies conducted in community settings [5, 12, 17]).
Clinic attendance for HIV treatment (self-report and objective) Follow-up: 1 month	903 per 1.000	**894 per 1.000** (713 to 1.000)*	**RR 0.99** (0.79 to 1.24)*	142 (2 RCTs) USA, Cameroon	⨁◯◯◯ VERY LOW [b,c,e,i]	**We are uncertain of the effect of the intervention on clinic attendance for HIV treatment among adults because the certainty of this evidence was assessed as very low.** (Studies conducted in community settings [13, 14]).
Clinic attendance for post-abortion care following self-management of medical abortion (objective report)[v] Follow-up: 2 to 3 weeks	783 per 1.000	**846 per 1.000** (775 to 916)*	**RR 1.08** (0.99 to 1.17)*	469 (1 RCT) South Africa	⨁⨁⨁◯ MODERATE [j]	**The intervention probably slightly increases the number of women attending post-abortion care. However, the range in which the actual effect may be indicates that the intervention may have little or no effect or may slightly increase the number of women attending post-abortion care.** (Study conducted in community setting [2]).
Clinic attendance for Voluntary Medical Male Circumcision (self-report and objective report) Follow-up: 3 weeks to 6 months	469 per 1.000	**483 per 1.000** (403 to 582)	**RR 1.03** (0.86 to 1.24)	510 (1 RCT) South Africa and Uganda	⨁⨁? ? LOW [l,m]	**The intervention may make little or no difference to the number of men that attend a clinic for Voluntary Medical Male Circumcision** (Study conducted in community settings [1]).
Health behavior, status and well-being						

Digital, targeted client communication for adult users of SRH services, compared to standard care in primary healthcare settings

Patient or population: Adult users / potential users of sexual and reproductive health services (SRH)
Setting: Community settings in high- (Australia, UK, USA) and middle- (Bangladesh, Cameroon, Kenya, India, Cambodia, South Africa, Brazil, Colombia, China, Uganda) countries.
Intervention: Targeted client communication (reminders and/or information/education via SMS, MMS, IVR, instant messaging, app instant messaging or voice calls)
Comparison: Standard care / no intervention

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Health behavior – use of effective contraception method (self-report) Follow-up: 4 months	459 per 1.000	**638 per 1.000** (537 to 762)*	**RR 1.39** (1.17 to 1.66)*	431 (1 RCT) Cambodia	⨁⨁◯◯ LOW [a,b]	**The intervention may increase the contraception use at 4 months among women** (Study conducted in community setting [19]).
Health behavior – use of effective contraception method (self-report) Follow-up: 12 months	428 per 1.000	**500 per 1.000** (393 to 633)*	**RR 1.17** (0.92 to 1.48)*	327 (1 RCT) Cambodia	⨁⨁◯◯ LOW [a,b]	**The intervention may increase the contraception use at 12 months among women** (Study conducted in community setting [19]).
Health behavior - Condom use 50% of the time (self-report) Follow-up: up to 12 months	243 per 1.000	**472 per 1.000** (243 to 919)*	**RR 1.94** (1.00 to 3.78)*	73 (1 RCT) USA	⨁◯◯◯ VERY LOW [a,c,d]	**We are uncertain of the effect of the intervention on condom use among adults because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [7]).
Adherence - Adherence to anti-retroviral medication (objective and self-report) Follow-up: up to 12 months	489 per 1.000	**538 per 1.000** (475 to 612)*	**RR 1.10** (0.97 to 1.25)*	1597 (6 RCTs) Brazil, India, Kenya (2), Cameroon (2)	⨁⨁◯◯ LOW [a,e]	**The intervention may increase the adherence to anti-retroviral medication among adults living with HIV and AIDS.** (Studies conducted in community settings [3, 10, 11, 14, 15, 18]).
CD4 count (cells per mm³)[2] Follow-up: 3 months (50 cells per mm³ was considered a clinically important change)	The mean CD4 count in the control groups ranged from 157 to 375 cells per mm³	The mean CD4 count in the intervention groups was **14.04 higher** (8.6 lower to 36.7 higher)*	**MD 14.04** (-8.62 to 36.71)*	435 (3 RCTs) China (2), Cameroon	⨁⨁◯◯ LOW [f,g]	**The intervention may make little or no difference to the health status among individuals living with HIV and AIDS, as assessed by CD4 count.** (Studies conducted in community settings. [8, 16, 11]).

[2] The panel should note that WHO no longer recommends the use of CD4 count to monitor the response to ART and to diagnose treatment failure. WHO has noted that 'In settings where routine viral load monitoring is available, CD4 cell count monitoring can be stopped in individuals who are stable on ART and virally suppressed (conditional recommendation, low-quality evidence).' (Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Recommendations for a public health approach. 2016. Geneva: WHO)

Digital, targeted client communication for adult users of SRH services, compared to standard care in primary healthcare settings

Patient or population: Adult users / potential users of sexual and reproductive health services (SRH)
Setting: Community settings in high- (Australia, UK, USA) and middle- (Bangladesh, Cameroon, Kenya, India, Cambodia, South Africa, Brazil, Colombia, China, Uganda) countries.
Intervention: Targeted client communication (reminders and/or information/education via SMS, MMS, IVR, instant messaging, app instant messaging or voice calls)
Comparison: Standard care / no intervention

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
HIV viral load suppression (< 400 copies per mL)[3] Follow-up: up to 12 months	680 per 1.000	**727 per 1.000** (605 to 884)*	**RR 1.07** (0.89 to 1.30)*	1169 (2 RCTs) Kenya, India	⨁◯◯◯ VERY LOW e,o,p	**We are uncertain of the effect of the intervention on HIV viral load among individuals living with HIV and AIDS because the certainty of this evidence was assessed as very low.** (Studies conducted in community settings [10, 18]).
Wellbeing among people living with HIV and AIDS (measured by SF12 or WHO QoL physical wellbeing subscale, assessed by SF12) Follow-up: up to 6 months		**SMD 0.25** (-0.14 to 0.65)* Interpreting SMDs: 0.2 represents a small effect, 0.5 a moderate effect, and 0.8 a large effect		343 (2 RCTs) China, Cameroon	⨁◯◯◯ VERY LOW a,e,f	**We are uncertain of the effect of the intervention on wellbeing among individuals living with HIV and AIDS because the certainty of this evidence was assessed as very low.** (Studies conducted in community settings [8, 11]).
Repeat abortion following an earlier abortion Follow-up: 12 months	69 per 1.000	**47 per 1.000** (19 to 115)*	**RR 0.68** (0.28 to 1.66)*	328 (1 RCT) Cambodia	⨁◯◯◯ VERY LOW a,d	**We are uncertain of the effect of the intervention on the number of repeat abortions following an earlier abortion because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [19]).
Satisfaction and acceptability						
Client acceptance of and satisfaction with the approach/ intervention	In general, all studies reported moderate to high levels of satisfaction and acceptability with the intervention. (Only intervention group assessed for this outcome thus non-comparable.)			N[28] (10 RCTs) Brazil, Cameroon (2), China, Colombia, Kenya, South Africa, USA (3)	⨁◯◯◯ VERY LOW t	**We are uncertain of the effect of the intervention on satisfaction with the approach/ intervention among individuals because the certainty of this evidence was assessed as very low (non-comparable).** (Studies conducted in community settings [2, 3, 6, 7, 9, 10, 11, 14, 16]).

[3] The panel should note that WHO has defined viral failure as follows: 'Viral failure is defined by a persistently detectable viral load exceeding 1000 copies/mL (two consecutive viral load measurements within a 3-month interval with adherence support between measurements) after at least 6 months of using ART' (page xiii). Evidence of treatment success is defined as two consecutive viral load measurements below 1000 copies/mL (Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Recommendations for a public health approach. 2016. Geneva: WHO)

Digital, targeted client communication for adult users of SRH services, compared to standard care in primary healthcare settings

Patient or population: Adult users / potential users of sexual and reproductive health services (SRH)
Setting: Community settings in high- (Australia, UK, USA) and middle- (Bangladesh, Cameroon, Kenya, India, Cambodia, South Africa, Brazil, Colombia, China, Uganda) countries.
Intervention: Targeted client communication (reminders and/or information/education via SMS, MMS, IVR, instant messaging, app instant messaging or voice calls)
Comparison: Standard care / no intervention

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Providers' acceptability/satisfaction	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on providers' acceptability/ satisfaction because no direct evidence was identified.**
Resource use						
Resource use	One study[6] reported a cost of about $2.41 for each additional person to be HIV tested, that is, the cost to get people to test over and above those who were likely to test without the intervention.			N[28] (1 RCT) South Africa	⨁◯◯◯ VERY LOW [t]	**We are uncertain of the effect of the intervention on resource use because the certainty of this evidence was assessed as very low.** (Study conducted in community settings [4]).
Unintended consequences						
Women's experience of physical violence, in the context of receiving targeted communication on contraception (Self report) Follow-up: 4 months	65 per 1.000	**109 per 1.000** (68 to 170)	**OR 1.74** (1.04 to 2.92)	768 (1 RCT) Bangladesh [21]	⨁⨁◯◯ LOW [u]	**The intervention may increase the number of women who experience physical violence.** (Study conducted in community settings [20]).
Other unintended consequences	Three studies[10, 11, 19] reported on unintended consequences as a result of the intervention. One study[10] explicitly reported no adverse events, while the other[11] reported that one female in the intervention arm requested to withdraw because she felt it had compromised her undisclosed status One study[19] reported that at four months follow-up, no participants experienced involvement in a road traffic accident or domestic abuse as a result of the intervention or control.			N[28] (3 RCTs) Cambodia, Cameroon, Kenya	⨁◯◯◯ VERY LOW [t]	**We are uncertain of the effect of the intervention on unintended consequences because the certainty of this evidence was assessed as very low (non-comparable).** (Studies conducted in community settings [10, 11, 19]).

*The 95% confidence interval (CI); **RR:** Risk ratio; **MD:** Mean difference; **RCT:** randomised controlled trial; **SMD:** standardised mean difference; **OR:** odds ratio

Digital, targeted client communication for adult users of SRH services, compared to standard care in primary healthcare settings

Patient or population: Adult users / potential users of sexual and reproductive health services (SRH)
Setting: Community settings in high- (Australia, UK, USA) and middle- (Bangladesh, Cameroon, Kenya, India, Cambodia, South Africa, Brazil, Colombia, China, Uganda) countries.
Intervention: Targeted client communication (reminders and/or information/education via SMS, MMS, IVR, instant messaging, app instant messaging or voice calls)
Comparison: Standard care / no intervention

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?

GRADE Working Group grades of evidence. **High certainty:** We are very confident that the true effect lies close to that of the estimate of the effect. **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect. **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

ARV: anti-retroviral medication; **HBV:** hepatitis B virus; **HIV:** human immunodeficiency virus; **HPV:** human papilloma virus; **IVR**: interactive voice response; **MMS**: multimedia messaging service; **RCT:** randomized controlled trial; **SMS:** short message service; **SRH**: sexual and reproductive health; **STI:** Sexually transmitted infection; **TCC:** targeted client communication; **VMMC:** voluntary male medical circumcision; **QoL:** quality of life

Explanations

a. Downgraded one level for risk of bias: Lack of participant and provider blinding, all studies at high or unclear risk of bias due to incomplete outcome data.
b. Downgraded one level for imprecision: Few events (<250)
c. Downgraded one level for indirectness: One study from high income country
d. Downgraded two levels for imprecision: Few events and a 95% confidence interval that encompasses both a potential small harmful effect and a potential large beneficial effect of intervention
e. Downgraded one level for inconsistency: Considerable statistical heterogeneity (I^2 >50%)
f. Downgraded one level for imprecision: Small sample size (continuous data < 300 in each group)
g. Downgraded one level for imprecision: Few events and a 95% confidence interval that encompasses both a potential small harmful effect and a potential large beneficial effect of intervention
h. Downgraded one level for risk of bias: Two studies with unclear randomisation sequence generation and allocation concealment, lack of participant and provider blinding in all studies
i. Downgraded one level for risk of bias: Both studies with unclear allocation concealment, lack of blinding of participants, providers, and outcome assessors, one study with high risk of bias due to incomplete outcome data
j. Downgraded one level for risk of bias: Lack of participant, provider and outcome assessor blinding, significant differences in baseline outcome measures
k. Downgraded one level for indirectness: Two studies from high income countries
l. Downgraded one level for imprecision: Few events (<250)
m. Downgraded one level for risk of bias: Lack of participant and provider blinding, unclear outcome data and only per-protocol analysis reported
o. Downgraded one level for risk of bias: One study with unclear sequence generation, both studies lack participant and provider blinding, one study with incomplete outcome data, one with selective reporting
p. Downgraded one level for imprecision: A 95% confidence interval that encompasses both a potential small harmful effect and a potential large beneficial effect of intervention
q. Downgraded one level for risk of bias: Two studies with unclear randomisation sequence generation, lack of participant and provider blinding, high or unclear risk of bias due to incomplete outcome data
r. One study focused on HIV testing [17], one study focusing on chlamydia testing [7] and in one study the type of testing was not specified [24]
t. Downgraded two levels for risk of bias and one level for indirectness (limited settings)
u. Downgraded one level for imprecision. Downgraded one level for risk of bias: outcome was self-reported
v. Note that participants in both the intervention and comparison arms were asked to attend a follow-up clinic visit for assessment of abortion completion two to three weeks after the initial abortion counselling and medicine administration. The study reports the following 'Both study groups received the standard abortion care from the clinic: abortion counselling and administration of 200-mg mifepristone on site; self-administration of 800-mcg misoprostol (400-mcg sublingual and 400-mcg buccal for all study clinics) 1 to 2 days later at home; and a follow-up clinic visit 2 to 3 weeks later for assessment of abortion completion.' (p227)

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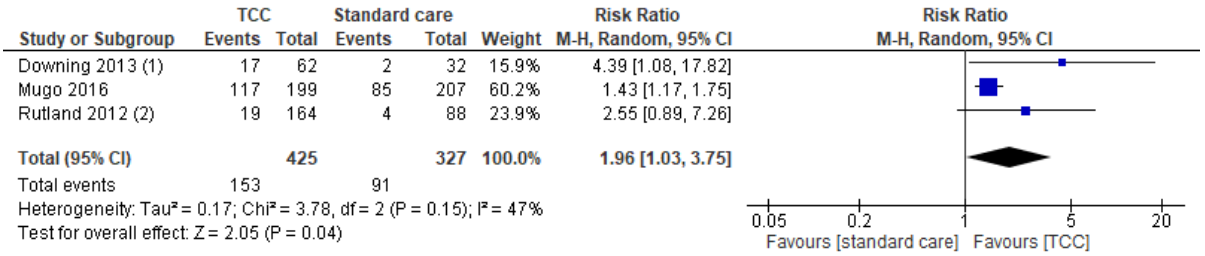
21. Participants in this trial in Bangladesh were women aged 18-49 who had received menstrual regulation from a participating clinic and who reported that they did not intend to become pregnant in the next 6 months. Note that Bangladesh is a context where post menstrual regulation is legal but abortion is not legal and where the rate of partner violence is high

Analyses

Utilisation of health services

Clinic attendance for STI/HIV testing

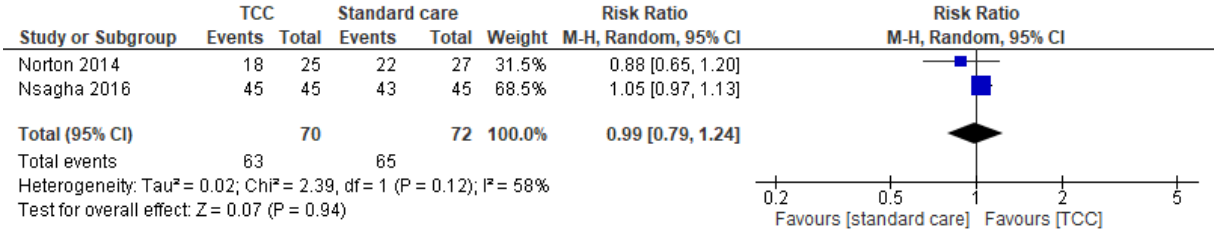


Footnotes

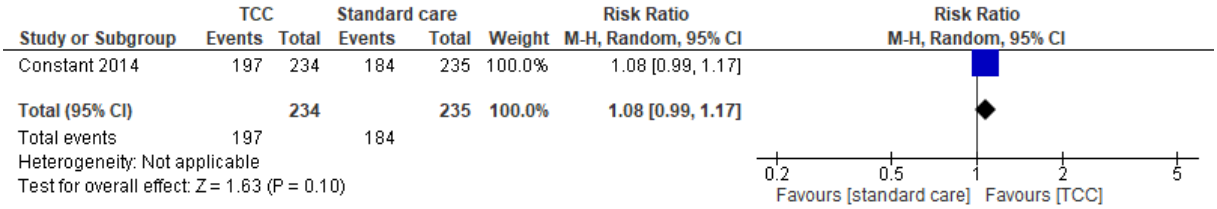
(1) Combined two intervention groups (SMS+incentive and SMS only)

(2) Combined two intervention groups (SMS + health promotion messages and SMS only)

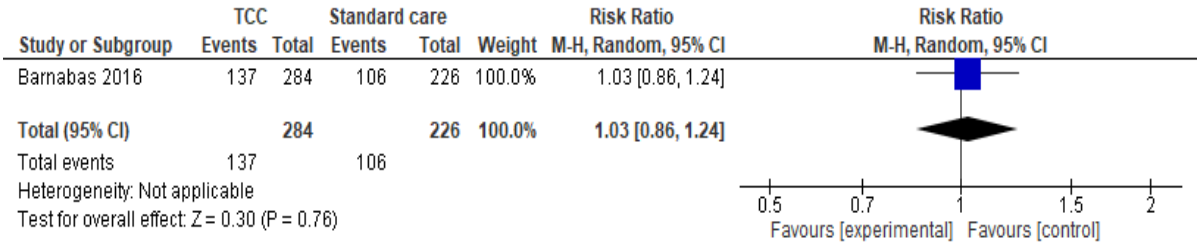
Clinic attendance for HIV treatment



Clinic attendance for post-abortion care following self-management of medical abortion

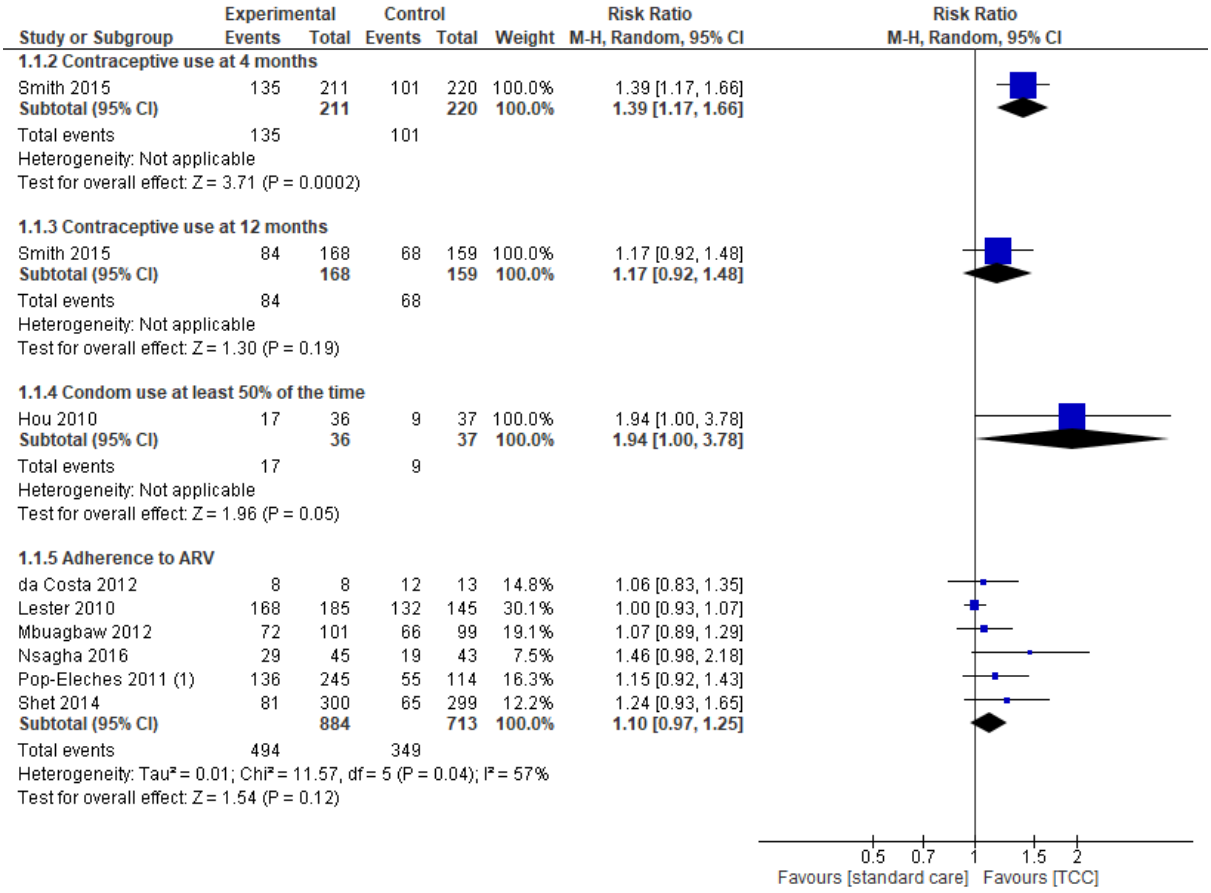


Clinic attendance for voluntary medical male circumcision


TCC
Standard care
Risk Ratio
Risk Ratio
Study or Subgroup
Events
Total
Events
Total
Weight
M-H, Random, 95% CI
M-H, Random, 95% CI
Barnabas 2016
137
284
106
226
100.0%
1.03 [0.86, 1.24]
Total (95% CI)
284
226
100.0%
1.03 [0.86, 1.24]
Total events
137
106
Heterogeneity: Not applicable
Test for overall effect: Z = 0.30 (P = 0.76)
0.5
0.7
1
1.5
2
Favours [experimental]
Favours [control]

Health behavior, status and well-being

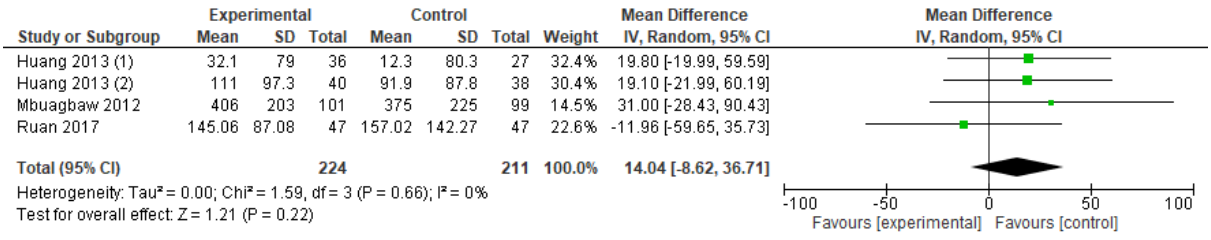
Health behavior



Footnotes

(1) Combined two intervention groups (long SMS and short SMS)

CD4 count among individuals living with HIV and AIDS

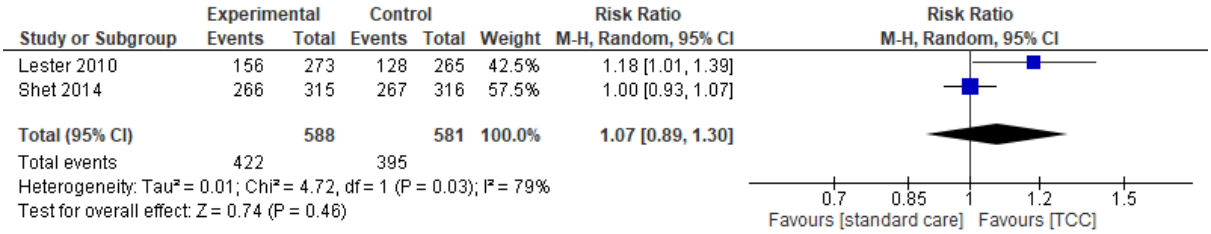


Footnotes

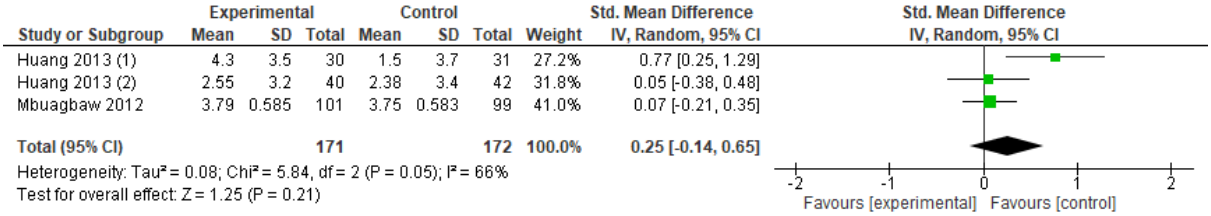
(1) ARV Experienced patients

(2) ARV Naive patients

HIV viral load suppression



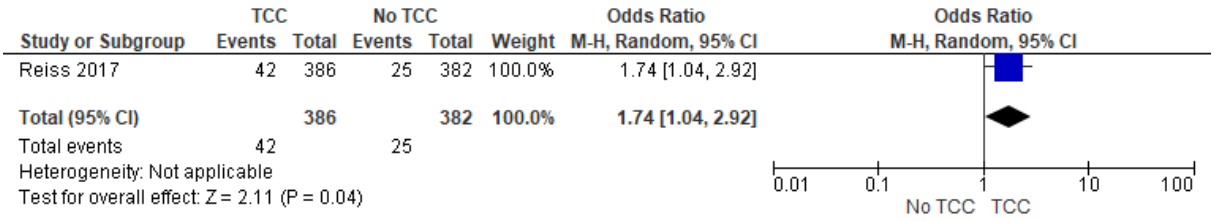
Wellbeing among people living with HIV and AIDS



Footnotes
(1) ARV Naive patients
(2) ARV Experienced patients

Unintended consequences

Women's experience of physical violence, in the context of receiving targeted communication on contraception



B.2 Summary of Findings table with plain language summary

Digital, targeted client communication for adult users of SRH services, compared to non-digital, targeted communication in primary healthcare settings

Patient or population: Adult users / potential users of sexual and reproductive health services (SRH)
Setting: Community settings in high- (USA) and middle- (Malaysia) income countries.
Intervention: Targeted client communication (reminders and/or information/education via SMS, MMS, IVR, instant messaging, app instant messaging or voice calls)
Comparison: Non-digital, targeted communication (letters, brochure, home visit)

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Utilization of healthcare services						
Clinic attendance for vaccination among adolescents and adults (HPV or HBV vaccines) Follow-up: 6 months	317 per 1.000	**397 per 1.000** (295 to 530)*	**RR 1.25** (0.93 to 1.67)*	334 (1 RCT) USA	⨁◯◯◯ VERY LOW [a,b,c]	**We are uncertain of the effect of the intervention on clinic attendance for vaccination among adolescents and adults because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [1]).
Clinic attendance for breast cancer screening (self-report) Follow-up: 6 months	250 per 1.000	**400 per 1.000** (235 to 685)*	**RR 1.60** (0.94 to 2.74)*	120 (1 RCT) USA	⨁◯◯◯ VERY LOW [a,b,c]	**We are uncertain of the effect of the intervention on clinic attendance for breast cancer screening among adults because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [2]).
Clinic attendance for cervical screening (objective report) Follow-up: 8 weeks	188 per 1.000	**216 per 1.000** (152 to 306)*	**RR 1.15** (0.81 to 1.63)*	500 (1 RCT) Malaysia	⨁◯◯◯ VERY LOW [a,d]	**We are uncertain of the effect of the intervention on clinic attendance for HIV treatment among adults because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [3]).
Health behavior, status and well-being						
Health behavior, status and well-being	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on health behaviour, status or well-being because no direct evidence was identified.**
Satisfaction and acceptability						
Client acceptance of and satisfaction with the approach/ intervention	Clients reported high levels of satisfaction with the intervention. (Only intervention group assessed for this outcome thus non-comparable.)			120 (1 RCT) USA	⨁◯◯◯ VERY LOW [e]	**We are uncertain of the effect of the intervention on satisfaction with the approach/ intervention among individuals because the certainty of this evidence was assessed as very low (non-comparable).** (Study conducted in community settings [2]).
Clients' and providers' acceptability/satisfaction	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on clients' and providers' acceptability/ satisfaction because no direct evidence was identified.**
Resource use						

Digital, targeted client communication for adult users of SRH services, compared to non-digital, targeted communication in primary healthcare settings

Patient or population: Adult users / potential users of sexual and reproductive health services (SRH)
Setting: Community settings in high- (USA) and middle- (Malaysia) income countries.
Intervention: Targeted client communication (reminders and/or information/education via SMS, MMS, IVR, instant messaging, app instant messaging or voice calls)
Comparison: Non-digital, targeted communication (letters, brochure, home visit)

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Resource use	One study[1] reported that the total cost of a screening program, using SMS reminders, was cheaper than phone calls or normal letters.			500 (1 RCT) Malaysia	⨁⨁◯◯ LOW [f]	**The intervention may use fewer resources than the comparison.** (Study conducted in community settings [3]).
Unintended consequences						
Unintended consequences	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on unintended consequences because no direct evidence was identified.**

*The 95% confidence interval (CI); **RR:** Risk ratio; **MD:** Mean difference; **RCT:** randomised controlled trial; **SMD:** standardised mean difference; **OR:** odds ratio

GRADE Working Group grades of evidence. **High certainty:** We are very confident that the true effect lies close to that of the estimate of the effect. **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect. **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

ARV: anti-retroviral medication; **HBV:** hepatitis B virus; **HIV:** human immunodeficiency virus; **HPV:** human papilloma virus; **IVR**: interactive voice response; **MMS**: multimedia messaging service; **RCT:** randomized controlled trial; **SMS:** short message service; **SRH**: sexual and reproductive health; **STI:** Sexually transmitted infection; **TCC:** targeted client communication; **VMMC:** voluntary male medical circumcision; **QoL:** quality of life

Explanations

a. Downgraded two levels for imprecision: Few events and a 95% confidence interval that encompasses both a potential small harmful effect and a potential large beneficial effect of intervention
b. Downgraded one level for indirectness: One study from high income country
c. Downgraded one level for risk of bias: All risk of bias domains unclear
d. Downgraded one level for risk of bias: Unclear allocation concealment or selective outcome reporting, lack of participant and provider blinding
e. Non-comparable results, thus downgraded to very low

References and notes

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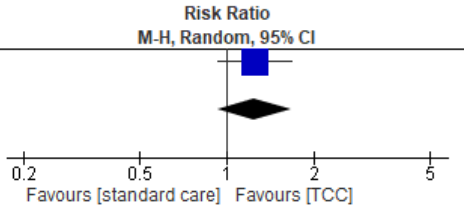
Analyses

Utilization of healthcare services

Clinic attendance for vaccination among adolescents and youth

Study or Subgroup	TCC Events	TCC Total	Standard care Events	Standard care Total	Weight	Risk Ratio M-H, Random, 95% CI
Russell 2012	66	167	53	167	100.0%	1.25 [0.93, 1.67]
Total (95% CI)		**167**		**167**	**100.0%**	**1.25 [0.93, 1.67]**
Total events	66		53			

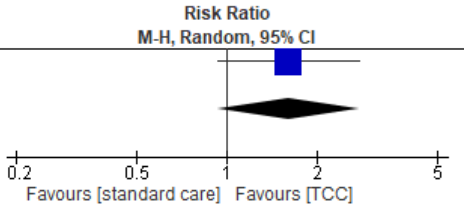
Heterogeneity: Not applicable
Test for overall effect: Z = 1.48 (P = 0.14)



Clinic attendance for breast cancer screening

Study or Subgroup	TCC Events	TCC Total	Standard care Events	Standard care Total	Weight	Risk Ratio M-H, Random, 95% CI
Lee 2016	24	60	15	60	100.0%	1.60 [0.94, 2.74]
Total (95% CI)		**60**		**60**	**100.0%**	**1.60 [0.94, 2.74]**
Total events	24		15			

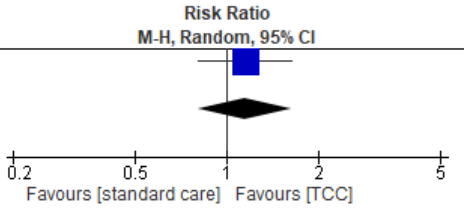
Heterogeneity: Not applicable
Test for overall effect: Z = 1.72 (P = 0.09)



Clinic attendance for cervical cancer screening

Study or Subgroup	TCC Events	TCC Total	Standard care Events	Standard care Total	Weight	Risk Ratio M-H, Random, 95% CI
Rashid 2013	54	250	47	250	100.0%	1.15 [0.81, 1.63]
Total (95% CI)		**250**		**250**	**100.0%**	**1.15 [0.81, 1.63]**
Total events	54		47			

Heterogeneity: Not applicable
Test for overall effect: Z = 0.78 (P = 0.44)



Summary of Findings C. Pregnant and postpartum women that use healthcare services

Targeted client communication compared to standard care for pregnant and post-partum women

Patient or population: Pregnant and post-partum women
Setting: Community settings in high- (Canada, UK, USA), middle- (Ecuador, India, Kenya, Thailand), and low-income (Tanzania) countries
Intervention: Targeted client communication (reminders and information/education via SMS, voice calls, voice messages, MMS, and e-mail)
Comparison: Standard care or non-targeted client communication (general health messages)

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Utilization of healthcare services						
Attendance at more than 4 antenatal care appointments	122 per 1.000	**147 per 1.000** (122 to 180)*	**RR 1.21** (1.00 to 1.48)*	2550 (1 RCT) Tanzania	⨁⨁⨁◯ MODERATE [d]	**The intervention probably increases the number of women attending more than 4 antenatal care appointments.** (Study conducted in community setting [6])
Attendance for antenatal influenza vaccination	270 per 1.000	**310 per 1.000** (216 to 448)*	**RR 1.15** (0.80 to 1.66)*	281 (1 RCT) Canada	⨁◯◯◯ VERY LOW [b,g]	**We are uncertain of the effect of the intervention on women's attendance for antenatal influenza vaccination because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [9]).
Skilled attendant at birth in settings where most women already use a skilled birth attendant	990 per 1.000	**990 per 1.000** (980 to 1.000)*	**RR 1.00** (0.99 to 1.01)*	1515 (1 RCT) India	⨁⨁⨁◯ MODERATE [d]	**The intervention probably makes little or no difference to the number of women receiving skilled birth attendance in settings where most women use a skilled birth attendant.** (Study conducted in community setting [4]).
Skilled attendant at birth in settings where many women do not use a skilled birth attendant	452 per 1.000	**583 per 1.000** (542 to 633)*	**RR 1.29** (1.20 to 1.40)*	2550 (1 RCT) Tanzania	⨁⨁⨁◯ MODERATE [d]	**The intervention probably increases the number of women receiving skilled birth attendance in settings where many women do not use a skilled birth attendant.** (Study conducted in community setting [6]).
Attending neonatal checkup in settings where most neonates are already taken for check-ups	958 per 1.000	**939 per 1.000** (834 to 1.000)*	**RR 0.98** (0.87 to 1.11)*	56 (1 RCT) Kenya	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of the intervention on women's attendance for neonatal checkup in settings where most neonates are taken for check-ups, because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [8]).
Attending neonatal checkup in settings where many neonates are not taken for check-ups	533 per 1.000	**720 per 1.000** (544 to 949)*	**RR 1.35** (1.02 to 1.78)*	135 (1 RCT) Ecuador	⨁◯◯◯ VERY LOW [a,c]	**We are uncertain of the effect of the intervention on women's attendance for neonatal checkup in settings where many neonates are not taken for check-ups, because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [7]).

Targeted client communication compared to standard care for pregnant and post-partum women

Patient or population: Pregnant and post-partum women
Setting: Community settings in high- (Canada, UK, USA), middle- (Ecuador, India, Kenya, Thailand), and low-income (Tanzania) countries
Intervention: Targeted client communication (reminders and information/education via SMS, voice calls, voice messages, MMS, and e-mail)
Comparison: Standard care or non-targeted client communication (general health messages)

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Timeliness of information and services	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on timeliness of information and services because no direct evidence was identified.**
Health behavior, status and well-being						
Maternal mortality	1 per 1.000	**3 per 1.000** (0 to 26)*	**RR 3.81** (0.43 to 34.02)*	2637 (1 RCT) Tanzania	⨁◯◯◯ VERY LOW [b,d]	**We are uncertain of the effect of the intervention on maternal mortality because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [6]).
Neonatal mortality	36 per 1.000	**19 per 1.000** (12 to 31)*	**RR 0.54** (0.33 to 0.87)*	2550 (1 RCT) Tanzania	⨁⨁◯◯ LOW [d,e]	**The intervention may reduce neonatal mortality.** (Study conducted in community setting [6]).
Neonatal diarrhoea	106 per 1.000	**111 per 1.000** (59 to 206)*	**RR 1.05** (0.56 to 1.94)*	332 (1 RCT) Kenya	⨁◯◯◯ VERY LOW [b,d]	**We are uncertain of the effect of the intervention on neonatal diarrhea because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [5]).
Health behaviour - Exclusive breastfeeding in the short term in settings where most women already breastfeed (up to 3 months)	1.000 per 1.000	**1.000 per 1.000** (930 to 1.000)*	**RR 1.00** (0.93 to 1.07)*	56 (1 RCT) Kenya	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of the intervention on exclusive breastfeeding in the short term in settings where most women already breastfeed, because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [8]).
Health behaviour - Exclusive breastfeeding in the short term in settings where some women already breastfeed (up to 3 months)	667 per 1.000	**867 per 1.000** (707 to 1.000)*	**RR 1.30** (1.06 to 1.59)*	135 (1 RCT) Ecuador	⨁◯◯◯ VERY LOW [a,c]	**We are uncertain of the effect of the intervention on exclusive breastfeeding in the short term in settings where some women already breastfeed, because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [7]).
Health behavior – taking iron and folate tablets during pregnancy	305 per 1.000	**521 per 1.000** (454 to 597)*	**RR 1.71** (1.49 to 1.96)*	1743 (1 RCT) India	⨁⨁⨁◯ MODERATE [d]	**The intervention probably increases the number of pregnant women taking iron and folate tablets** (Study conducted in community setting [4]).
Behavior – not smoking during pregnancy	555 per 1.000	**578 per 1.000** (550 to 611)*	**RR 1.04** (0.99 to 1.10)*	866 (2 RCTs) UK, USA	⨁⨁◯◯ LOW [e,f]	**The intervention may make little or no difference to the number of women that do not smoke during pregnancy.** (Studies conducted in community settings [1, 2]).

Targeted client communication compared to standard care for pregnant and post-partum women

Patient or population: Pregnant and post-partum women
Setting: Community settings in high- (Canada, UK, USA), middle- (Ecuador, India, Kenya, Thailand), and low-income (Tanzania) countries
Intervention: Targeted client communication (reminders and information/education via SMS, voice calls, voice messages, MMS, and e-mail)
Comparison: Standard care or non-targeted client communication (general health messages)

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Behavior – no alcohol consumption during pregnancy	974 per 1.000	**974 per 1.000** (945 to 1000)*	**RR 1.00** (0.97 to 1.03)*	459 (1 RCT) USA	⨁⨁◯◯ LOW [f,g]	**The intervention may make little or no difference to the number of women that do not consume alcohol during pregnancy.** (Study conducted in community setting [2]).
Satisfaction and acceptability						
Client acceptance of and satisfaction with the approach / intervention	The proportion of intervention group participants who reported being satisfied with intervention was 61.7%-89.8% in high-income settings[1, 9] 98.0% in upper-middle income settings [3, 7] and 89.3% in lower-middle income settings [4]. No study in low-income settings reported client satisfaction. Satisfaction was assessed in intervention groups and not control groups (non-comparable results).			N[10] (5 RCTs) Canada, Ecuador, India, Thailand, UK	⨁◯◯◯ VERY LOW [h]	**We are uncertain of the effect of the intervention on satisfaction with the approach/ intervention among individuals because the certainty of this evidence was assessed as very low (non-comparable).** (Studies conducted in community settings [1, 3, 4, 7, 9]).
Providers' acceptability/ satisfaction	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on providers' acceptability/ satisfaction because no direct evidence was identified.**
Resource use						
Resource use	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on resource use because no direct evidence was identified.**
Unintended consequences						
Unintended consequences	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on unintended consequences because no direct evidence was identified.**

*The 95% confidence interval (CI); **RR:** Risk ratio; **MD:** Mean difference; **RCT:** randomised controlled trial; **SMD:** standardised mean difference

GRADE Working Group grades of evidence. **High certainty:** We are very confident that the true effect lies close to that of the estimate of the effect. **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect. **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations

a. Downgraded one level for risk of bias: Unclear allocation concealment, lack of participant blinding and incomplete outcome data
b. Downgraded two levels for imprecision: Few events and a 95% confidence interval that encompasses a potential small harmful effect and a potential large beneficial effect of the intervention
c. Downgraded two levels for imprecision: Very few events reported

d. Downgraded one level for risk of bias: Unclear sequence generation and allocation concealment, lack of participant blinding
e. Downgraded one level for imprecision: Few events reported
f. Downgraded one level for risk of bias: Unclear allocation concealment and lack of participant and outcome assessor blinding, incomplete outcome data
g. Downgraded one level for indirectness: Studies from high-income countries
h. Non-comparable results, thus downgraded to very low

References and notes

1. Cooper, S.,Foster, K.,Naughton, F.,Leonardi-Bee, J.,Sutton, S.,Ussher, M.,Leighton, M.,Montgomery, A.,Parrott, S.,Coleman, T. Pilot study to evaluate a tailored text message intervention for pregnant smokers (MiQuit): study protocol for a randomised controlled trial. Trials [Electronic Resource]. 2015. 16:29
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8. McConnell, M.,Ettenger, A.,Rothschild, C. W.,Muigai, F.,Cohen, J. Can a community health worker administered postnatal checklist increase health-seeking behaviors and knowledge?: evidence from a randomized trial with a private maternity facility in Kiambu County, Kenya. BMC Pregnancy & Childbirth. 2016. 16:136
9. Yudin, M. H.,Mistry, N.,De, Souza,L, R.,Besel, K.,Patel, V.,Blanco, Mejia,Bernick, R.,Ryan, V.,Urquia, M.,Beigi, R. H.,Moniz, M. H.,Sgro, M. Text messages for influenza vaccination among pregnant women: A randomized controlled trial. Vaccine. 2017. 35:842-848
10. Due to unclear reporting in the included trials, the total number of individuals is not reported

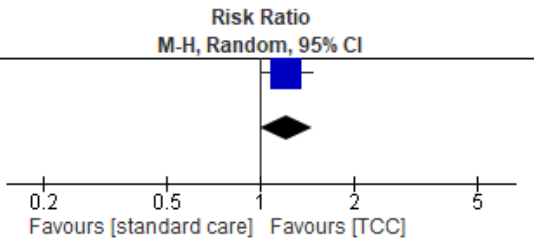
Analyses

Utilisation of services outcomes

Attendance at >4 antenatal care appointments

Study or Subgroup	TCC Events	TCC Total	Standard care Events	Standard care Total	Weight	Risk Ratio M-H, Random, 95% CI
Lund 2012	194	1311	151	1239	100.0%	1.21 [1.00, 1.48]
Total (95% CI)		**1311**		**1239**	**100.0%**	**1.21 [1.00, 1.48]**
Total events	194		151			

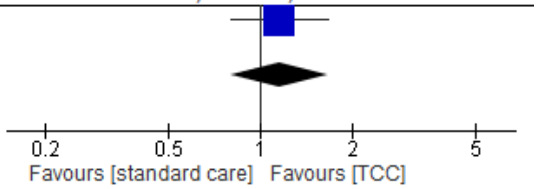
Heterogeneity: Not applicable
Test for overall effect: Z = 1.92 (P = 0.05)



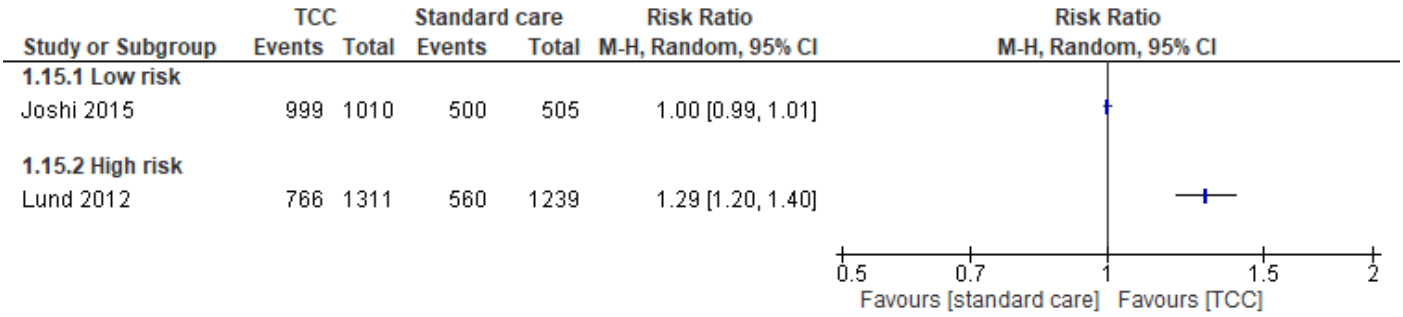
Attendance for antenatal influenza vaccine

Study or Subgroup	TCC Events	TCC Total	Standard care Events	Standard care Total	Weight	Risk Ratio M-H, Random, 95% CI
Yudin 2017	40	129	41	152	100.0%	1.15 [0.80, 1.66]
Total (95% CI)		**129**		**152**	**100.0%**	**1.15 [0.80, 1.66]**
Total events	40		41			

Heterogeneity: Not applicable
Test for overall effect: Z = 0.74 (P = 0.46)



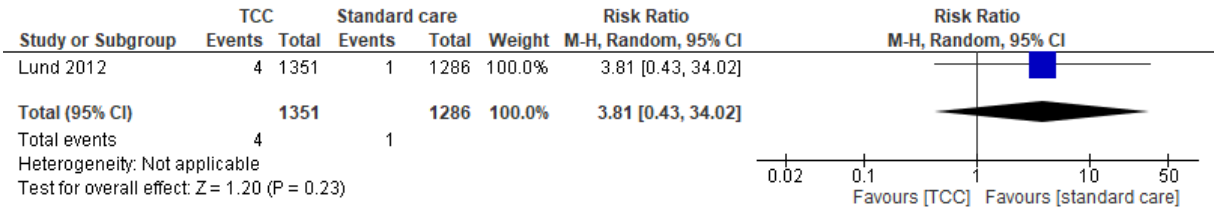
Skilled attendant at birth in settings where (1) most women already use a skilled birth attendant and (2) many women do not use a skilled birth attendant



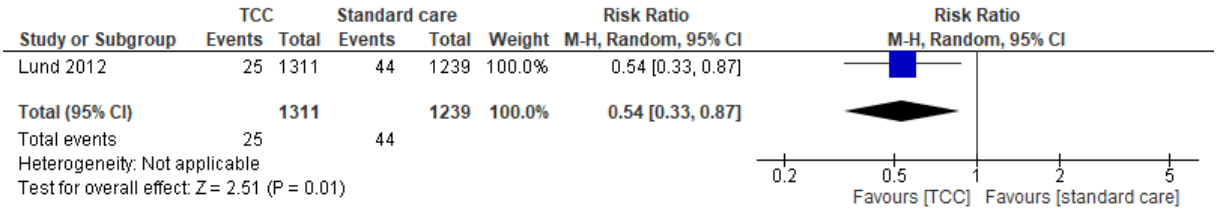
Health behavior, status and well-being

Health status and wellbeing outcomes

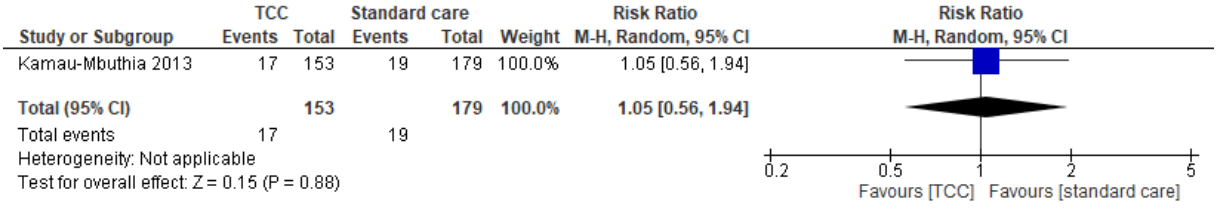
Maternal mortality



Neonatal mortality

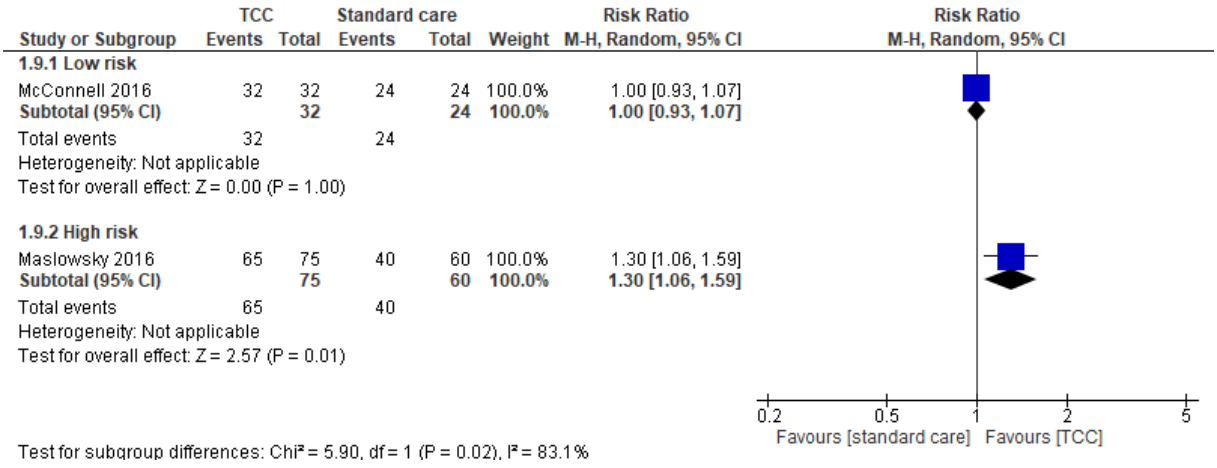


Neonatal diarrhea

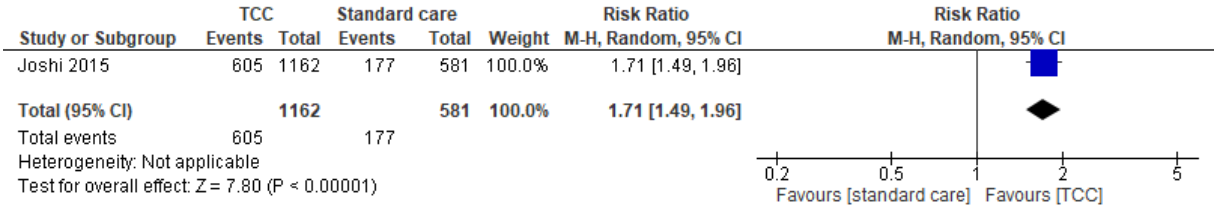


Health behaviour change outcomes

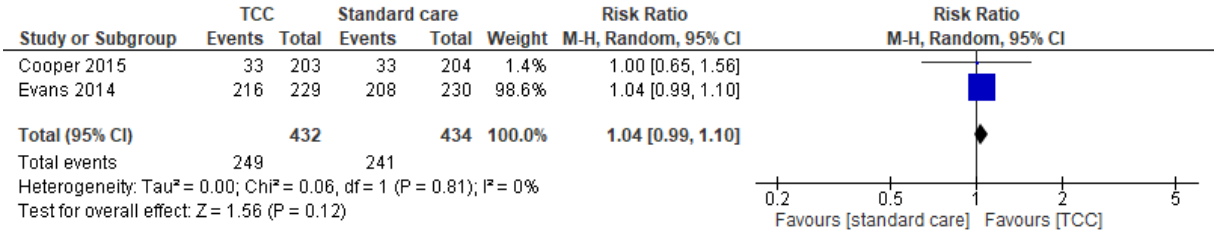
Exclusive breastfeeding in the short term in settings where (1) most women already breastfeed; (2) some women already breastfeed



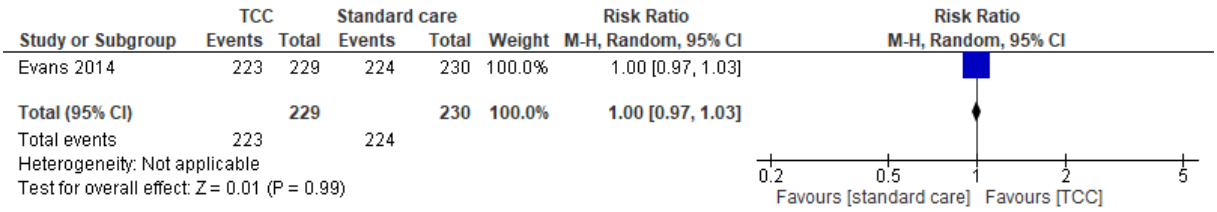
Taking iron and folate tablets during pregnancy



Not smoking during pregnancy



No alcohol during pregnancy



Summary of Findings D. Pregnant and postpartum women with HIV that use healthcare services

Targeted client communication compared to standard care for pregnant and post-partum women with HIV

Patient or population: Pregnant and post-partum HIV-positive women and their infants
Setting: Community settings in Kenya (lower middle income country)
Intervention: Targeted client communication (reminders and/or information/education via SMS or voice calls)
Comparison: Standard care

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Utilization of healthcare services						
Birth in a health facility	591 per 1,000	**502 per 1,000** (425 to 591)*	**RR 0.85** (0.72 to 1.00)*	479 (1 RCT) Kenya	⨁⨁◯◯ LOW [a]	**The intervention may reduce the number of women giving birth in a health facility. However, the range in which the actual effect may be indicates that the intervention may reduce or may have little or no effect on the number of women giving birth in a health facility.** (Study conducted in community setting [1]).
Attendance at postpartum care appointment (6-8 weeks postpartum)	118 per 1,000	**195 per 1,000** (120 to 318)*	**RR 1.66** (1.02 to 2.70)*	381 (1 RCT) Kenya	⨁⨁◯◯ LOW [b, e]	**The intervention may increase the number of women attending postpartum care appointments.** (Studies conducted in community settings [2]).
Timeliness of information and services	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on timeliness of information and services because no direct evidence was identified.**
Health behavior, status and well-being						
Maternal mortality	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on maternal mortality because no direct evidence was identified.**
Neonatal mortality	16 per 1,000	**15 per 1,000** (3 to 76)*	**RR 0.96** (0.20 to 4.72)*	381 (1 RCT) Kenya	⨁◯◯◯ VERY LOW [c, e]	**We are uncertain of the effect of the intervention on neonatal mortality because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [2]).

Targeted client communication compared to standard care for pregnant and post-partum women with HIV

Patient or population: Pregnant and post-partum HIV-positive women and their infants
Setting: Community settings in Kenya (lower middle income country)
Intervention: Targeted client communication (reminders and/or information/education via SMS or voice calls)
Comparison: Standard care

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Infant HIV test positive	11 per 1,000	**6 per 1,000** (1 to 26)*	**RR 0.55** (0.13 to 2.28)*	560 (2 RCTs) Kenya	⨁◯◯◯ VERY LOW [c,d]	**We are uncertain of the effect of the intervention on the number of infants that test positive for HIV because the certainty of this evidence was assessed as very low.** (Studies conducted in community settings [1, 2]).
Health behaviour - prenatal anti-retroviral medication adherence among pregnant women (34-36 weeks gestation)	996 per 1,000	**1000 per 1,000** (906 to 1,000)*	**RR 1.04** (0.91 to 1.19)*	503 (1 RCT) Kenya	⨁⨁⨁◯ MODERATE [f]	**The intervention probably makes little or no difference to the number of pregnant women adhering to prenatal anti-retroviral medication.** (Study conducted in community setting [1]).
Health behaviour - postnatal anti-retroviral medication adherence among mothers (6-8 weeks after birth)	881 per 1,000	**767 per 1,000** (670 to 802)*	**RR 0.87** (0.61 to 1.24)*	471 (1 RCT) Kenya	⨁⨁◯◯ LOW [f, g]	**The intervention may reduce the number of mothers adhering to postnatal anti-retroviral medication. However, the range in which the actual effect may be indicates that the intervention may reduce or increase adherence.** (Study conducted in community setting [1]).
Health behaviour - infant uptake of or adherence to anti-retroviral prophylaxis medication (assessed 6-10 weeks after birth)	978 per 1,000	998 per 1,000 (978 to 1,000)*	RR 1.02 (1.00 to 1.04)	471 (1 RCT) Kenya	⨁⨁◯◯ LOW [a]	**The intervention may lead to little or no difference in infant uptake of or adherence to anti-retroviral prophylaxis medication.** (Study conducted in community setting [1])
Health behaviour - infant HIV tested (6-8 weeks after birth)	864 per 1,000	**899 per 1,000** (829 to 976)*	**RR 1.04** (0.96 to 1.13)*	603 (2 RCTs) Kenya (2)	⨁⨁◯◯ LOW [d]	**The intervention may make little or no difference to the number of infants who receive an HIV test.** (Study conducted in community setting [1,2]).
Satisfaction and acceptability						
Client acceptance of and satisfaction with the approach/ intervention	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on client acceptability/ satisfaction because no direct evidence was identified.**
Providers' acceptability / satisfaction	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on providers' acceptability/ satisfaction because no direct evidence was identified.**
Resource use						

Targeted client communication compared to standard care for pregnant and post-partum women with HIV

Patient or population: Pregnant and post-partum HIV-positive women and their infants
Setting: Community settings in Kenya (lower middle income country)
Intervention: Targeted client communication (reminders and/or information/education via SMS or voice calls)
Comparison: Standard care

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Resource use	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on resource use because no direct evidence was identified.**
Unintended consequences						
Unintended consequences	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on unintended consequences because no direct evidence was identified.**

*The 95% confidence interval (CI); **RR:** Risk ratio; **MD:** Mean difference; **RCT:** randomised controlled trial; **SMD:** standardised mean difference

GRADE Working Group grades of evidence. **High certainty:** We are very confident that the true effect lies close to that of the estimate of the effect. **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect. **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

ARV: anti-retroviral medication; **HCW:** health care worker; **HIV:** human immunodeficiency virus; **PMTCT:** prevention of mother to child transmission; **SMS:** short message service; **TCC:** targeted client communication

Explanations

a. Downgraded two levels for risk of bias: More women were newly diagnosed with HIV in the control arm (55% versus 66%, p=0.015), randomisation procedures and allocation concealment were not described, lack of binding of participants, and only per-protocol analysis reported with unexplained dropouts (Kassaye 2016)
b. Downgraded one level for imprecision: few events
c. Downgraded two levels for imprecision: few events and a 95% confidence interval that encompasses a potential large harmful effect and a potential large beneficial effect of the intervention
d. Downgraded two levels for risk of bias: More women were newly diagnosed with HIV in the control arm (55% versus 66%, p=0.015), randomisation procedures and allocation concealment were not described, lack of binding of participants, and only per-protocol analysis reported with unexplained dropouts (Kassaye 2016); lack of participant and provider blinding, selective outcome reporting (Odeny 2014)
e. Downgraded one level for risk of bias: lack of participant and provider blinding, selective outcome reporting (Odeny 2014)
f. Downgraded one level for risk of bias: randomisation procedures and allocation concealment were not described, lack of binding of participants, and only per-protocol analysis reported with unexplained dropouts
g. Downgraded one level for imprecision: 95% confidence interval that encompasses a potential harmful effect and a potential beneficial effect of the intervention

References and notes

1. Kassaye SG, Ong'ech J, Sirengo M, Kose J, Matu L, McOdida P, et al. Cluster-Randomized Controlled Study of SMS Text Messages for Prevention of Mother-to-Child Transmission of HIV in Rural Kenya. AIDS Research & Treatment. 2016. 2016:1289328
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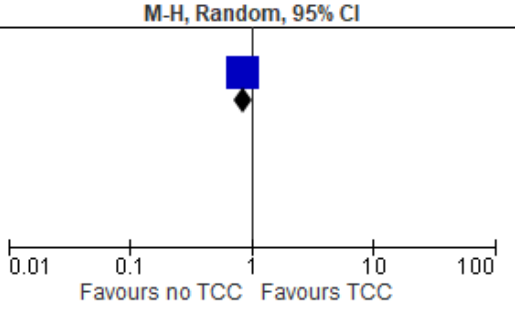
Analyses

Utilisation of health services

Birth in a health facility

Study or Subgroup	TCC Events	TCC Total	No TCC Events	No TCC Total	Weight	Risk Ratio M-H, Random, 95% CI
1.5.1 Intrapartum care: birth in health facility						
Kassaye 2016	124	247	137	232	100.0%	0.85 [0.72, 1.00]
Subtotal (95% CI)		**247**		**232**	**100.0%**	**0.85 [0.72, 1.00]**
Total events	124		137			

Heterogeneity: Not applicable
Test for overall effect: Z = 1.94 (P = 0.05)

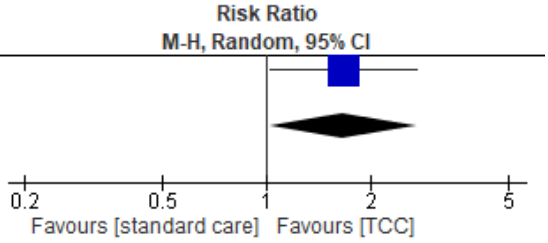


Test for subgroup differences: Not applicable

Attendance at postpartum care appointment

Study or Subgroup	TCC Events	TCC Total	No TCC Events	No TCC Total	Weight	Risk Ratio M-H, Random, 95% CI
Odeny 2014	38	194	22	187	100.0%	1.66 [1.02, 2.70]
Total (95% CI)		**194**		**187**	**100.0%**	**1.66 [1.02, 2.70]**
Total events	38		22			

Heterogeneity: Not applicable
Test for overall effect: Z = 2.06 (P = 0.04)



Health behavior, status and well-being

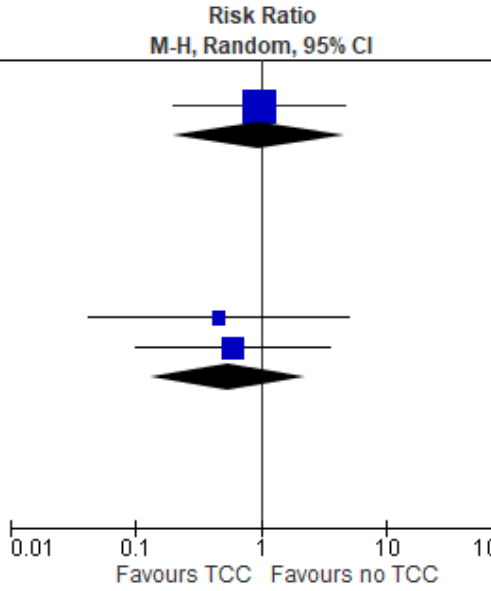
Health status

Study or Subgroup	TCC Events	TCC Total	No TCC Events	No TCC Total	Weight	Risk Ratio M-H, Random, 95% CI
1.3.1 Neonatal health: death						
Odeny 2014	3	194	3	187	100.0%	0.96 [0.20, 4.72]
Subtotal (95% CI)		**194**		**187**	**100.0%**	**0.96 [0.20, 4.72]**
Total events	3		3			

Heterogeneity: Not applicable
Test for overall effect: Z = 0.05 (P = 0.96)

1.3.3 Neonatal health: infant HIV test positive						
Kassaye 2016 (1)	1	122	2	113	35.6%	0.46 [0.04, 5.04]
Odeny 2014 (2)	2	171	3	154	64.4%	0.60 [0.10, 3.55]
Subtotal (95% CI)		**293**		**267**	**100.0%**	**0.55 [0.13, 2.28]**
Total events	3		5			

Heterogeneity: Tau² = 0.00; Chi² = 0.03, df = 1 (P = 0.86); I² = 0%
Test for overall effect: Z = 0.83 (P = 0.41)



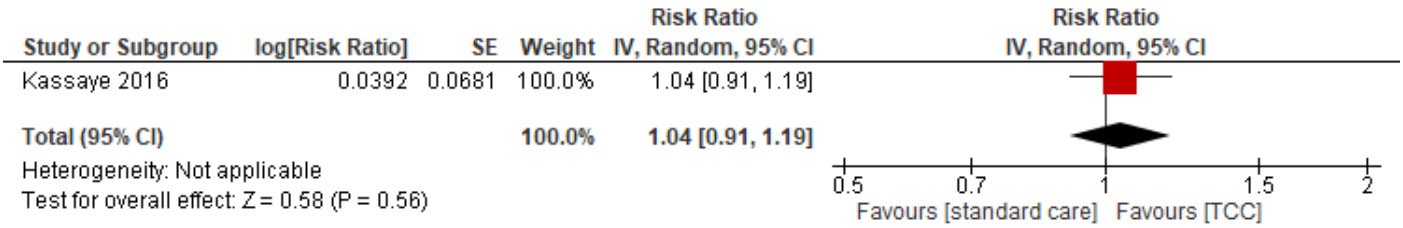
Test for subgroup differences: Chi² = 0.27, df = 1 (P = 0.60), I² = 0%

Footnotes

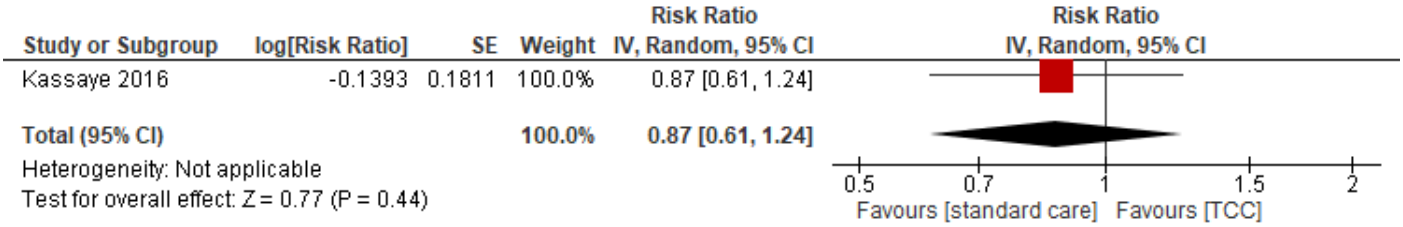
(1) Cluster-RCT, adjusted using ICC=0.05 (design effect=2.0075), sample size reduced by n=236
(2) There was one missing result, we assumed from the intervention group

Health behavior

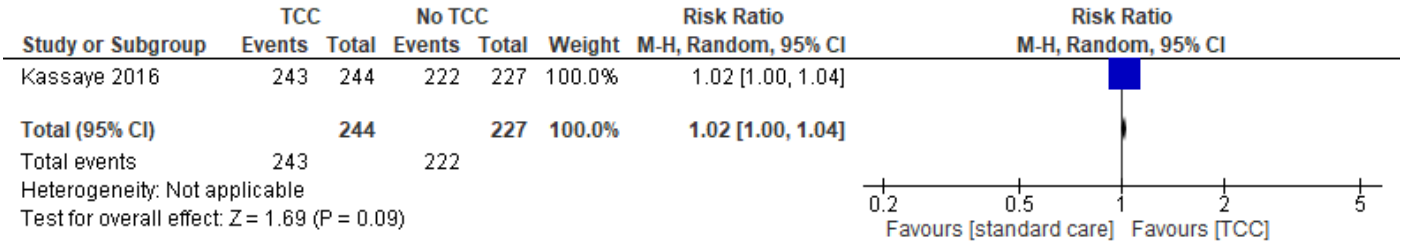
Prenatal antiretroviral medication adherence among pregnant women (34-36 weeks gestation)



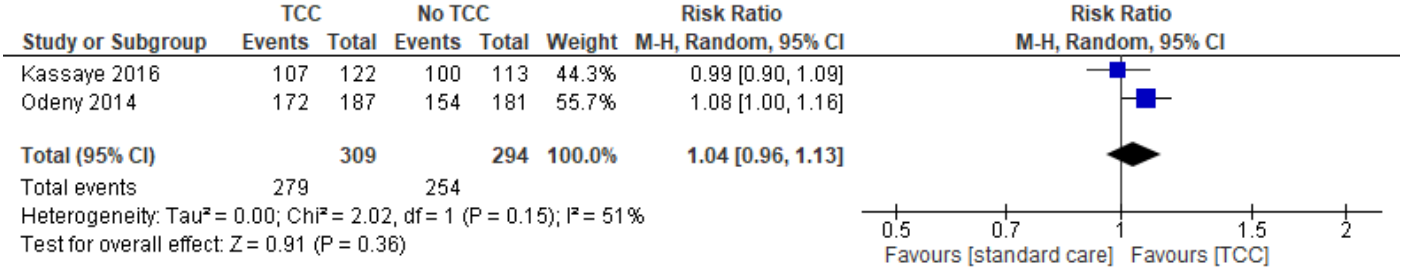
Postnatal antiretroviral medication among mothers (6-8 weeks after birth)



Infant uptake of or adherence to anti-retroviral prophylaxis medication



Infant HIV tested (6-8 weeks)



Summaries of Findings E. Parents of children < 5 years of age that use healthcare services

E.1 Summary of Findings table with plain language summary

Targeted client communication compared to standard care for parents of children < 5 years of age

Patient or population: Parents of children < 5 years of age
Setting: Community settings in high- (USA), middle- (Cameroon, Nigeria, Guatemala, Kenya, India), and low-income (Zimbabwe) countries
Intervention: Targeted client communication (reminders and/or information/education via SMS or voice calls)
Comparison: Standard care (13 studies)

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Utilization of healthcare services						
Receipt of vaccinations at 2 months	785 per 1.000	**895 per 1.000** (825 to 958)*	**RR 1.14** (1.05 to 1.22)*	583 (4 RCTs) USA (2), Kenya, Zimbabwe	⨁⨁⨁◯ MODERATE [c,m]	**The intervention probably increases the number of children receiving vaccinations at 2 months.** (Study conducted in community setting [1, 9, 8, 2]).
Receipt of vaccinations at 6 months	727 per 1.000	**800 per 1.000** (698 to 916)*	**RR 1.10** (0.96 to 1.26)*	944 (6 RCTs) USA (3), Kenya, Guatemala, Zimbabwe	⨁⨁◯◯ LOW [d,e,m]	**The intervention may increase the number of children receiving vaccinations at 6 months.** (Studies conducted in community settings [1, 2, 5, 8, 9, 12]).
Receipt of vaccinations at 12 months	Not estimable	Not estimable	Not estimable	3980 (4 RCTs) USA (2), Kenya, Nigeria	⨁◯◯◯ VERY LOW [f,g,h,m]	**We are uncertain of the effect of the intervention on the number of children receiving vaccinations at 12 months because the certainty of this evidence was assessed as very low.** (Studies conducted in community settings [10, 14, 7, 4]).
HIV-positive and HIV-exposed children's attendance at HIV medical appointments Follow-up: 2 days after intervention	508 per 1.000	**828 per 1.000** (640 to 1.000)*	**RR 1.63** (1.26 to 2.11)*	242 (1 RCT) Cameroon	⨁⨁⨁◯ MODERATE [i]	**The intervention probably increases the number of children attending HIV medical appointments.** (Study conducted in community setting [3]).
Early intervention for developmental delay Follow-up: 6 months	515 per 1.000	**546 per 1.000** (345 to 871)*	**RR 1.06** (0.67 to 1.69)*	64 (1 RCT) USA	⨁◯◯◯ VERY LOW [j,k,l]	**We are uncertain of the effect of the intervention on early intervention for developmental delay because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [11]).

Targeted client communication compared to standard care for parents of children < 5 years of age

Patient or population: Parents of children < 5 years of age
Setting: Community settings in high- (USA), middle- (Cameroon, Nigeria, Guatemala, Kenya, India), and low-income (Zimbabwe) countries
Intervention: Targeted client communication (reminders and/or information/education via SMS or voice calls)
Comparison: Standard care (13 studies)

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
No emergency room attendance among infants in the first 6 months after birth Follow-up: 6 months	576 per 1.000	**760 per 1.000** (593 to 979)*	**RR 1.32** (1.03 to 1.70)*	129 (1 RCT) USA	⨁◯◯◯ VERY LOW [i,j,k]	**We are uncertain of the effect of the intervention on the number of infants that do not attend emergency room in the first 6 months because the certainty of this evidence was assessed as very low.** (Study conducted in community setting and aimed to reduce emergency room attendance [9]).
Timeliness of information and services - vaccine receipt within a certain time period	501 per 1.000	**591 per 1.000** (521 to 666)*	**RR 1.18** (1.04 to 1.33)*	2400 (4 RCTs) USA (2), Nigeria, Kenya	⨁⨁⨁◯ MODERATE [h]	**The intervention probably improves the timeliness of vaccine receipt among children under 5 years.** (Studies conducted in community settings [1, 14, 6, 7]).
Health behavior, status and well-being						
Health behavior, status and well-being	No studies were identified that reported this outcome					**We are uncertain of the effec because no direct evidence was identified.**
Satisfaction and acceptability						
Client acceptable of and satisfaction with the approach/ intervention	One study[5] reported that intervention parents agreed that SMS reminders were helpful for remembering appointments compared to usual care parents and said that they would be willing to pay for future SMS reminders. One study[7] reported that 97.5% of participants thought the number of reminders was "just right". Another study[10] reported that 86.8% of participants liked the messages and 9.3% did not like them. The final study[14] reported that nearly all (98.0%) were very satisfied or satisfied with the messages.			N[15] (4 RCTs) Guatemala, Kenya, USA (2)	⨁◯◯◯ VERY LOW [n]	**We are uncertain of the effect of the intervention on client satisfaction because the certainty of this evidence was assessed as very low (non-comparable).** (Studies conducted in community setting [5, 7, 10, 13]).
Providers' acceptability/satisfaction	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on providers' acceptability/ satisfaction because no direct evidence was identified.**
Resource use						

Targeted client communication compared to standard care for parents of children < 5 years of age

Patient or population: Parents of children < 5 years of age
Setting: Community settings in high- (USA), middle- (Cameroon, Nigeria, Guatemala, Kenya, India), and low-income (Zimbabwe) countries
Intervention: Targeted client communication (reminders and/or information/education via SMS or voice calls)
Comparison: Standard care (13 studies)

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Resource use	One study[2] reported a cost of US$59.22 for all the messages (n=1368). Another[8] reported a cost of $0.27 USD per child for the project. One study[9] reported that the intervention was estimated to save between $51,030 and $104,277 in health care costs. Another[3] did not report the total costs but noted that text messaging was the most efficient intervention when both the direct costs of the intervention and staff working time were considered. Only one study[6] performed a cost-effectiveness analysis and found that projected cost of using SMS reminders was about a quarter what it would cost to use Junior Community Health Extension Workers (CHEWs) for functional home visits in one year.			N[14] (5 RCTs) Cameroon, Kenya, Nigeria, USA, Zimbabwe	⨁◯◯◯ VERY LOW [n]	**We are uncertain of the effect of the intervention on resource use because the certainty of this evidence was assessed as very low (non-comparable).** (Studies conducted in community setting [2, 8, 9, 3, 6]).
Unintended consequences						
Unintended consequences	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on unintended consequences because no direct evidence was identified.**

*The 95% confidence interval (CI); **RR:** Risk ratio; **MD:** Mean difference; **RCT:** randomised controlled trial; **SMD:** standardised mean difference

GRADE Working Group grades of evidence. **High certainty:** We are very confident that the true effect lies close to that of the estimate of the effect. **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect. **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

ARV: anti-retroviral medication; **HCW:** health care worker; **HIV:** human immunodeficiency virus; **PMTCT:** prevention of mother to child transmission; **SMS:** short message service; **TCC:** targeted client communication

Explanations

a. Downgraded one level for risk of bias: Unclear randomisation sequence generation and allocation concealment, lack of binding of participants and only per-protocol analysis reported
b. Downgraded one level for imprecision: small sample size
c. Downgraded one level for risk of bias: All studies unclear allocation concealment, lack of participant, provider and outcome assessor blinding
d. Downgraded one level for risk of bias: Three studies (75%) with unclear allocation concealment, lack of participant, provider and outcome assessor blinding, selective outcome reporting
e. Downgraded one level for indirectness: Three studies (50%) from high income countries
f. Downgraded one level for risk of bias: Two studies (50%) with unclear randomisation sequence generation and allocation concealment, three studies (75%) lacking participant and provider blinding
g. Downgraded one level for inconsistency: High statistical heterogeneity (I-sq > 50%)
h. Downgraded one level for indirectness: Two studies (50%) from high income countries
i. Downgraded one level for imprecision: Few events
j. Downgraded one level for risk of bias: Participants, providers, and outcome assessors not blinded, selective outcome reporting
k. Downgraded one level for indirectness: Study from high-income country

l. Downgraded three levels for imprecision: Few events and a 95% confidence interval that encompasses a potential large harmful effect and a potential large beneficial effect of intervention
m. The vaccination outcomes assessed were as follows: Study from Kenya [8]: receipt of pentavalent vaccine; study from Zimbabwe [2]: receipt of OPV, Penta, PCV; study from Guatemala [5]: receipt of pentavalent, pneumococcal, poliomyelitis, and rotavirus; study from USA [11]: receipt of DTaP, HepB, HIB, PCV, and polio; study from Kenya [7]: receipt of BCG, three doses of polio vaccine, three doses of pentavalent vaccine, and measles vaccine; study from Nigeria [4]: receipt of one dose of BCG vaccine, at least four doses of OPV vaccines, three doses of DPT vaccine, three doses of Hep B vaccines, and one dose each of measles and Yellow fever vaccine; study from the USA [10]: receipt of MMR; study from the USA [14]: receipt of influenza vaccine
n. Due to unclear reporting in the included trials, the total number of individuals is not reported

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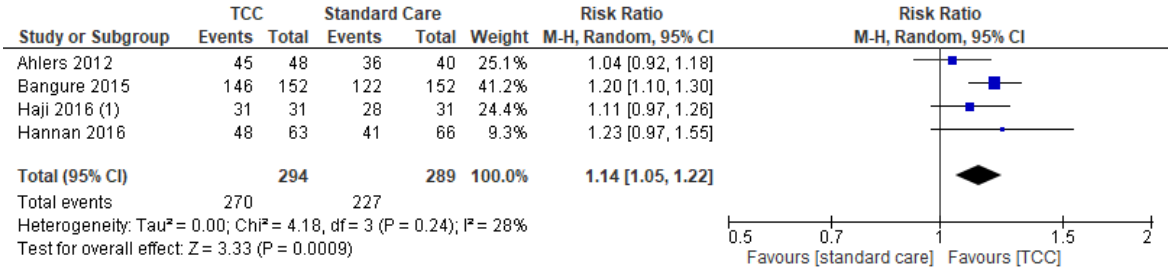
14. Due to unclear reporting in the included trials, the total number of individuals is not reported here.

Analyses

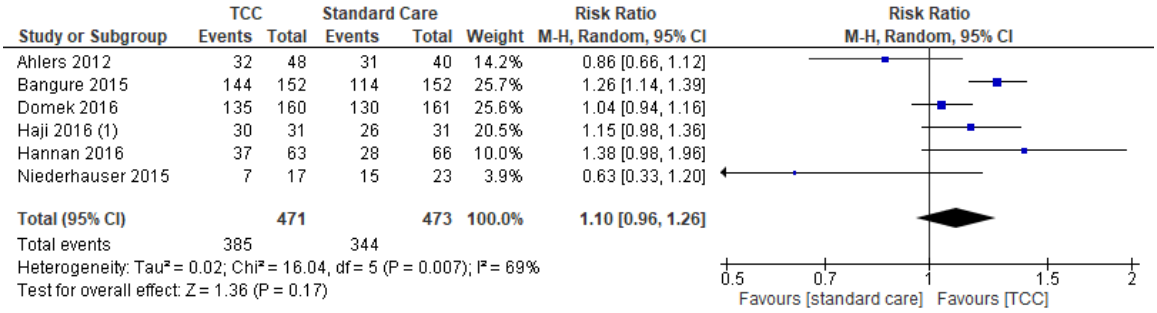
Utilisation of health service

Attendance for vaccinations at 2 months



Footnotes
(1) adjusted for clustering prior to meta-analysis using an ICC = 0.089 (Gibson et al 2017), consequently sample size was reduced by 682...

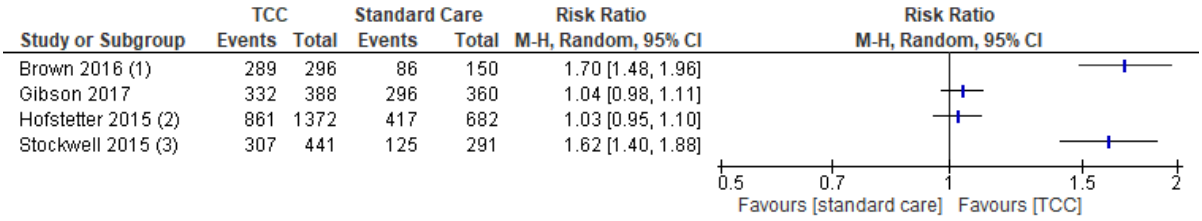
Attendance for vaccinations at 6 months



Footnotes

(1) adjusted for clustering prior to meta-analysis using an ICC = 0.089 (Gibson et al 2017), consequently sample size was reduced by 682...

Attendance for vaccinations at 12 months



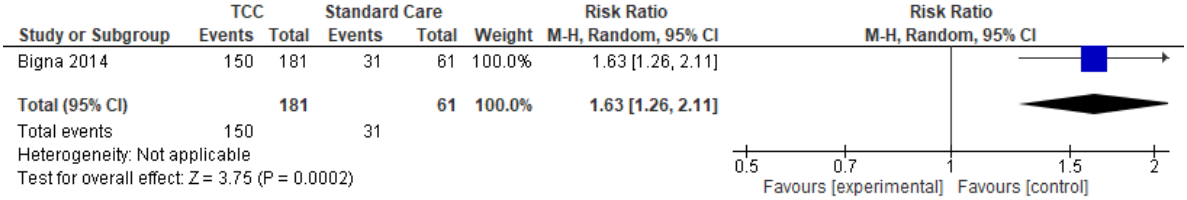
Footnotes

(1) Combined two intervention arms (reminder/recall and reminder/recall + HCP training)

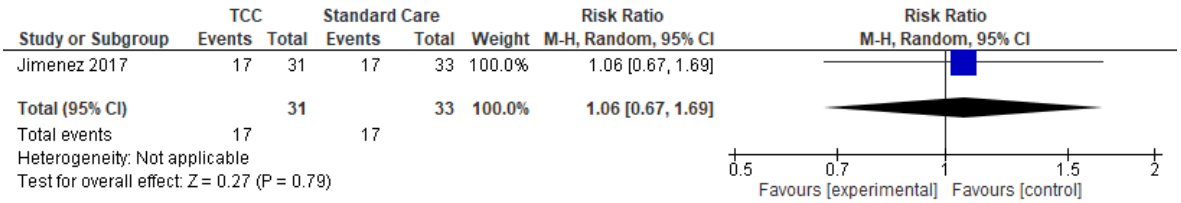
(2) Combined two intervention arms (Scheduling + appointment SMS reminders and appointment SMS reminders only)

(3) Combined two intervention arms (educational SMS and conventional SMS)

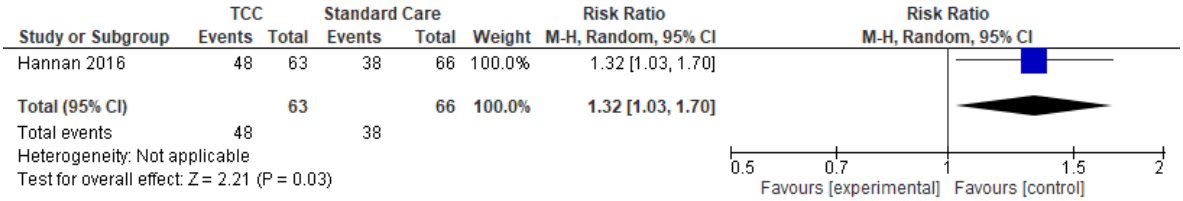
Attendance at HIV medical appointments



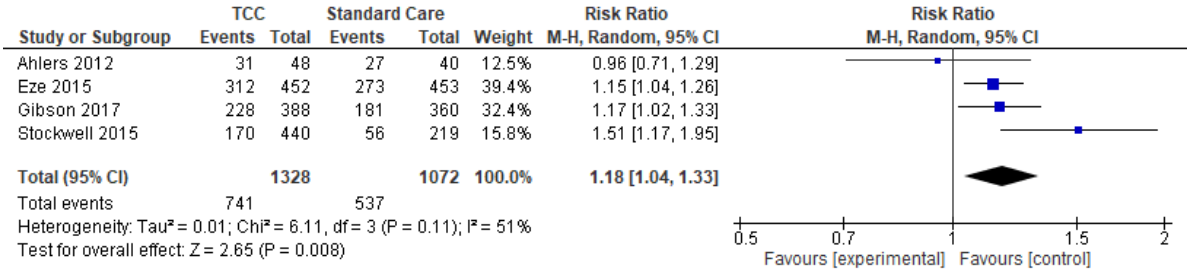
Early intervention for developmental delay



No emergency room attendance



Timeliness of information and services (vaccination)



E.2 Summary of Findings table with plain language summary

Digital, targeted client communication compared to non-digital, targeted client communication for parents of children < 5 years of age

Patient or population: Parents of children < 5 years of age
Setting: Community settings in middle-income country (India)
Intervention: Targeted client communication (reminders and/or information/education via SMS or voice calls)
Comparison: Targeted non-digital client communication (pamphlets, 1 study)

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Utilization of healthcare services						
Utilization of healthcare services	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on utilization of healthcare services because no direct evidence was identified.**
Health behavior, status and well-being						
Child mortality	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on child mortality because no direct evidence was identified.**
Health behaviour - Oral health in children (Visible Plaque Index, [0-100%], low=good) Follow-up: 4 weeks after intervention	The mean oral health in children in the control group was **33.5%** on the VPI scale	The mean oral health in children in the intervention group was **2.1% lower** (7.54 lower to 3.34 higher) on the VPI scale	-	143 (1 RCT) India	⨁⨁◯◯ LOW [a,b]	**The intervention may make little or no difference to oral health among children under 5 years.** (Study conducted in community setting [13]).

Digital, targeted client communication compared to non-digital, targeted client communication for parents of children < 5 years of age

Patient or population: Parents of children < 5 years of age
Setting: Community settings in middle-income country (India)
Intervention: Targeted client communication (reminders and/or information/education via SMS or voice calls)
Comparison: Targeted non-digital client communication (pamphlets, 1 study)

Outcomes	**Standard care**	**Targeted client communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Satisfaction and acceptability						
Client acceptability of and satisfaction with the approach/ intervention	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on client acceptability of and satisfaction with because no direct evidence was identified.**
Providers' acceptability/satisfaction	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on providers' acceptability/ satisfaction because no direct evidence was identified.**
Resource use						
Resource use	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on resource use because no direct evidence was identified.**
Unintended consequences						
Unintended consequences	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on unintended consequences because no direct evidence was identified.**

*The 95% confidence interval (CI); **RR:** Risk ratio; **MD:** Mean difference; **RCT:** randomised controlled trial; **SMD:** standardised mean difference

GRADE Working Group grades of evidence. **High certainty:** We are very confident that the true effect lies close to that of the estimate of the effect. **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect. **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

ARV: anti-retroviral medication; **HCW:** health care worker; **HIV:** human immunodeficiency virus; **PMTCT:** prevention of mother to child transmission; **SMS:** short message service; **TCC:** targeted client communication

Explanations

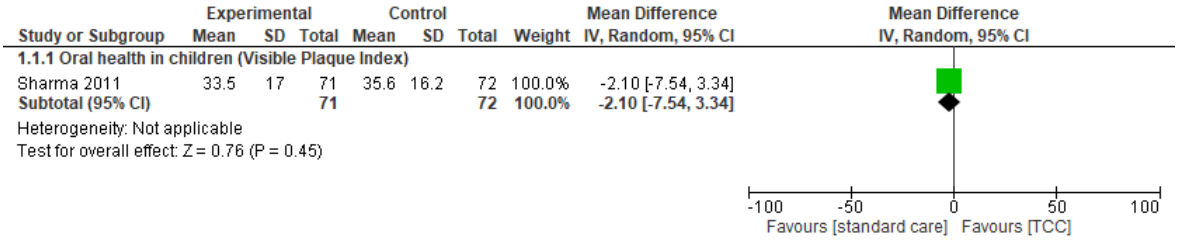
a. Downgraded one level for risk of bias: Unclear randomisation sequence generation and allocation concealment, lack of binding of participants and only per-protocol analysis reported
b. Downgraded one level for imprecision: small sample size

References and notes

1. Sharma, R.,Hebbal, M.,Ankola, A. V.,Murugabupathy, V.. Mobile-phone text messaging (SMS) for providing oral health education to mothers of preschool children in Belgaum City. Journal of Telemedicine & Telecare. 2011. 17:432-6

Analyses

Health behavior, status and well-being



Web Annex H: Client-to-Provider Telemedicine: Mobile-based technologies to support client to healthcare provider communication and management of care (unpublished review)

Link to published protocol:
https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD012928/full

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Abstract

Background

Telemedicine to facilitate the exchange of clinical information between clients and health care providers through the use of mobile technologies has the potential to support access to healthcare services, allow rapid transfer of information (including complex high velocity information) and benefit patients and clients.

Objectives

To assess the effectiveness of client-to-provider telemedicine through mobile technologies to support the communication of healthcare information and management of care on clients' health and well-being, to identify unintended consequences and the impact of mobile technologies on healthcare resources use, compared with usual care.

Search methods

We searched CENTRAL, MEDLINE, Embase and three other databases on 7 July 2017 together with reference checking, contact with topic experts, and two clinical trials registries.

Selection criteria

Randomised trials comparing mobile technologies to support client to healthcare provider communication and management of care (client to provider telemedicine), with usual care.

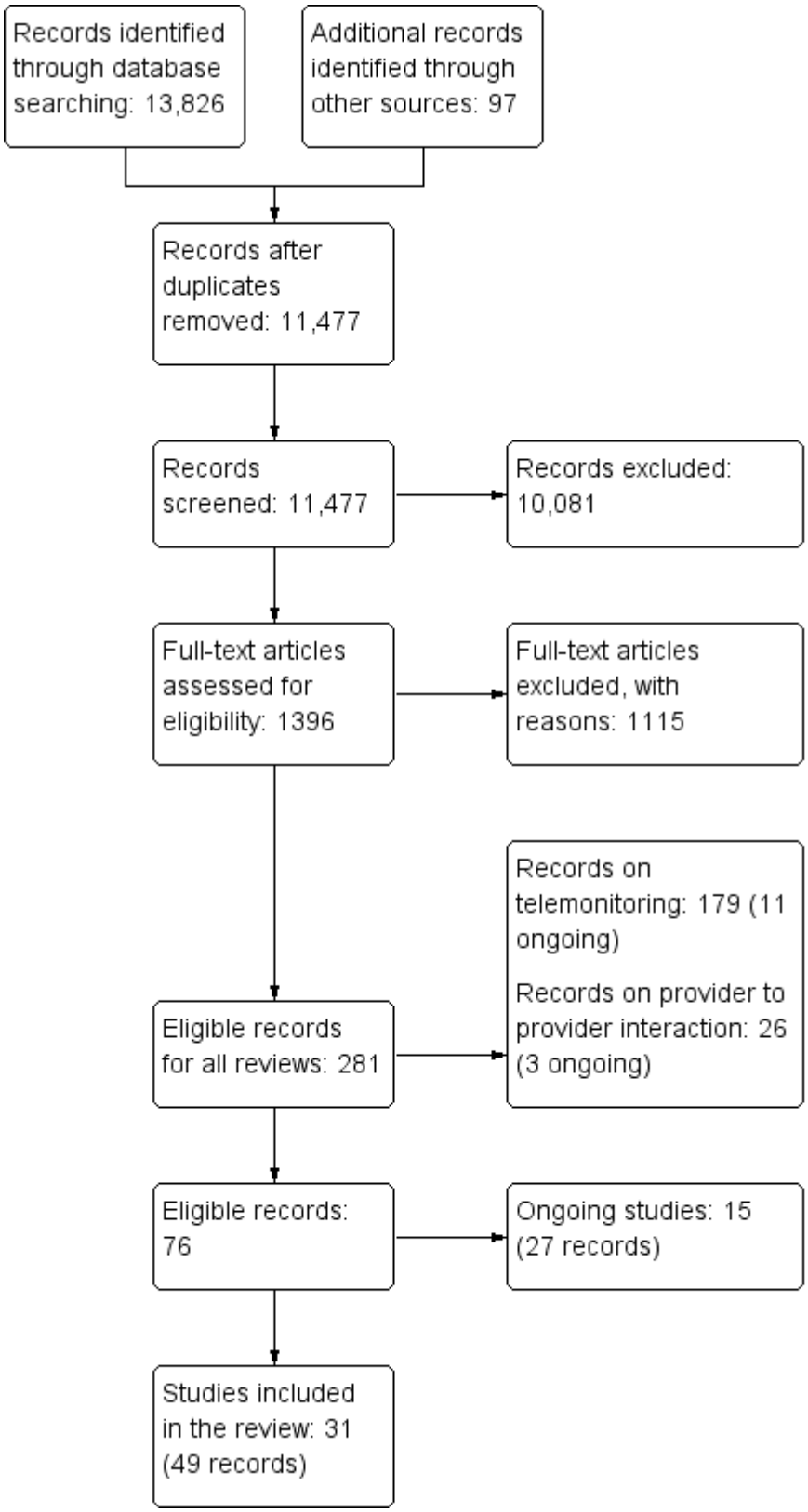
Data collection and analysis

We followed the standard methodological procedures expected by Cochrane and EPOC. We used the GRADE approach to assess the certainty of the body of evidence for the most important outcomes.

Main results

We included 31 studies (N = 18,394 randomised participants), all conducted in high and upper-middle income countries. The intervention was delivered by nurses (13 studies), physicians (4 studies) or lay health workers (3 studies). Studies recruited clients with different conditions and health problems, and the

function and way that the intervention was delivered varied. See the Summary of Findings tables for the results of the review.



For results, see Summary of Findings table below.

Summary of Findings

Client to healthcare provider telemedicine compared to usual care

Patient or population: Adults with type 2 diabetes, major depression, heart, dermatological, pulmonary and musculoskeletal conditions; older adults receiving home care; women who had delivered a baby; women who had an induced abortion; parents of children with asthma and food allergy; children with medical complexity; adults attempting to quit smoking
Setting: Community settings, primary care setting, and hospital-based setting in high (UK, Germany, The Netherlands, Canada, USA, Ireland, Norway, Denmark, Poland, and Italy) and middle (Turkey, Ecuador, Cambodia, and Kenya) income countries.
Intervention: Client to provider telemedicine (phone-based consultations, home-based monitoring followed by phone-based consultations, web-delivered physical rehabilitation, smartphone application for contacting provider)
Comparison: Usual care (management plan sent to the primary care provider; usual medical care according to guidelines; face to face appointments with the general practitioner; face to face home visits; general advice provided; referral to specialist appointment or care; clients were free to seek other treatment, but no specific recommendations provided)

Outcomes	**Usual care**	**Client to provider telemedicine**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Utilization of healthcare services						
Number of hospital admission (follow-up: 2 to 12 months)	328 per 1,000	**322 per 1,000** (220 to 361)*	**RR 0.98** (0.67 to 1.10)*	2783 (4 RCTs) Multisite (UK, Germany, The Netherlands), Germany, Canada, USA	⊕⊕⊖⊖ LOW [a, d]	**The intervention may make little or no difference to the number of hospital admissions among individuals with heart-related conditions or older individuals receiving home care.** (Studies conducted in hospital and primary care settings [1, 2, 3, 25])
Length of hospital stay (follow-up: 8 to 12 months)	Two studies recruiting clients with heart conditions show both negative and positive impacts. The first study shows an increase of 2 days (-0.18, 4.18)* in length of hospital stay. The second study shows a decrease of 2.5 days (-4.64, -0.36)* in length of hospital stay			1758 (2 RCTs) Multisite (UK, Germany, The Netherlands), Germany	⊕⊖⊖⊖ VERY LOW [a, d, g, h]	**We are uncertain of the effect of the intervention on length of hospital stay among individuals with heart-related conditions because the certainty of this evidence was assessed as very low.** (Studies conducted in hospital settings [1, 2])
Number of hospital and clinic visits (number of clients visiting) (follow-up: 1-12 months)	90 per 1,000	**34 per 1,000** (11 to 108)*	**RR 0.38** (0.12, 1.20)*	190 (2 RCTs) Turkey, Ireland	⊕⊖⊖⊖ VERY LOW [a, d, i]	**We are uncertain of the effect of the intervention on the number of individuals that visit hospitals or clinics because the certainty of this evidence was assessed as very low** (Studies conducted in hospital settings [7, 13])
Hospital and clinic visits (number of visits per client) (follow-up: 12-24 months)	The mean number of visits per client was 2.62	In the intervention group there was **0.29 fewer visits** per client (-0.63, 0.05)*		600 (3 RCTs) USA (2). Ecuador	⊕⊕⊖⊖ LOW [a, d]	**The intervention may slightly reduce the number of hospital or clinic visits among individuals with chronic conditions and depression and among woman who have given birth.** (Studies conducted in hospital and primary care settings [16, 18, 23]). Another study[4] did not provide enough data to be pooled in analysis.

Client to healthcare provider telemedicine compared to usual care

Patient or population: Adults with type 2 diabetes, major depression, heart, dermatological, pulmonary and musculoskeletal conditions; older adults receiving home care; women who had delivered a baby; women who had an induced abortion; parents of children with asthma and food allergy; children with medical complexity; adults attempting to quit smoking
Setting: Community settings, primary care setting, and hospital-based setting in high (UK, Germany, The Netherlands, Canada, USA, Ireland, Norway, Denmark, Poland, and Italy) and middle (Turkey, Ecuador, Cambodia, and Kenya) income countries.
Intervention: Client to provider telemedicine (phone-based consultations, home-based monitoring followed by phone-based consultations, web-delivered physical rehabilitation, smartphone application for contacting provider)
Comparison: Usual care (management plan sent to the primary care provider; usual medical care according to guidelines; face to face appointments with the general practitioner; face to face home visits; general advice provided; referral to specialist appointment or care; clients were free to seek other treatment, but no specific recommendations provided)

Outcomes	**Usual care**	**Client to provider telemedicine**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Health behavior, status and well-being						
Mortality among individuals with heart conditions (follow-up 6-12 months)	48 per 1,000	**27 per 1,000** (18 to 42)*	RR 0.57 (0.38 to 0.87)*	1978 (3 RCTs) Multisite (UK, Germany, The Netherlands), Germany, Canada	⨁⨁⊖⊖ LOW [b,l]	**The intervention may reduce mortality among individuals with heart-related conditions.** (Studies conducted in hospital and primary care [1, 2, 3])
Glycated hemoglobin (HbA1c) in individuals with diabetes type 2 (follow-up 12 months)	One study reported that the mean change in HbA1c was 0.15% (95% CI -0.58 to 0.29) for the m-health group and -0.16% (95% CI -0.50 to 0.18) for the control group. One study reported the mean difference between groups at follow-up to be -0.31% (95% CI -0.11 to 0.52). One study reported that there was little or no difference between groups (no usable data).			644 (3 RCTs) Denmark, Norway, UK	⨁⨁⨁⊖ MODERATE [b]	**The intervention probably makes little or no difference to diabetes control, assessed by HbA1c among individuals with diabetes type 2.** (Studies conducted in hospital and primary care [4, 5, 6])
Health-related quality of life (assessed with: ACT, NDI, RQLQ, SF-36) (follow-up: 1-6 months)		**SMD -0.37** (-0.81 to 0.06)* Interpreting SMDs: 0.2 represents a small effect, 0.5 a moderate effect, and 0.8 a large effect *Negative direction means high quality of life*		364 (3 RCTs) Turkey, Italy, Poland	⨁⨁⊖⊖ LOW [a, e]	**The intervention may improve health-related quality of life, assessed 1-6 months after the intervention.** (Studies conducted in hospital settings [7, 8, 9])

Client to healthcare provider telemedicine compared to usual care

Patient or population: Adults with type 2 diabetes, major depression, heart, dermatological, pulmonary and musculoskeletal conditions; older adults receiving home care; women who had delivered a baby; women who had an induced abortion; parents of children with asthma and food allergy; children with medical complexity; adults attempting to quit smoking
Setting: Community settings, primary care setting, and hospital-based setting in high (UK, Germany, The Netherlands, Canada, USA, Ireland, Norway, Denmark, Poland, and Italy) and middle (Turkey, Ecuador, Cambodia, and Kenya) income countries.
Intervention: Client to provider telemedicine (phone-based consultations, home-based monitoring followed by phone-based consultations, web-delivered physical rehabilitation, smartphone application for contacting provider)
Comparison: Usual care (management plan sent to the primary care provider; usual medical care according to guidelines; face to face appointments with the general practitioner; face to face home visits; general advice provided; referral to specialist appointment or care; clients were free to seek other treatment, but no specific recommendations provided)

Outcomes	**Usual care**	**Client to provider telemedicine**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Health-related quality of life (assessed with: MacNew, PACQLQ, SF-36) (follow-up: 6-18 months)		**SMD 0.03** (-0.07, 0.14)* Interpreting SMDs: 0.2 represents a small effect, 0.5 a moderate effect, and 0.8 a large effect		3159 (4 RCTs) Canada, USA (2), UK	⨁⨁⊖⊖ LOW [a, d]	**The intervention may make little or no difference to health-related quality of life, assessed 6-18 months after the intervention.** (Studies conducted in hospital and primary care [3, 4, 10, 11])
Symptoms of depression (using Hopkins Symptom Checklist) (follow up: 12 months)	The mean score was 0.85 points on a 0-4 scale	In the intervention group the score was **0.17 points lower** (-0.04 to -0.30)* On a 0-4 points scale where lower score means better		334 (1 RCT) USA	⨁⊖⊖⊖ VERY LOW [a, e, f]	**We are uncertain of the effect of the intervention on depressive symptoms among adults diagnosed with depressive disorder because the certainty of this evidence was assessed as very low.** (Study conducted in primary care [16])
Exclusive breastfeeding (follow up: 2-6 months)	484 per 1,000	**620 per 1,000** (523 to 731)*	**RR 1.28** (1.08 to 1.51)	334 (1 RCT) USA, Ecuador, Kenya	⨁⨁⊖⊖ LOW [a, e]	**The intervention may increase exclusive breastfeeding among postpartum women.** (Study conducted in primary care and hospital settings [17, 18, 19])
Satisfaction and acceptability						
Client acceptability/ satisfaction with the intervention	One study measured satisfaction with the intervention among individuals in the intervention group and found that: 42/49 were satisfied with service, 34/46 thought it gave added value and 22/48 preferred face to face. In another study the following was measured among individuals in the intervention group: Intervention was approachable: 90% agreed/strongly agreed; Intervention improved diabetes knowledge: 90% agreed/strongly agreed; Would prefer to see a provider in person: 50% agreed/strongly agreed			N[33] 2 (RCTs) UK, The Netherlands	⨁⊖⊖⊖ VERY LOW [c]	**We are uncertain of the effect of the intervention on client acceptability/ satisfaction with the intervention because the certainty of this evidence was assessed as very low.** (Studies conducted in community and primary care settings [6, 22])

Client to healthcare provider telemedicine compared to usual care

Patient or population: Adults with type 2 diabetes, major depression, heart, dermatological, pulmonary and musculoskeletal conditions; older adults receiving home care; women who had delivered a baby; women who had an induced abortion; parents of children with asthma and food allergy; children with medical complexity; adults attempting to quit smoking
Setting: Community settings, primary care setting, and hospital-based setting in high (UK, Germany, The Netherlands, Canada, USA, Ireland, Norway, Denmark, Poland, and Italy) and middle (Turkey, Ecuador, Cambodia, and Kenya) income countries.
Intervention: Client to provider telemedicine (phone-based consultations, home-based monitoring followed by phone-based consultations, web-delivered physical rehabilitation, smartphone application for contacting provider)
Comparison: Usual care (management plan sent to the primary care provider; usual medical care according to guidelines; face to face appointments with the general practitioner; face to face home visits; general advice provided; referral to specialist appointment or care; clients were free to seek other treatment, but no specific recommendations provided)

Outcomes	**Usual care**	**Client to provider telemedicine**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Client acceptability/satisfaction with care (using GPAQ and DTSQ, CAHPSCGS) (higher score means more satisfied)		**SMD 0.10** (-0.22, 0.42)* Interpreting SMDs: 0.2 represents a small effect, 0.5 a moderate effect, and 0.8 a large effect		1973 (4 RCTs) UK (2) USA (2)	⨁⊖⊖⊖ VERY LOW [a, f, g, h]	**We are uncertain of the effect of the intervention on client acceptability/ satisfaction with care because the certainty of this evidence was assessed as very low.** (Studies conducted in primary care setting [6, 11, 12 23]). Six other studies [2, 7, 18, 20, 24, 27] did not provide enough data to be pooled in analysis.
Number of clients satisfied with care	292 per 1,000	**535 per 1,000** (403 to 710)*	**RR 1.83** (1.38, 2.43)*	541 (2 RCTs) The Netherlands, USA	⨁⨁⊖⊖ LOW [a, d]	**The intervention may increase the number of individuals who are satisfied with care among people with chronic conditions and depression.** (Studies conducted in community and primary care settings [16, 22])
Resource use						
Healthcare costs (Follow-up: 10-18 months)	One study with adults with heart failure found that mean total all-causes costs per client during 18 months follow-up was USD 4678 less, (-4758 to -4597)* in the intervention group than the control group. Another study with children with complex congenital heart disease reported that delivering the intervention by videoconferencing was less costly than usual care. One study that measured costs to the health system and parents, evaluated an e-health portal for children with a skin condition and reported little or no difference between groups; one study measured costs to the health system of a PhysioDirect telephone intervention and reported little of no difference.			2807 (4 RCTs) USA, UK (2), The Netherlands	⨁⊖⊖⊖ VERY LOW [a, d, h]	**We are uncertain of the effect of the intervention on healthcare costs because the certainty of this evidence was assessed as very low.** (Studies conducted in hospital and primary care settings [4, 11, 14, 24])
Unintended consequences						

Client to healthcare provider telemedicine compared to usual care

Patient or population: Adults with type 2 diabetes, major depression, heart, dermatological, pulmonary and musculoskeletal conditions; older adults receiving home care; women who had delivered a baby; women who had an induced abortion; parents of children with asthma and food allergy; children with medical complexity; adults attempting to quit smoking
Setting: Community settings, primary care setting, and hospital-based setting in high (UK, Germany, The Netherlands, Canada, USA, Ireland, Norway, Denmark, Poland, and Italy) and middle (Turkey, Ecuador, Cambodia, and Kenya) income countries.
Intervention: Client to provider telemedicine (phone-based consultations, home-based monitoring followed by phone-based consultations, web-delivered physical rehabilitation, smartphone application for contacting provider)
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Outcomes	**Usual care**	**Client to provider telemedicine**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Unintended consequences – adverse clinical events	One study that recruited adults who sought help for smoking cessation reported more adverse events in the intervention group (RR 1.52, 95% CI 1.30 to 1.77). Two studies reported little or no difference between groups.			1916 (3 RCTs) USA, Norway, UK	⨁⨁⊖⊖ LOW [a, d]	**The intervention may make little or no difference to the number of adverse clinical events.** (Studies conducted in home and primary care settings [5, 11, 20])
Unintended consequences related to the intervention	One study recruiting women who had an induced abortion reported that there were little or no differences between groups for adverse effects of the intervention (specifically, car accidents caused by driving while using a mobile phone to access support).			430 (1 RCT) Cambodia	⨁⊖⊖⊖ VERY LOW [a, j]	**We are uncertain of the effect of the intervention on healthcare costs among children and adults with heart-related conditions, and adults with musculoskeletal problems because the certainty of this evidence was assessed as very low.** (Study conducted in hospital [26])

*The 95% confidence interval (CI); **RR:** Risk ratio; **MD:** Mean difference; **RCT:** randomised controlled trial; **SMD:** Standardised Mean Difference

GRADE Working Group grades of evidence. High certainty: We are very confident that the true effect lies close to that of the estimate of the effect. **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect. **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

ACT: Asthma Control Test **; CAHPSCGS:** Consumer Assessment of Healthcare Providers and Systems Clinician and Group survey; **DTSQ:** Diabetes Satisfaction and Treatment Questionnaire; **GPAQ:** General Practice Assessment Questionnaire; **HbA1c:** Glycated hemoglobin; **NDI:** Neck Disability Index; **PACQLQ:** Pediatric Asthma Quality of Life Questionnaire; **RQLQ:** Rhinoconjunctivitis Quality of Life Questionnaire

Explanations

a. Downgraded one point for high or unclear risk of performance and detection bias.
b. Downgraded one point for indirectness as studies conducted in (high income countries only; and the type of technologies were not clear).
c. Non-comparable results, thus downgraded to very low.
d. Downgraded one point for indirectness due to differences between interventions and comparison, uncertainty about the use of older technologies, and limited settings (high income countries).
e. Downgraded one point for imprecision (wide CI and small sample size).
f. Downgraded one point for indirectness due uncertainty about the use of older technologies (we were unable to ascertain whether mobile phones or landlines were used for some studies), and limited settings (high income countries).
g. Downgraded one point for imprecision (wide CI that crosses the line of no effect).
h. Downgraded one point for inconsistency (heterogeneity)
i. Downgraded two point for imprecision (very few events and wide 95% CI that crosses the line of no effect)
j. Downgraded two points for imprecision (no events)
k. Downgraded one point for high or unclear risk of reporting bias.
l. Downgraded half a point for imprecision and half a point for risk of performance bias

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33. Due to unclear reporting in the included trials, the total number of individuals is not reported

Web Annex I: Provider-to-provider telemedicine: Mobile-based technologies to support healthcare provider to healthcare provider communication and management of care (unpublished review)

Link to published protocol: https://www.cochrane.org/CD012927/EPOC_mobile-based-technologies-support-healthcare-provider-healthcare-provider-communication-and

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Abstract

Background

There is a worldwide shortage of skilled healthcare providers, triggered by ageing populations, rising prevalence of non-communicable diseases, migration patterns, and high turnover. The use of mobile-based telemedicine between healthcare providers (provider-to provider-telemedicine) for communication, consultations and client management might contribute to decrease that shortage.

Objectives

To assess the effects of provider-to-provider telemedicine through mobile-based technologies, compared with standard practice for supporting communication and client management between healthcare providers.

Search methods

We searched CENTRAL, MEDLINE, Embase and three other databases on 7 July 2017 together with reference checking and contact with topic experts to identify additional studies. We searched two clinical trials registries.

Selection criteria

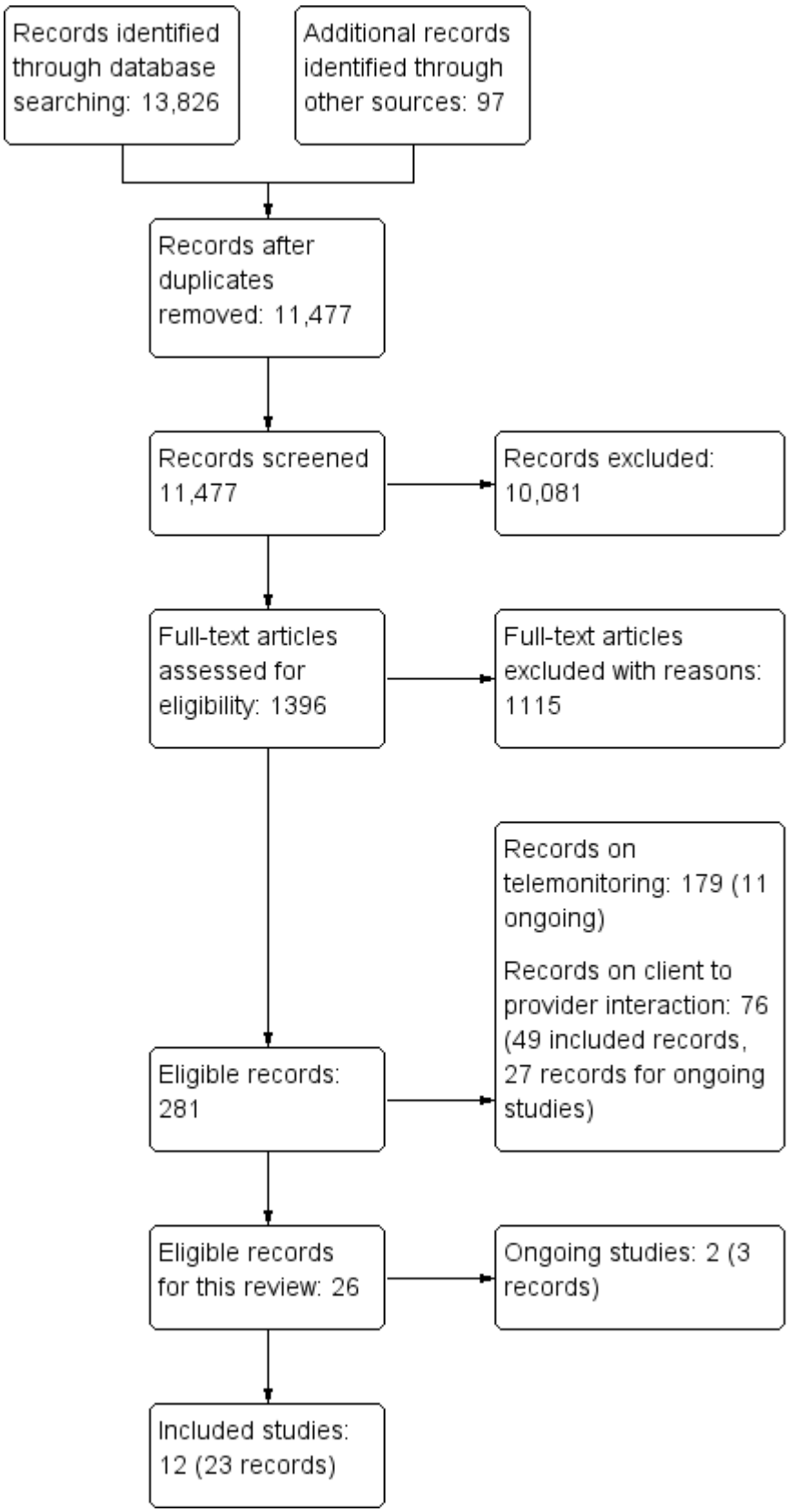
Randomised trials comparing mobile-based technologies to support healthcare provider to healthcare provider communication and management of care (provider-to-provider telemedicine) with usual care.

Data collection and analysis

We followed the standard methodological procedures expected by Cochrane and EPOC. We used the GRADE approach to assess the certainty of the body of evidence for the most important outcomes.

Main results

We included 12 studies (N = 4582 included clients or patients; the number of healthcare providers was not always described but ranged from two to 142 per study). The majority of studies were conducted in high and upper-middle income countries. The interventions mainly involved general practitioners consulting with other healthcare professionals who were geographically remote. Studies targeted clients with different health issues, and varied regarding the mode of delivery, components of the intervention, number of sessions, and healthcare providers involved.


Records identified through database searching: 13,826
Additional records identified through other sources: 97
Records after duplicates removed: 11,477
Records screened 11,477
Records excluded: 10,081
Full-text articles assessed for eligibility: 1396
Full-text articles excluded with reasons: 1115
Records on telemonitoring: 179 (11 ongoing)
Records on client to provider interaction: 76 (49 included records, 27 records for ongoing studies)
Eligible records: 281
Eligible records for this review: 26
Ongoing studies: 2 (3 records)
Included studies: 12 (23 records)

Summary of Findings

Mobile-based healthcare provider to healthcare provider communication compared to usual care

Patient or population: Primary care providers consulting with ophthalmologists/experienced eye investigators about adults with Type 2 diabetes; primary care providers consulting with radiologists about teenagers and adults requiring an ultrasound: emergency physicians consulting with hospital specialists about adults attending the emergency department; general practitioner consulting with dermatologists about adults; community-based peer health workers consulting with clinic staff about receiving antiretroviral therapy; community nurses consulting with diabetes specialist nurses and podiatrists about adults with Type 2 diabetes; physiotherapists consulting with rheumatologists about adults with rheumatoid arthritis; home visiting nursing staff consulting with a hospital physician about older adults
Setting: Community settings, primary care setting, and hospital-based setting in high (The Netherlands, USA, Norway, Italy), middle (Turkey, Dominican Republic), and low income (Uganda) countries.
Intervention: Mobile-based healthcare provider to healthcare provider communication (provider to provider telemedicine for retinal screening using non-mydriatic camera or portable ultrasound; teledermatology, secure messaging service, web-based videoconferencing and video calls; mobile text messaging; interactive web-based records).
Comparison: usual care (reminder to book an appointment with client's healthcare provider for an eye exam; regular examination during the index face to face appointment with the client's primary care provider, followed by instructions on how to return the report to the specialist; (healthcare providers communicated over the telephone; healthcare providers referred clients to additional appointments as needed; no access to mobile phone, clinic staff or additional training; monthly home visits done by nurses; healthcare providers communicated over the telephone)

Outcomes	**Usual care**	**Provider to provider communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Provider performance						
Frequency of clinical examinations or successful follow-ups performed (Follow-up: immediately after screening, after 18 months, and unclear in one trial)	Trials of telemedicine for retinal screening: Study 1: RR 1.60 (95% CI 1.31 to 1.95) Study 2: RR 5.56 (95% CI 2.19 to 14.10) Trial of telemedicine for people presenting with symptoms that required an ultrasound: RR 3.92 (95% CI 2.11 to 7.31)			731 (3 RCTs) USA (2), Dominican Republic	⨁⨁◯◯ LOW [a, b, c]	**The intervention may increase the number of individuals receiving clinical exams for diabetes eye management and the number of individuals presenting with symptoms requiring an ultrasound who had a successful follow-up appointment.** (Studies conducted in primary care settings [1, 2, 3])
Time between presentation and appropriate management or follow-up	Two studies reported that those allocated to the intervention group were admitted to hospital or discharged more quickly from the emergency department (median difference - 12 minutes, 95% CI -19 to -7); and those who required treatment from a dermatologist received treatment more quickly (mean difference - 40.5 days, 95% CI -23 to -58). One small study (<200 participants) reported little or no difference between groups.			725 (3 RCTs) Dominican Republic, Turkey, USA	⨁⨁◯◯ LOW [a, d]	**The intervention may reduce time between clients presenting with a health issue and appropriate management or follow-up among individuals visiting the emergency department, individuals with skin conditions, and individuals presenting with symptoms requiring an ultrasound.** (Studies conducted in hospital and primary care [3, 4, 5])
Utilization of healthcare services						
Hospitalization (follow-up: 12 months)	One study reported that the incidence rate ratio for hospitalizations was 95% CI: 0.54 to 1.19, p = 0.26* among older individuals treated with home enteral nutrition[p]			188 (1 RCT) Italy	⨁⨁◯◯ LOW [g]	**The intervention may have little or no effect on hospitalizations among older individuals treated with home enteral nutrition.** (Study conducted in hospital setting [10])

Mobile-based healthcare provider to healthcare provider communication compared to usual care

Patient or population: Primary care providers consulting with ophthalmologists/experienced eye investigators about adults with Type 2 diabetes; primary care providers consulting with radiologists about teenagers and adults requiring an ultrasound: emergency physicians consulting with hospital specialists about adults attending the emergency department; general practitioner consulting with dermatologists about adults; community-based peer health workers consulting with clinic staff about receiving antiretroviral therapy; community nurses consulting with diabetes specialist nurses and podiatrists about adults with Type 2 diabetes; physiotherapists consulting with rheumatologists about adults with rheumatoid arthritis; home visiting nursing staff consulting with a hospital physician about older adults
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Outcomes	**Usual care**	**Provider to provider communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Length of stay in the emergency department (follow-up: not reported)	One study reported that intervention group clients had a median ED length of stay of 240 minutes (IQR: 230 to 270, N=173). The comparison group clients had a median ED length of stay of 277 minutes (IQR: 270 to 287.8, N=172). Median difference –30 minutes (95% CI: -37 to –25)			345 (1 RCT) Turkey	⨁⨁◯◯ LOW [r]	**The intervention may reduce length of stay among individuals visiting the emergency department.** (Study conducted in hospital setting [4])
Outpatient clinic consultations (follow-up: 12 months)	Mean number of consultations per client was 2.5	In the intervention group there was **0.48 fewer consultations** per client (-1.46, 0.49)*		176 (1 RCT) Norway	⨁◯◯◯ VERY LOW [e, l, m]	**We are uncertain about the effect of the intervention on the number of outpatient consultations among individuals living with diabetes because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [7])
Referral (to a specialist) (follow-up: not reported)	1,000 per 1,000	**820 per 1,000** (750 to 880)*	**RR 0.82** (0.75 to 0.88)*	271 (1 RCT) USA	⨁◯◯◯ VERY LOW [a, f, q]	**We are uncertain of the effect of the intervention on the number of referrals to dermatologists among individuals presenting with skin-related symptoms or conditions, because the certainty of this evidence was assessed as very low.** (Study conducted in primary care setting [5])
Health behavior, status and well-being						

Mobile-based healthcare provider to healthcare provider communication compared to usual care

Patient or population: Primary care providers consulting with ophthalmologists/experienced eye investigators about adults with Type 2 diabetes; primary care providers consulting with radiologists about teenagers and adults requiring an ultrasound: emergency physicians consulting with hospital specialists about adults attending the emergency department; general practitioner consulting with dermatologists about adults; community-based peer health workers consulting with clinic staff about receiving antiretroviral therapy; community nurses consulting with diabetes specialist nurses and podiatrists about adults with Type 2 diabetes; physiotherapists consulting with rheumatologists about adults with rheumatoid arthritis; home visiting nursing staff consulting with a hospital physician about older adults
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Outcomes	**Usual care**	**Provider to provider communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Mortality among individuals living with HIV or diabetes (follow-up 11-12 months)	Two studies reported little or no differences between groups. One study recruited peer health workers who consulted with clinic staff (RR: 0.82, 95% CI 0.55 to 1.22), and another study recruited community nurses who consulted with diabetes specialist nurses (RR: 0.94, 95% CI 0.28 to 3.12).			1152 (2 RCTs) Uganda, Norway	⨁⨁◯◯ LOW [i, j]	**The intervention may lead to a small to moderate reduction in mortality among people living with HIV or diabetes. However, the range in which the actual effect may be indicates that the intervention may reduce or increase mortality.** (Studies conducted in community settings [6, 7])
Clinical improvement of condition among people with skin conditions (follow-up: 4 months)	444 per 1,000	**493 per 1,000** (422 to 577)*	**RR 1.11** (0.95 to 1.30)*	698 (1 RCT) USA	⨁⨁◯◯ LOW [h, l]	**The intervention may lead to little or no difference in clinical improvement among individuals with skin conditions.** (Study conducted in a primary care setting [8])
Health-related quality of life assessed with; EuroQol (follow-up: 9 months)	One study reported little or no difference between groups for health-related quality of life among individuals living with diabetes (MD -0.1 (-0.4 to 0.1)*).			182 (1 RCT) Norway	⨁◯◯◯ VERY LOW [f, l, m]	**We are uncertain of the effect of the intervention on health-related quality of life because the certainty of this evidence was assessed as very low.** (Study conducted in community setting [7])
Satisfaction and acceptability						
Client acceptability/ satisfaction with care assessed with: GS-PEQ, PSQ III (Follow-up: 1-12 months)	Mean satisfaction was 4.1 on a 1-5 scale where higher is better	In the intervention group the difference in satisfaction was **0.00 points** (-0.18, 0.18)* on the 1-5 scale		474 (2 RCTs) The Netherlands, Norway	⨁⨁◯◯ LOW [l, n]	**The intervention may make little or no difference to satisfaction with care among individuals with diabetes or skin conditions.** (Studies conducted in community settings [7, 9])

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Outcomes	**Usual care**	**Provider to provider communication**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Healthcare professionals' acceptability/satisfaction with the intervention	One study reported that GPs allocated to the intervention were more likely to agree that clients received timely appointments and to be satisfied with the consult process than GPs allocated to the control group.			275 (1 RCT) USA	⨁◯◯◯ VERY LOW [f, l, m]	**We are uncertain of the effect of the intervention on providers' acceptability/ satisfaction because the certainty of this evidence was assessed as very low.** (Study conducted in primary care setting [5])
Resource use						
Total cost (follow-up: 1-4 months)		**SMD -0.02** (-0.09 to 0.13)* Interpreting SMDs: 0.2 represents a small effect, 0.5 a moderate effect, and 0.8 a large effect		1303 (2 RCTs) USA, The Netherlands	⨁◯◯◯ VERY LOW [o, s]	**We are uncertain of the effect of the intervention on total costs because the certainty of this evidence was assessed as very low.** (Studies conducted in primary care and community settings [8, 9]). Two other studies[5, 6] did not provide sufficient data to be included in the pooled analysis.
Unintended consequences						
Quality of data transmission (number of images lost due to a technical problem) (self-reported by providers, follow-up: not reported)	29 per 1,000	**29 per 1,000** (12 to 68)*	**RR 0.99** (0.42 to 2.35)*	698 (1 RCT) USA	⨁◯◯◯ VERY LOW [h, l, k]	**We are uncertain of the effect of the intervention on unintended consequences because the certainty of this evidence was assessed as very low.** (Study conducted in primary care setting [8])

*The 95% confidence interval (CI); **RR:** Risk ratio; **MD:** Mean difference; **RCT:** randomised controlled trial; **SMD:** Standardised mean Difference

GRADE Working Group grades of evidence. High certainty: We are very confident that the true effect lies close to that of the estimate of the effect. **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect. **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations

a. Downgraded one point for indirectness due to differences between interventions and comparison, uncertainty about the use of older technologies, and limited settings (high income and upper-middle income countries).
b. Downgraded one point for inconsistency due to substantial statistical heterogeneity.
c. The 95% CI are wide, but do not include the line of no effect. We therefore did not downgrade for imprecision.
d. Downgraded one point for risk of bias (potential allocation and reporting bias)
e. Downgraded one point for imprecision (small sample size and broad 95% CI)
f. Downgraded one point for imprecision (small sample size)
g. Downgraded one point for imprecision (small sample size and broad 95% CIs that cross the line of no effect) and one point for risk of bias (attrition bias)
h. Downgraded one point for risk of bias (potential reporting and attrition bias)
i. Downgraded one point for imprecision (very few events and broad 95% CI that crosses the line of no effect) and one point for risk of bias (attrition bias)
j. Not downgraded for indirectness because the settings includes a low- income country and the technology is regarded as fairly recent.
k. Downgraded one point for imprecision (few events and broad 95% CI that crosses the line of no effect)
l. Downgraded one point for indirectness due to limited settings (only high income countries)
m. Downgraded one point for risk of bias (potential selection, performance bias and attrition bias)
n. Downgraded one point for risk of bias (potential performance and detection bias)
o. Downgraded two points for risk of bias (reporting and attrition bias)
p. The incidence rate ratio was not reported. Only the 95% CI was reported
q. Downgraded one point for risk of bias (performance bias, detection bias, reporting bias and potential selection bias)
r. Downgraded one point for indirectness (limited settings – middle income country only), half a point for risk of bias (performance bias, reported bias and potential selection bias) and half a point for imprecision (small sample size)
s. Downgraded one point for indirectness due to uncertainty about the use of older technologies and limited settings (high income countries only).

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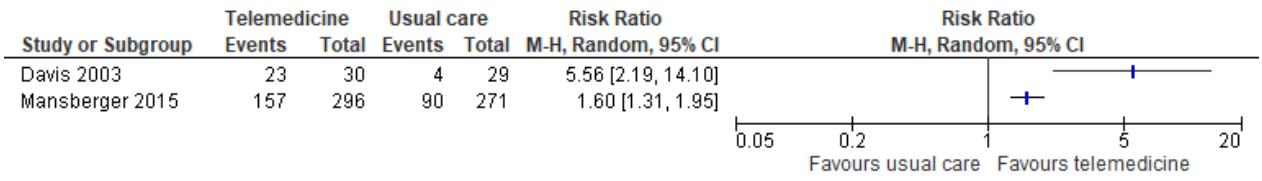
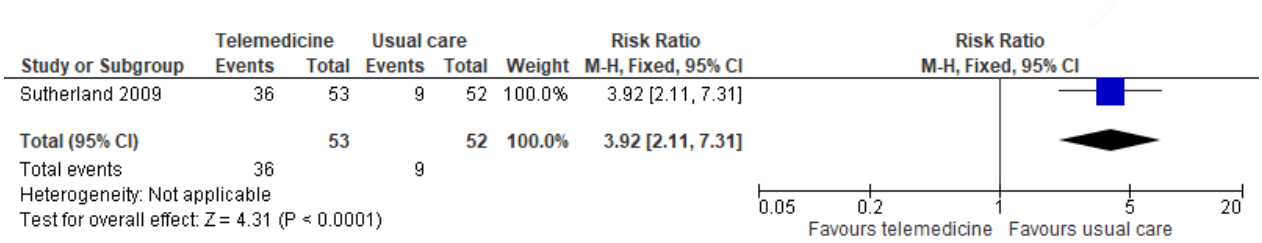
Analyses

Healthcare professional performance

Frequency of clinical examination among people requiring retinal screening

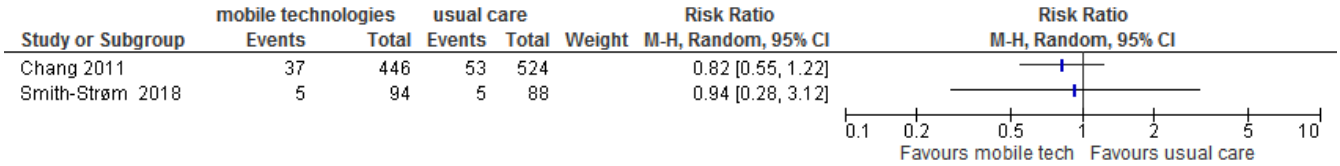


Frequency of clinical examination among people presenting with symptoms that required an ultrasound



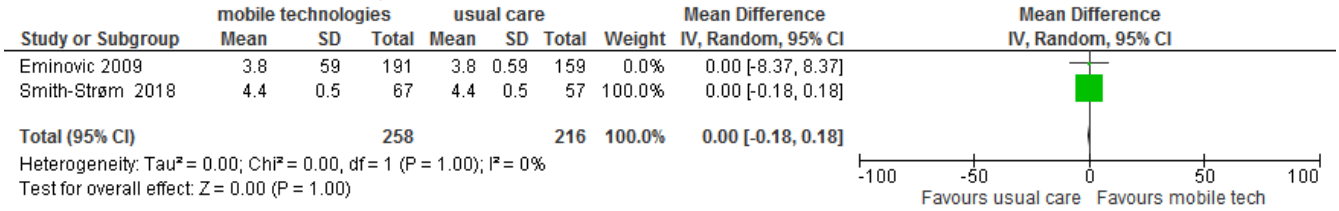
Health behavior, status and well-being

Mortality (11-12 months follow-up)



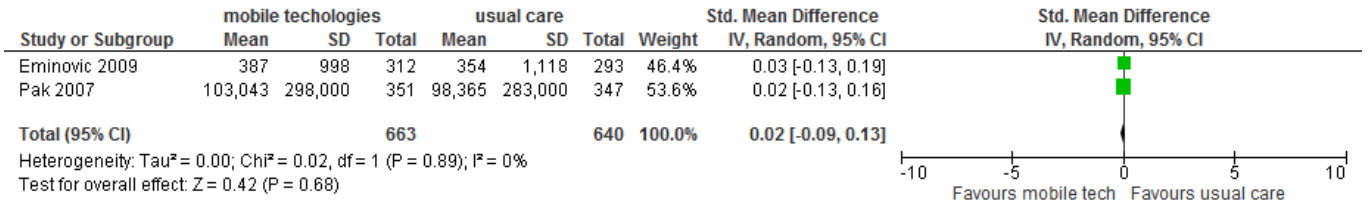
Satisfaction/acceptability

Client satisfaction with care



Resource use

Total costs



Web Annex J: Decision support tools via mobile devices to improve quality of care in primary healthcare settings (unpublished review)

Link to published protocol:
https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD012944/full

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Abstract

Background

The ubiquity of mobile devices has made it possible for clinical decision support systems (CDSS) to become available to healthcare providers on handheld devices at the point-of-care, especially in low and middle income countries. The use of CDSS by providers can potentially improve adherence to treatment protocols and patient outcomes. However, the evidence on the effect of the use of CDSS on mobile devices is sparse, and offers no clear way forward. To respond to this need, the World Health Organization (WHO) is establishing guidelines that aim to inform investments of the use of decision support tools on digital devices to strengthen primary healthcare.

Objectives

To assess the effects of digital clinical decision support tools accessible via mobile devices for primary healthcare providers in the context of primary care settings

Search methods

We searched Cochrane Central Register of Controlled Trials; (CENTRAL) in the Cochrane Library; MEDLINE Ovid; Embase Ovid; Global Health Library WHO; and POPLINE K4Heath on July 19, 2017. We searched the World Health Organization International Clinical Trials Registry Platform; and the US National Institutes of Health Ongoing Trials Register. We also searched Epistemonikos for related systematic reviews and potentially eligible primary studies. We conducted a grey literature search using mHealthevidence.org and issued a call for papers through popular digital health communities of practice. Finally, we conducted citation searches of included studies. We searched for studies published after 2000. We searched for studies in any language.

Selection criteria

Study design: We included randomized trials, irrespective of publication status or language of publication.

Types of participants: we included studies of all cadres of healthcare providers, including lay health workers and other individuals (administrative, managerial and supervisory staff) and groups involved in the delivery of primary health care services using clinical decision support tools; and studies of clients or patients receiving care from primary healthcare providers using digital decision support tools

Types of interventions: We included studies comparing digital clinical decision support tools accessible via mobile devices with non-digital decision support tools or no interventions, in the context of primary care. Decision support tools may include clinical protocols, check-lists and other job-aids which support risk prioritization of patients. By mobile devices, we mean mobile phones of any kind (but not analogue landline telephones), as well as tablets, personal digital assistants, and smartphones. Laptops are not included in this list. Studies where digital decision support tools were integrated with electronic medical records or other types of longitudinal tracking of clients were excluded.

Data collection and analysis

All the search results were screened using a machine learning classifier that gives each record a probability score of being a randomized trial (RCT). Titles and abstracts of studies with a 10 percent probability of being a RCT were screened by two reviewers, and those with less than 10 percent probability of being an RCT were screened by one reviewer. Two authors independently extracted data from the included studies and assessed the risk of bias. For the analyses, we calculated Mantel-Haenszel risk ratio (RR) for dichotomous outcomes and the mean difference (MD) for continuous outcomes, together with 95% confidence intervals (CIs). We used the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach to assess the certainty of the evidence and we prepared a Summary of Findings table. Differences in interventions and outcomes measures did not permit us to undertake meta-analysis.

Main results

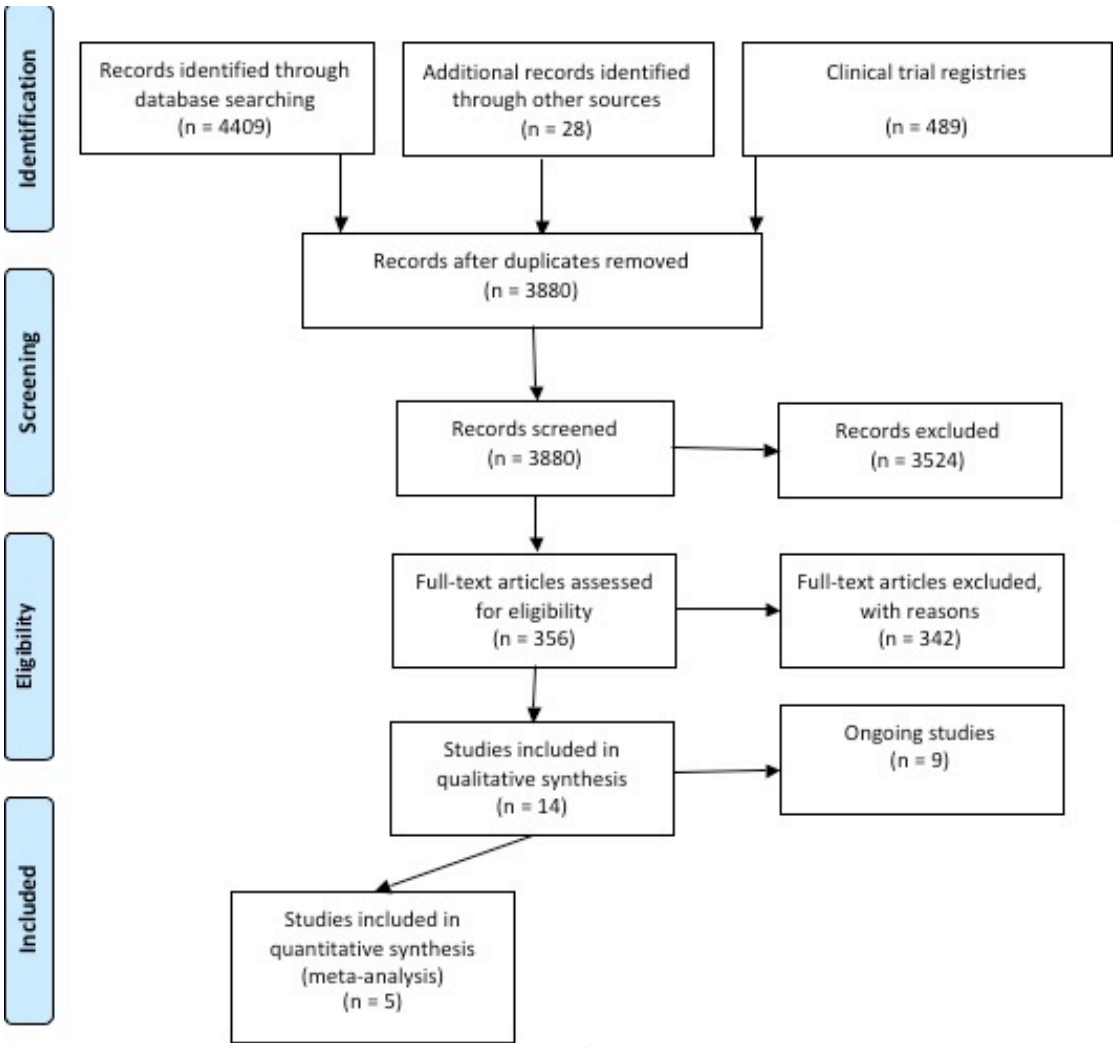
Five RCTs met our inclusion criteria. Three trials were conducted in the United States, one in India, and one in both India and China. The intervention:

- may increase the number of individuals with high cardiovascular disease risk taking their aspirin (low certainty evidence)
- probably increases the number of individuals taking their antihypertensive medication (moderate certainty evidence)
- probably make little or no difference to the number of individuals with hyperlipidemia reaching LDL cholesterol goals
- probably makes little or no difference to systolic blood pressure levels o to number of smokers among individuals with high cardiovascular disease risk (moderate certainty evidence)
- may make little or no difference to medication adherence; to HbA1c levels; or to satisfaction with the helpfulness or clarity of medication information among individuals with poorly controlled diabetes (low certainty evidence)

We are uncertain of the effect of the intervention on providers' adherence to recommended clinical practice; on providers' acceptability or satisfaction; on quality of data about services provided; on resource use; on utilization of healthcare services; and on unintended consequences because the certainty of this evidence was assessed as very low or no direct evidence was identified.

Authors' conclusions

Our review provides limited evidence that clinical decision support interventions delivered using mobile devices can improve outcomes in primary health care settings. Some moderate quality evidence suggests that the use of clinical decision support systems on mobile devices may result in improved adherence to medication among patients. However, this adherence may result in little or no effect on patient health outcomes. Further high quality trials are required to robustly establish the effects of clinical decision support interventions delivered by mobile devices.


Identification
Screening
Eligibility
Included
Records identified through database searching (n = 4409)
Additional records identified through other sources (n = 28)
Clinical trial registries (n = 489)
Records after duplicates removed (n = 3880)
Records screened (n = 3880)
Records excluded (n = 3524)
Full-text articles assessed for eligibility (n = 356)
Full-text articles excluded, with reasons (n = 342)
Studies included in qualitative synthesis (n = 14)
Ongoing studies (n = 9)
Studies included in quantitative synthesis (meta-analysis) (n = 5)

Summary of Findings

Mobile clinical decision support system compared to standard care in primary healthcare settings

Patient or population: Healthcare providers using clinical decision support tools and patients receiving care from such providers
Setting: Primary healthcare settings (India, China, USA)
Intervention: Mobile clinical decision support system
Comparison: Standard care or no intervention (standard care could be providers using PDA with decision rules about a non-intervention-related health area, provider training and decision support tools on paper, paper-based information booklet on management and follow-up of patients with diabetes, or usual care which did not involve any additional follow-up)

Outcomes	**Standard care**	**Mobile clinical decision support system**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Provider performance						
Providers' adherence to recommended practice	One study assessed effectiveness of providers' use of a digital decision support tool on non-steroidal anti-inflammatory drug prescribing safety. It reported the mean proportion of providers with unsafe prescriptions at 0.23 (n=31) for intervention group and 0.45 (n=28) for comparison group. The proportion of providers following recommended practice was 0.58 (n=31) for intervention group and 0.45 (n=28) for comparison group. Another study assessed the use of a digital decision support tool for management of fevers, diarrheas and respiratory problems by rural providers. It reported mean protocol compliance as 63.34% (8 providers, 38 patients) for intervention group and 69% (8 providers, 43 patients) for comparison for female patients, and 53.59% (8 providers, 27 patients) for intervention group and 71.12 (8 providers, 18 patients) for comparison for male patients. [1,2]			185 (2 RCTs) USA, India	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on providers' adherence to recommended clinical practice because the certainty of this evidence was assessed as very low.** (Both studies report incomplete data [1,2]).
Time between presentation and appropriate management	No studies were identified that reported on this outcome					**We are uncertain of the effect of this approach on providers' adherence to recommended clinical practice because no direct evidence was identified.**
Utilization of healthcare services						
Utilization outcomes	No studies were identified that reported on this outcome					**We are uncertain of the effect of this approach on utilization of healthcare services because no direct evidence was identified.**

Mobile clinical decision support system compared to standard care in primary healthcare settings

Patient or population: Healthcare providers using clinical decision support tools and patients receiving care from such providers
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Outcomes	**Standard care**	**Mobile clinical decision support system**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Health behavior, status and well-being						
Adherence - High-risk individuals taking aspirin in the last month at 1 year follow-up	22 per 1,000	206 per 1,000 (134 to 317)*	**RR 9.30** (6.05 to 14.28)*	2086 (1 RCT) India and China	⨁⨁◯◯ LOW [c,d]	**This approach may increase the number of individuals with high cardiovascular disease risk taking their aspirin.** (Study conducted in village communities [3]).
Adherence - Self-reported use of community healthcare providers–prescribed antihypertensive medication for ≥25 days in the past month at 1 year follow-up	94 per 1,000	362 per 1,000 (295 to 447)*	**RR 3.86** (3.14 to 4.76)*	2086 (1 RCT) India and China	⨁⨁⨁◯ MODERATE [c]	**This approach probably increases the number of individuals taking their antihypertensive medication.** (Study conducted in village communities [3]).
Adherence - Medication adherence at 3 months follow-up (On a 1-100 scale where higher is better)	Mean medication adherence was 90.5 points on a 1-100 scale	Mean medication adherence was 0.8 points higher (2.56 lower to 4.16 higher)* on a 1-100 scale	-	176 (1 RCT) USA	⨁⨁◯◯ LOW [d,e]	**This approach may make little or no difference to medication adherence among individuals with poorly controlled diabetes.** (Study conducted in a community health center [4]).
Haemoglobin a1c (HbA1c) (Controlled HbA1c is typically less than 7.5 or 7 (depending on risk factors))	Mean HbA1c was 7.9 %	Mean HbA1c was 0.1 % lower (0.63 lower to 0.43 higher)*		175 (1 RCT) USA	⨁⨁◯◯ LOW [d,e]	**This approach may make little or no difference to HbA1c levels among individuals with poorly controlled diabetes.** (Study conducted in a community health center [4]).

Mobile clinical decision support system compared to standard care in primary healthcare settings

Patient or population: Healthcare providers using clinical decision support tools and patients receiving care from such providers
Setting: Primary healthcare settings (India, China, USA)
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Comparison: Standard care or no intervention (standard care could be providers using PDA with decision rules about a non-intervention-related health area, provider training and decision support tools on paper, paper-based information booklet on management and follow-up of patients with diabetes, or usual care which did not involve any additional follow-up)

Outcomes	**Standard care**	**Mobile clinical decision support system**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Mean systolic blood pressure (Target systolic blood pressure is typically less than 140mm Hg)	Mean systolic blood pressure was **152.3 mmHg**	Mean systolic blood pressure was 2.8 mmHg lower (5.09 lower to 0.51 lower)*		2086 (1 RCT) India and China	⨁⨁⨁◯ MODERATE [e]	**This approach probably makes little or no difference to the systolic blood pressure level among individuals with high cardiovascular disease risk.** (Study conducted in village communities [3]).
Patients reaching LDL cholesterol goal	449 per 1,000	458 per 1,000 (400 to 530)*	**RR 1.02** (0.89 to 1.18)*	875 (1 RCT) USA	⨁⨁⨁◯ MODERATE [f]	**This approach probably make little or no difference to the number of individuals with hyperlipidemia reaching LDL cholesterol goals.** (Study conducted in primary care practices [5]).
Current smoker at 1 year follow-up	363 per 1,000	374 per 1,000 (334 to 421)*	**RR 1.03** (0.92 to 1.16)*	2086 (1 RCT) India and China	⨁⨁⨁◯ MODERATE [c]	**This approach probably makes little or no difference to the number of smokers among individuals with high cardiovascular disease risk.** (Study conducted in village communities [3]).
Satisfaction and acceptability						
Client satisfaction with clarity of medication information (On a 1-100 scale where higher is better)	Mean satisfaction was 82.6 points on a 1-100 scale	Mean satisfaction was 1.1 points higher (5.31 lower to 7.51 higher)* on a 1-100 scale		187 (1 RCT) USA	⨁⨁◯◯ LOW [e,g]	**This approach may make little or no difference to the satisfaction with clarity of medication information among individuals with poorly controlled diabetes.** (Study conducted in a community health center [4]).

Mobile clinical decision support system compared to standard care in primary healthcare settings

Patient or population: Healthcare providers using clinical decision support tools and patients receiving care from such providers
Setting: Primary healthcare settings (India, China, USA)
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Outcomes	**Standard care**	**Mobile clinical decision support system**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Client satisfaction with helpfulness of medication information (On a 1-100 scale where higher is better)	Mean satisfaction was 87.6 points on a 1-100 scale	Mean satisfaction was 2.8 higher (2.39 lower to 7.99 higher)*		187 (1 RCT) USA	⨁⨁◯◯ LOW [e,g]	**This approach may make little or no difference to the satisfaction with helpfulness of medication information among individuals with poorly controlled diabetes.** (Study conducted in a community health center [4]).
Providers' acceptability/satisfaction	Incomplete data. Outcomes measured after 2 months of using the system. Outcomes reported only for the intervention group.			8 (1 RCT) India and China	⨁◯◯◯ VERY LOW [c,h]	**We are uncertain of the effect of this approach on providers' acceptability/ satisfaction because the certainty of this evidence was assessed as very low.** (Study conducted in village communities [3]).
Quality of data about services provided	No studies were identified that reported this outcome					**We are uncertain of the effect of this approach on quality of data about services provided because no direct evidence was identified.**
Resource use						
Resource use	No studies were identified that reported on this outcome					**We are uncertain of the effect of this approach on resource use because no direct evidence was identified.**
Unintended consequences						
Unintended consequences	No studies were identified that reported on this outcome					**We are uncertain of the effect of this approach on unintended consequences because no direct evidence was identified.**

*The 95% confidence interval (CI); **RR:** Risk ratio; **MD:** Mean difference; **RCT:** randomised controlled trial

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Outcomes	**Standard care**	**Mobile clinical decision support system**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?

GRADE Working Group grades of evidence. High certainty: We are very confident that the true effect lies close to that of the estimate of the effect. **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect. **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations

a. Downgraded one step for risk of bias: Unclear random sequence generation and allocation concealment. Blinding of participants was not possible given the intervention.
b. Downgraded two steps for serious imprecision: Standard errors for the outcomes were not reported.
c. Downgraded one step for risk of bias due to lack of blinding of participants and unclear blinding of outcome assessment
d. Downgraded one step for imprecision due to few events
e. Downgraded one step for risk of bias: Unclear allocation concealment and selective outcome reporting
f. Downgraded one step due to risk of bias: Unclear random sequence generation and allocation concealment, participants, providers and outcome assessors not blinded
g. Downgraded one step for imprecision due to small sample size
h. Downgraded two steps for serious imprecision: Incomplete data

References and notes

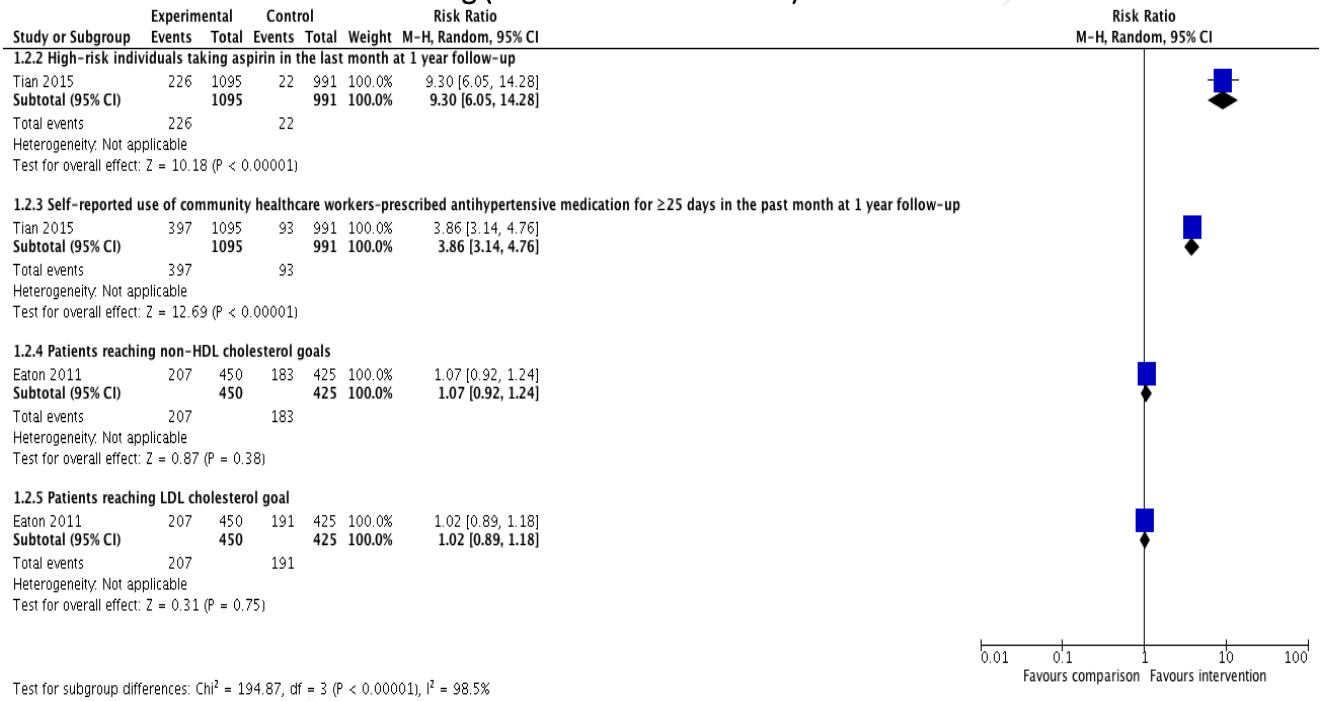
1. Berner ES, Houston TK, Ray MN, Allison JJ, Heudebert GR, Chatham WW, et al. Improving ambulatory prescribing safety with a handheld decision support system: a randomized controlled trial. Journal of the American Medical Informatics Association; 2006.
2. Gautham M, Iyengar MS, Johnson CW. Mobile phone–based clinical guidance for rural health providers in India. Health Informatics Journal; 2015.
3. M, Tian, V, Ajay, D, Dunzhu, S, Hameed, X, Li, Z, Liu, et al. A cluster-randomized controlled trial of a simplified multifaceted management program for individuals at high cardiovascular risk (SimCard Trial) in Rural Tibet, China, and Haryana, India. Circulation; 2015 Jul.
4. M, Heisler, H, Choi, G, Palmisano, R, Mase, C, Richardson, A, Fagerlin, et al. Comparison of community health worker–led diabetes medication decision-making support for low-income Latino and African American adults with diabetes using e-health tools versus print materials: a randomized, controlled trial. Annals of internal medicine; 2014 Nov.
5. CB, Eaton, DR, Parker, J, Borkan, J, McMurray, MB, Roberts, B, Lu, et al. Translating cholesterol guidelines into primary care practice: a multimodal cluster randomized trial. The Annals of Family Medicine; 2011 Nov.

Analyses

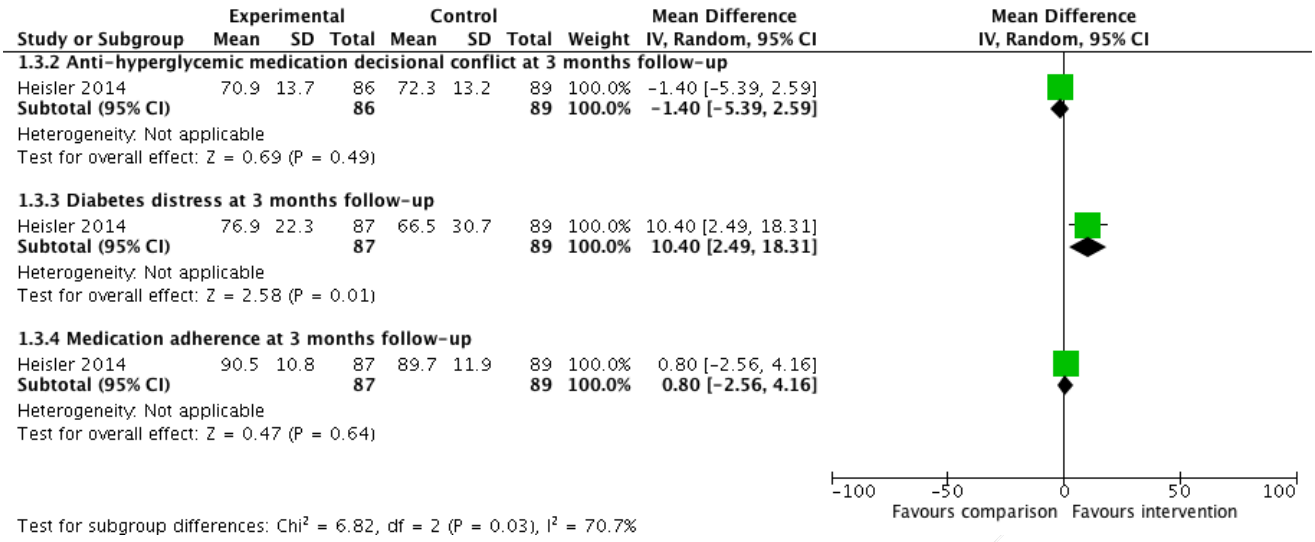
Providers' adherence to recommended practice

Study ID	Outcome	Findings	Comments
Berner 2006	1. Proportion of cases per physician with unsafe prescriptions 2. Proportion of cases per physician with key risk factor recorded	1. IG: 0.23 CG:0.45 2. IG:0.58 CG: 0.45	IG: 31 participants CG:28 participants Incomplete data reported. Standard errors not reported.
Gautham 2015	1. Mean protocol compliance for female patients 2. Mean protocol compliance for male patients	1. IG: 69 CG: 63.34 2. IG: 71.12 CG: 53.59	1. IG: 8 providers, 38 patients CG: 8 providers, 43 patients 2. IG: 8 providers, 27 patients CG: 8 providers, 18 patients Incomplete outcome data reported. Standard errors not reported.

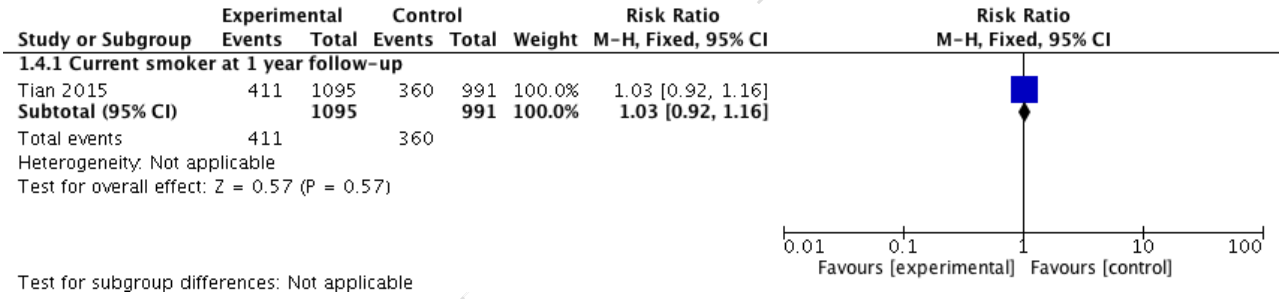
Patients' health status and well-being (dichotomous outcomes)



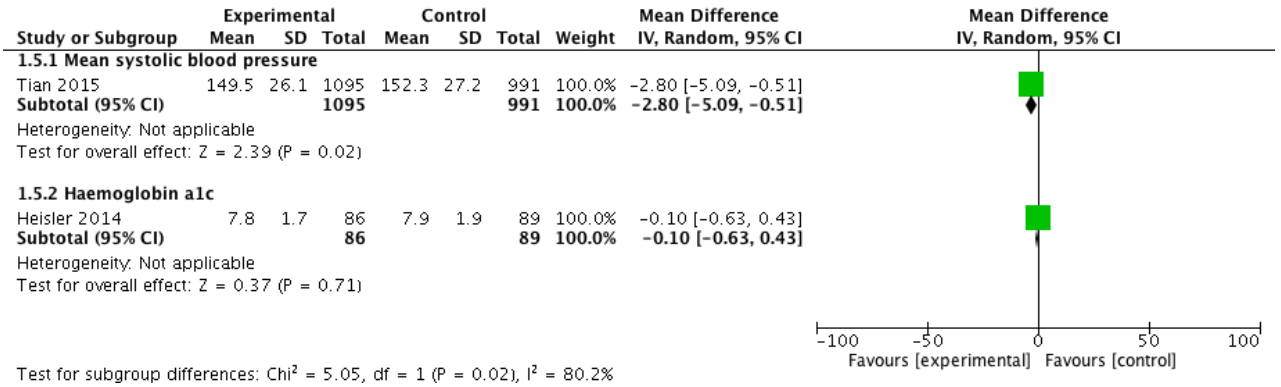
Patients' health status and well-being (continuous outcomes)



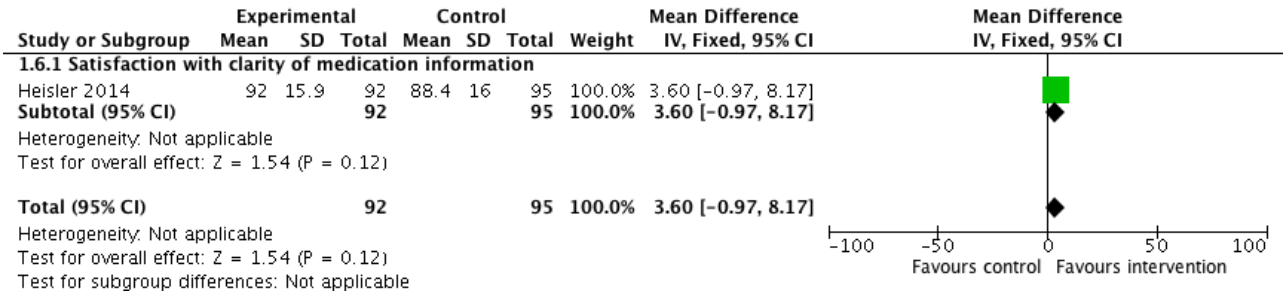
Patients' health status and well-being (dichotomous undesirable outcomes)



Patients' health status and well-being (continuous undesirable outcomes)



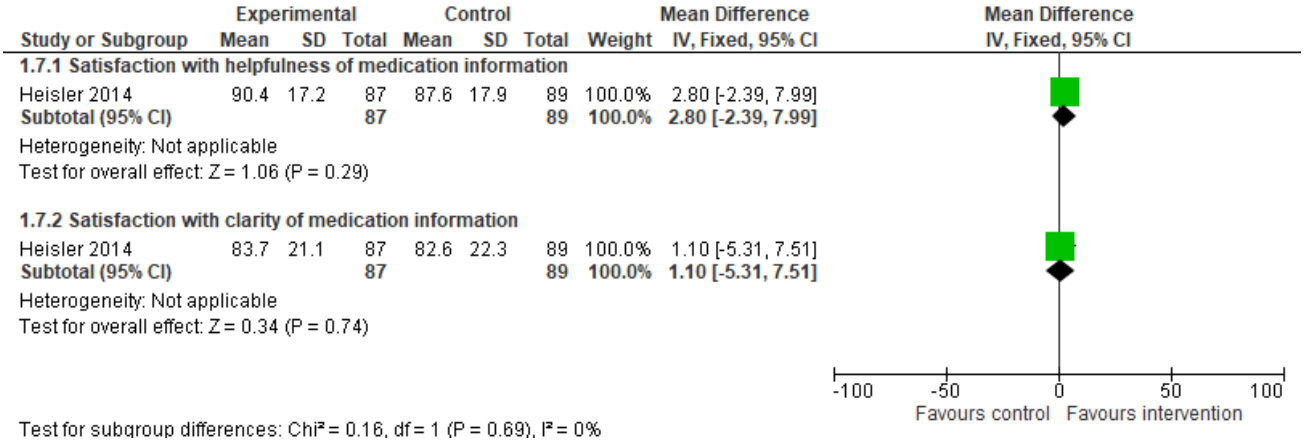
Client acceptability of the intervention



Providers' acceptability of the intervention

Study ID	Outcome	Finding	Comments
Tian 2015	1. Providers' level of comfort using the system 2. Providers' willingness to continue using the system 3. Providers' wish for more health conditions to be included in the system 4. Helpfulness of the system in enabling provider to follow guidelines 5. Ease of use of the system 6. Being able to remember steps without the system 7. Providers' willingness to recommend the system	1. 7/8 2. 7/8 3. 8/8 4. 6/8 5. 7/8 6. 0/8 7. 7/8	Outcomes measured after 2 months of using the system. Outcomes reported only for the intervention group. Incomplete data.

Patients' acceptability of the intervention



Web Annex K: Health professions' mobile digital education (mLearning): a Cochrane review by the Digital Health Education collaboration (unpublished review)

Link to pre print: http://preprints.jmir.org/preprint/12937

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Abstract

Background

There is a pressing need to implement efficient and cost effective training to adequately equip healthcare professionals with the required competencies. Mobile learning (mLearning) has been mooted as an effective means to deliver healthcare professional education due to the high access, low cost and portability of mobile devices.

Objectives

The primary objective of this study is to assess the effectiveness of mLearning interventions in healthcare professional education in terms of knowledge, skills, attitude and satisfaction. In addition, we will assess the effect of mLearning on clinical practice and patient-related outcomes. We will assess the economic aspects of the mLearning interventions (e.g. cost-effectiveness, implementation cost, return on investment) and also any adverse and/or unintended effects of mLearning interventions.

Search methods

We searched the following databases from January 1990 to 16th August 2017: MEDLINE, Embase, the Cochrane Central Register of Controlled Trials (CENTRAL), PsychINFO, ERIC, CINAHL and Web of Science Core Collection. We also searched reference lists of eligible studies and relevant systematic reviews as well as trial registries (clinicaltrial.gov, and WHO ICTRP) for ongoing studies.

Selection criteria

Study design: We included randomised controlled trials (RCTs) and cluster-RCTs (cRCTs). We also included RCTs with unclear or high risk of bias for sequence generation. We excluded crossover trials due to high likelihood of carry-over effect. We included studies in which mLearning interventions were used to deliver the learning content of the course. This includes studies where mLearning methods were the sole means by

which the intervention was delivered, or where mLearning methods were part of a complex, multi-component intervention (i.e., blended learning), as long as the contribution of the mLearning component to overall learning has been assessed. Only studies that compare an mLearning intervention to any form of traditional learning (i.e., any learning activity undertaken by traditional means including face-to-face instruction, test-book based learning, practical work or independent study) have been included.

Types of participants: We included studies with participants who are enrolled in a post-registration health professional educational programme, defined as any type of study after a qualification which is recognised by the relevant governmental or professional bodies that enables the qualification holder entry into or continuation of work in the healthcare workforce in a more independent or senior role. We included candidates for, and holders of, the qualifications listed in the Health Field of Education and Training of the International Standard Classification of Education (UIS 2012), except students of traditional, alternative and complementary medicine.

Types of interventions: We defined mLearning interventions as any teaching, learning and or training intervention that is delivered through handheld mobile devices using wireless transmissions: third generation of mobile telecommunications technology (3G), fourth generation of mobile telecommunications technology (4G), global system for mobile communications, originally groupe spécial mobile (GSM), general packet radio services (GPRS), enhanced data rates for GSM evolution (EDGE or EGPRS), MMS, SMS, universal mobile telecommunications system (UMTS), wireless networking (wifi or any other wireless local area network (WLAN)) or long term evolution (LTE) standard. Handheld mobile devices include but are not limited to mobile phones, smartphones, PDAs, tablets, tablets and Moving Picture Experts Group (MPEG)-1 audio layer 3 (MP3) players.

Types of outcomes:

- Participants' knowledge, measured using any validated or non-validated instrument to measure difference in pre- and post-test scores.
- Participants' skills, measured using any validated or non-validated instrument (e.g., pre- and post-test scores, time to perform a procedure, number of errors made whilst performing a procedure).
- Participants' professional attitudes towards patients (e.g., awareness of moral and ethical responsibilities involved in patient contact) and/or towards new clinical knowledge or skills measured using only validated instruments. Where applicable, participants' attitude towards their ability to understand the knowledge and/or apply the skills they learned. Participants' satisfaction with the learning intervention measured using only validated instruments.
- Healthcare professional behaviours, change in clinical practice and patient-related outcomes.
- Economic aspects of the mLearning interventions (e.g. cost-effectiveness, implementation cost, return on investment).
- Any adverse and/or unintended effects of mLearning interventions.

Data collection and analysis

Two authors independently screened all records, extracted data from the included studies and assessed the risk of bias. For the analyses, when possible, we present outcomes using post-intervention standardized mean difference (SMD) and interpret the effect size using Cohen's rule of thumb (i.e. with 0.2 representing a small effect, 0.5 a moderate effect, and 0.8 a large effect). We used the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach to assess the certainty of the evidence and we prepared a Summary of Findings table.

Main results

Eleven RCTs with 1604 participants were included for the analyses. All studies were published between 2009 and 2017, with 91% (10 out of 11) of studies published between 2014 and 2017. The interventions tested in studies consisted of smartphone and tablet applications, Short Message Service (SMS), Personal

Digital Assistant (PDA), podcasts and recorded presentations delivered on an iPod. Six studies involved residents, one study involved each of the following: nurses; emergency medicine service providers; neurosurgery trainees; family physicians; while one study included both practicing physicians and residents in training. Nine studies were conducted in high-income settings, with five in the US, one in each of the following: UK; The Netherlands; Switzerland and Denmark. The remaining two studies were conducted in upper-middle income settings, China and Iran. Six studies assessed knowledge, five studies assessed skills, two studies each assessed attitudes and satisfaction with the education received, two studies included a cost-analysis, while one study assessed healthcare professional behaviour in terms of drug prescriptions.

See the Summary of Findings tables for the results of the review.

Summary of Findings table

mlearning (alone or blended) compared to traditional learning for education of post-registration healthcare professionals

Patient or population: Post-registration healthcare professionals
Setting: Primary / generalist and specialist care settings
Intervention: mLearning (alone or blended) (SMS text messages; tablet-based curriculum including lecture videos; app on an tablet containing multimedia material; audio from 5 conferences synced with the presenters' powerpoint slides and made available on a portable digital device; daily email and/or RSS feed prompt with 5 questions to participants' mobile device plus traditional didactics; smartphone app with didactic modules and multimedia material; MP3 containing heart sound audio files; tablet-based box trainer)
Comparison: Traditional learning (face-to-face lecture/s; one day training; textbook training; conference attendance; traditional didactics; standard debriefing following a simulated case; standard box trainer)

Outcomes	**Traditional learning**	**mlearning (alone or blended)**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Knowledge						
Healthcare professionals' knowledge on management of health issues (Assessed using MCQ tests (3 trials; other kinds of tests (2 trials); unclear (1 trial)) Follow-up: immediately post-intervention to 4 weeks		**SMD 0.89** (0.77 to 1.01) Interpreting SMDs: 0.2 represents a small effect, 0.5 a moderate effect, and 0.8 a large effect		1253 (6 RCTs) China, Denmark, Iran, USA (3)	⨁⨁◯◯ LOW [a, b]	**The intervention may increase healthcare professionals' knowledge regarding the management of health issues** (Studies conducted in primary health centres and hospitals[1, 2, 3, 4, 5, 6])
Provider performance						
Provider performance outcomes	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on provider performance because no direct evidence was identified**
Utilization of healthcare services						
Utilization outcomes	No studies were identified that reported this outcome					**We are uncertain of the effect of the intervention on utilization of healthcare services because no direct evidence was identified.**
Health behavior, status and well-being						
Health behavior, status and well-being outcomes	No studies were identified that reported these outcomes					**We are uncertain of the effect of the intervention on people's health behaviour, status and well-being because no direct evidence was identified.**
Satisfaction and acceptability						

mlearning (alone or blended) compared to traditional learning for education of post-registration healthcare professionals

Patient or population: Post-registration healthcare professionals
Setting: Primary / generalist and specialist care settings
Intervention: mLearning (alone or blended) (SMS text messages; tablet-based curriculum including lecture videos; app on an tablet containing multimedia material; audio from 5 conferences synced with the presenters' powerpoint slides and made available on a portable digital device; daily email and/or RSS feed prompt with 5 questions to participants' mobile device plus traditional didactics; smartphone app with didactic modules and multimedia material; MP3 containing heart sound audio files; tablet-based box trainer)
Comparison: Traditional learning (face-to-face lecture/s; one day training; textbook training; conference attendance; traditional didactics; standard debriefing following a simulated case; standard box trainer)

Outcomes	**Traditional learning**	**mlearning (alone or blended)**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Healthcare professionals' satisfaction with the intervention (5 point Likert scale, visual analogue scale) Follow-up: immediately post-intervention	One study reported higher post-intervention satisfaction scores (SMD: 0.73 (95% CI: 0.30 to 1.17) in the mLearning group compared to traditional learning group. One study had non-comparable outcome data.			119 (2 RCTs) Switzerland, USA	⨁◯◯◯ VERY LOW c, d, e	**We are uncertain of the effect of the intervention on healthcare professionals' satisfaction because the certainty of this evidence was assessed as very low.** (Studies conducted in hospitals [7,8])
Healthcare professionals' skills and attitudes						
Healthcare professionals' clinical (3 trials) or communication (1 trial) skills – higher score more desirable (measured with checklists, questionnaires, global rating scale, practical test) Follow-up: immediately post intervention		**SMD 1.17** (0.92 to 1.42) Interpreting SMDs: 0.2 represents a small effect, 0.5 a moderate effect, and 0.8 a large effect		305 (4 RCTs) Denmark, Switzerland, USA (2)	⨁◯◯◯ VERY LOW f, .g, h	**We are uncertain of the effect of the intervention on healthcare professional clinical and communication skills because the certainty of this evidence was assessed as very low.** (Studies conducted in hospital or specialist settings [2, 7, 8, 10])
Healthcare professionals' clinical skills – lower score more desirable (measured with a practical test) Follow-up: immediately post intervention		**SMD -0.05** (-0.91 to 0.81) Interpreting SMDs: 0.2 represents a small effect, 0.5 a moderate effect, and 0.8 a large effect		21 (1 RCT) UK	⨁◯◯◯ VERY LOW m, n	**We are uncertain of the effect of the intervention on healthcare professional clinical skills because the certainty of this evidence was assessed as very low.** (Study conducted in hospital or specialist setting [9])
Healthcare professionals' self-efficacy and self-belief in relation to the training they received[12] (measured with Likert scales) Follow-up: immediately post intervention		**SMD 0.36** (-0.01 to 0.73) Interpreting SMDs: 0.2 represents a small effect, 0.5 a moderate effect, and 0.8 a large effect		120 (2 RCTs) The Netherlands, USA	⨁◯◯◯ VERY LOW l, j, k	**We are uncertain of the effect of the intervention on healthcare professionals' attitudes because the certainty of this evidence was assessed as very low.** (Studies conducted in hospitals [8, 11])

mlearning (alone or blended) compared to traditional learning for education of post-registration healthcare professionals

Patient or population: Post-registration healthcare professionals
Setting: Primary / generalist and specialist care settings
Intervention: mLearning (alone or blended) (SMS text messages; tablet-based curriculum including lecture videos; app on an tablet containing multimedia material; audio from 5 conferences synced with the presenters' powerpoint slides and made available on a portable digital device; daily email and/or RSS feed prompt with 5 questions to participants' mobile device plus traditional didactics; smartphone app with didactic modules and multimedia material; MP3 containing heart sound audio files; tablet-based box trainer)
Comparison: Traditional learning (face-to-face lecture/s; one day training; textbook training; conference attendance; traditional didactics; standard debriefing following a simulated case; standard box trainer)

Outcomes	**Traditional learning**	**mlearning (alone or blended)**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Resource use						
Resource use	One study reported that textbook-guided training was significantly more cost-effective than mobile app-guided training (Incremental Cost Effectiveness Ratio -861 967 [95% CI: 1071.7 to -3.2] USD per percentage point change in OSAUS score[13]). Another study reported a 280-fold lower cost per person in the mLearning (daily text message) compared to traditional learning (one day workshop) group.			1015 (2 RCTs) China, Denmark	⨁◯◯◯ VERY LOW [l]	**We are uncertain of the effect of the intervention on resource use because the certainty of this evidence was assessed as very low.** (Studies conducted in primary health centres and hospital [1,2])
Unintended consequences						
Unintended consequences	No studies were identified that reported on this outcome					**We are uncertain of the effect of the intervention on unintended consequences because no direct evidence was identified.**

*The 95% confidence interval (CI); **RR:** Risk ratio; **MD:** Mean difference; **RCT:** randomised controlled trial; **SMD:** Standardised mean Difference

GRADE Working Group grades of evidence. High certainty: We are very confident that the true effect lies close to that of the estimate of the effect. **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect. **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations

a. Downgraded by one level for risk of bias: unclear whether sequence generation random or high risk (3 trials); unclear if allocation concealed (6 trials); unclear if outcome assessment blinded (3 trials); unclear if outcome data complete (3 trials); high risk of selective outcome reporting (1 trial)
b. Downgraded by one level for inconsistency: large variations in effect and lack of overlap among confidence intervals
c. Downgraded by one level for risk of bias: unclear if allocation concealed (1 trial); unclear if outcome assessment blinding (1 trial)
d. Downgraded by one level for imprecision: very few events (<250)
e. Downgraded by one level for indirectness: all trials conducted in high income countries
f. Downgraded by one level for risk of bias: unclear whether sequence generation random (1 trials); unclear if allocation concealed (3 trials); unclear if outcome assessment blinded (3 trials); unclear if outcome data complete (1 trial); and other risk of bias (1 trial)
g. Downgraded by one level for inconsistency: large variations in effect and lack of overlap among confidence intervals
h. Downgraded by one level for indirectness: all trials conducted in high income countries
i. Downgraded by one level for risk of bias: unclear if allocation concealed (2 trials)
j. Downgraded by one level for imprecision: confidence interval includes no effects and very few study participants
k. Downgraded by one level for indirectness: all trials conducted in high income countries
l. Non-comparable results due to the differences in assessment methods used and therefore downgraded to very low.
m. Downgraded by one level for risk of bias: unclear if allocation concealed and unclear if outcome assessment blinded
n. Downgraded by two levels for imprecision

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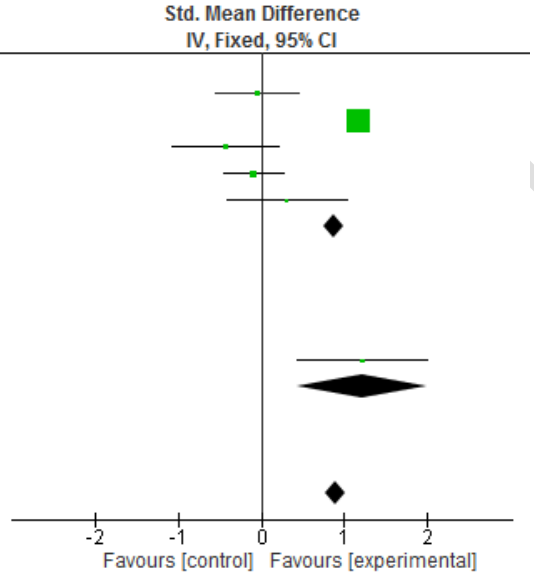
12. Donato (USA) assessed "learner self-rated proficiency". Konings (The Netherlands) used a single question using 5 point scale asking participants about "Amount learned from work"
13. OSAUS: Objective Structured Assessment of Ultra-sound Skills

Analyses

Healthcare professionals' knowledge

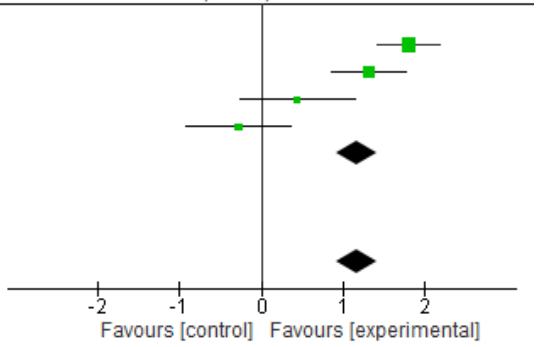
Study or Subgroup	Experimental Mean	SD	Total	Control Mean	SD	Total	Weight	Std. Mean Difference IV, Fixed, 95% CI
1.1.1 mLearning vs traditional								
Alipour 2014	5.8	2	30	5.9	1.8	30	5.4%	-0.05 [-0.56, 0.45]
Chen 2014	0.47	0.16	490	0.31	0.11	487	75.6%	1.16 [1.03, 1.30]
Nilsson 2017	35.29	2.16	18	36.25	2.25	20	3.3%	-0.43 [-1.07, 0.22]
Prasad 2016	79.16	6.3	60	80.16	13.46	58	10.7%	-0.10 [-0.46, 0.27]
Tempelhof 2009	65.6	16.89	15	60.4	15.64	15	2.7%	0.31 [-0.41, 1.03]
Subtotal (95% CI)			**613**			**610**	**97.8%**	**0.88 [0.76, 1.00]**
Heterogeneity: Chi² = 76.00, df = 4 (P < 0.00001); I² = 95%								
Test for overall effect: Z = 14.47 (P < 0.00001)								
1.1.2 Blended learning vs traditional								
Walter 2014	86	11	16	71	13	14	2.2%	1.22 [0.43, 2.01]
Subtotal (95% CI)			**16**			**14**	**2.2%**	**1.22 [0.43, 2.01]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 3.03 (P = 0.002)								
Total (95% CI)			**629**			**624**	**100.0%**	**0.89 [0.77, 1.01]**
Heterogeneity: Chi² = 76.68, df = 5 (P < 0.00001); I² = 93%								
Test for overall effect: Z = 14.76 (P < 0.00001)								
Test for subgroup differences: Chi² = 0.69, df = 1 (P = 0.41), I² = 0%								



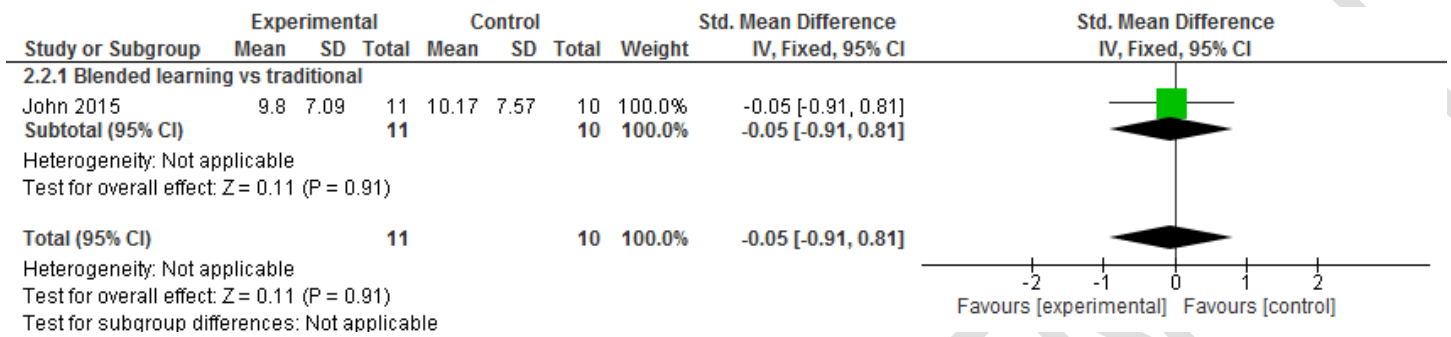
Healthcare professionals' skills

(where a higher score is more desirable)

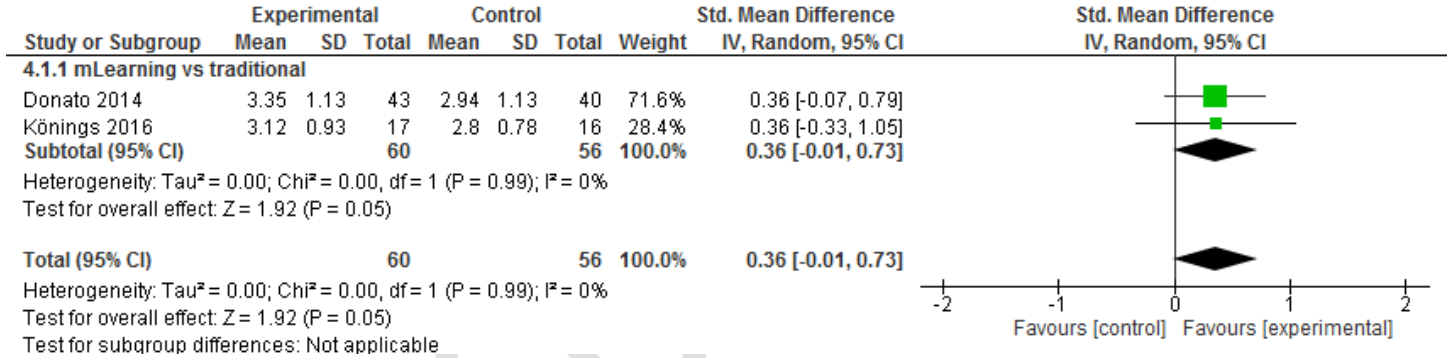
Study or Subgroup	Experimental Mean	SD	Total	Control Mean	SD	Total	Weight	Std. Mean Difference IV, Fixed, 95% CI
2.1.1 mLearning vs traditional learning								
Calhoun 2017	4	0.49	68	3.1	0.5	80	42.7%	1.81 [1.42, 2.19]
Donato 2014	9.51	3.31	44	5.6	2.52	43	29.1%	1.32 [0.85, 1.78]
Montanari 2016	292.3	51.7	16	271.8	37.2	16	12.8%	0.44 [-0.26, 1.15]
Nilsson 2017	42.3	7.54	18	45.3	12.8	20	15.4%	-0.28 [-0.92, 0.36]
Subtotal (95% CI)			**146**			**159**	**100.0%**	**1.17 [0.92, 1.42]**
Heterogeneity: Chi² = 34.61, df = 3 (P < 0.00001); I² = 91%								
Test for overall effect: Z = 9.11 (P < 0.00001)								
Total (95% CI)			**146**			**159**	**100.0%**	**1.17 [0.92, 1.42]**
Heterogeneity: Chi² = 34.61, df = 3 (P < 0.00001); I² = 91%								
Test for overall effect: Z = 9.11 (P < 0.00001)								
Test for subgroup differences: Not applicable								



Healthcare professionals' skills
(where a lower score is more desirable, i.e. time to successfully complete a task)

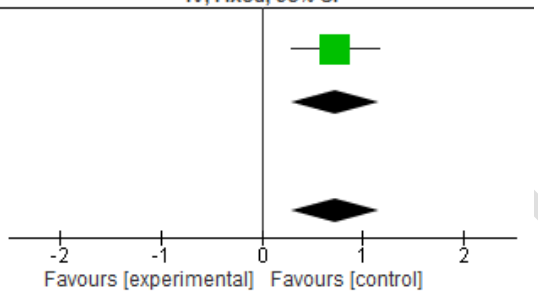


Healthcare professionals' self-efficacy and self-belief in relation to the training they received



Healthcare providers' satisfaction with the intervention

Study or Subgroup	Experimental Mean	SD	Total	Control Mean	SD	Total	Weight	Std. Mean Difference IV, Fixed, 95% CI
5.1.1 mLearning vs traditional								
Donato 2014	5.19	0.94	44	4.23	1.59	43	100.0%	0.73 [0.30, 1.17]
Montanari 2016	0	0	16	0	0	16		Not estimable
Subtotal (95% CI)			**60**			**59**	**100.0%**	**0.73 [0.30, 1.17]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 3.29 (P = 0.0010)								
Total (95% CI)			**60**			**59**	**100.0%**	**0.73 [0.30, 1.17]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 3.29 (P = 0.0010)								
Test for subgroup differences: Not applicable								



Web Annex L: Digital tracking, provider decision support systems and targeted client communication via mobile devices to improve primary health care (unpublished review)

Link to published protocol:

https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD012925/full

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Abstract

Background

The widespread availability of mobile connectivity has made it possible for healthcare providers to digitally record and follow client interactions with the healthcare system to ensure continuity of care, especially in low- and middle-income contexts with limited infrastructure. Digitally tracking clients using mobile devices can be coupled with other functions, such as clinical decision support tools to improve the adherence of the provider to recommended treatment protocols and/or targeted digital communication with clients to support health behaviors. However, the evidence on the effect of such multifaceted interventions is sparse, and offers no clear way forward. To respond to this need, the World Health Organization (WHO) is establishing guidelines that aim to inform investments of the use of such tools on digital devices to strengthen primary healthcare.

Objectives

In the context of primary healthcare settings, we aimed to assess:

- effects of digitally tracking clients' health service use and status combined with decision support conducted via mobile device;
- effects of digitally tracking clients' health service use and status combined with TCCs accessible via mobile device; and
- effects of digitally tracking clients' health service use and status combined with decision support conducted via mobile device and TCCs accessible via mobile device.

Search methods

We searched Cochrane Central Register of Controlled Trials; (CENTRAL) in the Cochrane Library; MEDLINE Ovid; Embase Ovid; Global Health Library WHO; and POPLINE K4Heath on July 24, 2017. We searched the World Health Organization International Clinical Trials Registry Platform; and the US National Institutes of Health Ongoing Trials Register. We also searched Epistemonikos for related systematic reviews and potentially eligible primary studies. We conducted a grey literature search using mHealthevidence.org and issued a call for papers through popular digital health communities of practice. Finally, we conducted citation searches of included studies. We searched for studies published after 2000. We searched for studies in any language.

Selection criteria

Study design: We included individual and cluster-randomised trials; controlled before-after studies, provided they have at least two intervention sites and two control sites; and interrupted time series studies, if there is a clearly defined time point when the intervention occurred and at least three data points before and three after the intervention.
Types of participants: we included studies of all cadres of healthcare providers, including lay health workers and others individuals (administrative, managerial and supervisory staff) and groups involved in client registration, tracking and the delivery of primary health care services using mobile devices; studies of clients or patients receiving care from primary healthcare providers using mobile devices.
Types of interventions: We included studies of multi-faceted interventions that comprise a mobile system that allows providers to longitudinally follow up on clients by entering and accessing data on healthcare services utilized by the client (i.e. digital tracking of clients) combined with- clinical decision support system (CDSS) via mobile devices only; or with targeted client communication (TCC) via mobile devices only; or with both CDSS and TCC. By mobile devices, we mean mobile phones of any kind (but not analogue landline telephones), as well as tablets, personal digital assistants, and smartphones. Laptops are not included in this list. We compared these interventions to standard practice or interventions that included non-digital system.

Data collection and analysis

Two authors independently screened all records, extracted data from the included studies and assessed the risk of bias. For the analyses, we calculated Mantel-Haenszel risk ratio (RR) for dichotomous outcomes and the mean difference (MD) for continuous outcomes, together with 95% confidence intervals (CIs). We used the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach to assess the certainty of the evidence and we prepared a Summary of Findings table.

Main results

Three studies met our inclusion criteria for the first objective. These studies show that digital tracking with clinical decision support compared to standard care:

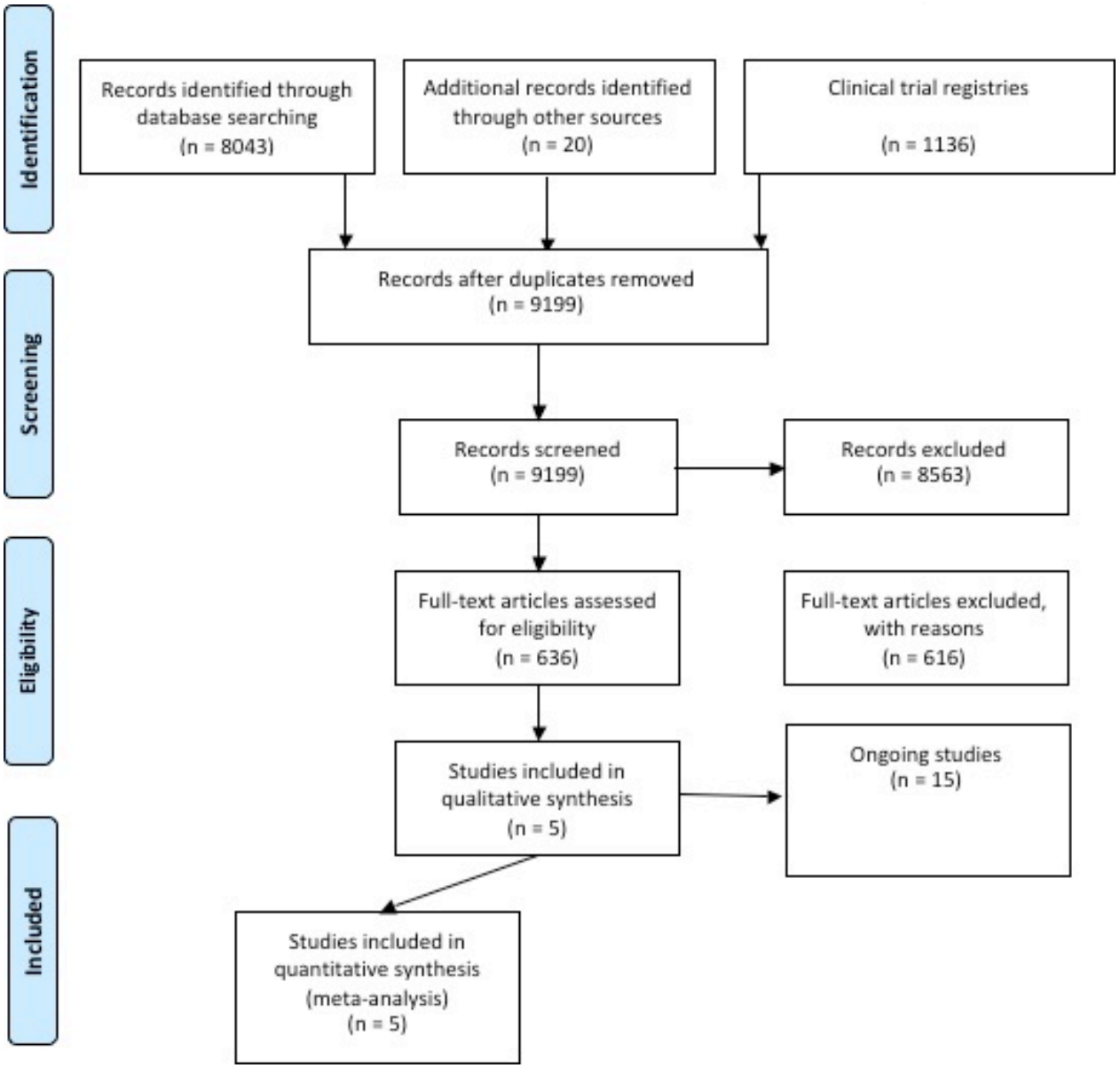
- probably slightly increases the number of children under 5 years receiving Polio 3 vaccine; but probably makes little or no difference to the number of children under 5 years being fully immunized; and receiving the BCG vaccine, the DPT3 vaccine, or the measles vaccine (moderate certainty evidence)
- probably increases the number of pregnant women taking at least 90 iron tablets during pregnancy, and attending at least 3 antenatal care visits; but probably makes little or no difference to the number of pregnant women giving birth at a healthcare facility; or receiving at least 2 tetanus injections (moderate certainty)
- probably increases the number of women immediately breastfeeding; but probably makes little or no difference to the number of women exclusively breastfeeding for 6 months (moderate certainty)
- probably increases the number of women using contraception 6 months or later after giving birth; but probably makes little or no difference to the number of women using contraception within 6 months after birth (moderate certainty)
- We are uncertain of the effect of this approach on emergency department visits among children with pulmonary disease; on asthma severity during office visit among individuals with asthma and on hospitalization among children with pulmonary disease because the certainty of this evidence was assessed as very low.
- We are uncertain of the effect of this approach on providers' acceptability/ satisfaction; patient acceptability/ satisfaction; time between presentation and appropriate management; quality of data about services provided; and providers' adherence to recommended practice; resource use; or unintended consequences because no direct evidence was identified.

Two studies met our inclusion criteria for the third objective (the effect of digital tracking with clinical decision support and targeted client communication). However, we are uncertain of the effect of this approach because of a lack of direct evidence for the outcomes we were interested in or because the certainty of this evidence was assessed as very low.

No studies met our inclusion criteria for the second objective (the effect of digitally tracking clients' health service use and status combined with TCCs).

Authors' conclusions

Our review provides mixed evidence on the effect of tracking combined with CDSS using mobile devices. Two studies of the effect of tracking combined with CDSS and TCC were graded to be of very low quality and provided limited evidence. Our review identified no studies that could be classified as tracking combined with TCC. Further high quality trials are required to robustly establish the effects of these multifaceted interventions delivered by mobile devices.



Summary of Findings

1. Digital tracking with clinical decision support compared to standard care in primary healthcare settings

Digital tracking with clinical decision support compared to standard care in primary healthcare settings

Patient or population: General practice pediatricians and community health workers delivering services to children (5-18 years old) presenting with acute asthma, pregnant women, postpartum women and children due for vaccination
Setting: Community-based settings in high income country (USA) and low-income countries (rural community-based settings in India and China)
Intervention: Digital tracking of client information with clinical decision support
Comparison: Standard care including usual non-digital acute asthma care, standard antenatal and postnatal care using paper-based decision-support tools, and routine vaccination work with a vaccination SMS-reminder (sent to both intervention and comparison groups)

Outcomes	**Standard care**	**Tracking with clinical decision support**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Provider performance						
Providers' adherence to recommended practice	No studies were identified that reported this outcome					**We are uncertain of the effect of this approach on providers' adherence to recommended practice because no direct evidence was identified.**
Time between presentation and appropriate management	No studies were identified that reported this outcome					**We are uncertain of the effect of this approach on time between presentation and appropriate management because no direct evidence was identified.**
Utilization of healthcare services						
Vaccination - Children under 5 years being fully immunized **	599 per 1,000	629 per 1,000 (581 to 683)*	RR 1.05 (0.97 to 1.14)*	1132 (2 RCTs) India and China	⊕⊕⊕◯ MODERATE [e]	**This approach probably makes little or no difference to the number of children under 5 years being fully immunized.** (Studies conducted in rural community-based settings [1,2]).
Vaccination - Children under 5 receiving BCG vaccine	988 per 1,000	988 per 1,000 (959 to 1,000)*	RR 1.00 (0.97 to 1.02)*	1132 (2 RCTs) India and China	⊕⊕⊕◯ MODERATE [e]	**This approach probably makes little or no difference to the number of children under 5 years receiving BCG vaccine.** (Studies conducted in rural community-based settings [1,2]).

Digital tracking with clinical decision support compared to standard care in primary healthcare settings

Patient or population: General practice pediatricians and community health workers delivering services to children (5-18 years old) presenting with acute asthma, pregnant women, postpartum women and children due for vaccination
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Comparison: Standard care including usual non-digital acute asthma care, standard antenatal and postnatal care using paper-based decision-support tools, and routine vaccination work with a vaccination SMS-reminder (sent to both intervention and comparison groups)

Outcomes	**Standard care**	**Tracking with clinical decision support**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Vaccination - Children under 5 receiving Polio 3 vaccine	648 per 1,000	687 per 1,000 (648 to 732)*	RR 1.06 (1.00 to 1.13)*	1132 (2 RCTs) India and China	⨁⨁⨁◯ MODERATE [e]	**This approach probably slightly increases the number of children under 5 years receiving Polio 3 vaccine.** (Studies conducted in rural community-based settings [1,2]).
Vaccination - Children under 5 receiving DPT3 vaccine	790 per 1,000	797 per 1,000 (758 to 845)*	RR 1.01 (0.96 to 1.07)*	1132 (2 RCTs) India and China	⨁⨁⨁◯ MODERATE [e]	**This approach probably makes little or no difference to the number of children under 5 years receiving DPT3 vaccine.** (Studies conducted in rural community-based settings [1,2]).
Vaccination - Children under 5 receiving Measles vaccine	904 per 1,000	958 per 1,000 (895 to 1,000)*	RR 1.06 (0.99 to 1.14)*	205 (1 RCT) China	⨁⨁◯◯ LOW [d,f]	**This approach probably makes little or no difference to the number of children under 5 years receiving Measles vaccine.** (Study conducted in rural community-based settings [2]).
Emergency department visits among children with pulmonary disease	60 per 1,000	63 per 1,000 (60 to 67)*	RR 1.06 (1.00 to 1.13)*	152 (1 non-RCT) USA	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on emergency department visits among children with pulmonary disease because the certainty of this evidence was assessed as very low.** (Study conducted in an academic medical practice [3])

Digital tracking with clinical decision support compared to standard care in primary healthcare settings

Patient or population: General practice pediatricians and community health workers delivering services to children (5-18 years old) presenting with acute asthma, pregnant women, postpartum women and children due for vaccination
Setting: Community-based settings in high income country (USA) and low-income countries (rural community-based settings in India and China)
Intervention: Digital tracking of client information with clinical decision support
Comparison: Standard care including usual non-digital acute asthma care, standard antenatal and postnatal care using paper-based decision-support tools, and routine vaccination work with a vaccination SMS-reminder (sent to both intervention and comparison groups)

Outcomes	**Standard care**	**Tracking with clinical decision support**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Hospitalization among children with pulmonary disease	36 per 1,000	37 per 1,000 (35 to 39)*	RR 1.04 (0.99 to 1.09)*	152 (1 non-RCT) USA	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on hospitalization among children with pulmonary disease because the certainty of this evidence was assessed as very low.** (Study conducted in an academic medical practice [3])
Women give birth in a healthcare facility	839 per 1,000	848 per 1,000 (814 to 890)*	RR 1.01 (0.97 to 1.06)*	1550 (1 RCT) India	⨁⨁⨁◯ MODERATE [c]	**This approach probably makes little or no difference to the number of women giving birth at a healthcare facility.** (Study conducted in rural community-based settings [1])
Pregnant women attending at least 3 antenatal care visits	288 per 1,000	498 per 1,000 (438 to 567)*	RR 1.73 (1.52 to 1.97)*	1553 (1 RCT) India	⨁⨁⨁◯ MODERATE [a]	**This approach probably increases the number of pregnant women attending at least 3 antenatal care visits.** (Study conducted in rural community-based settings [1])
Pregnant women receiving at least 2 tetanus injections	894 per 1,000	938 per 1,000 (911 to 965)*	RR 1.05 (1.02 to 1.08)*	1552 (1 RCT) India	⨁⨁⨁◯ MODERATE [c]	**This approach probably makes little or no difference to the number of pregnant women receiving at least 2 tetanus injections.** (Study conducted in rural community-based settings [1])
Timeliness of receiving healthcare service	No studies were identified that reported on this outcome.					**We are uncertain of the effect of this approach on time between presentation and appropriate management because no direct evidence was identified.**
Health behaviors, status and well-being						

Digital tracking with clinical decision support compared to standard care in primary healthcare settings

Patient or population: General practice pediatricians and community health workers delivering services to children (5-18 years old) presenting with acute asthma, pregnant women, postpartum women and children due for vaccination
Setting: Community-based settings in high income country (USA) and low-income countries (rural community-based settings in India and China)
Intervention: Digital tracking of client information with clinical decision support
Comparison: Standard care including usual non-digital acute asthma care, standard antenatal and postnatal care using paper-based decision-support tools, and routine vaccination work with a vaccination SMS-reminder (sent to both intervention and comparison groups)

Outcomes	**Standard care**	**Tracking with clinical decision support**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Improved asthma severity during office visit	464 per 1,000	604 per 1,000 (446 to 813)*	RR 1.30 (0.96 to 1.75)*	152 (1 non-RCT) USA	⨁◯◯◯ VERY LOW [a,b]	**We are uncertain of the effect of this approach on asthma severity during office visit among individuals with asthma because the certainty of this evidence was assessed as very low.** (Study conducted in an academic medical practice setting [3])
Pregnant women consuming at least 90 iron tablets during pregnancy	109 per 1,000	172 per 1,000 (134 to 222)*	RR 1.58 (1.23 to 2.04)*	1553 (1 RCT) India	⨁⨁⨁◯ MODERATE [c]	**This approach probably increases the number of pregnant women taking at least 90 iron tablets during pregnancy.** (Study conducted in rural community-based settings [1])
Immediate breastfeeding	622 per 1,000	759 per 1,000 (709 to 814)*	RR 1.22 (1.14 to 1.31)*	1553 (1 RCT) India	⨁⨁⨁◯ MODERATE [c]	**This approach probably increases the number women immediately breastfeeding.** (Study conducted in rural community-based settings [1])
Women exclusively breastfeeding for 6 months	611 per 1,000	636 per 1,000 (574 to 703)*	RR 1.04 (0.94 to 1.15)*	919 (1 RCT) India	⨁⨁⨁◯ MODERATE [c]	**This approach probably makes little or no difference to the number of women exclusively breastfeeding for 6 months.** (Study conducted in rural community-based settings [1])
Women currently using contraception within 6 months after birth	272 per 1,000	300 per 1,000 (232 to 387)*	RR 1.10 (0.85 to 1.42)*	585 (1 RCT) India	⨁⨁◯◯ LOW [c,d]	**This approach may make little or no difference to the number of women currently using contraception within 6 months after birth.** (Study conducted in rural community-based settings [1])

Digital tracking with clinical decision support compared to standard care in primary healthcare settings

Patient or population: General practice pediatricians and community health workers delivering services to children (5-18 years old) presenting with acute asthma, pregnant women, postpartum women and children due for vaccination
Setting: Community-based settings in high income country (USA) and low-income countries (rural community-based settings in India and China)
Intervention: Digital tracking of client information with clinical decision support
Comparison: Standard care including usual non-digital acute asthma care, standard antenatal and postnatal care using paper-based decision-support tools, and routine vaccination work with a vaccination SMS-reminder (sent to both intervention and comparison groups)

Outcomes	**Standard care**	**Tracking with clinical decision support**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Women currently using contraception 6 months or later after giving birth	302 per 1,000	401 per 1,000 (335 to 480)*	RR 1.33 (1.11 to 1.59)*	888 (1 RCT) India	⨁⨁⨁◯ MODERATE [c]	**This approach probably increases the number of women currently using contraception 6 months or later after giving birth.** (Study conducted in rural community-based settings [1])
Satisfaction/acceptability						
Providers' acceptability/satisfaction	No studies were identified that reported this outcome					**We are uncertain of the effect of this approach on providers' acceptability/ satisfaction because no direct evidence was identified.**
Patient acceptability/satisfaction	No studies were identified that reported this outcome					**We are uncertain of the effect of this approach on patient acceptability/ satisfaction because no direct evidence was identified.**
Quality of data about services provided	No studies were identified that reported this outcome					**We are uncertain of the effect of this approach on quality of data about services provided because no direct evidence was identified.**
Resource use and unintended consequences						
Resource use	It was estimated that it would cost $112 per healthcare provider and $5.66 per patient, to set up the digital intervention. About $72.24 per healthcare provider, and $3.62 per patient would be needed annually in operating costs. $69.53 would be needed every three years per healthcare provider to replace mobile phones. The operating costs do not include management costs.			569 (1 RCT) India	⨁◯◯◯ VERY LOW [g]	**We are uncertain of the effect of this approach on resource use because the certainty of this evidence was assessed as very low.** (Study conducted in rural community-based settings) [1])

Digital tracking with clinical decision support compared to standard care in primary healthcare settings

Patient or population: General practice pediatricians and community health workers delivering services to children (5-18 years old) presenting with acute asthma, pregnant women, postpartum women and children due for vaccination
Setting: Community-based settings in high income country (USA) and low-income countries (rural community-based settings in India and China)
Intervention: Digital tracking of client information with clinical decision support
Comparison: Standard care including usual non-digital acute asthma care, standard antenatal and postnatal care using paper-based decision-support tools, and routine vaccination work with a vaccination SMS-reminder (sent to both intervention and comparison groups)

Outcomes	**Standard care**	**Tracking with clinical decision support**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Unintended consequences	No studies were identified that reported on this outcome					**We are uncertain of the effect of this approach on unintended consequences because no direct evidence was identified.**

*The 95% confidence interval (CI); **RR:** Risk ratio; **MD:** Mean difference; **RCT:** Randomised controlled trial; **SMD:** Standardised mean difference
** Full immunization (in India) includes BCG birth, 3 doses OPV, 3 doses DPT, measles. Full immunization in China includes BCG, 3 doses Hepatitis, 3 doses OPV, 3 doses DPT and measles.

GRADE Working Group grades of evidence. High certainty: We are very confident that the true effect lies close to that of the estimate of the effect. **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect. **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect.

BCG: Bacille Calmette Guerin (against tuberculosis); **DPT3:** Immunization to protect against 3 infections: diphtheria, pertussis (whooping cough), and tetanus; **OPV:** oral polio vaccine

Explanations

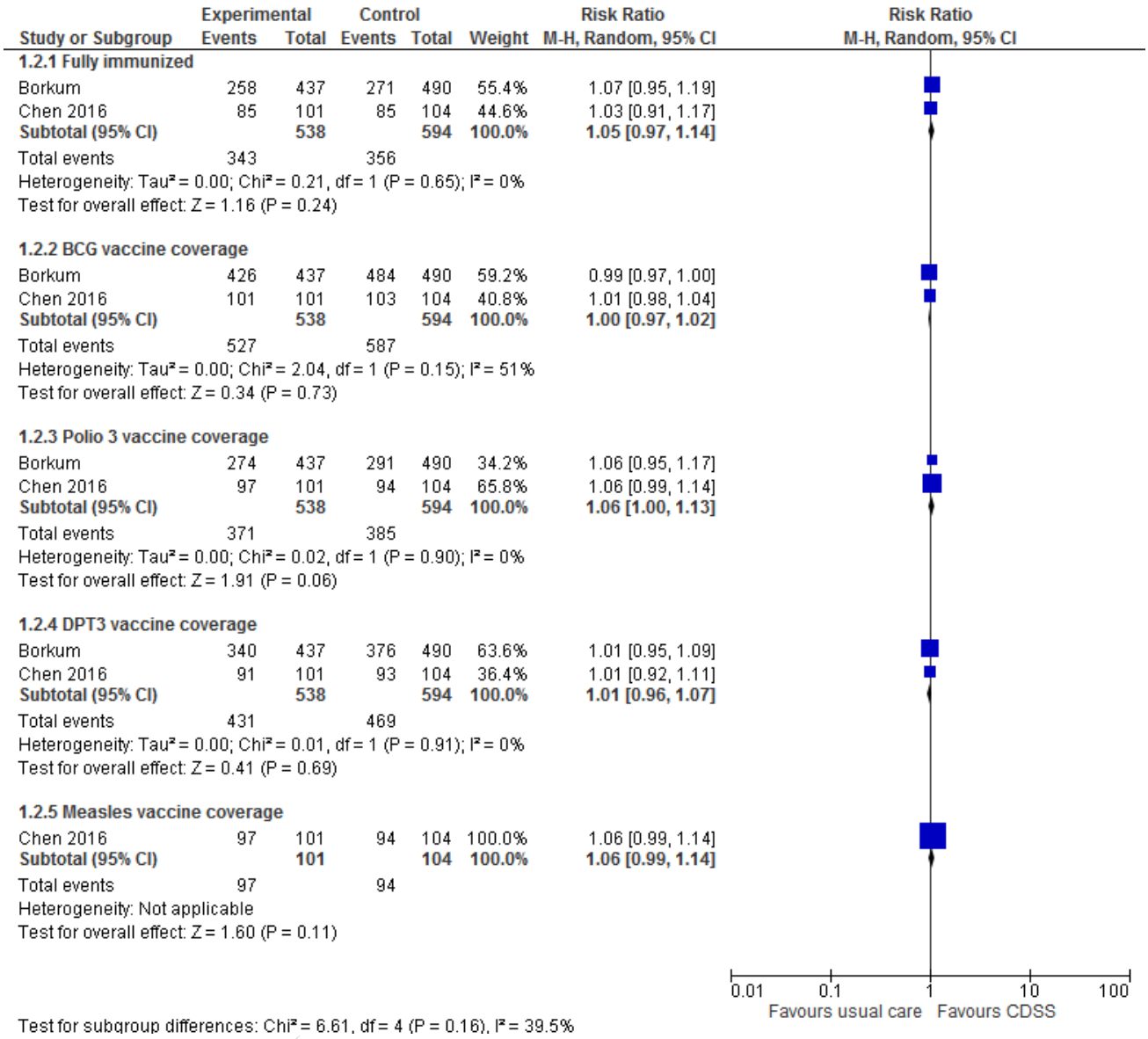
a. Downgraded two steps for risk of bias- intervention assignment is not randomized
b. Downgraded one step for indirectness- study was conducted in a high-income country
c. Downgraded one step for risk of bias- unclear allocation concealment, blinding of participants and personnel was not possible, study lacks blinding of outcome assessment
d. Downgraded one step for imprecision due to few events
e. Downgraded one step for risk of bias- one study has unclear allocation concealment. Both studies lack of participants, personnel and outcome assessment.
f. Downgraded one step for risk of bias- Study lacked blinding of participants and personnel, and has unclear blinding of outcome assessment
g. Downgraded three steps for risk of bias as cost information was retrospectively collected and authors state that the information may not be complete or accurate, and cost data are not presented for the comparison arm.

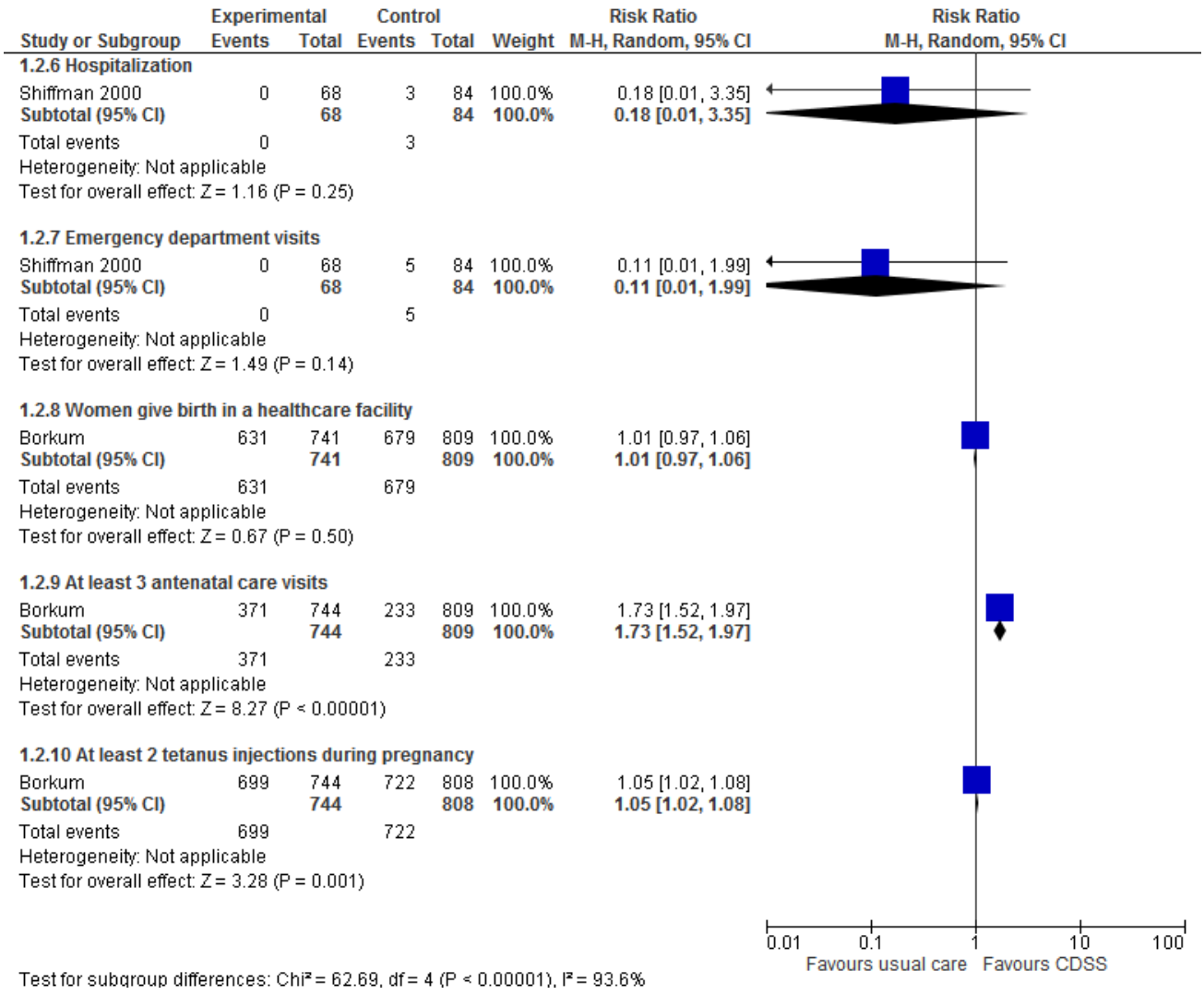
References and notes

1. Borkum E, Sivasankaran A,Sridharan S,Rotz D,Sethi S,Manoranjini M,Ramakrishnan L,Rangarajan A. Evaluation of the Information and Communication Technology (ICT) Continuum of Care Services (CCS) Intervention in Bihar. Mathematica Policy Research; 2015.
2. L, Chen, X, Du, L, Zhang, Velthoven, van, H, M, Q, Wu, al, et. Effectiveness of a smartphone app on improving immunization of children in rural Sichuan Province, China: a cluster randomized controlled trial. BMC Public Health; 2016.
3. N, Shiffman,R, A, Freudigman,K, A, Brandt,C, Y, Liaw, D, Navedo,D. A guideline implementation system using handheld computers for office management of asthma: Effects on adherence and patient outcomes. Pediatrics; 2000.

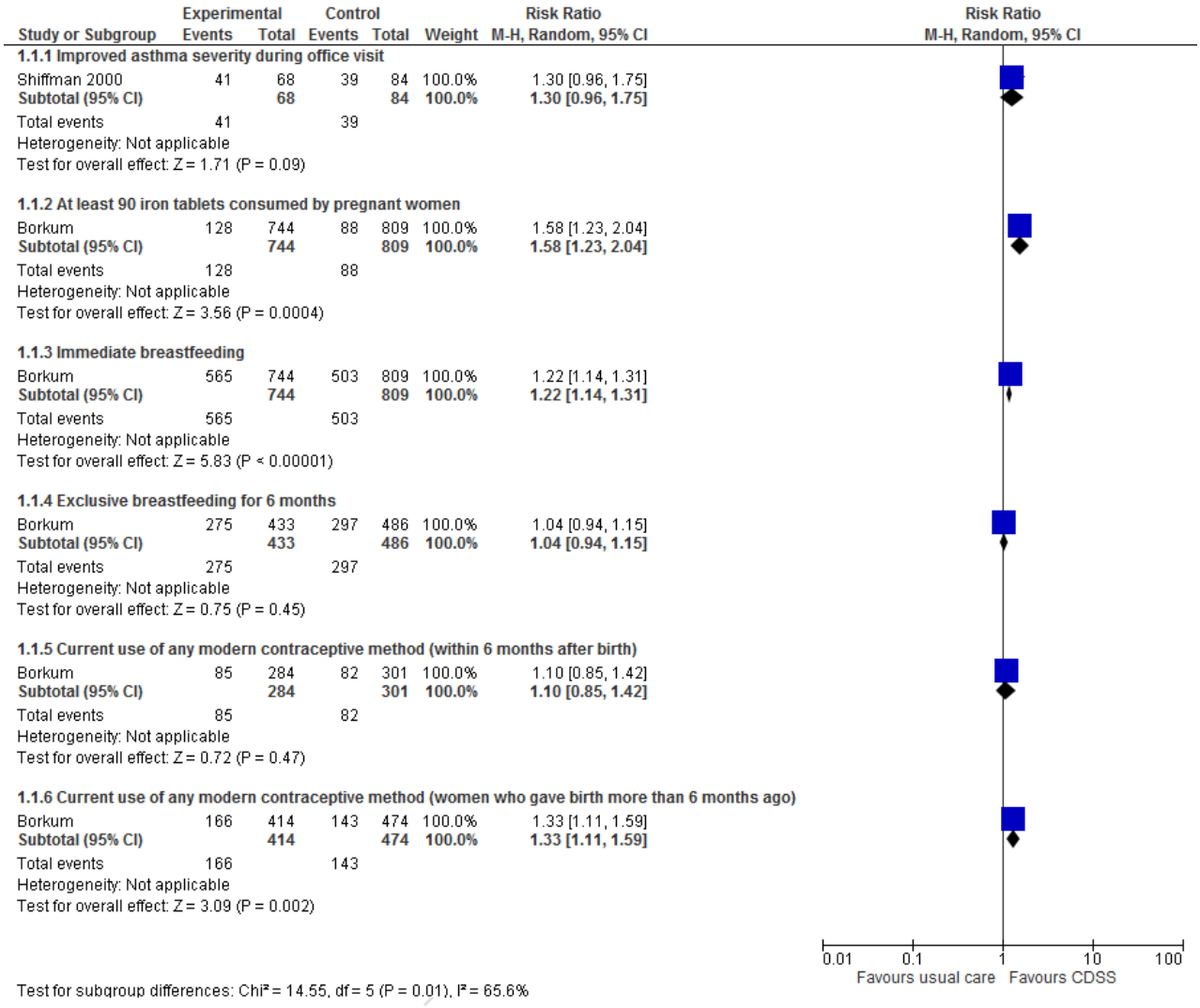
Analyses

Healthcare utilization




Experimental
Control
Risk Ratio
Risk Ratio
Study or Subgroup Events Total Events Total Weight M-H, Random, 95% CI
M-H, Random, 95% CI
1.2.6 Hospitalization
Shiffman 2000 0 68 3 84 100.0% 0.18 [0.01, 3.35]
Subtotal (95% CI) 68 84 100.0% 0.18 [0.01, 3.35]
Total events 0 3
Heterogeneity: Not applicable
Test for overall effect: Z = 1.16 (P = 0.25)
1.2.7 Emergency department visits
Shiffman 2000 0 68 5 84 100.0% 0.11 [0.01, 1.99]
Subtotal (95% CI) 68 84 100.0% 0.11 [0.01, 1.99]
Total events 0 5
Heterogeneity: Not applicable
Test for overall effect: Z = 1.49 (P = 0.14)
1.2.8 Women give birth in a healthcare facility
Borkum 631 741 679 809 100.0% 1.01 [0.97, 1.06]
Subtotal (95% CI) 741 809 100.0% 1.01 [0.97, 1.06]
Total events 631 679
Heterogeneity: Not applicable
Test for overall effect: Z = 0.67 (P = 0.50)
1.2.9 At least 3 antenatal care visits
Borkum 371 744 233 809 100.0% 1.73 [1.52, 1.97]
Subtotal (95% CI) 744 809 100.0% 1.73 [1.52, 1.97]
Total events 371 233
Heterogeneity: Not applicable
Test for overall effect: Z = 8.27 (P < 0.00001)
1.2.10 At least 2 tetanus injections during pregnancy
Borkum 699 744 722 808 100.0% 1.05 [1.02, 1.08]
Subtotal (95% CI) 744 808 100.0% 1.05 [1.02, 1.08]
Total events 699 722
Heterogeneity: Not applicable
Test for overall effect: Z = 3.28 (P = 0.001)
0.01
0.1
1
10
100
Favours usual care
Favours CDSS
Test for subgroup differences: Chi² = 62.69, df = 4 (P < 0.00001), I² = 93.6%

Health behaviors, status, well-being



2. Digital tracking with clinical decision support and targeted client communication compared to standard care in primary healthcare settings

Digital tracking with clinical decision support and targeted client communication compared to standard care in primary healthcare settings

Patient or population: Nurses and health officers providing maternal and child health services to pregnant women, and health assistants and vaccinators providing vaccination services to children (0-11 months)
Setting: Primary health facilities in rural and urban Ethiopia, and community-based settings in hard-to-reach rural and urban Bangladesh
Intervention: Digital tracking with clinical decision support and targeted client communication (one-way information support)
Comparison: Standard care involving no use of a digital aid

Outcomes	**Standard care**	**Tracking with targeted client communication (interactive text messaging)**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Provider performance						
Providers' adherence to recommended practice	No studies were identified that reported this outcome					**We are uncertain of the effect of this approach on providers' adherence to recommended practice because no direct evidence was identified.**
Time between presentation and appropriate management	No studies were identified that reported this outcome					**We are uncertain of the effect of this approach on time between presentation and appropriate management because no direct evidence was identified.**
Utilization of healthcare services						
Vaccination – children (0-11 months) being fully immunized - Rural	552 per 1,000	768 per 1,000 (596 to 989)*	RR 1.39 (1.08 to 1.79)*	136 (1 non-RCT) Bangladesh	⨁◯◯◯ VERY LOW [b,c]	**We are uncertain of the effect of this approach on number of children that are fully immunized in rural setting because the certainty of this evidence was assessed as very low.** (Study conducted urban and rural health facilities [2]).
Vaccination – children (0-11 months) being fully immunized - Urban	339 per 1,000	570 per 1,000 (421 to 780)*	RR 1.68 (1.24 to 2.30)*	210 (1 non-RCT) Bangladesh	⨁◯◯◯ VERY LOW [b,c]	**We are uncertain of the effect of this approach on number of children that are fully immunized in urban setting because the certainty of this evidence was assessed as very low.** (Study conducted urban and rural health facilities [2]).

Digital tracking with clinical decision support and targeted client communication compared to standard care in primary healthcare settings

Patient or population: Nurses and health officers providing maternal and child health services to pregnant women, and health assistants and vaccinators providing vaccination services to children (0-11 months)
Setting: Primary health facilities in rural and urban Ethiopia, and community-based settings in hard-to-reach rural and urban Bangladesh
Intervention: Digital tracking with clinical decision support and targeted client communication (one-way information support)
Comparison: Standard care involving no use of a digital aid

Outcomes	**Standard care**	**Tracking with targeted client communication (interactive text messaging)**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Vaccination – children (0-11 months) receiving BCG + Pentavalent vaccine - Rural	388 per 1,000	190 per 1,000 (105 to 334)*	RR 0.49 (0.27 to 0.86)*	136 (1 non-RCT) Bangladesh	⨁◯◯◯ VERY LOW [b,c]	**We are uncertain of the effect of this approach on number of children receiving BCG + Pentavalent vaccine in rural setting because the certainty of this evidence was assessed as very low.** (Study conducted urban and rural health facilities [2]).
Vaccination – children (0-11 months) receiving BCG + Pentavalent vaccine- Urban	527 per 1,000	416 per 1,000 (311 to 558)*	RR 0.79 (0.59 to 1.06)*	210 (1 non-RCT) Bangladesh	⨁◯◯◯ VERY LOW [b,c]	**We are uncertain of the effect of this approach on number of children receiving BCG + Pentavalent vaccine in urban setting because the certainty of this evidence was assessed as very low.** (Study conducted urban and rural health facilities [2]).
Women give birth in a healthcare facility	267 per 1,000	425 per 1,000 (361 to 497)*	RR 1.59 (1.35 to 1.86)*	1224 (1 non-RCT) Ethiopia	⨁◯◯◯ VERY LOW [a]	**We are uncertain of the effect of this approach on number of women giving birth at a healthcare facility because the certainty of this evidence was assessed as very low.** (Study conducted urban and rural health facilities [1]).
Pregnant women attending at least 4 antenatal care visits	234 per 1,000	269 per 1,000 (223 to 328)*	RR 1.15 (0.95 to 1.40)*	1224 (1 non-RCT) Ethiopia	⨁◯◯◯ VERY LOW [a]	**We are uncertain of the effect of this approach on number of women attending at least 4 antenatal care visits because the certainty of this evidence was assessed as very low.** (Study conducted urban and rural health facilities [1]).

Digital tracking with clinical decision support and targeted client communication compared to standard care in primary healthcare settings

Patient or population: Nurses and health officers providing maternal and child health services to pregnant women, and health assistants and vaccinators providing vaccination services to children (0-11 months)
Setting: Primary health facilities in rural and urban Ethiopia, and community-based settings in hard-to-reach rural and urban Bangladesh
Intervention: Digital tracking with clinical decision support and targeted client communication (one-way information support)
Comparison: Standard care involving no use of a digital aid

Outcomes	**Standard care**	**Tracking with targeted client communication (interactive text messaging)**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Women attending postnatal care in a health center	206 per 1,000	406 per 1,000 (338 to 486)*	RR 1.97 (1.64 to 2.36)*	1224 (1 non-RCT) Ethiopia	⨁◯◯◯ VERY LOW [a]	**We are uncertain of the effect of this approach on number of women attending postnatal care in a health center because the certainty of this evidence was assessed as very low.** (Study conducted urban and rural health facilities [1]).
Timeliness of receiving healthcare service	No studies were identified that reported on this outcome.					**We are uncertain of the effect of this approach on time between presentation and appropriate management because no direct evidence was identified.**
Health status and well-being						
Health status and well-being	No studies were identified that reported on this outcome.					**We are uncertain of the effect of this approach on health status and well-being because no direct evidence was identified.**
Satisfaction/acceptability						
Providers' acceptability/satisfaction	No studies were identified that reported this outcome					**We are uncertain of the effect of this approach on providers' acceptability/ satisfaction because no direct evidence was identified.**
Patient acceptability/satisfaction	No studies were identified that reported this outcome					**We are uncertain of the effect of this approach on patient acceptability/ satisfaction because no direct evidence was identified.**
Quality of data about services provided	No studies were identified that reported this outcome					**We are uncertain of the effect of this approach on quality of data about services provided because no direct evidence was identified.**

Digital tracking with clinical decision support and targeted client communication compared to standard care in primary healthcare settings

Patient or population: Nurses and health officers providing maternal and child health services to pregnant women, and health assistants and vaccinators providing vaccination services to children (0-11 months)
Setting: Primary health facilities in rural and urban Ethiopia, and community-based settings in hard-to-reach rural and urban Bangladesh
Intervention: Digital tracking with clinical decision support and targeted client communication (one-way information support)
Comparison: Standard care involving no use of a digital aid

Outcomes	**Standard care**	**Tracking with targeted client communication (interactive text messaging)**	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	What happens?
Resource use						
Resource use	No studies were identified that reported this outcome					**We are uncertain of the effect of this approach on resource use because no direct evidence was identified.**
Unintended consequences						
Unintended consequences	No studies were identified that reported on this outcome					**We are uncertain of the effect of this approach on unintended consequences because no direct evidence was identified.**

*The 95% confidence interval (CI); **RR:** Risk ratio; **MD:** Mean difference; **RCT:** Randomised controlled trial

GRADE Working Group grades of evidence. **High certainty:** We are very confident that the true effect lies close to that of the estimate of the effect. **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect. **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

BCG: Bacille Calmette Guerin (against tuberculosis)

Explanations

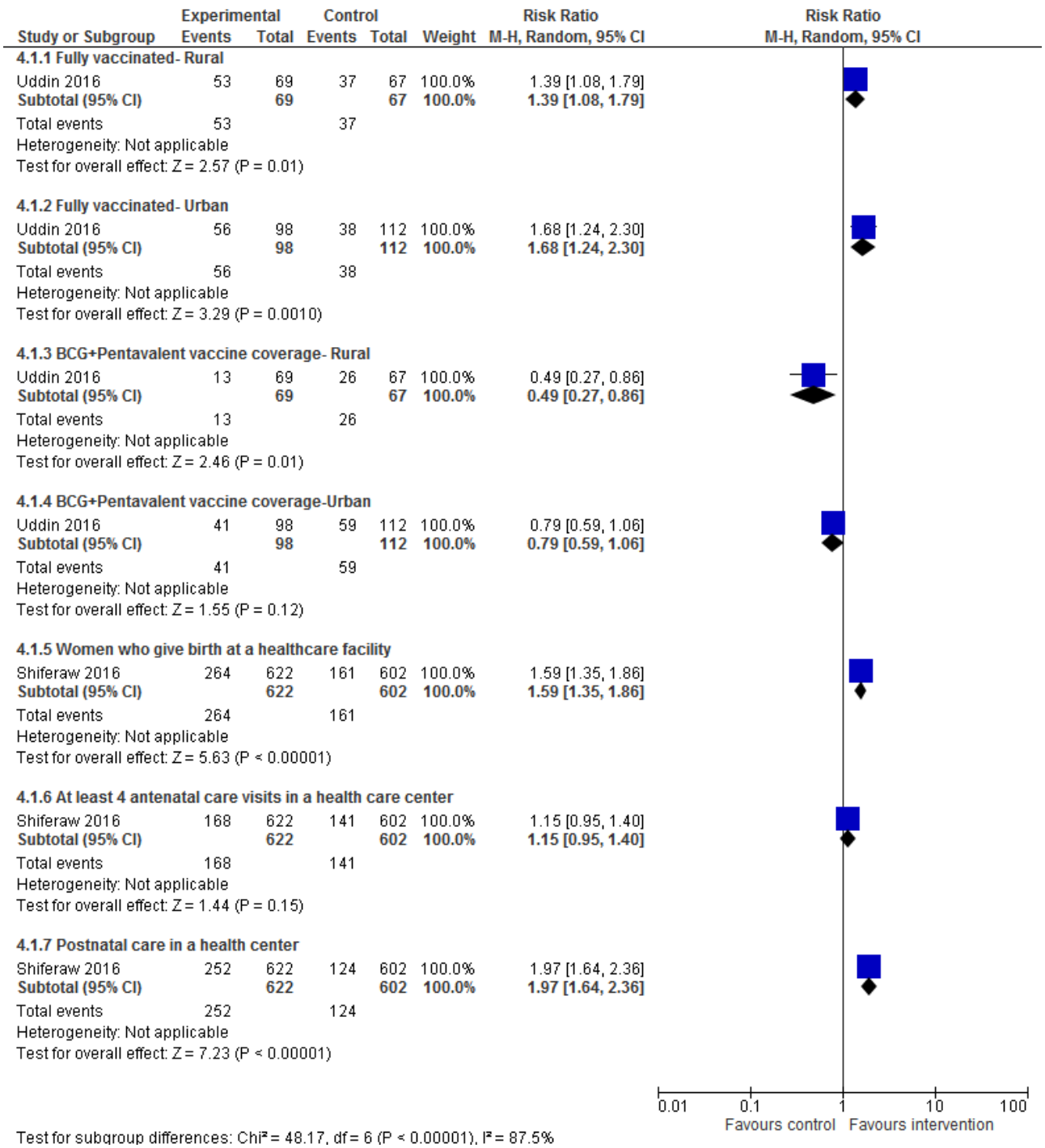
a. Downgraded two steps for risk of bias- intervention was not randomized, lack of blinding of participants and personnel, only women who had follow-up records were included in the analysis suggesting incomplete outcome data reporting.
b. Downgraded two steps for risk of bias- intervention was not randomized, lack of blinding of participants and personnel, unclear outcome assessment, unclear incomplete outcome data reporting,
c. Downgraded one step for imprecision- small sample size

References and notes

1. S, Shiferaw, M, Spigt, M, Tekie, M, Abdullah, M, Fantahun, J, Dinant,G. The effects of a locally developed mHealth intervention on delivery and postnatal care utilization; A prospective controlled evaluation among health centres in Ethiopia. PLoS ONE; 2016.
2. J, Uddin,M, M, Shamsuzzaman, L, Horng, A, Labrique, L, Vasudevan, K, Zeller, al, et. Use of mobile phones for improving vaccination coverage among children living in rural hard-to-reach areas and urban streets of Bangladesh. Vaccine; 2016.

Analyses

Healthcare utilization



Web Annex M: Cross-cutting acceptability and feasibility issues and implementation considerations for health workers

NB: These considerations should be referenced when reviewing the Web Supplement 1 (Evidence to Decision Frameworks) of health worker interventions.

Most of the digital health interventions in this guideline are targeted at or expected to be used by health workers. The following findings point to factors that are likely to influence the acceptability and feasibility of these interventions. These findings are based on reviews and overviews of digital health interventions in primary care (Annex 8 (WO)); telemedicine (Annex 2C (CG)); digital health devices for stock notification (Annex 7 (SA)), birth and death notification via mobile devices (Annex 6 (LV)) and mLearning (Annex 3b (PL)).

Acceptability

Factors that may increase acceptability: Digital health interventions allow health workers to **expand their range of tasks** as well as take on tasks previously assigned to higher level workers. This can be experienced as satisfying and fulfilling, both for those to whom tasks are shifted, as well as to those from whom tasks are shifted (moderate confidence, WO-F9). Health workers working in rural and remote contexts particularly appreciate the **efficiency** of digital health technologies as these allow them to offer services through the device (moderate confidence, WO-F13). Health workers are likely to perceive digital health technologies to be more efficient because of the **increased speed** with which they allow them to work (moderate confidence, WO-F11). These technologies are also likely to **save traveling time** for health workers in urban settings, allowing them to spend more time with their clients (moderate confidence, WO-F13). Health workers may appreciate the **portability** of digital health technologies because this allows them to be **flexible**, to work when convenient, and not have to be office-bound to access information (low confidence, WO-F14). Health workers, particularly lay health workers in LMIC settings, also perceive digital health technologies as allowing them to better **coordinate the delivery of care through connecting them to other people and sectors** in the health system and to clients and communities (moderate confidence, WO-F1).

Some health workers also report that digital health technologies **raise their social status** and increase the trust and respect they receive in communities. This is in part due to the device itself, but is also because they use these devices to access higher level care. Lay health workers in particular, feel that the devices **increase the respect they receive from health professionals** and from the community (moderate confidence, WO-F25a; LV-FB2). Similar findings are seen among health workers in training, although there is also some concern that clients and colleagues might regard their use of mobile phones as unprofessional because of their association with recreation (low confidence, PL-F8).

Factors that may decrease acceptability: Some health workers do not experience digital health interventions as efficient as these interventions **do not reduce their workload and in some cases increase their workload** (moderate confidence, WO-F11), making them less likely to accept these interventions (moderate confidence, CG-F4). Health workers may perceive digital health interventions as increasing their workload when it means maintaining two systems (i.e. digital and paper-based), when there are staff shortages, when the addition of the digital health intervention to current work is not understood and appreciated by supervisors, or when they themselves perceive the intervention as peripheral to their work. While some health workers do not object to the additional work, others expect to be remunerated for it (low confidence, WO-F27; LV-FB4).

Health workers may also be concerned about **loss, damage and theft** and may complain about having to carry both a personal and a work phone (low confidence, WO-F31b, PL-F2). In some settings, health workers use their personal mobile phones and Internet access for work purposes, although this use is not necessarily formalised and **health worker expenses are not always covered**. (low confidence, W=-F22; LV-FB1). This can include expenses for air time or for charging their phone. Health workers may see these personal costs as a burden. However, they may feel a moral imperative to assist their clients by using their own phones despite the personal costs this incurs (low confidence, WO-F22).

Health workers' perceptions and experiences of digital health interventions are likely to be **shaped by their pre-existing technology literacy**. Health workers who manage well have positive views about the use of mobile devices. However, health workers who struggle to use these technologies have negative perceptions about its usefulness, may not understand the information generated by these technologies, and are also anxious about making errors. In some instances, poor techno-literacy **threatens job security** (high confidence, WO-F20). However, even technologically more competent users are reported as needing support and repeat training in the use of the programmes and devices (low confidence, PL-F21).

Feasibility

Many health workers, particularly in rural and remote areas, experience logistical challenges when using digital health technologies, including **poor network connectivity and no easy access to electricity** to charge their mobile phones (high confidence, WO-F30, CG-F2; SA-F1; PL-F23; LV-FE2). In some instances, poor connectivity also results in client dissatisfaction because it creates delays in receiving healthcare (high confidence, WO-F30).

Health workers want easy-to-use, reliable equipment and ongoing technical support (high confidence, CG-F2; SA-F6; SA-F5; WO-F19). They also feel that the use of these technologies can be expanded to a wider range of settings, services, and illnesses (high confidence, WO-F29). However, health workers often report **installation and usability issues**, and **poor integration with other digital systems** (high confidence, F2–CG; PL-F4). While the integration of digital health interventions into existing healthcare systems may be important, this requires many changes and may be difficult to achieve (low confidence, CG-F17). For instance, institutional support and local champions may be considered important for ensuring integration into existing systems, but staff re-organisation and the breakdown of existing partnerships may undermine this support (low confidence, CG-F17).

Health workers may experience a number of **problems with the design of the programmes or of the device itself**, including programmes in languages they are not proficient in, inaccurate rendering of the local language font, small screens, devices being ill-suited for note-taking, and SMS character limitations (low confidence, WO-F31a; PL-F3). While the involvement of staff and clients in the planning, design and implementation of the digital system is considered important by health workers (moderate confidence WO-F29; SA-F6), this is not always done (moderate confidence, CG-F15). Health workers may be dissatisfied with digital health technologies when technology changes are too rapidly introduced, or when their expectations of the technologies are not met (low confidence, WO-F15).

Some stakeholders are also concerned about the **confidentiality of medical information and data security** (moderate confidence, CG-F12). Health workers may try to protect clients' confidential information when using digital health devices, in particular when the information concerns stigmatised conditions such as HIV/AIDS (low confidence, WO-F21). Achieving informed consent for sharing records and images can also be challenging, particularly in settings with low levels of literacy or computer literacy (moderate confidence, CG-F13).

Training is considered important for staff acceptance and system use (high confidence, CG-F6; SA-F4; PL-F25; LV-FB3). While some health workers experience **difficulties in understanding and using digital health** technologies, health workers and trainers feel that **training and familiarity with these technologies can help** overcome these difficulties. Some health workers feel hampered in learning to use mobile health technologies if it is not also used by their clinical mentors (moderate confidence, WO-F18). This may be particularly important as health workers requiring technical support may receive this support from higher level staff or from peers (low confidence, WO-F19). **Supportive supervision is also considered important** for staff acceptance and system use (moderate confidence, SA-F8).

Digital systems can make it possible to track and monitor health workers' activities. Health workers may feel that this changes how they work and **may make their work more visible**. Some health workers may perceive this as **positive**, but it may leave other health workers with the sense of **"big brother watching"**. Supervisors may feel that this allows them to be more aware of the work of lower level health workers and to address problems (low confidence, WO-F4; LV-A2).

Even where challenges tied to the design and usability of digital systems and devices are addressed, these systems **may not be able mitigate a number of broader health systems challenges**, for example, an underlying lack of supplies (low confidence, SA-F2).

Implementation considerations

Digital interventions are a potential tool for strengthening health system and improving the delivery of care. However, they can only work as well as the context allows. Digital health has the potential to help address problems such as distance and access, but still share many challenges with other health systems interventions, including poor health worker training, poor supervision, a lack of health workers, and poor access to equipment and supplies. All of these challenges still need to be addressed, in addition to the new needs digital health brings with it.

The WHO/ITU National eHealth Strategy Toolkit [9] has identified the following implementation considerations:

- Infrastructure
- Health workforce
- Governance
- Financial resources
- Interoperability and standards
- Policy and regulations

In addition, drawing on systematic reviews of the global evidence, we identified the following cross-cutting implementation issues*:*

Involve stakeholders in programme design and implementation

- Involve health workers, facility staff and other users in the design, user testing and implementation of the programme, and include them in decisions about changes to the programme. Ensure that the programmes and digital devices are easy to install and to use
- When designing the programme and planning health worker training, pay particular attention to the needs of health workers who are not technically literate. Make an effort to ensure that the requirements of the new programme do not threaten their job security
- Raise awareness of the programme among clients and potential clients in order to increase their trust in and use of the programme

Assess how programmes can be efficiently integrated with the rest of the health system

- Assess how the programme will be integrated technically into existing healthcare systems
- Monitor how the programme is affecting health worker roles and daily activities. Is it reducing or increasing health workers' workloads? For instance, is the health worker expected to maintain a new digital system in addition to other, paper-based or non-digital systems? If additional work is expected, at least in a transition phase, will health workers have time to manage these additional activities, and will they be compensated for any additional work?

Secure data confidentiality and informed consent

- Put systems in place to ensure data confidentiality. Ensure that these systems meet national legal standards. Also ensure that these systems meet clients' concerns and that health workers, clients and other stakeholders are aware of and able to use these systems
- Develop systems for ensuring informed consent among all citizens, including those with literacy problems

Ensure that health workers have adequate training, supervision, support and incentives

- Deliver training to health workers before the programme is rolled out. In addition, ensure that refresher training, training for new staff, and training in connection with programme or device updates is easily available
- Ensure that training and support is available through different channels, including individual training sessions, online, and through peers
- Ensure that supervisors are familiar with the programme and the device and receive appropriate training
- Ensure that health workers have ongoing and easily accessible technical support
- Explore whether any increase in health workers' workload or scope of practice needs to be reflected in increased salaries or incentives

Ensure access to network connectivity and electricity

- Assess whether health workers are likely to have reliable network connectivity and access to electricity in all their work settings. Put systems in place to deal with situations where connectivity or electricity may be lacking. This may include the provision of solar chargers or enabling the digital system to function without requiring internet or data connectivity

Ensure that health workers have access to functioning digital devices

- Put systems in place to replace health workers' lost, broken or stolen mobile phones and to ensure that this happens within a short timeframe. There should be processes in place that clearly communicate the consequences of lost devices and efforts to limit misuse of devices, and which may be included as part of a contractual agreement. There should also by an ability to monitor all phones that have been distributed to health workers in order to more easily provide IT support for repairs and protect from potential misuse.
- Where health workers are expected to use their own mobile devices for work purposes:
  - ensure that this does not lead to any personal costs for them
  - ensure that organisational applications are compatible with these devices
  - develop systems and guidelines to ensure data privacy and security

The implementation considerations should also be guided by the Principles for Digital Development [https://digitalprinciples.org/], which include the following:

- Design with the User
- Understand the Existing Ecosystem
- Design for Scale
- Build for sustainability
- Be Data Driven
- Use Open Standards, Open Data, Open Source and Open Innovation
- Reuse and Improve
- Address Privacy & Security
- Be collaborative

(Following the guideline panel meeting we will consolidate and align implementation considerations with the appropriate frameworks)