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Mobile phone text messaging for improving the uptake of vaccinations: a systematic review protocol

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Mobile phone text messaging for improving the uptake of vaccinations: a systematic review protocol

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ABSTRACT

Background: Low vaccine coverage is a major public health concern, the consequences of which contribute to around 1.5 million child deaths from vaccine-preventable diseases. Thus, innovative strategies to rapidly increase coverage and recall rates for vaccinations are urgently required. Mobile text messaging (or short messaging service, SMS) has the potential to help increase vaccination coverage and therefore we propose to conduct a review of the current best evidence for the use of SMS as an intervention to promote vaccination coverage.

Methods/Design: This article describes the protocol for a systematic review of the effectiveness of SMS in improving the uptake of vaccination. Primary and secondary outcomes of interest are pre-specified. We will preferably include randomized controlled trials (RCTs). However, non-randomized studies (NRS) will be considered if there is an inadequate number of RCTs. We will search several bibliographic databases (for example PubMed, EMBASE, CINAHL, CENTRAL, Science Citation Index, Africa-Wide Information, and WHOLIS electronic databases and search sources for grey literature. Following data extraction and assessment of risk of bias, we will meta-analyze studies and conduct sub-group analyses, according to intervention subtypes. We will assess clinical heterogeneity and statistical heterogeneity. For outcomes without quantitative data, a descriptive analysis will be used.

Discussion: Our results can be used by researchers and policy-makers to help inform them of the efficacy of mobile phone text messaging interventions to promote increased vaccination coverage.

Strengths and limitations of this study

To our knowledge, this is the first systematic review protocol that will attempt to assess the
impact of mobile text messaging on promoting the uptake of vaccination amongst adults, adolescents and parents or caregivers of children.

This study will help inform clinical practice and future studies on the effectiveness of media platforms.

Non-randomised studies of low-quality evidence may be this study's limitation. We will, however, conduct appropriate analyses to assess the overall robustness of the results.

Background

Vaccinations, when given at the most sensitive developmental years of childhood, help to promote comprehensive and capable immunity, enabling children to fight off certain diseases [1 2]. In addition, vaccinations are widely regarded as one of the most cost-effective public health interventions that help to reduce global child morbidity and mortality [3 4]. Low coverage of vaccinations is a major public health concern. In Africa alone, more than seven million children did not receive the full spectrum of vaccinations recommended before reaching one year of age in 2009 [5]. It is also estimated that 1.5 million children died globally from vaccine-preventable diseases where World Health Organization (WHO) pre-qualified vaccines were available [6].

The Global Vaccine Action plan (GVAP) is the most recently launched global effort by the WHO to help increase vaccination coverage. The GVAP has set a target that by 2020 vaccination coverage for populations should reach 90% national vaccination coverage and at least 80% at district levels utilizing national vaccination programmes [7]. It is guided by six principles: country ownership, shared responsibility and partnership, equity, integration, sustainability, and innovation [8]

A variety of factors impact achieving low coverage rates; challenges such as immunisation awareness, demand for immunisation, level of trust in the health system, adequate human resources, access, timeliness of vaccinations, service delivery, poor infrastructure and vaccination monitoring [3]. Vaccination coverage seems to be lower in low-income households, where limited access to health education, contributes to poor

health-seeking behaviour along with an inability to improve general wellbeing [1 2 9]. Uneducated parents therefore are less likely to understand the importance of vaccinating to prevent potentially harmful diseases. In light of these obstacles to vaccination coverage, the strategy to improve vaccination coverage needs to be innovative as alluded to in the GVAP, well thought out and able to penetrate low income households effectively.

Globally, mobile phone use is rapidly increasing, with an estimated six billion mobile phone users worldwide at the end of 2011 [10]. In particular, mobile phone text messaging has gained popularity among people living in low- and middle-income countries and may be the key to penetrating hard to reach areas in the developing world. Text messaging has proven to be a cost effective method of relaying health information and reminders than the more traditional methods such as face to face, phone calls, pamphlets, mail and email [5]. As immunisation usually requires multiple consecutive monthly visits after the first vaccine dose in order to complete the schedule, short messaging service (SMS) can be used as reminder for an upcoming visit and recall when a visit has been missed [1]. In addition, an SMS intervention, also known as mobile phone text messaging, can be delivered alone or bundled with other interventions [11]. Diseases that have used mobile technology successfully include HIV where a 90% adherence was observed among text message recipients compared with a 40% adherence in the control group [12].

We therefore propose to conduct a systematic review of the current best evidence for the use of mobile phone text messaging to improve vaccination coverage.

Methods

The review protocol has not been registered in any prospective registers of systematic reviews.

Criteria for considering studies for this review

Type of studies

We will include randomized controlled trials (RCTs), interrupted time series and controlled before and after studies (CBA).

Types of participants

Participants will be adults, children or caregivers of those receiving vaccinations, in community-based settings.

Types of interventions

We will include interventions in which mobile phone text messages are used to promote uptake of vaccinations. The text messaging needs to be delivered to a person needing a vaccination, or in the case of an infant or child, to a caregiver. Eligible studies will be those that compared SMS to no intervention, or to other interventions for increasing vaccination coverage. If we find less than ten studies that include only SMS as the intervention, we will include studies in which mobile phone voice speaking or voice messaging are interventions; studies in which the use of a beeper or pager is the intervention; studies in which the use of multimedia messaging service is the

intervention; and studies in which text messages are bundled with other interventions. In such circumstances, we will stratify the analysis by type of intervention.

Types of outcome measures

Results must include quantitative data for outcomes measured.

Primary outcomes:

The primary outcome is vaccination coverage, irrespective of disease.

Secondary outcomes:

Secondary outcomes are the recall rate in persons who had previously missed their vaccinations.

Search methods for identification of studies

A comprehensive and exhaustive search will be performed by RK with the help of the University of Cape Town librarian, to identify all relevant studies available by 30 June 2013, regardless of language or publication status. We will search both peer-reviewed journal articles and grey literature (unpublished, internal or non-reviewed papers and reports).

Database

We will search the following electronic databases: PubMed; EMBASE; Cochrane Central Register of Controlled Trials (CENTRAL); ISI Web of Science (Science Citation Index); Africa-Wide Information, Cumulative Index of Nursing and Allied Health (CINAHL), and WHO library databases (WHOLIS). We will use both text words and medical subject

heading (MeSH) terms; for example vaccination*, immunization*, immunisation*, "Immunization"(MeSH), "Vaccination"(MeSH), "Immunization, Secondary"(MeSH) OR "Immunization Programs"(MeSH), "Immunization Schedule"(MeSH), "Mass Vaccination"(MeSH), mobile phone, text messaging, text*, SMS, reminder*, recall, telemedicine, mHealth, and eHealth. These terms will be used in varying combinations. The literature search strategy will be adapted to suit each database. Table 1 shows the main search strategy we will use.

Conference proceedings

We will search the following conference proceedings for relevant abstracts:. Vaccine and International Society for Vaccines Congress, International African Vaccinology Conference, Annual Vaccines Congress, Annual Conference on Vaccine Research, World Congress on Pediatric Infectious Diseases, International Pediatric Association Conference, National Immunization Conference, and the Annual Infectious Diseases in Children Symposium.

Searching other sources

For ongoing studies, we will search the WHO International Clinical trials Registry Platform, Clinicaltrials.gov, Pan African Clinical Trials Registry (PACTR), and contact individual researchers working in the field as well as the following organizations: WHO, Global Alliance for Vaccines and Immunisation, Centers for Disease Control and Prevention, and mHealth Alliance. We will also search the website of mHealth Alliance and mHealth in the Low Resource Settings resources database [20] for eligible studies.

Reference lists

We will obtain reference lists of relevant studies identified and the full-text articles reviewed for inclusion in the review will be checked for additional information.

Data collection and analysis

The methods for data collection and analysis will be based on the Cochrane Handbook of Systematic Reviews for Interventions [13].

Selection of studies

We will construct a screening guide to ensure that the inclusion criteria are adhered to and consistently applied by all review authors. Two review authors (RK and ME), working independently, will screen the titles and abstracts of all studies identified through the literature searches for eligibility. RK will obtain the full text of studies deemed potentially eligible. The two authors (RK and ME) will independently assess the full text of each article for eligibility, and compare their results and resolve discrepancies by discussion and consensus, consulting a third author (CW) to resolve any persistent disagreements. For all studies excluded by the assessors we will describe the reasons for exclusion.

Data extraction and management

References will be managed using Thomson ISI Research-Soft Endnote 9.0 [14]. Two authors will independently extract descriptive and outcome data for each included article using a standardized data collection form, resolving any discrepancies by

discussion and consensus; failing which, a third author (CW) will arbitrate. RK will enter the final data into the Cochrane Collaboration Review Manager Version 5.1 statistical software (http://ims.cochrane.org/RevMan). CW will crosscheck the data entered to ensure that there are no data entry errors.

Assessment of risk of bias in included studies

Two authors will independently assess the risk of bias in the included studies. Separate criteria will be used to assess RCTs and non-randomized studies. The criteria used to assess the risk of bias of in RCTs will be random sequence generation; allocation concealment; blinding of participants, study personnel; blinding of outcome assessors; incomplete outcome data; selective outcome reporting; other sources of bias, and overall risk of bias, in accordance with the methods used by the Cochrane Collaboration [13] as well as the Cochrane Consumers and Communication Review Group [15]. The criteria used for risk of bias assessment for non-randomized studies will include selection bias (with regard to comparability of groups, confounding and adjustment); performance bias (in terms of the fidelity of the interventions, and quality of the information regarding who received which interventions, including blinding of study subjects and healthcare providers); detection bias (regarding unbiased and correct assessment of outcomes, including blinding of assessors); attrition bias (with regard to completeness of sample, follow-up and data); and reporting bias (with regard to publication biases and selective reporting of results) [13]. Studies will be scored as having low, high or unclear risk of bias. The two authors will resolve disagreements in the assessment of risk of bias by discussion and consensus, consulting a third author to resolve any persistent disagreements.

Measures of treatment effect

Data analysis will be conducted using the Cochrane Collaboration Review Manager Version 5.1 statistical software (http://ims.cochrane.org/RevMan). The outcomes of interest will be either dichotomous or continuous. We will calculate risk ratios and their corresponding 95% confidence intervals and P-values for dichotomous outcomes, and mean differences for continuous outcomes.

Dealing with missing data

In cases of missing or incomplete information presented in the included studies, we shall contact authors for further information.

Data synthesis, assessment/investigation of heterogeneity

We will assess clinical heterogeneity by examining types of participants, interventions, and outcomes in each study. We will pool data only from studies judged to be clinically homogenous. Statistical heterogeneity in each meta-analysis will be assessed using the chi-square test and quantified using the I-squared statistic. If studies are sufficiently homogenous (in terms of study populations, interventions, and outcomes), then we will pool the data across studies and estimate summary effect sizes using a fixed-effects model. Otherwise, we will use the random-effects model. We will perform subgroup analyses by intervention subtypes: long versus short messages; daily versus weekly messages; short weekly messages versus long weekly messages; short daily messages versus long daily messages; and two-way interactive communication versus one-way communication [16] [12 17]. We will also stratify analysis by study design (randomized controlled separate from non-randomized studies) and intervention type (multiple

interventions involving text messaging separate from text messaging alone). Finally, we will use the grading of recommendations assessment, development, and evaluation (GRADE) approach [18] to assess the quality of evidence for the effectiveness of the SMS intervention. This method results in an assessment of the quality of the body of evidence as high, moderate, low, or very low. Evidence is considered of high quality if 'further research is very unlikely to change our confidence in the estimate of effect'; and moderate quality if 'further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate'. Low quality evidence implies that 'further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate', and very low quality that 'we have very little confidence in the effect estimate'.

Sensitivity analyses

Several sensitivity analyses will be performed: first to determine whether the study design (RCT versus nonrandomized study) could influence the results of the meta-analysis; second, to evaluate whether the model of the statistical method (random-effects vs fixed-effects model) could change the results, and third, to determine the impact of excluding studies with a high risk bias on the results, with emphasis on allocation concealment, blinded outcome assessment, and losses to follow-up (with a cut off of 25% loss to follow-up).

Presenting and reporting of results

Findings in our systematic review will be presented in several ways. Flow diagrams will be used to summarise the study selection process. Funnel plots will be used to assess

publication bias if we identify 10 or more eligible studies. The kappa statistic [19] will be used to assess agreements between the full-text screening, data extraction and risk of bias assessment by the two authors (RK and ME). GRADE summary of tables of findings, risk of bias tables or graphs, and forest plots will also be used where appropriate. The reporting of outcomes without quantitative data will be descriptive. Lastly, we will provide a list of excluded studies with reasons for exclusion.

Ethics

Systematic reviews draw on publicly available data and do not directly involve human subjects, and therefore do not require formal ethical review [20]. The study protocol will be reviewed by supervisors with expertise in methodology (systematic review) and submitted to the University of Cape Town Departmental Research Committee for approval.

Discussion

Expected significance of the study

The findings of this systematic review will have implications for policy, practice and research. We will discussed the relevance of our findings to childhood immunisation programmes in Africa in the decade of vaccines with emphasis on applicability, effects on equity, cost implications, and monitoring and evaluation.

Our systematic review will provide evidence of whether policy-makers can adopt mobile phone text messaging alone or in combination with other interventions in efforts to improve uptake of vaccines in national immunisation programmes. It will also inform clinic or hospital managers of how best to use the intervention to improve vaccination coverage. The systematic review may also identify specific considerations that would needs to be taken into account for future studies, such as study location, content and timing of messages, whether or not parents or caregivers replied to text messages, how text messages were sent (automated versus manual), indicators for immunisation programmes, variety of text messages sent (inclusion of jokes or lifestyle tips), duration of the study, whether or not participants were provided with the mobile handsets, and sample size [21].

Abbreviations

WHO: World Health Organization; GVAP: Global Vaccine Action plan; SMS: Short messaging service; RCT: Randomized Controlled Trials; CBA: Controlled Before and After study; MeSH: medical subject heading;.

Contributorship Statement

RK and ME drafted the protocol.

CW conceived of the review.

All authors developed the design of the protocol and will be involved in data acquisition.

All authors have given their approval for publication of the protocol

Competing Interests

None

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Table 1. PubMed search strategy, modified as needed for use in other databases

Search	PubMed
#1	(immunization[Mesh]) OR ((immunis* OR immuniz* OR vaccin*)
#2	(adolescents OR children OR teenagers)
#3	"SMS" OR cellphone OR "mobile phone" OR "text messaging" OR "short message service" OR "text reminder"
#4	#1 AND #2
#5	#3 AND #4

MeSH, medical subject heading

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ABSTRACT

Introduction: Low vaccine coverage is a major public health concern, the consequences of which contribute to around 1.5 million child deaths from vaccine-preventable diseases. Thus, innovative strategies to rapidly increase coverage and recall rates for vaccinations are urgently required. Mobile text messaging (or short messaging service, SMS) has the potential to help increase vaccination coverage and therefore we propose to conduct a review of the current best evidence for the use of SMS as an intervention to promote vaccination coverage.

Methods and Analysis: This article describes the protocol for a systematic review of the effectiveness of SMS in improving the uptake of vaccination. Primary and secondary outcomes of interest are pre-specified. We will preferably include randomized controlled trials (RCTs). However, non-randomized studies (NRS) will be considered if there is an inadequate number of RCTs. We will search several bibliographic databases (for example PubMed, EMBASE, CINAHL, CENTRAL, Science Citation Index, Africa-Wide Information, and WHOLIS electronic databases and search sources for grey literature. Following data extraction and assessment of risk of bias, we will meta-analyze studies and conduct sub-group analyses, according to intervention subtypes. We will assess clinical heterogeneity and statistical heterogeneity. For outcomes without quantitative data, a descriptive analysis will be used. This review protocol is registered in the PROSPERO International Prospective Register of systematic reviews, registration number 2014:CRD42014007531

Ethics and dissemination: Ethics is not required for this study, given that this is a protocol for a systematic review, which uses published data. This findings of this study will be disseminated through peer-reviewed publications and conference presentations. We anticipate that the results could be used by researchers and policy-makers to help inform them of the efficacy of mobile phone text messaging interventions to promote increased vaccination coverage.

Strengths and limitations of this study

- To our knowledge, this is the first systematic review protocol that will attempt to assess the impact of mobile text messaging on promoting the uptake of vaccination amongst adults, adolescents and parents or caregivers of children.
- This study will help inform clinical practice and future studies on the effectiveness of media platforms.
- Non-randomised studies of low-quality evidence may be this study's limitation. We will, however, conduct appropriate analyses to assess the overall robustness of the results.

Introduction

Vaccinations, when given at the most sensitive developmental years of childhood, help to promote comprehensive and capable immunity, enabling children to fight off certain diseases [1 2]. In addition, vaccinations are widely regarded as one of the most cost-effective public health interventions that help to reduce global child morbidity and mortality [3 4]. Low coverage of vaccinations is a major public health concern. In Africa alone, more than seven million children did not receive the full spectrum of vaccinations recommended before reaching one year of age in 2009 [5]. It is also estimated that 1.5 million children died globally from vaccine-preventable diseases where World Health Organization (WHO) pre-qualified vaccines were available [6].

The Global Vaccine Action plan (GVAP) is the most recently launched global effort by the WHO to help increase vaccination coverage. The GVAP has set a target that by 2020 vaccination coverage for populations should reach 90% national vaccination coverage and at least 80% at district levels utilizing national vaccination programmes [7]. It is guided by six principles: country ownership, shared responsibility and partnership, equity, integration, sustainability, and innovation [8]

A variety of factors impact achieving low coverage rates; challenges such as immunisation awareness, demand for immunisation, level of trust in the health system, adequate human resources, access, timeliness of vaccinations, service delivery, poor infrastructure and vaccination monitoring [4]. Vaccination coverage seems to be lower in low-income households, where limited access to health education, contributes to poor

health-seeking behaviour along with an inability to improve general wellbeing [1 2 9]. Uneducated parents therefore are less likely to understand the importance of vaccinating to prevent potentially harmful diseases. In light of these obstacles to vaccination coverage, the strategy to improve vaccination coverage needs to be innovative as alluded to in the GVAP, well thought out and able to penetrate low income households effectively.

Globally, mobile phone use is rapidly increasing, with an estimated six billion mobile phone users worldwide at the end of 2011 [10]. In particular, mobile phone text messaging has gained popularity among people living in low- and middle-income countries and may be the key to penetrating hard to reach areas in the developing world. Text messaging has proven to be a cost effective method of relaying health information and reminders than the more traditional methods such as face-to-face, phone calls, pamphlets, mail and email [5]. As immunisation usually requires multiple consecutive monthly visits after the first vaccine dose in order to complete the schedule, short messaging service (SMS) can be used as reminder for an upcoming visit and recall when a visit has been missed [1]. In addition, an SMS intervention, also known as mobile phone text messaging, can be delivered alone or bundled with other interventions [11] . Diseases that have used mobile technology successfully include HIV where a 90% adherence was observed among text message recipients compared with a 40% adherence in the control group [12]. We therefore propose to conduct a systematic review of the current best evidence for the use of mobile phone text messaging to improve vaccination coverage.

Methods

This review protocol has been published in the PROSPERO International Prospective Register of systematic reviews (http://www.crd.york.ac.uk/PROSPERO), registration number 2014:CRD42014007531.

Criteria for considering studies for this review

Type of studies

We will include randomized controlled trials (RCTs), interrupted time series and controlled before and after studies (CBA).

Types of participants

Participants will be caregivers of infants or children, adolescents and adults including pregnant women drawn from any setting, community-based or otherwise.

Types of interventions

We will include interventions in which mobile phone text messages serve as a reminder to be vaccinated, as educational information or, as information regarding vaccine availability at the clinic in an attempt to promote uptake of vaccinations. Vaccinations could include routine infant immunisations, those against human papilloma virus, influenza, meningococcal (MCV4) or tetanus/diptheria/accellular pertussis (Tdap). Eligible studies will be those that compared SMS to no intervention, or to other interventions for increasing vaccination coverage. If we find less than ten studies that include only SMS as the intervention, we will include studies in which mobile phone voice speaking or voice messaging are

interventions; studies in which the use of a beeper or pager is the intervention; studies in which the use of multimedia messaging service is the intervention; and studies in which text messages are bundled with other interventions. In such circumstances, we will stratify the analysis by type of intervention.

Types of outcome measures

Results must include quantitative data for outcomes measured.

Primary outcomes:

The primary outcome is vaccination coverage, irrespective of disease. We will use the definition of vaccine coverage as stipulated by the respective authors.

Secondary outcomes:

Secondary outcomes are the recall rate in persons who had previously missed their vaccinations, scheduled appointments for vaccination or completeness of vaccination records.

Search methods for identification of studies

A comprehensive and exhaustive search of databases and conference proceedings will be performed by RK with the help of the University of Cape Town librarian, to identify all relevant studies available by 30 June 2014, regardless of language or publication status. We will search both peer-reviewed journal articles and grey literature (unpublished, internal or non-reviewed papers and reports).

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We will search the following electronic databases: PubMed; EMBASE; Cochrane Central Register of Controlled Trials (CENTRAL); ISI Web of Science (Science Citation Index); Africa-Wide Information, Cumulative Index of Nursing and Allied Health (CINAHL), and WHO library databases (WHOLIS). We will use both text words and medical subject heading (MeSH) terms; for example vaccination*, immunization*, immunisation*, "Immunization"(MeSH), "Vaccination"(MeSH), "Immunization, Secondary"(MeSH) OR "Immunization Programs"(MeSH), "Immunization Schedule"(MeSH), "Mass Vaccination"(MeSH), mobile phone, text messaging, text*, SMS, reminder*, recall, telemedicine, mHealth, and eHealth. These terms will be used in varying combinations. The literature search strategy will be adapted to suit each database. Table 1 shows the main search strategy we will use.

Conference proceedings

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Searching other sources

For ongoing studies, we will search the WHO International Clinical trials Registry Platform, Clinicaltrials.gov, Pan African Clinical Trials Registry (PACTR), and contact individual researchers working in the field as well as the following organizations: WHO,

Global Alliance for Vaccines and Immunisation, Centers for Disease Control and Prevention, and mHealth Alliance. We will also search the website of mHealth Alliance and mHealth in the Low Resource Settings resources database for eligible studies.

Reference lists

We will obtain reference lists of relevant studies identified and the full-text articles reviewed for inclusion in the review will be checked for additional information.

Data collection and analysis

The methods for data collection and analysis will be based on the Cochrane Handbook of Systematic Reviews for Interventions [13].

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Two authors will independently assess the risk of bias in the included studies. Separate criteria will be used to assess RCTs and non-randomized studies. The criteria used to assess the risk of bias of in RCTs will be random sequence generation; allocation concealment; blinding of participants, study personnel; blinding of outcome assessors; incomplete outcome data; selective outcome reporting; other sources of bias, and overall risk of bias, in accordance with the methods used by the Cochrane Collaboration [13] as well as the Cochrane Consumers and Communication Review Group[14]. The criteria used for risk of bias assessment for non-randomized studies will include selection bias (with regard to comparability of groups, confounding and adjustment); performance bias (in terms of the fidelity of the interventions, and quality of the information regarding who received which interventions, including blinding of study subjects and healthcare providers); detection bias (regarding unbiased and correct assessment of outcomes, including blinding of assessors); attrition bias (with regard to completeness of sample, follow-up and data); and reporting bias (with regard to publication biases and selective reporting of results) [13]. Studies will be scored as having low, high or unclear risk of bias. The two authors will resolve disagreements in the assessment of risk of bias by discussion and consensus, consulting a third author to resolve any persistent disagreements.

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We will assess clinical heterogeneity by examining types of participants, interventions, and outcomes in each study. We will pool data only from studies judged to be clinically homogenous. Statistical heterogeneity in each meta-analysis will be assessed using the chi-square test and quantified using the I-squared statistic [17] . If studies are sufficiently homogenous (in terms of study populations, interventions, and outcomes), then we will pool the data across studies and estimate summary effect sizes using a fixed-effects model. Otherwise, we will use the random-effects model. Should heterogeneity remain significant, we will discuss the findings as a narrative summary.

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Finally, we will use the grading of recommendations assessment, development, and evaluation (GRADE) approach [20] to assess the quality of evidence for the effectiveness of the SMS intervention. This method results in an assessment of the quality of the body of evidence as high, moderate, low, or very low. Evidence is considered of high quality if 'further research is very unlikely to change our confidence in the estimate of effect'; and moderate quality if 'further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate'. Low quality evidence implies that 'further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate', and very low quality that 'we have very little confidence in the effect estimate'.

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Several sensitivity analyses will be performed: first to determine whether the study design (RCT versus nonrandomized study) could influence the results of the meta-

analysis; second, to evaluate whether the model of the statistical method (random-effects vs fixed-effects model) could change the results, and third, to determine the impact of excluding studies with a high risk bias on the results, with emphasis on allocation concealment, blinded outcome assessment, and losses to follow-up (with a cut off of 25% loss to follow-up).

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Findings in our systematic review will be presented in several ways. Flow diagrams will be used to summarise the study selection process. Funnel plots will be used to assess publication bias if we identify 10 or more eligible studies. The kappa statistic [21] will be used to assess agreements between the full-text screening, data extraction and risk of bias assessment by the two authors (RK and ME). GRADE summary of tables of findings, risk of bias tables or graphs, and forest plots will also be used where appropriate. The reporting of outcomes without quantitative data will be descriptive. Lastly, we will provide a list of excluded studies with reasons for exclusion.

Ethics and dissemination

Systematic reviews draw on publicly available data and do not directly involve human subjects, and therefore do not require formal ethical review [22]. The study protocol will be reviewed by supervisors with expertise in methodology (systematic review) and submitted to the University of Cape Town Departmental Research Committee for approval.

The findings of this systematic review will have implications for policy, practice and research. We will discuss the relevance of our findings to childhood immunisation programmes in Africa in the decade of vaccines with emphasis on applicability, effects on equity, cost implications, and monitoring and evaluation. Our systematic review will provide evidence of whether policy-makers can adopt mobile phone text messaging alone or in combination with other interventions in efforts to improve uptake of vaccines in national immunisation programmes. It will also inform clinic or hospital managers of how best to use the intervention to improve vaccination coverage. The systematic review may also identify specific considerations that would needs to be taken into account for future studies, such as study location, content and timing of messages, whether or not parents or caregivers replied to text messages, how text messages were sent (automated versus manual), indicators for immunisation programmes, variety of text messages sent (inclusion of jokes or lifestyle tips), duration of the study, whether or not participants were provided with the mobile handsets, and sample size [23].

Abbreviations

WHO: World Health Organization; GVAP: Global Vaccine Action plan; SMS: Short messaging service; RCT: Randomized Controlled Trials; CBA: Controlled Before and After study; MeSH: medical subject heading;.

Acknowledgements

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Contributionship statement

Robyn Kalan, BSc (Hons) Nursing is a research fellow. Tshepiso Ramafuthole, Kurt Allie and Fatima Ebrahim are MBChB students. Mark Engel, MPH, PhD and Charles Wiysonge, MD, PhD are senior researchers.

CW, TR, KA, and FE conceived of the review. All authors developed the design of the protocol and will be involved in data acquisition. RK undertook the drafting of the manuscript. RK and ME will analyze the data and participate in the interpretation of the results. All authors have given their approval for publication.

Competing interests

The authors declare that they have no competing interests.

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Table 1. PubMed search strategy, modified as needed for use in other databases

Search	PubMed
#1	(immunization[Mesh]) OR ((immunis* OR immuniz* OR vaccin*)
#2	(adolescents OR children OR teenagers)
#3	"SMS" OR cellphone OR "mobile phone" OR "text messaging" OR "short message service" OR "text reminder"
#4	#1 AND #2
#5	#3 AND #4

MeSH, medical subject heading

Mobile phone text messaging for improving the uptake of vaccinations: a systematic review protocol

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Keywords: Vaccine coverage, vaccination, Mobile text messaging, short messaging service, SMS

Word Count: 2424

ABSTRACT

~~Background~~Introduction: Low vaccine coverage is a major public health concern, the consequences of which contribute to around 1.5 million child deaths from vaccine-preventable diseases. Thus, innovative strategies to rapidly increase coverage and recall rates for vaccinations are urgently required. Mobile text messaging (or short messaging service, SMS) has the potential to help increase vaccination coverage and therefore we propose to conduct a review of the current best evidence for the use of SMS as an intervention to promote vaccination coverage.

Methods and Analysis~~/Design~~: This article describes the protocol for a systematic review of the effectiveness of SMS in improving the uptake of vaccination. Primary and secondary outcomes of interest are pre-specified. We will preferably include randomized controlled trials (RCTs). However, non-randomized studies (NRS) will be considered if there is an inadequate number of RCTs. We will search several bibliographic databases (for example PubMed, EMBASE, CINAHL, CENTRAL, Science Citation Index, Africa-Wide Information, and WHOLIS electronic databases and search sources for grey literature. Following data extraction and assessment of risk of bias, we will meta-analyze studies and conduct sub-group analyses, according to intervention subtypes. We will assess clinical heterogeneity and statistical heterogeneity. For outcomes without quantitative data, a descriptive analysis will be used. This review protocol is registered in the PROSPERO International Prospective Register of systematic reviews, registration number 2014:CRD42014007531

~~Discussion~~**Ethics and dissemination**: Ethics is not required for this study, given that this is a protocol for a systematic review, which uses published data. This findings of this study will be disseminated through peer-reviewed publications and conference presentations. We anticipate that the ~~Our~~ results could ~~can~~ be used by researchers and policy-makers to help inform them of the efficacy of mobile phone text messaging interventions to promote increased vaccination coverage.

Strengths and limitations of this study

- To our knowledge, this is the first systematic review protocol that will attempt to assess the impact of mobile text messaging on promoting the uptake of vaccination amongst adults, adolescents and parents or caregivers of children.
- This study will help inform clinical practice and future studies on the effectiveness of media platforms.
- Non-randomised studies of low-quality evidence may be this study's limitation. We will, however, conduct appropriate analyses to assess the overall robustness of the results.

~~Background~~Introduction

Vaccinations, when given at the most sensitive developmental years of childhood, help to promote comprehensive and capable immunity, enabling children to fight off certain diseases [1 2]. In addition, vaccinations are widely regarded as one of the most cost-effective public health interventions that help to reduce global child morbidity and mortality [3 4]. Low coverage of vaccinations is a major public health concern. In Africa alone, more than seven million children did not receive the full spectrum of vaccinations recommended before reaching one year of age in 2009 [5]. It is also estimated that 1.5 million children died globally from vaccine-preventable diseases where World Health Organization (WHO) pre-qualified vaccines were available [6].

The Global Vaccine Action plan (GVAP) is the most recently launched global effort by the WHO to help increase vaccination coverage. The GVAP has set a target that by 2020 vaccination coverage for populations should reach 90% national vaccination coverage and at least 80% at district levels utilizing national vaccination programmes [7]. It is guided by six principles: country ownership, shared responsibility and partnership, equity, integration, sustainability, and innovation [8]

A variety of factors impact achieving low coverage rates; challenges such as immunisation awareness, demand for immunisation, level of trust in the health system, adequate human resources, access, timeliness of vaccinations, service delivery, poor infrastructure and vaccination monitoring [4]. Vaccination coverage seems to be lower in low-income households, where limited access to health education, contributes to poor

health-seeking behaviour along with an inability to improve general wellbeing [1 2 9]. Uneducated parents therefore are less likely to understand the importance of vaccinating to prevent potentially harmful diseases. In light of these obstacles to vaccination coverage, the strategy to improve vaccination coverage needs to be innovative as alluded to in the GVAP, well thought out and able to penetrate low income households effectively.

Globally, mobile phone use is rapidly increasing, with an estimated six billion mobile phone users worldwide at the end of 2011 [10]. In particular, mobile phone text messaging has gained popularity among people living in low- and middle-income countries and may be the key to penetrating hard to reach areas in the developing world. Text messaging has proven to be a cost effective method of relaying health information and reminders than the more traditional methods such as face-to-face, phone calls, pamphlets, mail and email [5]. As immunisation usually requires multiple consecutive monthly visits after the first vaccine dose in order to complete the schedule, short messaging service (SMS) can be used as reminder for an upcoming visit and recall when a visit has been missed [1]. In addition, an SMS intervention, also known as mobile phone text messaging, can be delivered alone or bundled with other interventions [11] . Diseases that have used mobile technology successfully include HIV where a 90% adherence was observed among text message recipients compared with a 40% adherence in the control group [12]. We therefore propose to conduct a systematic review of the current best evidence for the use of mobile phone text messaging to improve vaccination coverage.

Methods

This review protocol has been published in the PROSPERO International Prospective Register of systematic reviews (http://www.crd.york.ac.uk/PROSPERO), registration number 2014:CRD42014007531.

Criteria for considering studies for this review

Type of studies

We will include randomized controlled trials (RCTs), interrupted time series and controlled before and after studies (CBA).

Types of participants

Participants will be caregivers of infants or children, adolescents and adults including pregnant women drawn from any setting, community-based or otherwise.

~~Participants will be adults, children or caregivers of those receiving vaccinations, in community-based settings.~~

Types of interventions

We will include interventions in which mobile phone text messages serve as a reminder to be vaccinated, as educational information or, as information regarding vaccine availability at the clinic in an attempt ~~are used~~ to promote uptake of vaccinations. Vaccinations could include routine infant immunisations, those against human papilloma virus, influenza, meningococcal (MCV4) or tetanus/diptheria/accellular pertussis (Tdap). ~~The text messaging needs to be delivered to a person needing a vaccination, or in the case of an infant or~~

~~child, to a caregiver.~~ Eligible studies will be those that compared SMS to no intervention, or to other interventions for increasing vaccination coverage. If we find less than ten studies that include only SMS as the intervention, we will include studies in which mobile phone voice speaking or voice messaging are interventions; studies in which the use of a beeper or pager is the intervention; studies in which the use of multimedia messaging service is the intervention; and studies in which text messages are bundled with other interventions. In such circumstances, we will stratify the analysis by type of intervention.

Types of outcome measures

Results must include quantitative data for outcomes measured.

Primary outcomes:

The primary outcome is vaccination coverage, irrespective of disease. We will use the definition of vaccine coverage as stipulated by the respective authors.

Secondary outcomes:

Secondary outcomes are the recall rate in persons who had previously missed their vaccinations, scheduled appointments for vaccination or completeness of vaccination records.

Search methods for identification of studies

A comprehensive and exhaustive search of databases and conference proceedings will be performed by RK with the help of the University of Cape Town librarian, to identify all relevant studies available by ~~30 June 2013~~30 June 2014, regardless of language or

publication status. We will search both peer-reviewed journal articles and grey literature (unpublished, internal or non-reviewed papers and reports).

Database

We will search the following electronic databases: PubMed; EMBASE; Cochrane Central Register of Controlled Trials (CENTRAL); ISI Web of Science (Science Citation Index); Africa-Wide Information, Cumulative Index of Nursing and Allied Health (CINAHL), and WHO library databases (WHOLIS). We will use both text words and medical subject heading (MeSH) terms; for example vaccination*, immunization*, immunisation*, "Immunization"(MeSH), "Vaccination"(MeSH), "Immunization, Secondary"(MeSH) OR "Immunization Programs"(MeSH), "Immunization Schedule"(MeSH), "Mass Vaccination"(MeSH), mobile phone, text messaging, text*, SMS, reminder*, recall, telemedicine, mHealth, and eHealth. These terms will be used in varying combinations. The literature search strategy will be adapted to suit each database. Table 1 shows the main search strategy we will use.

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~~***Dealing with missing data***~~

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~~Presenting and r~~Reporting of ~~results~~this review

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~~Discussion~~

~~*Expected significance of the study*~~

The findings of this systematic review will have implications for policy, practice and research. We will discussed the relevance of our findings to childhood immunisation programmes in Africa in the decade of vaccines with emphasis on applicability, effects on equity, cost implications, and monitoring and evaluation. Our systematic review will provide evidence of whether policy-makers can adopt mobile phone text messaging alone or in combination with other interventions in efforts to improve uptake of vaccines in national immunisation programmes. It will also inform clinic or hospital managers of how best to use the intervention to improve vaccination coverage. The systematic review may also identify specific considerations that would needs to be taken into account for future studies, such as study location, content and timing of messages, whether or not parents or caregivers replied to text messages, how text messages were sent (automated versus manual), indicators for immunisation programmes, variety of text messages sent (inclusion of jokes or lifestyle tips), duration of the study, whether or not participants were provided with the mobile handsets, and sample size [23].

Abbreviations

WHO: World Health Organization; GVAP: Global Vaccine Action plan; SMS: Short messaging service; RCT: Randomized Controlled Trials; CBA: Controlled Before and After study; MeSH: medical subject heading;.

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~~Author's c~~Contributions~~hip statement~~

Robyn Kalan, BSc (Hons) Nursing is a research fellow. Tshepiso Ramafuthole, Kurt Allie and Fatima Ebrahim are MBChB students. Mark Engel, MPH, PhD and Charles Wiysonge, MD, PhD are senior researchers.

CW, TR, KA, and FE conceived of the review. All authors developed the design of the protocol and will be involved in data acquisition. RK undertook the drafting of the manuscript. RK and ME will analyze the data and participate in the interpretation of the results. All authors have given their approval for publication.

Competing interests

The authors declare that they have no competing interests.

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Table 1. PubMed search strategy, modified as needed for use in other databases

Search	PubMed
#1	(immunization[Mesh]) OR ((immunis* OR immuniz* OR vaccin*)
#2	(adolescents OR children OR teenagers)
#3	"SMS" OR cellphone OR "mobile phone" OR "text messaging" OR "short message service" OR "text reminder"
#4	#1 AND #2
#5	#3 AND #4

MeSH, medical subject heading