Shortening the Time to Bring Evidence into Practice: Dissemination of Research Findings Using On-Line Videos

Junko Kiriya

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Department of Population Health

Faculty of Epidemiology and Population Health

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NAME IN FULL (Block Capitals): Junko Kiriya

STUDENT ID NO: 289950

SIGNED: 

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ABSTRACT OF THESES

NAME IN FULL (Block Capitals): JUNKO KIRIYA

STUDENT ID NO: 289950

TITLE OF THESIS: Shortening the Time to Bring Evidence into Practice - Dissemination of Research Findings Using On-Line Videos

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Abstract

Background

Research findings that have global impact need to be disseminated fast worldwide. A systematic review of dissemination methods found a small number of studies whose study quality was poor and which did not provide strong evidence. On-line videos have become one of the major information sharing methods. In a cross-sectional study of on-line videos, emotional content appeared to be associated with high view counts. However, the confidence interval was broad and there was a chance of confounding. Therefore, I examined the effectiveness of emotional content in an on-line video on the extent to which the video was shared.

Methods

I conducted a two arm randomised controlled trial. I created two videos one of which was more emotional. Outcome was video sharing. Participants were researchers and health care professionals in midwifery, obstetrics and gynaecology. An independent statistician

generated a random allocation sequence using a computer programme (1:1 allocation). I sent an invitation e-mail with a link to the video to participants and asked them to watch the video and share it if they found it helpful. The data were collected for 14 days after the e-mail was sent. The person who assessed the outcome and analysed data was masked to intervention allocation.

Results

8353 participants, 4178 in the intervention group and 4175 in the control group, were included. 221 participants (5.3%) watched the intervention video and 215 participants (5.2%) watched the control video. Of those who were randomised to the intervention video, 44 (1.1%) participants shared it and 37 (0.9%) of the participants randomised to the control video shared it (RR 1.2 [95%CI 0.8 to 1.8], p=0.44).

Conclusion

The results were imprecise as the number of outcome events was low. The results, albeit imprecise, showed that there was no strong evidence for the effectiveness of emotional content on on-line video sharing.

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Introduction to thesis

Even when results from clinical trials show convincingly that a treatment reduces the risk of an adverse health outcome, it can take many years before the results are applied in clinical practice. Balas and Boren estimate that it takes about 17 years for research findings to be introduced into medical practice[1]. In their review of studies quantifying the time lags in the health research translation process, Morris et al. show that the average time lag is a decade and it could be a few decades[2]. Because of this long delay, patients are denied effective treatments and may be exposed to ineffective or harmful treatments. There is an urgent need to reduce the delay in using research results.

The first stage in bringing evidence into practice is effective dissemination. Although knowing about an effective health care intervention does not mean that it will be used, it will not be used if health professionals have never heard about it. Effective dissemination is necessary but not sufficient for implementation. This thesis aims to identify effective strategies for the global dissemination of research findings.

Chapter 1 illustrates the importance of effective dissemination using a case study of the results of the CRASH-2 clinical trial. The CRASH-2 trial was a randomised controlled trial of the effect of the anti-fibrinolytic tranexamic acid (TXA) on death and vascular occlusive events in bleeding trauma patients. A total of 20,211 adult trauma patients with significant bleeding, who were within 8 hours of their injury, were randomly allocated to receive TXA

or matching placebo. TXA significantly reduced death due to bleeding (RR=0.85, 95%CI 0.76 to 0.96) and all-cause mortality (RR=0.91, 95%CI 0.85 to 0.97), with no increase in vascular occlusive events. In chapter 1, I estimated the number of premature deaths that can be prevented each year if health professionals working in trauma care world-wide used TXA in their daily practice.

Chapter 2 explores methods that have been used for dissemination. A literature review was conducted and more than 40 methods were identified. These methods were categorised into two: direct (face-to-face) communication and indirect communication. Direct communication includes strategies such as educational outreach and local opinion leaders. Indirect communication includes using social media such as newspapers and on-line tools such as websites.

Chapter 3 presents a systematic review which examined the effectiveness of the existing dissemination methods identified in chapter 2. It found that there were few randomised controlled trials (RCTs) that evaluated the traditional and new dissemination approaches such as educational outreach and on-line contents. In addition, the quality of the RCTs included in the review was poor and the effect of the conventional dissemination methods that these studies presented was uncertain. The existing long time lag between the production of research evidence and its use in practice indicate that new methods are required for the rapid global dissemination of results.

Practitioners often adopt new treatments based on the information that are shared through their networks[3]. Therefore, information sharing could be one of the best ways to achieve efficient dissemination and implementation of research findings. Recently, on-line videos are being used as a new information sharing tool. With short videos, practitioners understand the summary of research findings quickly and share the videos with their colleagues on-line. Creating short videos about research findings and sending them to practitioners may contribute to efficient dissemination. Therefore, from chapter 4, this thesis focuses on on-line videos as a new dissemination tool.

Chapter 4 explores what kind of videos are more likely to be shared. A cross-sectional study was conducted to examine the association between factors in on-line videos and the number of views of the videos. The result showed that emotional content is associated with view counts and it could double the view counts. However, the possible effect varied widely and it was not sure how much emotional content can affect view counts.

Given the result of the cross-sectional study in chapter 4, the effect of emotional content in an on-line video on its sharing was examined. Two short videos that are identical apart from the intervention, emotional content, were made and sent to doctors. Forwarding rate of each video was compared. Chapter 5 presents a pilot RCT to test the effect of emotional content on video forwarding, and chapter 6 presents the main RCT, the DIFFUSION (DIsseminating Findings Fast USIng ON-line videos) trial.

Finally, chapter 7 integrates the results of all studies in this thesis considering the current situation regarding dissemination methods. Based on the effect of emotional content that RCTs in this thesis found, it discusses the prospect for on-line videos as a new tool for the dissemination of research findings among health professionals.

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1 Why is dissemination important? Estimation of the number of avoidable deaths with tranexamic acid use based on results from the CRASH-2 trial

1.1 Introduction

Because of the long time lag between the publication of clinical trial results and their implementation in clinical care, patients may be denied effective treatments or may be exposed to ineffective or harmful treatments. This chapter examines the public health importance of early introduction of research findings into medical practice, using as a case study, an assessment of the impact of giving tranexamic acid to bleeding trauma patients.

1.1.1 Current situation regarding traumatic death

World-wide, more than 5 million people die as a result of injury every year[1]. Injuries account for 9% of total deaths, which is more than AIDS, malaria and tuberculosis combined[2]. The leading causes of injury vary from country to country. Road traffic crash is one of the top ten causes of death accounting for 2.1% of global mortality[3]. More than 90% of these road deaths occur in low and middle-income countries. Intentional injuries, nearly half of which are due to interpersonal violence and war, are also major causes of injury fatalities. These types of violence are strongly related to poverty and poor political governance[4]. Hence, low and middle-income countries are apt to have high fatalities attributed to violence. Overall, these countries are at higher risk of trauma mortality than other countries.

The number of traumatic deaths, especially those due to road traffic crashes, is expected to increase over the next few decades[5]. Even though there is an urgent need to implement effective road safety intervention, prevention is not the only way to reduce trauma deaths. Improvement in trauma treatment could also have an important impact on the reduction of trauma deaths.

1.1.2 Tranexamic acid and the CRASH-2 trial

Haemorrhage is the second leading cause of trauma death after central nervous system (CNS) injuries and accounts for 30-40% of all injury deaths. Although haemorrhage accounts for a smaller proportion of traumatic deaths than CNS injuries, it may be "more amenable to interventions to reduce mortality and morbidity" than CNS injuries[6].

The CRASH-2 trial was an international randomised controlled trial (RCT) to assess the effects of tranexamic acid (TXA) on death due to traumatic bleeding. It included 20,211 patients with traumatic haemorrhage enrolled in 274 hospitals in 40 countries[7]. TXA is an anti-fibrinolytic, which helps blood clotting[7,8]. The CRASH-2 showed that if given within an hour of injury, TXA reduces the risk of death due to bleeding by 32% (relative risk 0.68, 95%CI 0.57-0.82). If given within three hours of injury, TXA reduces the risk of death by 21% (RR 0.79, 95%CI 0.64-0.97)[9]. There was no evidence of any increased risk of fatal or non-fatal vascular occlusive events with TXA[7]. TXA is a cheap generic drug available worldwide and can be a highly cost effective intervention if introduced in low, middle and high-income countries[10]. Considering low and middle-income countries have high trauma mortality, this

cheap, safe and easy-to-use drug could make a huge difference in the number of premature deaths due to traumatic haemorrhage. Therefore, introducing TXA into medical practice is an urgent matter.

1.1.3 Aim and objectives

To quantify the benefit from early introduction of research findings. The results of the CRASH-2 trial will be used to estimate the number of premature deaths that might be averted both globally and in each country by using TXA for traumatic haemorrhage treatment, and to identify the countries where the largest number of premature deaths can be prevented by using this treatment.

1.2 Methods

1.2.1 Estimation model

I assumed that treatment with TXA can affect only patients who had haemorrhagic trauma and survived to reach hospitals to receive the treatment. In order to estimate this population, the number of traumatic deaths due to bleeding (N_B) was required. Since the proportion of haemorrhage differs depending on the mechanism of injury[11], I calculated the number of haemorrhagic deaths in blunt trauma and penetrating trauma separately. Firstly, I obtained the number of deaths from blunt trauma (N_{BT}) and penetrating trauma (N_{PT}). Secondly, I estimated the contribution of bleeding among blunt ($P_{B,BT}$) and penetrating ($P_{B,PT}$) trauma deaths and applied them to the numbers obtained as follows:

$$N_B = N_{BT} \times P_{B,BT} + N_{PT} \times P_{B,PT}$$

Thirdly, I estimated the proportion of in-hospital deaths (P_H). The number of in-hospital deaths attributed to traumatic bleeding (N_{HB}) was then computed based on the following equation:

$$N_{HB} = N_B \times P_H$$

In order to calculate the total number of premature deaths that can be averted, I applied the relative risk reduction of death with TXA ($1\text{-}RR_{TXA}$) from the CRASH-2 results to the number of in-hospital deaths due to traumatic bleeding as follows:

$$\text{Premature death averted} = N_{HB} \times (1\text{-}RR_{TXA})$$

The relative risk of death with TXA changes according to the time of treatment initiation[9]. Therefore, I applied two different relative risks: within one hour (0.68) and three hours

(0.72). I then ranked countries according to the number of premature deaths that can be averted. Regarding the top country, independent estimation was conducted using more specific variables of the country.

1.2.2 Source of data

The numbers of deaths from blunt trauma (N_{BT}) and penetrating trauma (N_{PT}) were obtained from death estimates in 2008 by WHO. I excluded three (poisoning, fire and drowning) out of nine injury categories of the estimates because they were irrelevant to bleeding (Table 1.1). I categorised road traffic accidents, falls and other unintentional injuries as blunt trauma, and all intentional injuries as penetrating trauma. Data for other parameters ($P_{B,BT}$, $P_{B,PT}$ and P_H) in the equations were extracted from the CRASH-2 results and from studies identified through a systematic review. The details of the systematic review are described below. As for the country where the largest number of premature deaths due to bleeding could be averted, I extracted data relevant to the country from the studies found in the systematic review. I then applied the country's data to the model to obtain country specific estimate.

Table 1.1 Categories of injuries

A. Unintentional injuries
1. Road traffic accidents
2. Poisoning (excluded)
3. Falls
4. Fires (excluded)
5. Drownings (excluded)
6. Other unintentional injuries
B. Intentional injuries
1. Self-inflicted injuries
2. Violence
3. War and conflict

1.2.3 Systematic review methods

Criteria for considering studies for this review

Types of studies

There was no study type restriction.

Types of outcome measures

I included studies that presented at least one of the following outcomes: the proportion of in-hospital deaths, the proportion of deaths due to bleeding in blunt trauma deaths and the proportion of deaths due to bleeding in penetrating trauma deaths.

Search methods for identification of studies

Electronic searches

I searched MEDLINE, EMBASE and CAB Abstracts. Appendix 1-A presents searching strategies for each database. The search was conducted on 2 March 2011. I explored other relevant studies through references of the found articles.

Language

There was no language restriction.

Publication year

To reflect the most recent situation regarding traumatic deaths, I included articles published from January 2004 to March 2011 in the review.

Data collection and analysis

Selection of studies

I searched for articles using the following search terms; injury, trauma, death, mortality, fatal, epidemiology, burden, blunt trauma, multiple trauma and traumatic shock. Two investigators independently examined titles and abstracts of the identified papers. After the screening, results were combined and disagreements were resolved by discussion. I excluded studies in which any trauma that was not related to bleeding accounted for more than 25% of total trauma deaths, which were not based on medical records, in which the

data of in-hospital deaths were not distinguished from those of pre-hospital deaths and which focused on specific trauma mechanism or trauma cause.

Data extraction and analyses

I extracted data on study design, setting, sample size, the proportions of in-hospital deaths, the proportions of deaths due to bleeding in blunt trauma deaths and the proportions of deaths due to bleeding in penetrating trauma deaths from the selected reports and tabulated them in a spreadsheet.

If available, I retrieved the numbers of deaths due to bleeding, all deaths due to blunt and penetrating trauma, all in-hospital deaths and all deaths to calculate the proportions listed above. I computed average, median, crude average, inverse variance weighted average (fixed effect model and random effect model) for each parameter. As these meta-analyses used proportions and they varied widely, I transformed them using Freeman-Tukey arcsine square root transformation method[12,13]. I then calculated weighted means (fixed effect model and random effect model) and back-transformed them to obtain the pooled proportion.

1.2.4 Data analyses

Application of the data to the equations

I applied the proportions and the numbers obtained from the data sources to the equations and computed the number of avoidable premature deaths due to bleeding. I used the

figures calculated with transformed weighted average by Freeman-Tukey method as the base case for the application of the data.

Sensitivity analyses

After applying the data to the equations, I conducted sensitivity analyses. The bounds of the distribution were lower and upper 95% confidence intervals (CIs) of each variable. To calculate the 95% CIs of lower range and upper range, I applied 95% CIs of the relative risks of two initiation times (≤1h 0.57 - 0.82, ≤3h 0.63 - 0.83) from the CRASH-2 trial results. Microsoft Excel and STATA12 were used for data analyses.

1.3 Results

1.3.1 Systematic review results

Description of studies

Figure 1.1 shows a flow diagram of the systematic review. I identified 79 reports to be examined after screening the 1120 records. However, seven of the reports were unavailable. As a result, I examined 72 full texts of the identified reports. Consequently, I identified 18 studies presented in 17 reports[9–25]. These studies were conducted in 13 countries: USA, Canada, Australia, UK, Spain, France, Denmark, Norway, Italy, Brazil, South Africa, Mozambique and India. Most of the studies are from North American or Western European countries, and data from South American, African or Asian countries were scarcely available. The data from the CRASH-2 trial were available directly from the trial coordinating team. Therefore, the trial was included at the end of the flow diagram. Accordingly, I included 19 studies in the meta-analysis. The data of the CRASH-2 trial results were from 40 countries. Appendix 1-B shows the characteristics of the included studies. Fourteen studies had data on the proportion of in-hospital deaths[10–12,14,16–24] in total number of deaths. Five studies provided data on the proportion of haemorrhage in blunt trauma deaths[9,13,15,25,26] whereas four studies presented data on the proportion of haemorrhage in penetrating trauma deaths[9,13,25,26].

Meta analyses

Appendix 1-C shows the number of studies from which data were extracted, range, average, crude average, median and other pooled averages with 95% CIs (interquartile range for

median) of each parameter. Of total trauma deaths, 44.4% (95% CI 33.4 - 55.6%) occurred in hospital. Haemorrhage accounted for 17.7% (13.0 - 22.9%) of blunt trauma deaths and 55.3% (48.5 - 61.9%) of penetrating trauma deaths.

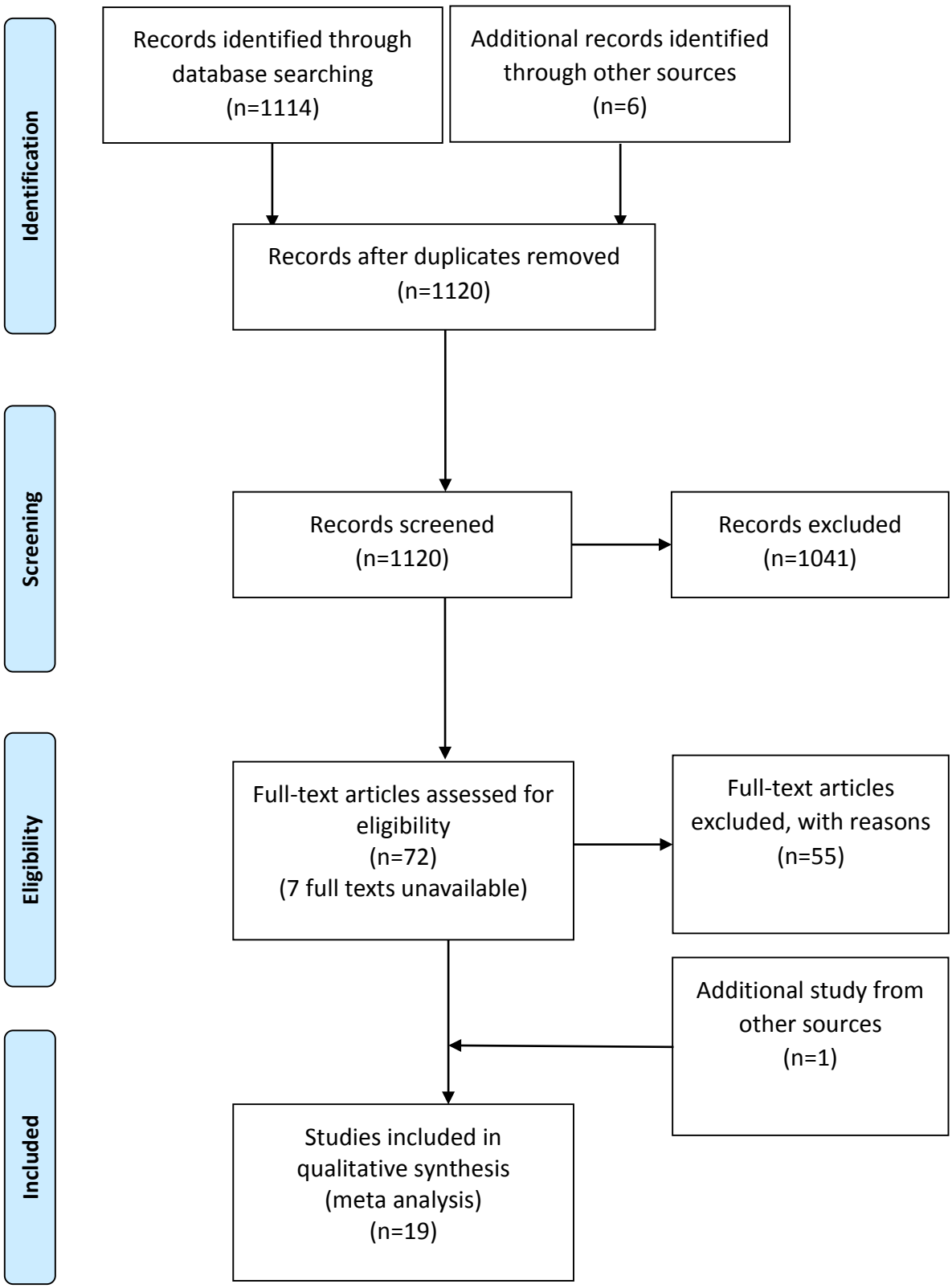

Figure 1.1 Flow diagram of the systematic review

1.3.2 Estimation results

Application of the data to the equations

According to the WHO report, the global estimate of traumatic deaths in 2008 was 4,364,216 (2,865,027 deaths from blunt trauma and 1,499,190 from penetrating trauma). Based on the data, I estimated that 593,256 trauma deaths due to haemorrhage are occurring in hospitals every year. If TXA is introduced to patients within one hour of injury, approximately 190,000 lives can be saved worldwide and 125,000 patients could survive with the treatment introduced within three hours of injury. Table 1.2 lists countries with more than 1,000 premature deaths that can be prevented. India became the first in the list with 35,654 premature deaths prevented.

As for the India-specific estimate, I found one study that provided the data of the proportion of in-hospital deaths at 75.9%[28]. However, this is unexpectedly high considering the patient transportation system and the long journey times in India[31]. Therefore, I applied the global estimate of proportion of in-hospital deaths at 44.4%. I calculated proportions of haemorrhage in the two mechanisms of injury in India using the CRASH-2 trial data (Table 1.3). With the country-specific data, I estimated that 27,057 and 23,675 premature deaths can be averted in India alone if TXA is given to patients within one hour and three hours of injury, respectively.

Table 1.2 List of countries by the numbers of deaths averted

	In-hospital death (traumatic) bleeding	*death averted TXA ≤ 1 hour*	*death averted TXA ≤ 3 hours*
Worldwide	593,256	189,842	166,112
Countries with > 1,000 deaths averted			
India	111,420	35,654	31,198
China	95,714	30,628	26,800
Russia	26,218	8,390	7,341
Brazil	22,042	7,054	6,172
USA	21,205	6,785	5,937
Indonesia	16,167	5,173	4,527
Myanmar	13,859	4,435	3,881
Iraq	13,322	4,263	3,730
Pakistan	12,970	4,150	3,632
Bangladesh	12,057	3,858	3,376
Ethiopia	10,590	3,389	2,965
Congo	10,480	3,353	2,934
Japan	10,442	3,341	2,924
Nigeria	9,754	3,121	2,731
Sri Lanka	9,676	3,096	2,709
Thailand	8,299	2,656	2,324
Mexico	8,279	2,649	2,318
Sudan	8,173	2,615	2,289
Colombia	8,079	2,585	2,262
Philippines	6,685	2,139	1,872
Ukraine	5,547	1,775	1,553
Uganda	5,465	1,749	1,530
Afghanistan	5,067	1,621	1,419
South Africa	5,055	1,618	1,415
Tanzania	4,678	1,497	1,310
Iran	4,604	1,473	1,289
Kenya	4,594	1,470	1,286
France	4,533	1,451	1,269
Viet Nam	4,533	1,451	1,269
Venezuela	4,446	1,423	1,245
South Korea	4,262	1,364	1,193
Côte d'Ivoire	4,223	1,351	1,182
Germany	4,210	1,347	1,179
Mozambique	3,377	1,081	946

Table 1.3 Parameters for India specific estimation

	%In-hospital death in all deaths	*%Haemorrhagic deaths (BT)*	*%Haemorrhagic deaths (PT)*
India (95%CI)	44.4 (33.4 – 55.7)	23.3 (18.9 – 28.3)%	21.4 (4.7 – 50.8)%

BT= blunt trauma, PT=penetrating trauma

Sensitivity analyses

Table 1.4 presents the results of the sensitivity analyses. The range of the number of premature deaths prevented world-wide was from 117,521 (95% CI 66,106 – 157,319) to 281,841 (158,536 – 378,724) with admission of TXA within one hour of injury. With the treatment given within three hours, the number varied from 102,831 (62,433 – 135,884) to 246,611 (149,728 – 325,879).

Because I found only one study which provided data for India, I calculated the bounds of distribution specific to India using the CRASH-2 trial results. The results showed that in India, from 12,827 (95%CI 7,215 – 17,237) to 53,168 (29,907 – 71,445), and from 11,224 (6,815 – 14,832) to 46,522 (28,246 – 61,476) premature deaths could be averted with TXA administration within one hour and three hours of injury respectively.

Table 1.4 Summary of the sensitivity analysis results

	Number of death prevented (95% CI)	
	Lower range	*Upper range*
Worldwide		
TXA introduction ≤1 hour	117,521 (66,106 – 157,319)	281,841 (158,536 – 378,724)
TXA introduction ≤3 hour	102,831 (62,433 – 135,884)	246,611 (149,728 – 325,879)
India		
TXA introduction ≤1 hour	12,827 (7,215 – 17,237)	53,168 (29,907 – 71,445)
TXA introduction ≤3 hour	11,224 (6,815 – 14,832)	46,522 (28,246 – 61,476)

1.4 Discussion

1.4.1 Principal findings

This study has shown that the largest number of premature deaths that could be averted with TXA use would be in India, China, Russia, Brazil and the United States. I estimated up to 89,000 premature deaths due to traumatic haemorrhage could be prevented in these countries with TXA use. It also shows that, despite the most conservative form of estimate, introduction of TXA to trauma patients with haemorrhage within one hour and three hours of injury can prevent approximately 118,000 and 103,000 premature deaths respectively every year world-wide.

1.4.2 Strengths and weaknesses

Strengths of the study

This is the first study to estimate the number of premature deaths that could be averted each year if TXA was used in the treatment of traumatic haemorrhage. The estimation models used in this study could be applied to many countries with different situations regarding traumatic death as long as accurate data for each parameter are available.

In the systematic review, I searched three different data bases without language limitation. In addition, the CRASH-2 data were from 40 countries and the WHO estimate cover around 200 countries. Therefore, this study gives a good coverage of data regarding traumatic deaths due to bleeding and in-hospital deaths. Although there was a limitation in the

number of studies that provided useful information for the estimation, the results of this study are based on the best available data.

Risk of bias in included studies

The study by Boulanger et al. was based on the data from National Trauma Data Bank (NTDB). It tends to include data from larger hospitals, younger and more severely injured patients[32]. Therefore, the proportion of haemorrhage in trauma deaths calculated based on NTDB's data might be higher than that in other hospitals and does not represent the national situation regarding trauma deaths.

The studies by Tien et al.[30] and Gilroy[20] are retrospective review of medical records and the causes of death were assigned by the authors. It is not mentioned if more than one person examined the data and they agreed on the diagnoses. Therefore, a chance of misclassification remained. Whereas, in the study by Dutton et al.[18], two independent parties reviewed the records and the diagnoses were agreed by both.

Potential bias in the review process

Some of the studies included in the systematic review were clinical trials testing the effectiveness of trauma treatments. There might have been other clinical trials that had negative results and therefore did not get published. Therefore, the literature search might have been affected by publication bias. Risk of misclassification was minimised by having two independent observers to extract and agree on data from relevant studies.

Weaknesses in the estimation process

Despite extensive searches, I found few eligible studies. The proportions of in-hospital deaths and haemorrhage in blunt and penetrating trauma deaths varied widely among countries or even within a country. I applied the averages of these proportions to the models for all countries and could not reflect the diversity in situations regarding the cause or the place of deaths in different countries. For example, the proportion of in-hospital deaths must differ between developing countries and developed countries. If data from variety of countries were available, more precise estimate would be available, which enables a comparison of countries according to the region, socio-economic level or other factors that affect trauma care level.

The causes of deaths in the WHO death estimates do not refer to the mechanism of injury. Therefore, I categorised these causes into two mechanisms of injury, blunt and penetrating trauma. There is a chance of misclassification in the categorisation process such that the categories classified as blunt trauma (i.e. road traffic accidents) might include penetrating traumas and vice versa. Consequently, the result of this study could be overestimating or underestimating the number of premature deaths prevented.

Lastly, the estimate might have been affected by a random error as unexpected and large scale disasters could affect WHO death estimates. For example, a cyclone, Nargis, attacked Myanmar in May 2008 and the death toll went up to more than 130,000[33]. This is

presumably why Myanmar is in the ninth place of the ranking based on the WHO death estimates from 2008.

1.4.3 Implications

The results of this study indicate the importance of rapid global dissemination and timely implementation of trial results. I estimated the number of avoidable premature deaths based on the number of in-hospital deaths because only those who survived to reach the hospital can benefit from TXA. However, a large number of deaths from penetrating trauma, which is strongly related to bleeding, occur during pre-hospital period[11]. In addition, in developing countries, where majority of traumatic deaths occur, patients' arrival at hospital is often delayed due to the poor road conditions and transport systems. The effectiveness of TXA is higher if introduced less than one hour of injury. Implementing the early administration of TXA during pre-hospital period may prevent a greater number of premature deaths from traumatic haemorrhage.

1.4.4 Future research

Further research is required to obtain country specific estimates by collecting data for each parameter from more countries. As mentioned above, the proportion of haemorrhage in traumatic deaths and the proportion of in-hospital deaths among all deaths vary from country to country. In addition, time from injury to admission to a hospital matters because the timing of introduction of TXA influences its effect. Patients in India, Vietnam and Pakistan, where the road infrastructure is poor and emergency services are not well

established can take a long time to reach hospital[31,34,35]. Collecting detailed data regarding trauma care situations will enable us to calculate the number of trauma deaths attributed to bleeding in hospitals more accurately.

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2. What strategies can be used for dissemination? A literature review of conventional dissemination methods

2.1 Introduction

2.1.1 Current situation regarding dissemination

Chapter 1 demonstrated the importance of early translation of research findings to clinical practice. As regards this, Rogers in his theory of "the diffusion of innovation" outlines five key stages: knowledge, persuasion, decision, implementation and confirmation[1]. Knowledge represents the stage where an individual or an organisation becomes aware of new evidence. Persuasion is the stage where they become more interested in the evidence and start considering whether or not to adopt it. Decision is when they arrive at a decision whether or not to adopt the new evidence. If they decide to adopt it, they bring it into practice, which is the implementation stage. Finally, at the confirmation stage, they judge if the decision made was appropriate. Dobbins et al.[2] summarised different stages between evidence and practice that correspond with each stage in Rogers' theory (Figure 2.1). They used the words "research utilisation" for "implementation". The report published by the NHS Centre for Reviews and Dissemination points out that merely disseminating information does not necessarily result in change in practice and claims that dissemination and implementation should be distinguished from each other[3]. It defines these two concepts, stating that "dissemination involves raising awareness of research messages and implementation involves getting the findings of research adopted into practice" (p2, NHS Centre for Reviews and Dissemination, 1999[3]).

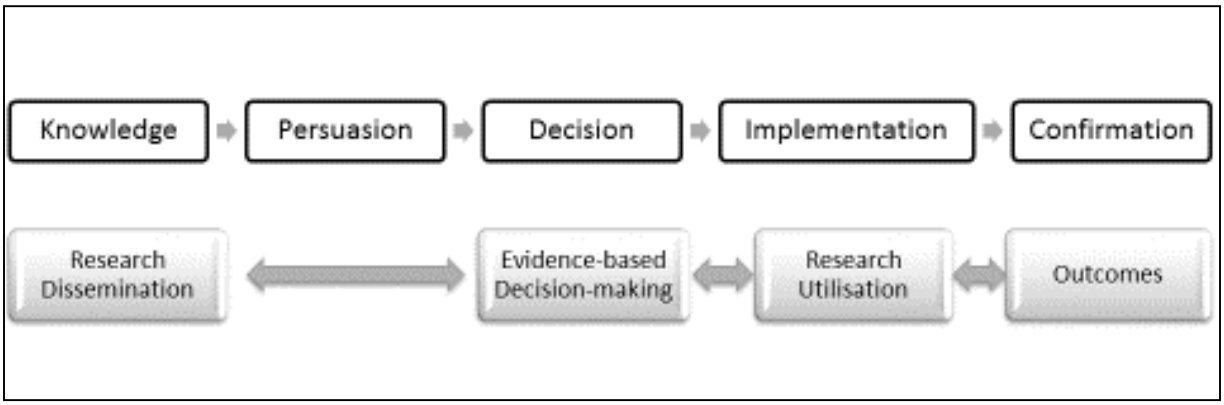

Figure 2.1 Framework for research dissemination and utilisation (adopted from Dobbins, 2002[2])

Although a doctor's knowledge that a particular healthcare intervention is effective does not necessarily lead to its use in clinical practice, health interventions are unlikely to be used in the absence of such knowledge. In other words, dissemination is necessary but not sufficient for implementation. Considering its importance in the process of bringing evidence into practice, this study focuses on the primary stage of diffusion of innovation, namely the "knowledge" as described by Rogers and the "research dissemination" stage as described by Dobbins et al. In addition, Lomas defines dissemination as a process whereby "synthesized information is actively broadcasted to practitioners" through "a respected and relevant authority"[4]. Bearing in mind the definitions outlined above, for the purpose of this thesis I define dissemination as the process by which information on the effectiveness and safety of healthcare interventions is communicated among practitioners through their own networks or organisational authority.

Currently, a wide range of different dissemination strategies are used. They include the distribution of educational materials, continuing medical education, the influence of

opinion leaders and medical conferences[5,6]. With changes in information technology, there are many new ways to disseminate research findings. This chapter seeks to identify the available methods for the dissemination of research findings and to describe their features.

2.1.2 Aim of the study

To identify strategies that can be used for the dissemination of research results.

2.2 Methods

2.2.1 Criteria for considering studies for this review

Types of studies

As the purpose of this review was to identify and create a list of dissemination methods, I did not examine all the studies that discussed the same dissemination methods. Once I extracted information on one dissemination method, I excluded other studies that mentioned the same method. Repeating the process, I searched the databases until saturation.

Types of participants

All types of participants including health care professionals and non-health care professionals.

Types of interventions

All types of intervention to improve awareness of information. However, strategies that cannot be applied to medical doctors were excluded. I also excluded studies that focused only on implementation.

Types of outcome measures

As the focus of this study is the identification of dissemination strategies, I did not determine the outcomes.

Language

There was no language restriction.

Publication year

World Wide Web (Web) is the main system of the internet that provides functions to view websites. Since the Web was first largely introduced on the internet in 1991[7], the way to communicate information has dramatically changed. Therefore, this review included articles published from January 1992 to November 2012.

Publication status

Both published and unpublished articles were included in the search.

2.2.2 Search methods for identification of studies

Electronic searches

I searched the following databases online: MEDLINE, EMBASE, HMIC, Global Health, the Cochrane library, Campbell library.

I conducted the online database search on 26 November 2012. Appendix 2-A presents the details of search strategies and the terms used.

Searching other sources

I also examined reviews of dissemination or implementation methods[5,6,8] that had been identified prior to the search to find methods that might have been missed out in the

electronic searches. In addition, I conducted a Google search on 4 December 2012. Appendix 2-B presents the strategy for this search. A Google search normally yields a large number of results. Google has unique algorithms to sort results by relevance based on terms on the websites, the recentness of the content and other information[9]. The relevance of those websites decreases as one goes through the search result. Therefore, I included only the websites listed on the first 5 pages of the search result.

Selection of studies

I screened the titles and abstracts of the records retrieved from the search result. I excluded reports that were clearly unrelated to the topic. As regards reports that were potentially relevant, full texts were obtained and investigated for eligibility.

2.2.3 Data extraction and analyses

I extracted all dissemination methods that were mentioned in the relevant reports and tabulated them. If methods were described in an abstract of a report, I did not obtain the full text but included the report in the analysis. After extraction of all methods, I grouped similar methods.

2.3 Results

2.3.1 Description of studies

Figure 2.1 shows a flow diagram of the identification of the reports. The database search yielded 542 records and 92 records were found applicable[10–101]. Of the eligible records, 86 were journal publications, one was a section of a handbook and five were presentations at conferences. One blog post which discusses dissemination methods was found through the Google search[102]. All of the methods that had been mentioned in the previous reviews of dissemination methods were found in the electronic search and I did not find any method from other sources.

Intervention studies including randomised controlled trials (RCTs), cluster-RCTs, non-randomised controlled trials were described in 23 reports[10,11,14,15,24,25,32,36,39,53,57–59,61,68,71,77,79,83–85,91,98]. Second largest study type was evaluation of dissemination methods in 22 reports[12,16,20,21,28,43,44,46,49,54,63,65–67,69,70,76,82,87,89,90], followed by descriptive cross-sectional studies in 21 reports[17,19,26,29,30,34,35,37,40,42,47,62,74,80,93,95–97,99–101]. The others were not study reports but articles that discussed dissemination methods.

Figure 2.2 shows the change of the number of reports on dissemination methods over the past 20 years. Of the 93 reports, 80 (86%) were written in 2002 onwards and 36 (39%) in 2010 onwards.

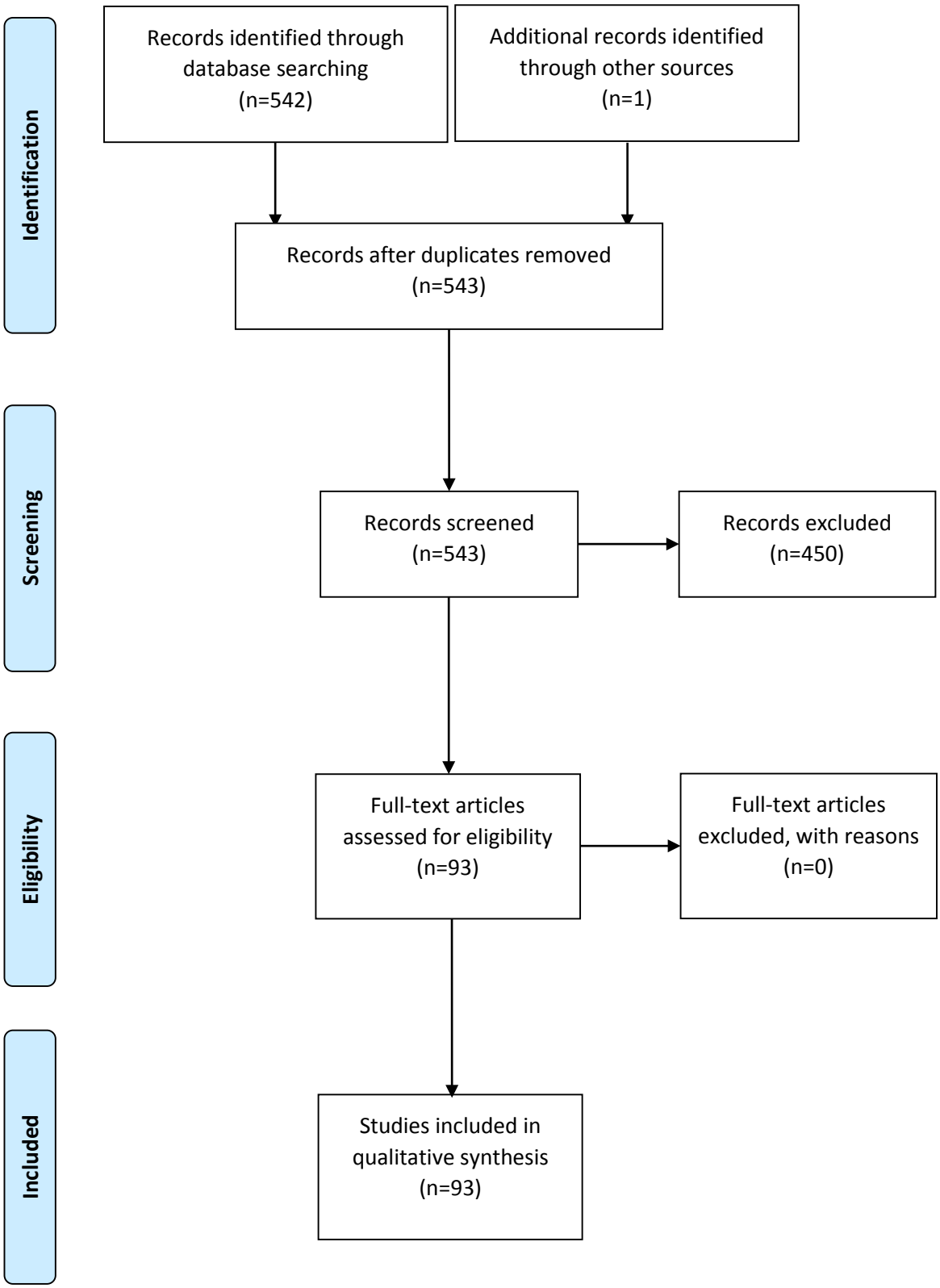

Figure 2.2 Flow diagram of the systematic review

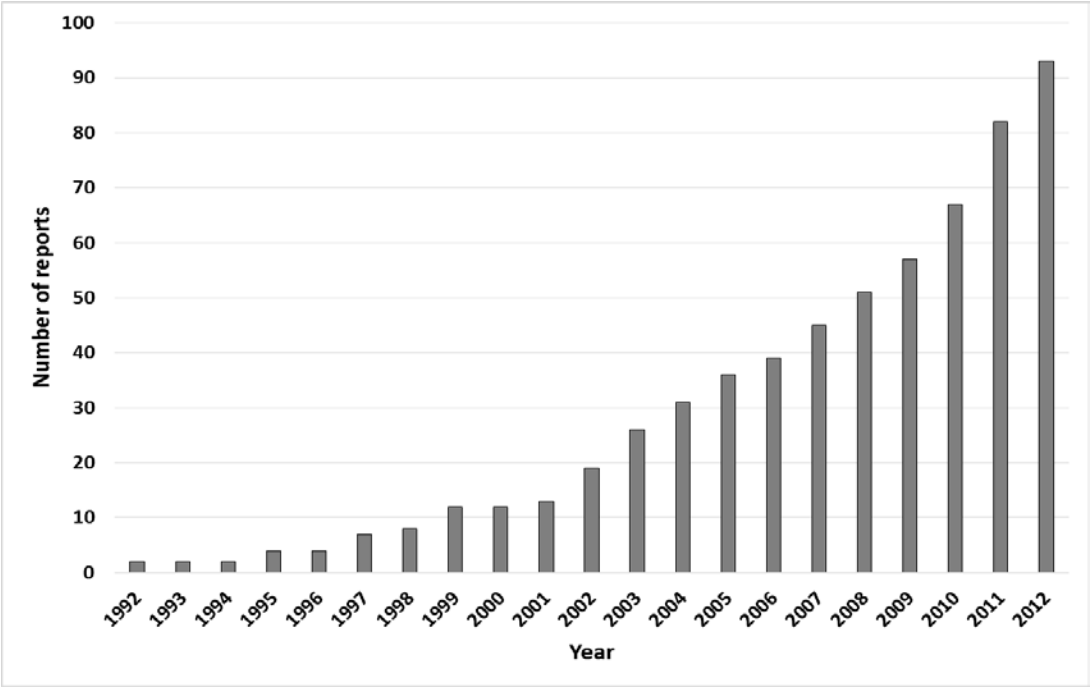

Figure 2.3 Cumulative number of articles about dissemination methods

2.3.2 Existing dissemination methods

Table 2.1 is the list of dissemination methods found in this study. Based on the type of communication, I divided the strategies largely into two groups: direct (face-to-face) communication and indirect communication. I categorised internet-based, distance-learning educational programmes as direct communication because they are delivered to individuals and are interactive. I grouped similar strategies into sub-categories such as direct teaching (i.e. workshops and lectures), distant learning (i.e. telehealth and video conference), computer-based educational materials (i.e. CD-ROMs), non-computer-based educational materials (i.e. manuals and printed guidelines), web-based educational materials (i.e. e-learning course and websites) and multifaceted programmes (combinations of aforementioned methods).

Table 2.1 List of dissemination methods

Direct (face-to-face) communication	Indirect communication
Educational outreach[13,59,98]	Mailing[17,21,58] (postcards[11])
Audit and feedback[13,39,81]	Newsletter (monthly through website[66])
Presentation in hospitals[29]	Website[17,20–22,29,42,54,55,65,68,71,73,74,82,83,87,94,95]
Invited lectures[29]	Online database[31,45,48,69,76,80,82,92,96,97] (wiki[12,46])
Workshops[10,32,68,79,84,91]	Email[17,42] (daily[49], mailing list[37,44,47,50,61])
Educational meetings[32,43,59]	University extension agency[25]
Conferences[13,30,31,43,55,61,63]	Reminder (electronic[12], other[14,15,39,81])
Fair[101], Public event[18,25,86](booth[101], poster[101])	Play in a theatre[28]
Personal communication[84], Word-of-mouth[43] (colleagues[25,43])	Social media[17,99] (Twitter[26,34,62], Facebook[16], blog[34,52,88,89])
Health officials' advice network[64], Professional alliance[23]	Guideline[32,39] (summarised[15], paper-based[41,53], mailed[14,79,98], electronic[53,72,83])
Continuing Medical Education (CME)[42] (internet-based interactive[23,27,33,40,57,67,75,77,83], personal[14,18,83,97,98])	Educational material[13] (CD-ROM[45,71,84,85], paper-based[85], video[85], monograph[41], webcast[102], video game[75], mailed[81])
Local opinion leaders[13,39,79,81], Educationally influential physicians[100], Advocates[32]	Internet-based information sharing groups[17,38,65,84], Online message board[87]
	Journal publications[29–31,42,55,61,81] (paper-based[41], electronic[45,82])
	Publication[18,25,93] (book[42], poster[36], pamphlet[71,90], bulletin[59] (electronic[22,51], paper-based)
	Multi-media campaign[86] (media press release[43], TV[75,97], newspaper[97], magazine[97])
	Report[10,68] (final, summary[29], policy documents, paper-based[29], electronic[29])
	Smartphone application[17], Personal Digital Assistant (PDA) software[17]
	Phone[17]
	Inventory[56]
	Web-based tool kit[70]
	Instant messaging[19]

2.4 Discussion

2.4.1 Principal findings

This study identified direct and indirect communication methods which were divided into 33 sub-categories. Online tools are widely used for indirect communication. The rapid growth of internet users[103] is likely to be the cause of the rapid expansion of dissemination using indirect communication tools. In fact, among many methods, websites seem to be the most common way to provide information. Many medical organisations create their own websites and upload other communication tools such as podcasts and online videos on the websites providing research findings to promote evidence based medicine (EBM). Even media that used to be non-computer-based such as flyers and pamphlets have been digitalised and distributed online. In addition, the number of reports on dissemination methods increased since 2002 especially in 2010 onwards (figure 2.2). This implies growing interest in this area.

2.4.2 Strengths and weaknesses

This is the most recent study that reviewed and synthesised the information about dissemination methods. While most overviews and systematic reviews discuss conventional dissemination methods[5,6,8] this study reflected the change in the way of communication due to the evolution of information technology.

Potential bias in the review process

Studies on dissemination methods that were found to be ineffective might not have been submitted to journals and so might not have been included in this review resulting in publication bias. There is also a chance that some eligible studies were missed especially since only one person (JK) screened the search result and selected applicable reports.

2.4.3 Implications

Although it seems that indirect online methods are now forming the main stream of dissemination, face-to-face communication still plays an important role. For example, British doctors are expected to revalidate every five years[104] and they must provide information to prove that they are keeping up to date[105]. For that, they need to take part in educational activities such as attending conferences and publishing articles[106]. Therefore, conferences or other face-to-face communication methods are still an effective way to disseminate research findings as they are motivated to attend for revalidation.

On the other hand, online-based methods enable it to communicate information with many people around the world rapidly and at relatively low cost. Therefore, these means based around information technology have become and are likely to stay the dominant method to disseminate research findings.

2.4.4 Future research

I identified means to communicate information in this study. It is helpful to clarify what methods are effective and what are not. Further research is required to examine the effectiveness of each method.

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3 How effective are the current dissemination approaches? A systematic review of effectiveness of conventional dissemination methods

3.1 Introduction

3.1.1 Background

In 1999 the National Health Service (NHS) Centre for Reviews and Dissemination published an overview of 44 systematic reviews of interventions to promote the dissemination and implementation of research findings[1]. The focus was on direct communication with health practitioners for example, through lectures or via opinion leaders, and on the provision of hard copies of information such as journals or guidelines. However, since then information technology has developed and dissemination can now be done via digitalised materials and online. In fact, many of the dissemination methods identified in chapter 2 were online tools. An updated analysis of the effectiveness of dissemination interventions including these new tools is therefore required.

3.1.2 Aim of the study

To examine the effectiveness of methods used for information dissemination until today.

3.2 Methods

3.2.1 Criteria for considering studies for this review

Types of studies

Randomised controlled trials (RCTs) and cluster-randomised controlled trials (cluster RCTs).

Types of participants

Health care professionals including medical practitioners, dentists, nurses, pharmacists, occupational therapists, physical therapists, speech-language-hearing therapists and nutritionists. I excluded studies which included medical students and residents.

Types of interventions

The interventions identified in the previous chapter to improve health care professionals' awareness or knowledge of research evidence. Table 3.1 presents the interventions included in the search.

Types of outcome measures

Health care professionals' awareness or knowledge of research evidence. Awareness refers to whether or not participants know of the topic or scientific evidence. Knowledge refers to their level of understanding of the topic or scientific evidence.

Table 3.1 Dissemination methods included in the search

Direct (face-to-face) communication	Indirect communication
Educational outreach	Mails
Audit and feedback	Newsletters
Presentations	Websites
Invited lectures	On-line databases, wikis
Workshops	Emails, Mailing lists
Educational meetings	University Extension agencies
Conferences	Reminders
Fairs, Public events, Booths, Posters	Play in a theatre
Word-of-mouth	Publications (books, pamphlets, bulletins, journals)
Advice networks	Guideline (summarized, paper-based, mailed, electronic)
Continuing Medical Education (CME)	Educational materials (CD-ROMs, videos, monographs, webcasts, video games)
Local opinion leaders, Educationally influential physicians, Advocates	Information sharing groups, Online message boards
	Social media (Twitter, Facebook, blog)
	Media press release TVs News papers Magazines
	Reports
	Smartphone applications, Personal digital assistant (PDA)
	Telephones
	Inventories
	Web-based tools
	Instant messaging

3.2.2 Search methods for identification of studies

Electronic searches

I searched MEDLINE (OvidSP), EMBASE(OvidSP), HMIC(OvidSP), Global Health(OvidSP), CINAHL (EBSCO Host), Web of Science, Scopus, the Cochrane library and the Campbell library using the search strategies shown in appendix 3-A. Appendix 3-B shows the medical subject headings used to search each database. The search was conducted on 18 February 2013.

Searching other sources

I examined the publications identified in the archive of the NHS Centre for Reviews and Dissemination. I also screened the reference lists of the included reports and those of relevant systematic reviews.

Language

There was no language restriction.

Publication year

The systematic review to identify conventional dissemination methods in chapter 2 was restricted to reports published from 1992 onwards. Therefore, this review included reports published from January 1992 to February 2013.

3.2.3 Data collection and analysis

Selection of studies

I screened all titles and abstracts of the records retrieved from the search and removed duplicates. Records that were clearly unrelated to the topic were removed. I then obtained full-texts of the potentially relevant reports and assessed the eligibility. I also screened the references of the selected reports in the same manner.

Data extraction and management

I extracted and tabulated the data in the following categories from the selected reports.

Study methods: study design, location of the study, method of randomisation, allocation concealment and blinding method

Participants: inclusion and exclusion criteria, sample size, characteristics (e.g. age, speciality, sex)

Intervention and control: duration of intervention, content, format, source, recipient, setting and timing, details of control intervention

Follow up: duration of follow up, number of withdrawal

Outcome: type of outcome (awareness or knowledge), measure of outcome (e.g. score of examination), methods for outcome assessment (e.g. multiple choice questionnaire)

Analysis: statistical methods of analysis, measure of effect, effect of the intervention on the outcome

Assessment of risk of bias in included studies

I assessed the potential for bias in each of the included studies by considering the following six domains: generation of random sequence, allocation concealment, blinding (participants and outcome assessment), incomplete outcome data, selective reporting and other important concerns about bias.

For cluster randomised controlled trials I considered the following sources of bias: recruitment bias, baseline imbalance, loss of clusters, incorrect analysis and comparability with individually randomised trials. In cluster trials, recruitment of individuals is sometimes conducted after randomisation of clusters. If a person who recruits individuals in the clusters has knowledge of allocation, participants might be selectively recruited, which is called recruitment bias. Therefore, cluster trials are more prone to selection bias than individually randomised trials[2,3]. Baseline imbalance is one of the indicators to detect that randomisation or recruitment was not appropriately conducted. If a large difference in baseline characteristics was found between groups ($p<0.005$), I assumed that there was a chance of selection bias and I examined the recruitment methods[4].

Another important source of bias that affects systematic reviews is selective reporting of outcomes, such that outcomes that show intervention effects are selectively reported. To minimise this bias, I wrote to the authors of reports on RCTs and cluster RCTs that evaluated an eligible intervention with eligible participants but did not report knowledge or awareness as an outcome. I asked them by email if they had collected data on participants' knowledge regardless of the main outcomes of their studies presented in the reports.

Types of effect measures

Risk difference, risk ratios and odds ratios with 95% confidence intervals (CIs) for dichotomous outcomes. Mean difference and standardised mean difference with 95% CIs for continuous outcomes.

Unit of analysis issues

In RCTs, the health care professional was the unit of analysis. In cluster RCTs, the group such as a hospital or a department was the unit of analysis.

Sub-group analyses

Because there is evidence that poor allocation concealment is a major source of bias in randomised controlled trials[5], I considered separately trials with adequate allocation concealment and trials with inadequate or unclear allocation concealment.

Dealing with missing data

For reports which did not provide necessary data I contacted. If the data were unavailable and the results were unjustifiable without the data, I excluded the reports from the review.

Assessment of publication biases

In the event that more than 10 studies evaluated the effect of the same interventions on the same outcome, I planned to investigate the potential for publication bias using a funnel plot.

3.3 Results

3.3.1 Description of studies

Results of the search

Figure 3.1 presents the process of searching and selecting the relevant references. The electronic database search yielded 4,243 records and 74 records were found through other sources. I did not find any relevant report in the archive of the NHS Centre for Reviews and Dissemination. After removing duplicates, I screened the titles and abstracts of the remaining 3011 records. I found that 179 of these were potentially eligible and therefore obtained the full-texts of the reports. Of the 179 reports, four reports[6–9] on three studies did not provide sufficient data to judge eligibility. I contacted the authors, one of them did not respond and another confirmed that they no longer had the data. Therefore, I excluded these two reports. The author of the other two reports on one study provided an unpublished final report with sufficient data[10]. I included this main report in the quality synthesis and excluded the original two reports. During the assessment of selective reporting bias, one of the contacted authors provided a report[11] of a different study which was eligible for this review. I also included this report in the quality synthesis. I excluded 160 reports: 55 used ineligible designs; 20 involved ineligible participants; 13 examined ineligible interventions; and 64 did not report participants' knowledge or awareness as an outcome; four were protocols.

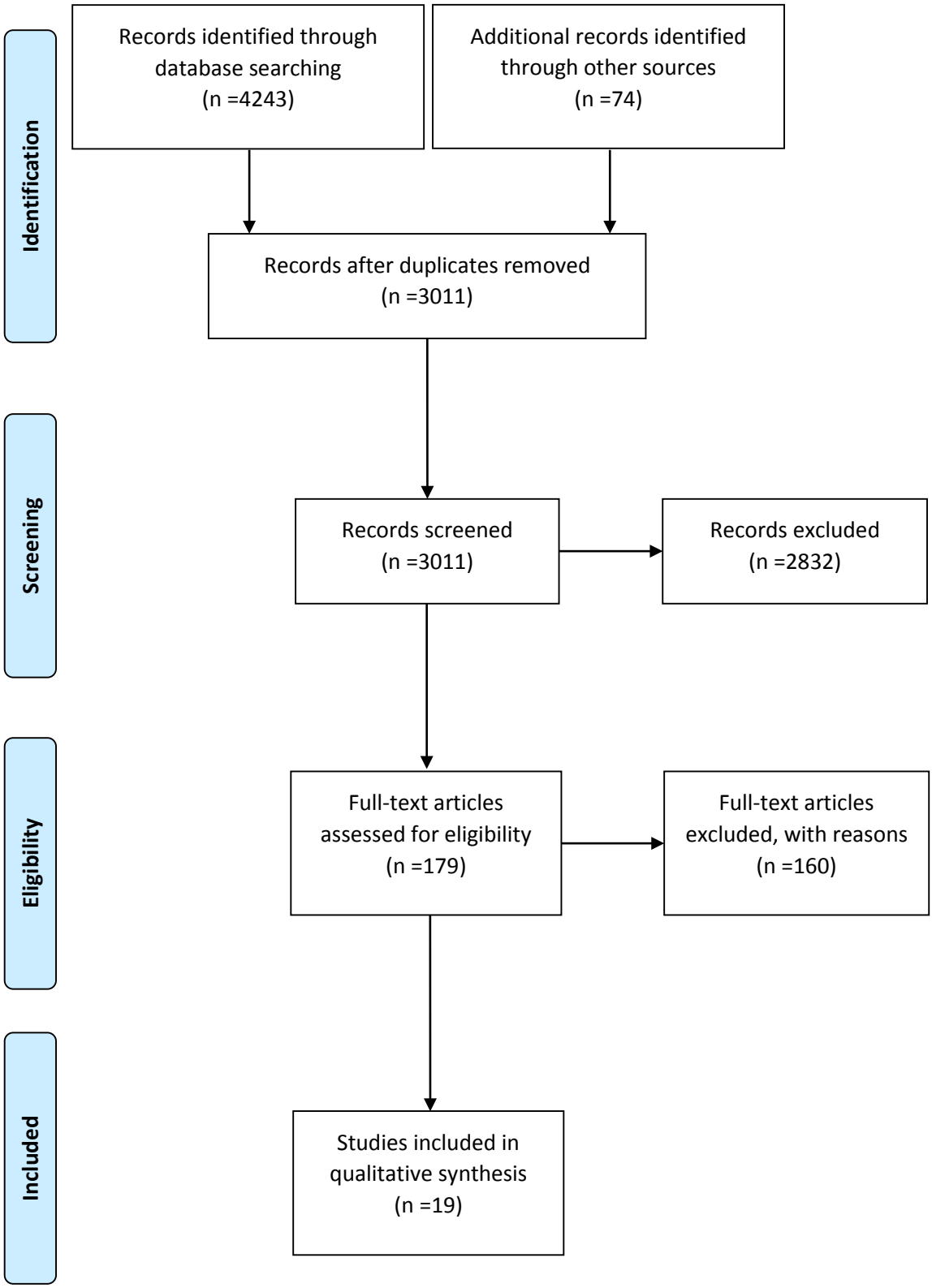

Figure 3.1 Flow diagram of identification of studies

Included studies

Nineteen reports[10–28] met the inclusion criteria and I included them in the quality analysis. Seventeen reports were published in English, and one was in German. The unpublished, which was provided by one of the contacted authors, was in English. There were ten RCTs and nine cluster RCTs. Appendix 3-C summarises the characteristics of the included studies.

Setting

The trials were conducted in Germany, the United States of America, Canada, the United Kingdom, Australia, France, Indonesia, Iran, Israel and the Netherlands. One study was conducted worldwide using an emailing list as a dissemination method with subscribers from all over the world. The publication dates of the included reports were from 1996 to 2011.

Participants

In 12 trials the participants were medical doctors, in the other trials they were nurses, dentists, prescribers and mental healthcare providers. In three trials, participants were a combination of medical doctors, nurses and other healthcare providers.

Interventions

Several different interventions were evaluated: direct teaching (i.e. workshops and lectures), computer-based educational materials (i.e. CD-ROMs), non-computer-based educational materials (i.e. manuals and printed guidelines), web-based educational

materials (i.e. e-learning courses and websites) and multifaceted programmes (combinations of aforementioned methods).

There were six studies on the effect of direct teaching, three on computer-based educational materials, three on non-computer-based educational materials, six on web-based materials and five on multifaceted programmes. Four of these studies investigated more than one method in each study which belong to different categories.

Outcomes

All studies assessed participants' knowledge using multiple choice or open ended questionnaires. They collected data, such as the score of the questionnaire or the proportion of correct answers of all questions at two different time points (pre- and post-intervention). They compared the results between the two time points and between different groups (intervention and control).

3.3.2 Risk of bias in included studies

Table 3.2 is the summary of risk of bias and appendix 3-D describes the details of the risk of bias in each study.

Allocation

Sequence generation

Seven reports[14–18,20,22] used adequate sequence generation methods such as random number tables, computer-generated sequences and minimisation random assignment procedure and these were judged to be low risk of bias. I ranked the other 12 reports[10–13,19,21,23–28] as unclear due to insufficient information.

Allocation concealment

Three reports mentioned allocation concealment: participants centrally randomised at the coordinating centre[14]; sealed opaque envelopes[21,24]. As these methods were appropriate for allocation concealment, I judged these four studies as low risk of selection bias. I ranked the other 16 studies[10–14,16–20,22,23,25–28] as unclear due to insufficient information.

Blinding

Blinding of participants

Three reports[10,16,20] stated that participants were not blinded to their allocation. The other reports provided insufficient information[11–15,17–19,21–28]. I judged all studies as high risk of

bias because it is impossible to blind participants in studies testing educational interventions.

Blinding of outcome assessment

Although most reports did not mention blinding of outcome assessment, 11 studies[13,15–17,19,20,22–25,27] used objective methods (i.e. true/false questionnaires) for outcome assessment. I judged them as low risk of bias. I rated six studies[10,12,14,21,26,28] as unclear because they did not describe detailed outcome assessment methods. Another study[11] used open ended essay questions and two independent observer marked them. The validity of the marking was presented with high correlation of the scores. However, the report did not mention if the assessors were blinded or not. Therefore, I also ranked this study as unclear. One study[18] used a self-report and I judged it as high risk of recall bias.

Incomplete outcome data

In one study[16], participants in the control group were significantly more likely to withdraw than those in the intervention group. The reason for the withdrawals was not presented in the report. Therefore, I judged this report as unclear. I also rated seven other studies[15,19–21,23–25] as unclear for not providing the reason for withdrawal of participants and not explaining whether the withdrawal affected the effect of the intervention. One cluster RCT[27] was judged as unclear for not presenting the total number of participants but using only the number of participants whose data were used for the analyses. In other nine studies[10–14,17,18,22,26], there was neither withdrawal nor difference in rates of assessment completion

between groups. Another study[28] explained the reason for withdrawal and it did not seem to affect the results. I judged these studies as low risk of bias.

Selective reporting

In 15 reports[10–14,16–20,22–25,28], outcomes that were mentioned in the result section were pre-specified in the method section. One of them[24] had a protocol published before the study was conducted. I judged these studies as low risk of bias. I rated one study[15] as unclear because it did not pre-specify outcome in the method section but described the details of the outcome and how it was assessed in the result section. In three reports[21,26,27], some outcomes described in the method section were not referred to in the result section. Therefore, I judged them as high risk of bias for selective outcome reporting.

I identified 64 reports that used eligible study design, participants and interventions but did not present the outcome of interest. For further investigation of selective reporting bias, I contacted the authors of these reports by email and asked if they had collected data on participants' knowledge. I could not contact 30 of them because their email addresses were either unavailable or no longer in use. Of those who had valid email addresses, 15 authors responded and 19 authors did not. Of those who responded, 13 confirmed that they had not collected data on participants' knowledge and one author was not certain if they had assessed the outcome of interest as he no longer had access to the data. The other author confirmed that they had assessed participants' knowledge but not presented the data in

the report I found. She provided another report with sufficient data, which I included in the quality synthesis.

Publication bias

I did not find enough studies to produce a funnel plot. Therefore, I did not conduct the assessment of the presence of publication bias.

Other sources of bias

To minimise contamination bias, one study[14] used cluster as a unit of analysis, two others[15,19] conducted block randomisation and one other study[16] recruited one participant per practice.

Domains regarding cluster RCTs

Recruitment bias

In six[14,19–21,24,25] studies, participants were recruited objectively based on inclusion criteria at the same time as clusters. I judged these studies as low risk of recruitment bias. Three studies[10,23,27] did not mention how recruitment was conducted and I rated them as unclear.

Baseline imbalance

Seven studies[10,14,19,20,23–25] did not find baseline imbalance in the intervention and control groups. In one study[21], participants "in the intervention group had significantly more years of experience than those in the control". Although they stated that there was significant

difference in the number of experienced participants (p=0.047), the p-value was not as small as to detect selection bias (p<0.005). Given that the recruitment method of this study was objective, I judged this study as low risk of selection bias. The other study[27] did not mention baseline data of the participants and I rated it as unclear.

Loss of clusters

Four studies[14,21,24,25] had no withdrawals of cluster and I judged them as low risk of bias. In the other studies[10,19,20,23,27], there were a few drop-outs of clusters. Nevertheless, they mentioned neither the reason for the withdrawals nor the effect of the withdrawals on the results. I rated these studies as unclear.

Incorrect analysis

I judged the analytical methods in seven studies[10,14,19–21,24,25] as appropriate and low risk of bias. One study[23] did not take cluster effect into consideration during the data analyses and I judged it as high risk of bias. I rated the other study[27] as unclear due to insufficient information.

Comparability with individually randomised trials

Because of the diversity in the interventions and the outcome measurement methods, meta-analyses and integration of the effects found in each of the included studies was unfeasible. Therefore, I dismissed the assessment of the risk of bias regarding this domain.

Table 3.2 Summarised risk of bias

		Random sequence generation	Allocation concealment	Blinding of participants	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	Other sources of bias	Recruitment bias (C-RCT)	Baseline imbalance (C-RCT)	Loss of clusters (C-RCT)	Incorrect analysis (C-RCT)
Butzlaff 2004[15]	RCT	+	?	-	+	?	?	+				
Carroll 2011[16]	RCT	+	?	-	+	?	+	+				
Chan 1999[28]	RCT	?	?	-	?	+	+					
Dimeff 2011[17]	RCT	+	?	-	+	+	+					
Hagemeister 2008[26]	RCT	?	?	-	?	+	-					
Harned 2011[18]	RCT	+	?	-	-	+	+					
Margalit 2005[12]	RCT	?	?	-	?	+	+					
Shirazi 2009[11]	RCT	?	?	-	?	+	+					
Tanna 2011[13]	RCT	?	?	-	+	+	+					
Van der Sanden 2005[22]	RCT	+	?	-	+	+	+					
Amsallem 2007[14]	C-RCT	+	+	-	?	+	+	+	+	+	+	+
Downs 2003[10]	C-RCT	?	?	-	?	+	+		?	+	?	+
Elliott 1997[25]	C-RCT	?	?	-	+	?	+		+	+	+	+
Kirshbaum 2008[19]	C-RCT	?	?	-	+	?	+	+	+	+	?	+
Liaw 2008[20]	C-RCT	+	?	-	+	?	+		+	+	?	+
Santoso 1996[27]	C-RCT	?	?	-	+	?	-		?	?	?	?
Searle 2002[21]	C-RCT	?	+	-	?	?	-		+	+	+	+
Vollmar 2007[23]	C-RCT	?	?	-	+	?	+		?	+	?	-
Vollmar 2010[24]	C-RCT	?	+	-	+	?	+		+	+	+	+

3.3.3 Effects of interventions

Direct teaching methods

Table 3.3 summarises the size and the precision of effects of direct teaching methods in the relevant studies. One study used a direct teaching method as an intervention[26] but it did not provide sufficient data, therefore, I excluded it from the data analyses. Six studies[10–12,14,23,25] examined the effect of direct teaching methods.

Amsallem et al.[14] examined the effect of an active knowledge transfer programme. The intervention group received knowledge brokers' visits about cardiology and discussion sessions. Control intervention was not mentioned in the report. The outcome was the score of a questionnaire about standardised summary of systematic reviews in cardiology. The increase in the mean score was greater in the intervention group than that of the control group [between group difference: 6 points (data for 95% CI were not provided), p=0.04].

Downs et al.[10] examined the effect of practice-based workshops. The intervention group attended a three hour workshop on Alzheimer's disease facilitated by experienced general practitioners. The control group did not receive the educational programme. The outcome was the score of a knowledge test about Alzheimer's disease. The increase in the mean score was greater in the intervention group than that of the control group [between group difference: 6 points (data for 95% CI were not provided), p=0.03].

Elliot et al.[25] examined the effect of minifellowship. The intervention group received didactic presentations, clinical preceptorships and an outreach programme about cancer pain management for two days. Control intervention was not mentioned in the report. The outcome was the score of a questionnaire on cancer pain management. The increase in the mean score was slightly greater in the intervention group than that of the control group among physicians [between group difference: 0.2 points (data for 95% CI were not provided), p-value was not provided]. The increase in the mean score was greater in the intervention group than that of the control group among nurses [between group difference: 1.5 points (data for 95% CI were not provided), p-value was not provided].

Margalit et al.[12] examined the effect of interactive continuing medical education. The intervention group had role-playing of patient care and discussion on bio-psychological-oriented primary care with less lectures and reading assignments. The control group received didactic lectures, discussion and reading assignment. The outcome was the proportion of correct answers in a questionnaire on bio-psychological-oriented primary care. The increase in the mean proportion of correct answers was greater in the intervention group than that of the control group [between group difference: 6.1% (data for 95% CI were not provided), p=0.1].

Shirazi et al.[11] examined the effect of interactive continuing medical education. The intervention group received lectures and discussion in modified buzz groups followed by videos about depressive disorders. The control group received mini-lectures followed by

questions and answers. The outcome was the score of multiple choice and Likert scale questionnaire and essay questions on depression management. The increase in the mean score of the multiple choice and Likert questionnaire was greater in the intervention group than that of the control group [between group difference: 1.1 points (data for 95% CI were not provided), $p<0.01$]. The increase in the mean score of the essay questions in the intervention group was greater than that of the control group [between group difference: 1.0 point (data for 95% CI were not provided), $p=0.01$].

Vollmer et al.[23] examined the effect of a training with extra two hours of training. The intervention group received basic three hour training followed by presentations by opinion leaders and video and interactive elements about dementia. The control group received only the basic training and no further education programme. The outcome was the score of questionnaire on dementia diagnosis and therapy. The increase in the mean score of the tests in the intervention group was greater than that of the control group [between group difference: 3.1 points (data for 95% CI were not provided), $p<0.001$].

Table 3.3 Summary of findings: direct teaching (ordered by category and study ID)

Study ID	Intervention	Outcome	N (#data)	Group	Increase (95% CI)	Effect difference or relative effect(95%CI)
Amsallem 2007[14]	Knowledge brokers' visits and discussion	Score of a multiple choice questionnaire	72 (54)	Intervention	7.9 (6.4-9.3)	Difference in mean score increase: 6 points /100
				Control	1.9 (0.4-3.3)	
Downs 2003[10]	Practice-based workshops	Score of a multiple choice questionnaire	206 (203)	Intervention	4	Difference in mean score increase: 6 points/200
				Control	-2	
Elliott 1997[25]	minifellowship (didactic presentations, clinical preceptorships with experiential clinical rounds) and an outreach programme	Score of a 15-item questionnaire with possible range of 13-65 by **1)physicians** and **2)nurses**	344 (274)	1)Intervention	-1.9	Difference in mean score increase: 0.2 points
				1)Control	-1.7	
				2)Intervention	-1.9	Difference in mean score increase: 1.5 points
				2)Control	-0.4	
Hagemeister 2008[26]	Seminar	Proportion of participants who scored 5 or more in an 8 question test	6027 (2474)	Intervention	-	This intervention was excluded from the study due to low response rate
				Control	-	

Study ID	Intervention	Outcome	N (#data)	Group	Increase (95% CI)	Effect difference or relative effect(95%CI)
Margalit 2005[12]	Interactive continuing medical education	Proportion of correct answers in a 194-item open question	44 (44)	Intervention	37.4%	Difference in mean proportion increase: 6.1%
				Control	31.3%	
Shirazi 2009[11]	Interactive education in differently sized groups based on the level of readiness to change	1)Score of multiple choice and Likert scale questionnaire	192 (159)	1)Intervention	4.0 (-)	Difference in mean score increase: 1.1 points
				1)Control	2.9 (-)	
		2)Score of vignettes and essay question		2)Intervention	1.3 (-)	Difference in mean score increase: 1.0 points
				2)Control	0.3 (-)	
Vollmar 2007[23]	Multimodal training	Score of a multiple choice questionnaire	137 (132)	Intervention	5.1±2.3	Difference in mean score increase: 3.1 points
				Control	2.0±1.9	

Computer-based educational materials

Table 3.4 summarises the size and the precision of effects of computer-based educational materials in the relevant studies. Three studies[10,15,26] examined the effect of computer-based educational materials.

Butzlaff et al.[15] examined the effect of an electronic version of guideline. The intervention group received access to an electronic version of general clinical guideline via CD-ROM and online. The control group received no intervention. The outcome was the number of correctly answered questions about the contents of the guideline. There was no difference in the increase in the median number of correctly answered questions between the intervention group and the control group [between group difference: 0 point (data for 95% CI were not provided), p=0.69].

Downs et al.[10] examined the effect of an electronic tutorial (intervention A) and decision support system (intervention B). The intervention A group received a CD-ROM which contained an 'electronic book' on Alzheimer's disease and the intervention B group received access to the support system in a medical record software. The control group received no intervention. The outcome was the score of a knowledge test about Alzheimer's disease. The increase in the mean score was greater in the intervention A group than that of the control group [between group difference: 11 points (data for 95% CI were not provided), p<0.01]. The increase in the mean score was greater in the intervention B group than that

of the control group [between group difference: 3 points (data for 95% CI were not provided), p<0.01].

Hagemeister et al.[26] examined the effect of interactive guideline. The intervention group received an interactive guideline of treatment for hypertension on a CD. The control group received no intervention. The outcome was the proportion of participants who scored five or more in eight question test on the knowledge of diagnosis and treatment of hypertension conducted after the intervention. The proportion who scored five or more after the intervention was smaller in the intervention group than that of the control group [between group difference: -3.9% (data for 95% CI were not provided), p=0.1].

Table 3.4 Summary of findings: computer-based educational materials (ordered by category and study ID)

Study ID	Intervention	Outcome	N (#data)	Group	Increase (95% CI)	Effect difference or relative effect (95%CI)
Butzlaff 2004[15]	CD-ROM version of a guideline	Number of correctly answered questions in a multiple choice questionnaire	72 (72)	Intervention	0 (-1, 2)	Difference in median number increase: 0
				Control	0 (-1, 2)	
Downs 2003[10]	1)Electronic tutorial on a CD-ROM 2)Decision support system	Score of a multiple choice test	206 (206)	Intervention A	9	Difference in mean score increase: 11 points
				Intervention B	1	Difference in mean score increase: 3 points
				Control	-2	
Hagemeister 2008[26]	Interactive guideline	Proportion of participants who scored 5 or more in an 8 question test	6027 (2474)	Intervention	-	Difference in mean proportion increase: -3.9%
				Control	-	

Non-computer-based educational materials

Table 3.5 summarises the size and the precision of effects of non-computer-based educational materials in the relevant studies. Three studies[19,22,26] examined the effect of non-computer-based educational materials.

Hagemeister et al.[26] examined the effect of printed guideline. The intervention group received a printed summary of a guideline for hypertension treatment. The control group received no intervention. The outcome was the proportion of participants who scored five or more in eight question test on the knowledge of diagnosis and treatment of hypertension conducted after the intervention. The proportion who scored five or more after the intervention was smaller in the intervention group than that of the control group [between group difference: -3.8% (data for 95% CI were not provided), p=0.1].

Kirshbaum et al.[19] examined the effect of targeted booklet. The intervention group received "Exercise and Breast Cancer", a booklet for breast care nurses. The control intervention was not mentioned in the report. The outcome was the number of participants who correctly answered questions on breast cancer. The odds ratios of getting correct answer in the intervention grope compared to the control group were more than 1.0 for each of 17 questions (data are presented in Table 3.5).

Van der Sanden et al.[22] examined the effect of clinical practice guidelines. The intervention group received a dental clinical practice guideline for the management of a certain dental

problem. The control intervention was not mentioned in the report. The outcome was the mean number of wrong treatment decision. The reduction in the mean number of wrong treatment decision was greater in the intervention group than that of the control group [between group difference in decrease: 2.4 points (95% CI: 0.1 to 4.7), $p<0.05$]. Another outcome was the proportion of correct treatment decision for the same dental problem. The increase in the mean proportion was greater in the intervention group than that of the control group [between group difference: 14.5% (data for 95% CI were not provided), p-value was not provided].

Table 3.5 Summary of findings: non-computer-based educational materials (ordered by category and study ID)

Study ID	Intervention	Outcome	N (#data)	Group	Increase (95% CI)	Effect difference or relative effect (95%CI)
Hagemeister 2008[26]	Printed guideline	Proportion of participants who scored 5 or more in an 8 question test	6027 (2474)	Intervention	-	Difference in mean proportion increase: -3.8%
				Control	-	
Kirshbaum 2008[19]	Targeted booklet	Number of participants who correctly answered each of 17 questions	104 (92)	Intervention	-	Odds ratios of getting correct answers:
				Control	-	Q1 8.3 (2.4-25) Q2 11.1 (3.9-33.3) Q3 perfect prediction Q4 3.1 (1.4-7.1) Q5 3.5 (1.4-8.3) Q6 4 (1.6-10) Q7 2.4 (1-5.6) Q8 1.1 (0.5-2.5) Q9 4.4 (1.4-14.3) Q10 2.5 (1-6.3) Q11 1.9 (0.8-4.2) Q12 2.6 (1-6.3) Q13 1.6 (0.5-5.9) Q14 1.3 (0.4-4.6) Q15 2.6 (1.1-6.7) Q16 3.7 (1.7-8.3) Q17 2.8 (1.2-6.7)

Study ID	Intervention	Outcome	N (#data)	Group	Increase (95% CI)	Effect difference or relative effect (95%CI)
Van der Sanden 2005[22]	Guideline	1) Decrease in number of wrong treatment decision 2) Proportion of correct decision for a treatment	92 (82)	1)Intervention	-4.8 (3.2-6.4)	Difference in mean number decrease: 2.4 (0.1-4.7)
				1)Control	-2.4 (0.7-4.2)	
				2)Intervention	20.9% (12.8-29.0%)	Difference in mean proportion increase: 14.5%
				2)Control	6.4% (0.5-12.3%)	

Web-based materials

Table 3.6 summarises the size and the precision of effects of web-based materials in the relevant studies. Six studies[13,14,17,18,24,28] examined the effect of web-based materials.

Amsallem et al.[14] examined the effect of a passive knowledge transfer programme. The intervention group received an access to educational materials about cardiology available on the internet. The control intervention was not mentioned in the report. The outcome was the score of a questionnaire about standardised summary of systematic reviews in cardiology. The increase in the mean score was greater in the intervention group than that of the control group [between group difference: 1.8 points (data for 95% CI were not provided), p=0.5].

Chan et al.[28] examined the effect of problem-based small-group learning via the internet. The intervention group received access to online problem-based small-group learning system about depression in the elderly. The control group received access to similar internet based educational system without small-group learning. The outcome was the score of a multiple choice questionnaire on depression in the elderly. The mean of total scores (pre- and post-intervention scores combined) was greater in the intervention group than that of the control group [between group difference: 2.1 points (data for 95% CI were not provided), p=0.5].

Dimeff et al.[17] examined the effect of e-learning course. The intervention group received e-learning course of dialectical behaviour therapy, which is "a comprehensive cognitive behavioural treatment for borderline personality disorder". The control group received a manual of dialectical behaviour therapy. The outcome was the proportion of correct answers of a questionnaire on the dialectical behaviour therapy. The increase in the mean proportion of correct answers was greater in the intervention group than that of the control group right after the intervention and at the 15 week follow-up [between group difference: post-intervention 4% (data for 95% CI were not provided), p-value was not provided; 15 week follow-up 7% (data for 95% CI were not provided), $p<0.05$].

Harned et al.[18] examined the effect of online interactive multimedia training. The intervention group received access to the online training system on anxiety disorders. The control group received an access to a placebo control online training system. The outcome was the proportion of correct answers of a test on therapy for anxiety disorders. The increase in the mean proportion of correct answers was greater in the intervention group than that of the control group [between group difference: 44% (data for 95% CI were not provided), $p<0.05$].

Tanna et al.[13] examined the effect of an email alert with articles. Group A received an email alert with an article selected from set A. Group B received the same email alert with an article selected from set B. The outcome was the score of questionnaire on recently published articles related to nephrology. The participants in the group A did not read the

article participants in the group B read and vice versa. Each group served as a control group for the other group. Therefore, the authors looked at the increase in scores between pre and post-intervention tests instead of between group difference. The mean score of post-intervention test was slightly greater than that of pre-intervention test [increase in mean score: 0.03 points (95% CI: -0.13 to 0.2), p=0.7].

Vollmar et al.[24] examined the effect of e-learning system. The intervention group took online modules which included interactive case stories followed by discussions and received web-based guideline for dementia. The control group had conventional lectures and discussion sessions. The outcome was the score of knowledge test of dementia. The increase in the mean score was slightly greater in the intervention group than that of the control group [between group difference: 0.07 points (95% CI: -0.84 to 0.98), p=0.88].

Table 3.6 Summary of findings: web-based materials (ordered by category and study ID)

Study ID	Intervention	Outcome	N (#data)	Group	Increase (95% CI)	Effect difference or relative effect (95%CI)
Amsallem 2007[14]	Educational material available on the study website every week	Score of a multiple choice questionnaire	72 (54)	Intervention	5.8 (4.2-7.4)	Difference in mean score increase: 1.8 points/100
				Control	4.0 (2.6-5.3)	
Butzlaff 2004[15]	Web-based guideline	Median of correctly answered questions in a multiple choice questionnaire	72 (72)	Intervention	0 (-1, 2)	Difference in median score increase: 0 points/25
				Control	0 (-1, 2)	
Dimeff 2011[17]	E-learning course	Proportion of correct answers in an 23-item multiple choice test at **1)post-intervention** and **2)15 week follow-up**	132 (110)	1)Intervention	48%	Difference in mean proportion increase: 4%
				1)Control	44%	
				2)Intervention	38%	Difference in mean proportion increase: 7%
				2)Control	31%	
Harned 2011[18]	Online training	Proportion of correct answers in a 27-item multiple choice test	46 (46)	Intervention	42%	Difference in mean proportion increase: 44%
				Control	-2%	

Study ID	Intervention	Outcome	N (#data)	Group	Increase (95% CI)	Effect difference or relative effect (95%CI)
Tanna 2011[13]	Email alert	Score of a questionnaire ranging from -12 to 12	1683 (803)	Intervention	0.03±0.08 (-0.1-0.2)	Between group difference was not provided
Vollmar 2010[24]	online modules with interactive case stories and discussion	Score of a 20 item knowledge test	305 (97)	Intervention	3.67	Difference in mean score increase: 0.07 points (-0.84 to 0.98)
				Control	3.60	

Multifaceted approaches

Table 3.7 summarises the size and the precision of effects of multifaceted approaches in the relevant studies. Five studies[16,18,20,21,27] examined the effect of multifaceted approaches.

Caroll et al.[16] examined the effect of three knowledge translation strategies. The intervention group received interactive educational workshops, portfolio and responsive timely knowledge support service. The control group received educational materials only. The outcome was the number of participants who answered correctly each of three questions about genetics. The odds ratios of getting correct answer in the intervention group compared to the control group were more than 1.0 for each of three questions [OR of answering questions correctly Q1: 2.6 (95% CI: 0.9 to 7.3), Q2: 1.4 (0.3 to 6.5), Q3: 1.2 (0.5 to 3.3), p-values were not provided].

Harned et al.[18] examined the effect of a combination of interactive multimedia online training and motivational interviewing-based intervention. The intervention group received access to the online training system on anxiety disorders and motivational interviewing-based phone calls which were about 20 minutes long. The control group received an access to placebo control online training system. The outcome was the proportion of correct answers of a test on therapy for anxiety disorders. The increase in the mean of the proportion of correct answers in the intervention group was greater than that of the control group [between group difference: 46% (data for 95% CI were not provided), $p<0.05$].

Liaw et al.[20] examined the effect of a combination of small group workshops and locally adapted guidelines. The intervention group received three-hour workshops for two days and guidelines of asthma management. The control group A received the guideline only and the control group B received an alternative education programme without resource material. The outcome was the proportion of correct answers of a test on asthma management. The increase in the mean proportion of correct answers was greater in the intervention group than that of the control group A and B [difference in increase: with control A 10.7% (95% CI: -0.6% to 22.0%), p=0.06; with control B 7.6% (95% CI: -4.4% to 19.6%), p=0.2].

Santoso et al.[27] examined the effect of a combination of different educational methods. The intervention group A attended small group face-to-face discussions and received booklets about management of diarrhoea. The intervention group B received formal seminars and booklets. The control group did not participate in any educational programme. The outcome was the score of a test on the treatment of diarrhoea in children compared. The increase in the mean score in the intervention group A was slightly smaller than that of the intervention group B [between group difference: -0.3 points (data for 95% CI were not provided), p>0.05]. The data for the comparison between the intervention group A and the control group and between the intervention group B and the control group were not provided.

Searle et al.[21] examined the effect of a combination of guidelines, workshops and opinion leaders. The intervention group attended problem-based interactive workshops facilitated by selected opinion leaders. They also received evidence-based guidelines, written material and laminated management algorithm for dysfunctional uterine bleeding. The control intervention was not mentioned in the report. The outcome was the score of a questionnaire on dysfunctional uterine bleeding. They did not compare knowledge increase between the intervention and the control group but looked only at the increase in the median test score in each group. There was a decrease in knowledge in the intervention group [increase in median score: -1 point (data for 95% CI were not provided), p=0.01] and no change in the control group [increase in median score: 0 point (data for 95% CI were not provided), p>0.05].

Table 3.7 Summary of findings: multifaceted methods (ordered by category and study ID)

Study ID	Intervention	Outcome	N (#data)	Group	Increase (95% CI)	Effect difference or relative effect (95%CI)
Carroll 2011[16]	Workshops + portfolio + knowledge support service (sent by email or fax)	Number of participants who answered correctly each of three questions	125 (80)	Intervention Control	- -	Odds ratios of getting correct answers compared to control group: Q1 2.6 (0.9-7.3) Q2 1.4 (0.3-6.5) Q3 1.2 (0.5-3.3)
Harned 2011[18]	Online training + motivational interviewing	Proportion of correct answers in a 27-item multiple choice test	46 (46)	Intervention Control	48% -2%	Difference in mean proportion increase: 50%
Liaw 2008[20]	Workshops + guidelines	Proportion of correct answers in a 21-item test	63 (51)	Intervention Control 1 Control 2	17.3% 8.3% 8.4%	Difference in mean proportion increase with control1: 10.7% (-0.6% to 22%) Difference in mean proportion increase with control2: 7.6% (-4.4% to 19.6%)

Study ID	Intervention	Outcome	N (#data)	Group	Increase (95% CI)	Effect difference or relative effect (95%CI)
Santoso 1996[27]	1) Small group face-to-face discussion + booklet	Score of a 10 score test		Intervention 1	2.8	Difference in mean score increase between intervention 1 and 2: 0.3 points
	2)Formal seminar + booklet			Intervention 2	3.1	Comparison with control group was not conducted
				Control	-	
Searle 2002[21]	Evidence-based guidelines + workshop + opinion leaders	Score of an open-ended and clinical scenario questionnaire	62 (46)	Intervention	-1	Not mentioned
				Control	0	

3.4 Discussion

3.4.1 Principal findings

I found ten RCTs and nine cluster RCTs that assessed the effectiveness of methods for dissemination among health care professionals. I categorised the methods into five groups: direct teaching, computer-based materials, non-computer-based materials, web-based materials and multifaceted methods. This review includes several new dissemination tools (e.g. online tools and digitalised educational materials) not examined in the previous review by Oxman and Davis[29]. The methodological quality of the small number of RCTs and cluster RCTs eligible for this review was generally poor. Therefore, I cannot draw any reliable conclusion about the effectiveness of the conventional dissemination methods.

3.4.2 Strengths and weaknesses of the study

Strengths of the study

To include all relevant studies and minimise selection bias, I searched a broad range of databases with no language restriction. I included systematic reviews and overviews previously conducted on conventional dissemination methods which covered dissemination strategies used before 1992 and also screened their references. Therefore, it is less likely that I missed studies on dissemination strategies published before 1992. Selective reporting bias is difficult to assess by merely reading the reports because this type of bias occurs when some information is not presented in the report. If the outcome is not mentioned in the method section, detecting unreported information of the outcome is

impossible. I minimised this bias by contacting the authors of relevant reports and asking them if there were unreported outcomes.

Quality of the evidence

I judged most studies as high risk of bias or unclear due to insufficient data and the quality of the included studies was generally poor. Especially the information regarding allocation was not provided in most reports and the risk of bias remained unclear. Less than half of the studies mentioned the process of random sequence generation and only three studies provided information of allocation concealment. More than half of the studies clearly mentioned the blinding of outcome assessment. The risk of bias for incomplete outcome data was low in most RCTs. Whereas most reports of cluster RCTs neither explained the reason for missing data nor justify the imbalance in the number of withdrawal. As for reporting bias, the extent to which the activity of contacting authors would actually reduce bias depends on whether authors respond. In fact, only less than a quarter of the authors of the 64 relevant studies responded and the risk of bias in the rest remained unclear. Although some clusters dropped out in most cluster RCTs, their reports did not mention the reason for the withdrawals and its effect on the results. Therefore, the risk of bias for loss of cluster remained unclear in most cluster RCTs. With regard to other domains specific to cluster RCTs, I had sufficient information from the reports to judge the risk of bias.

Potential bias in the review process

Despite the broad and sensitive searching to identify relevant studies, there is a chance that I missed some relevant studies in the selection process as one person (JK) screened the search result. I could not test publication bias because I did not find sufficient number of studies in the current review. Most studies identified in this review were conducted in European countries and North American countries. It is uncertain if this is because relevant studies are not conducted in other countries or due to publication bias such that trials conducted in these countries are more likely to get published.

There is a chance that I overlooked or misclassified some data because one observer (JK), who was not blinded to the study question, extracted data. Data synthesis was unfeasible due to insufficient data and only vague evaluations were given to the effectiveness of strategies for dissemination of research findings.

3.4.3 Implications

I found many studies which examined the effectiveness of implementation methods, which shows the tendency in studies to focus on implementation in the area of getting evidence into practice. That is because implementation is what matters for shortening the time between producing evidence and putting it into practice. However, testing implementation strategies without understanding efficient dissemination may not result in successful implementation. It is ideal that effective dissemination methods are established before implementation strategies are planned. This review also revealed that no study has been

conducted on the effectiveness of online videos for dissemination of medical information despite its huge growth as an information sharing method. This requires an RCT on the effectiveness of online videos for dissemination of medical information among health care professionals.

3.4.4 Future research

Johnson et al. point out that new technologies provide us with opportunities to promote dissemination and the key for the future of dissemination research is to fully explore and exploit new technologies[7].

Jennet and Premkumar present evidence that new technologies are useful in the dissemination of research results[8]. However, the new technologies they discussed are computer-based systems and such technologies have developed considerably over the 20 years since the report was published. As the internet made global communication easier, online tools became one of the most widely used technologies. The current review found several studies that examined the use of online tools, which indicates that the use of the internet for dissemination is increasing. Nevertheless, the category of web-based materials in this study included only educational materials, online training courses and email alerts. Although online videos have been emerging as a new communication tool, their use for dissemination of medical information among health care professionals has not been evaluated in an RCT until now. This requires further study to examine the effectiveness of utilising online videos to disseminate medical research findings. In addition, most of the included studies were conducted in developed countries. There is an urgent need to identify

efficient ways of disseminating research findings to developing countries. Therefore, more studies need to be conducted to understand which strategies are effective for dissemination of medical information in developing countries.

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4 What makes a video popular? A cross-sectional study of the effects of online video characteristics on video view counts

4.1 Introduction

4.1.1 Background

In chapter 1, I estimated the potential impact of the global implementation of a policy of giving tranexamic acid (TXA) to bleeding trauma patients. The results suggested that India was the country where the largest number of deaths due to bleeding could be averted with early administration of TXA. For this reason, it is important that the results of the trial are disseminated to the more than 600,000 physicians in India[1]. Novel approaches will be required to disseminate research results to such a large number of doctors in a rapid and cost-effective way.

Over the last few decades, the internet has facilitated rapid, global communication[2,3]. People share information using email, weblogs and social networking services[4]. Short online videos are becoming increasingly popular. The most popular video sharing website is YouTube[5]. Since its launch in 2005, its number of users has increased rapidly and in 2010, total views of videos exceeded 700 billion[6]. Currently, it is available in 25 countries and in 43 languages. YouTube has a "share" button underneath each online video and by clicking it users can forward the video to others. In this way, online videos can be disseminated widely and inexpensively via the internet.

Bearing in mind the amount of new medical information that doctors must process, it is essential that information is presented in such a way that doctors can grasp key findings quickly. A randomised controlled study of teaching methods for medical students studying surgery found that computer-based video instruction was effective in improving and retaining suturing skills compared to the control group, which had received no intervention[7]. Given that education using videos improves doctors' practice and that video sharing websites share information broadly and quickly, online videos can be a potentially powerful communication tool for dissemination of medical research findings.

To achieve successful dissemination using online videos, it is important to understand what characteristics make a medical online video popular. A descriptive study examined the contents of popular YouTube videos. These popular videos included ones with the highest view counts and 89% of them included emotional contents[8]. However, this study examined only the top ranked videos in terms of popularity (i.e. "most viewed" and "most responded") and did not compare them with videos at a lower rank. Therefore, the results do not provide evidence for the association between emotional content and view counts. Regarding the relationship between the duration of a video and its popularity, a cross-sectional study of more than 2,000 online videos on YouTube concluded that there was no correlation between video length and the number of views[9]. Although the sample size of this study was large, the studied categories were limited to "entertainment" and "science & technology", and the extent to which these findings are generalizable to medicine is open to debate.

Using online videos to disseminate medical research findings could shorten the time of translation of evidence into practice. In order to achieve that, I need to understand which characteristics lead to an online video being shared by many people. YouTube provides the number of views, called view counts, which is one indicator of popularity. Understanding the factors that affect view counts may help create an online video that will be shared by many people. However, few studies have examined the associations between constituent elements of online videos and the number of views. Therefore, the characteristics of an online video that affect view counts need to be explored.

4.1.2 Aim of the study

To examine the association between the characteristics of medical online videos and view counts.

4.2 Methods

4.2.1 Study design

I conducted a cross-sectional study of medical online videos on YouTube. I used YouTube because it is the most visited video-sharing website[10].

4.2.2 Study sample and variables

The study population was medical online videos uploaded on YouTube since 23 April 2005, when the first video was uploaded to the site[11]. Figure 4.1 presents hypothesised associations between characteristics and view counts (see appendix 4-A for details of each variable).

Exposure

The following exposure variables were examined[8,9,12]: back-ground music (BGM), voice, sound effect, emotion, animation, valence of the topic (positive or negative), length (short or long) and keywords in the title of the video. Videos were classified as "short" if they were shorter than the modal length of all videos included in the study.

Outcome

The outcome was the number of views of a video per day. The total number of views of a video provided by YouTube, or the "view count" represents the number of people who started watching the video[13]. Although the number of people who completed watching the video would be more appropriate to analyse for this study, these data were unavailable, I

used view counts as the closest available index. View counts were divided by the number of days the video was available on YouTube to calculate views per day. I classified the outcome as "high" if the number after rounding to the nearest ten was larger than the 75th percentile of the views per day of the included videos.

Confounder

The following variables were considered as confounders: clinical feature of diseases, sex, age group, a country where the video topic was set (English speaking country or not), presentation methods and the main idea. All of them were assumed to be related to one of the exposure variables, emotion.

Sample size

Sample size was calculated based on a minimum required sample size (10 individuals) per variable in a regression model[14]. As 16 variables were intended to be included in the regression model for this study, a minimum of 160 videos was required.

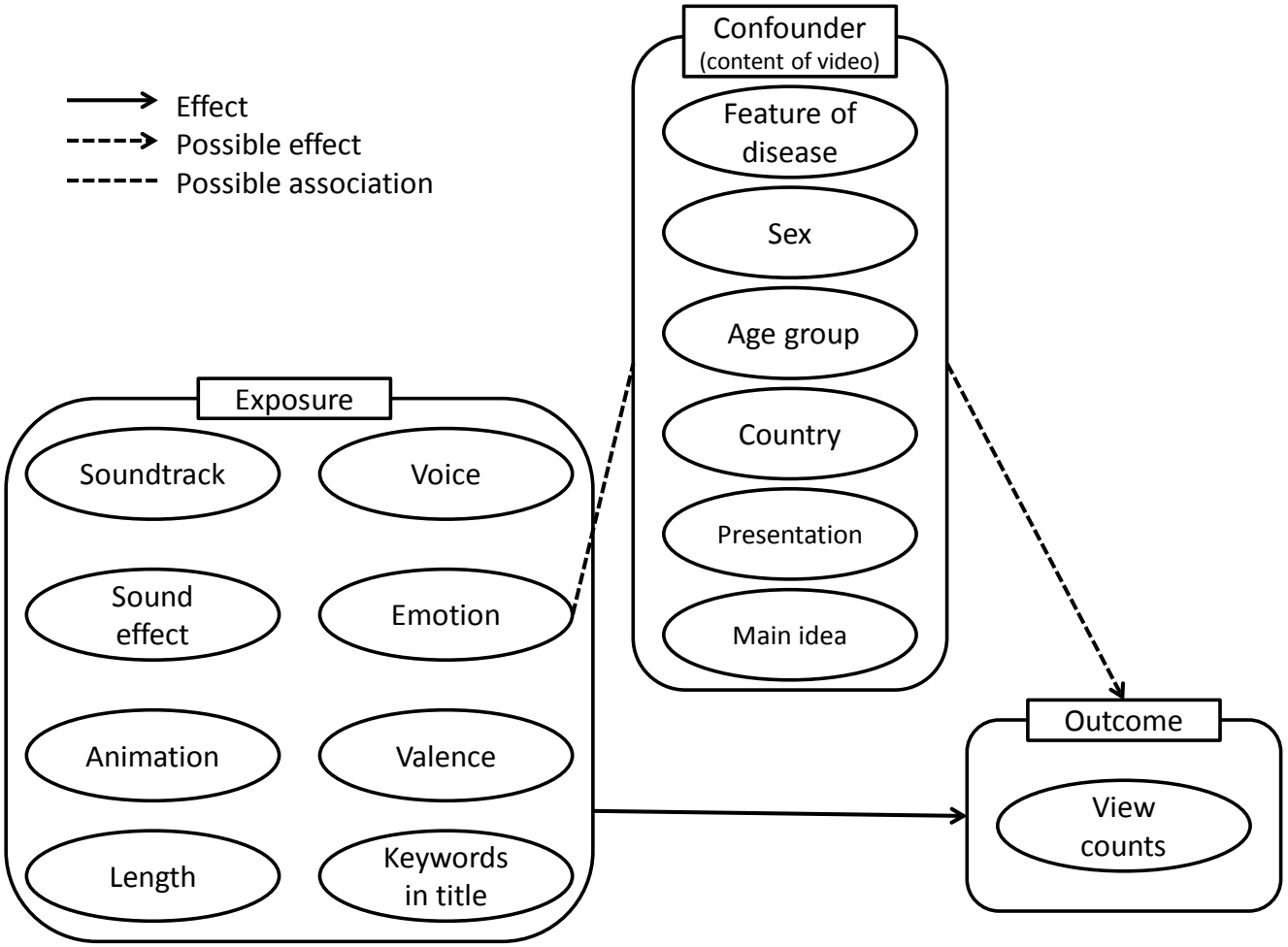

Figure 4.1 Causal diagram of video characteristics and view counts

4.2.3 Search methods and selection of videos

I searched YouTube for sample videos using the keyword "medical" (see appendix 4-B for the search options). The search was limited to videos relevant to medicine, symptoms, diagnosis and treatment. As YouTube imposed 15-minute limitation on uploaded videos in July 2010[15], I excluded videos longer than 15 minutes. I defined professional videos as those which were part of a film, TV advertisement or TV or radio programme. I also classified music videos by professional musicians as professional videos. Because professional musicians are popular and their music videos gain much higher view counts than amateur videos the sample was restricted to amateur videos. In addition, the language was restricted to English because view counts are affected by the language used.

One observer (JK) screened the YouTube search results and determined the eligibility of the videos. Videos on YouTube are accompanied with view counts (appendix 4-C). To ensure that knowledge of view counts would not influence the evaluation of the two subjective exposure variables, emotions and valence, the observer downloaded the eligible videos, recorded their view counts and removed the view counts from the videos so that assessors of exposure and confounder variables would not see them. The search was conducted and the eligible videos were downloaded on 10 November 2011.

4.2.4 Data collection and analysis

I divided the downloaded videos into two groups and allocated two independent assessors (NG and MH) to each of the groups. The assessors watched the videos and coded the

exposure and confounder variables. To assess inter-rater reliability of assessment of emotion and valance, a third observer (KK) watched and assessed 50 videos that had previously been assessed by MH. I then calculated Kappa coefficients and assessed reliability of the coding of the two subjective variables[16,17]. Inter-rater agreement was rated based on the following five categories: poor (k<0.2), fair (k=0.2 to 0.4), moderate (0.41 to 0.6), good (0.61 to 0.8) and very good (0.81 to 1.0)[18]. Because there is no gold standard for evaluation of subjective variables, and evaluation of emotion and valance varies from person to person, I could not solve disagreements in the evaluation of these subjective variables. As for the other variables, the first observer (JK) assessed all the eligible videos and inter-rater agreement of each variable between her and the two assessors (NG and MH) was examined. Disagreements in the evaluation of these objective variables were resolved through discussion.

In the main analyses, I first conducted χ^2 tests to calculate odds ratios of gaining high view counts for each variable (univariable analyses). Second, I performed logistic regression analyses to see the independent effect of each variable adjusted for the other variables (multivariable analyses). In the logistic regression analyses, I examined variance inflation factors (VIFs) to detect multicollinearity. This indicator provides an idea of how much of the variance in one independent variable is related to the other independent variables[19]. As a rule of thumb, a VIF over 10 indicates the possibility of multicollinearity between variables in a regression model[20]. Subsequently, variables with a VIF over 10 were excluded from the

model. Google document forms and Microsoft Excel were used for data collection, and Microsoft Excel and STATA version 12 were used for the statistical analyses.

4.2.5 Ethics

Because all videos were in the public domain there were no issues related to confidentiality.

4.3 Results

4.3.1 Characteristics of videos

The search yielded approximately 4,880,000 videos related to medicine, however only 725 of them could be viewed in the search results. All these videos were screened for eligibility. As a result, 265 videos were found eligible, all of which had been uploaded between 29 November 2006 and 2 November 2011.

Table 4.1 presents the mean, minimum and maximum number of view counts and views per day. Figure 4.2 and 4.3 show the distribution of videos by views per day and logarithm of views per day respectively. There were 107 (39%) videos that had fewer than 50 views per day. The 75th percentile was 197 views per day. Therefore, I classified the number of views as "high" if it was larger than 200 views per day.

Table 4.1 Mean, minimum and maximum number of view counts

	Mean	***Minimum***	***Maximum***
Total view counts	532,931	147	45,897,757
View counts per day	557	0.38	33,020

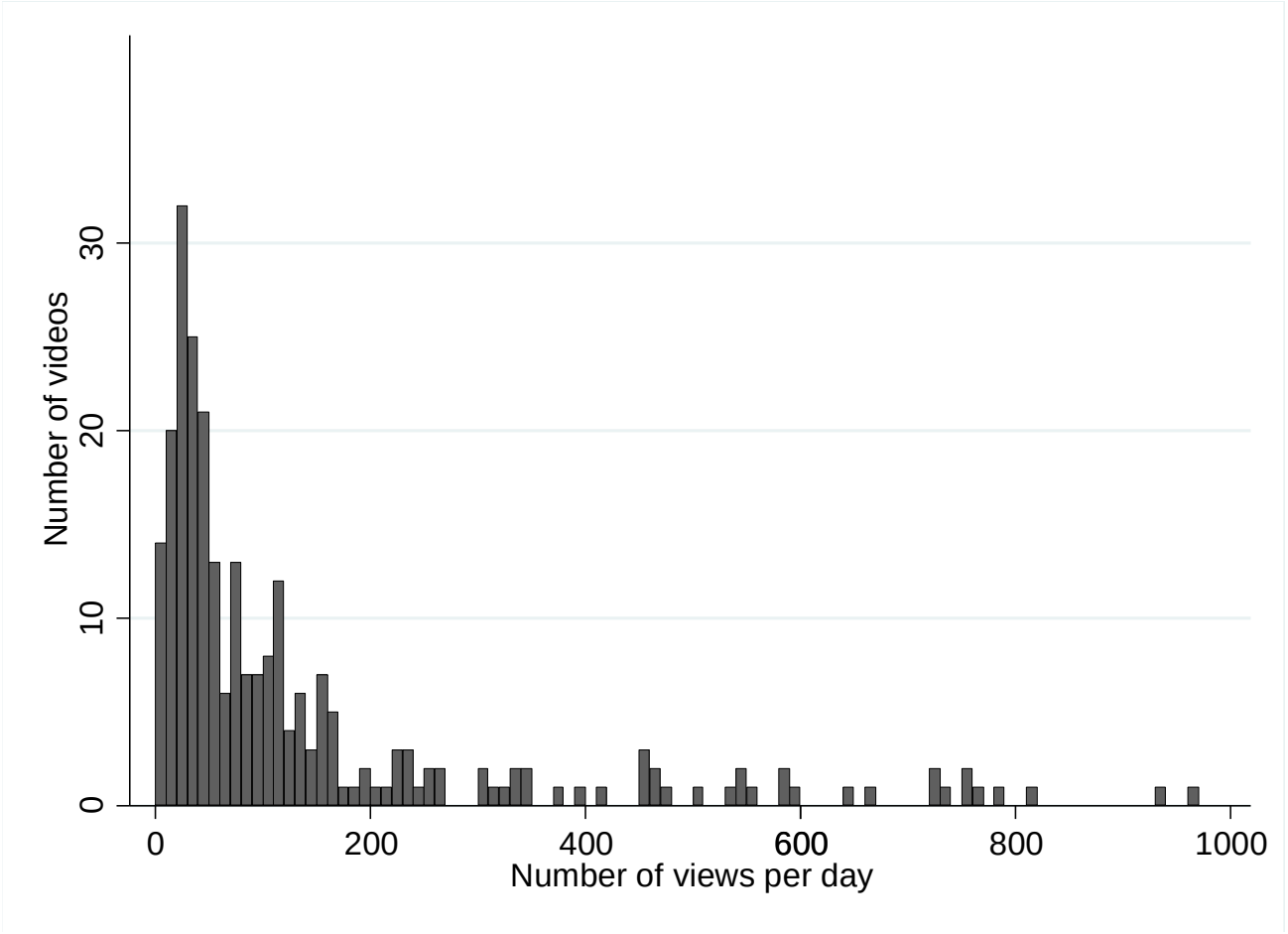

Figure 4.2 Distribution of videos by views per day

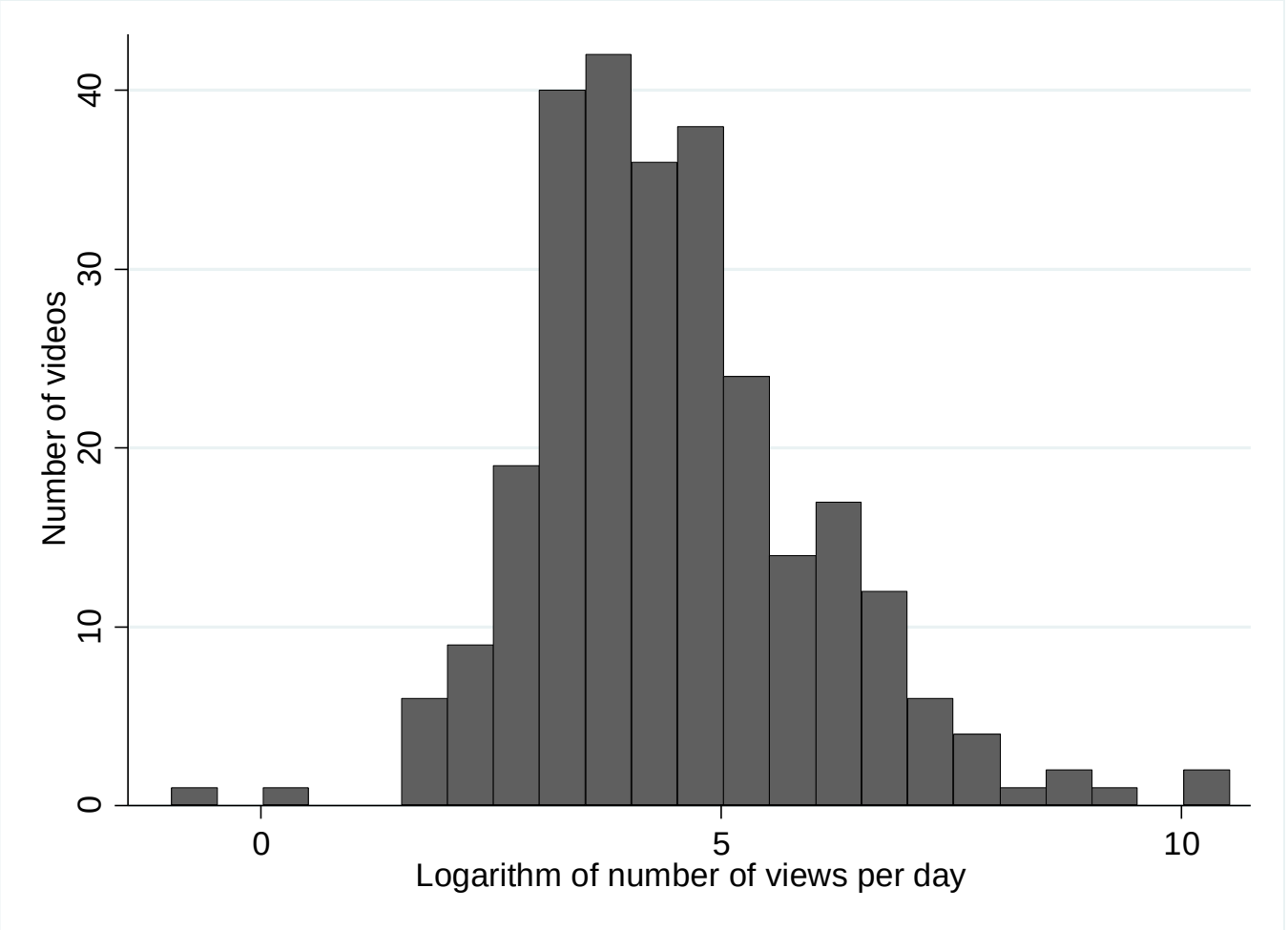

Figure 4.3 Distribution of videos by logarithm of views per day

Mean length was approximately 6.5 minutes. The shortest video was 27 seconds and the longest was 15 minutes. A histogram of length (figure 4.4) showed bimodal distribution. Although the mode was around 10 minutes, I attributed the peak at 10 minutes to the 10-minute limitation that had been in place from March 2006 to July 2010[21]. Therefore, I chose 200 seconds (the second largest peak) as a threshold for classifying videos as "short".

4.3.2 Reliability of data assessment

Inter-rater agreement of the evaluation of emotion and valance was fair between KK and MH (k=0.22 [95%CI 0.05 to 0.39] and 0.32 [0.05 to 0.6], respectively). The disagreement in these subjective variables could not be resolved. Table 4.2 presents the details of the inter-rater agreement of the subjective variables.

Table 4.2 Inter-rater agreement of evaluation of subjective variables

Between observer MH and KK (video numbers 88-137)

	% Agreement	*Kappa*	*(95% CI)*	*P value*
Emotion	54.0	0.22	(0.05 - 0.39)	0.01
Valence	74.0	0.32	(0.05 - 0.60)	<0.01

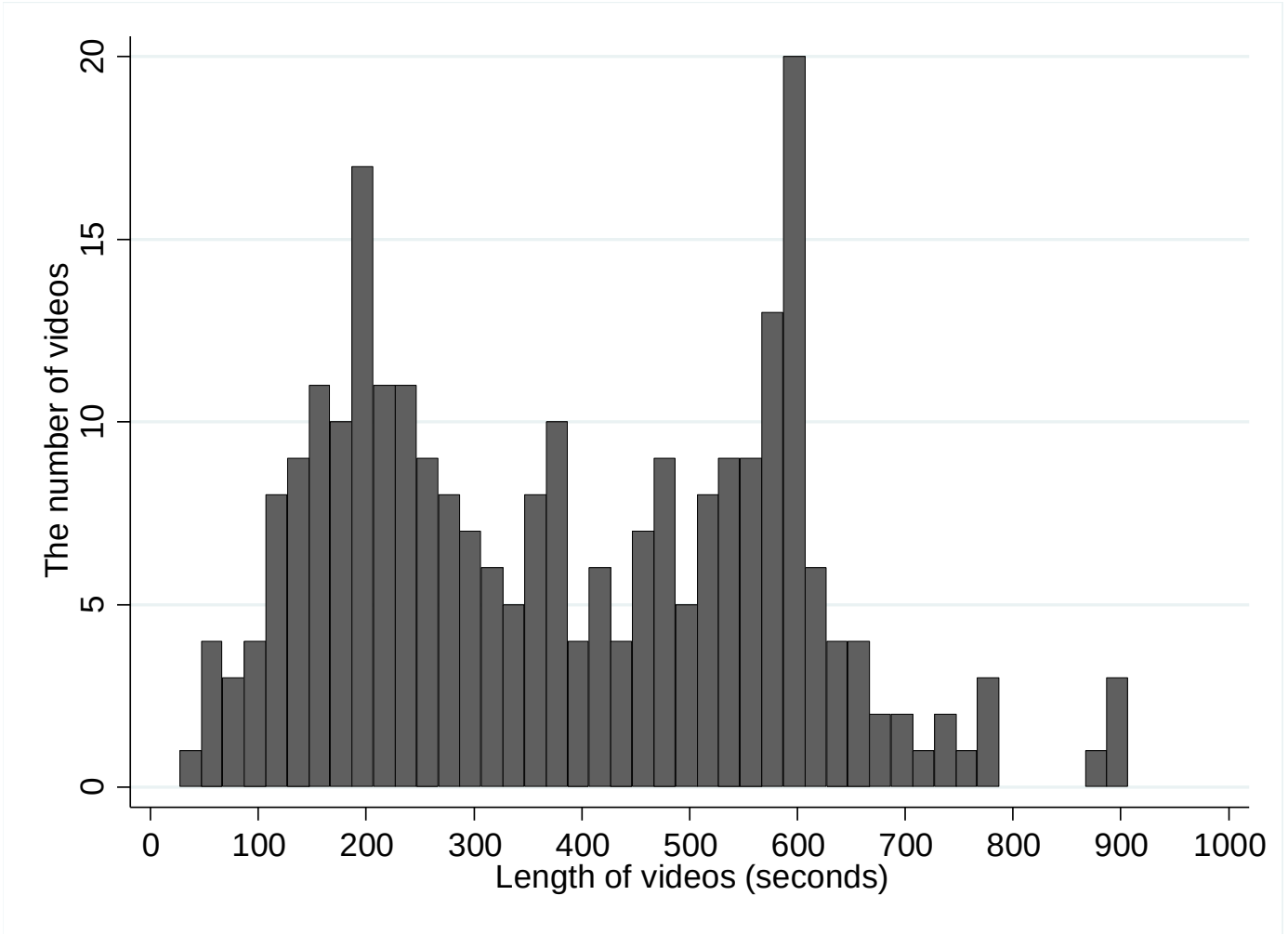

Figure 4.4 Distribution of video length

Agreement for objective variables was low between JK and MH with four out of the 13 variables poor (age group: k=0.11 [95%CI 0.02 to 0.13], country: 0.00 [-], topic in the title: 0.12 [-0.13 to 0.38], presence of non-patient: 0.15 [-0.02 to 0.32]). Six variables were fair or moderate (animation: k=0.5 [95%CI 0.35 to 0.65], clinical feature: 0.4 [0.24 to 0.43], presence of patient: 0.6 [0.41 to0.8], demonstration: 0.3 [0.17 to 0.43], main idea: 0.57 [0.44 to 0.61]). Three variables were rated as good or very good (BGM: k=0.76 [95%CI 0.63 to 0.9], voice: 1.0 [1.0 to 1.0], sex: 0.66 [0.21 to 1.0]). On the other hand, the agreement between JK and NG was high for seven variables, resulting with good or very good agreement (BGM: k=0.75 [95%CI 0.64 to 0.86], clinical feature: 0.64 [0.59 to 0.69], voice: 0.91 [0.78 to 1.0], sex: 0.87 [0.83 to 0.93], country: 0.85 [0.57 to 1.0], presence of patient, main idea). Five variables were moderate or fair (animation: k=0.41 [0.28 to 0.54], age group: 0.38 [-], presence of non-patient: 0.24 [0.07 to 0.4], demonstration: 0.38 [0.25 to 0.51], sound effect: 0.22 [-0.03 to 0.47]). Agreement in one variable was rated as poor (topic in the title: k=0.04 [-0.15 to 0.23]). Table 4.3 presents the details of inter-rater agreement of the objective variables. All disagreements in the evaluation of these variables were resolved by discussion.

Table 4.3 Inter-rater agreement of evaluation of objective variables

Between observer JK and MH (video numbers 88-265)

	% Agreement	*Kappa*	*(95% CI)*	*P value*
Animation	73.3	0.50	(0.35 to 0.65)	<0.01
Back-ground music	88.9	0.76	(0.63 to 0.90)	<0.01
Clinical feature	52.2	0.40	(0.24 to 0.43)	<0.01
Voice	100.0	1.00	(1.00 to 1.00)	<0.01
Age group	63.1	0.11	(0.02 to 0.13)	<0.01
Sex	97.8	0.66	(0.21 to 1.00)	<0.01
Country	98.9	0.00	(-)	<0.01
Topic in the title	87.8	0.12	(-0.13 to 0.38)	0.05
Presence of patient	85.6	0.60	(0.41 to 0.80)	<0.01
Presence of non-patient	61.8	0.15	(-0.02 to 0.32)	0.04
Demonstration	60.0	0.30	(0.17 to 0.43)	<0.01
Main idea	77.3	0.57	(0.44 to 0.61)	<0.01
Sound effect	75.6	0.24	(0.06 to 0.42)	<0.01

Table 4.3 Inter-rater agreement of evaluation of objective variables (continued)

Between observer JK and NG (Video numbers 1-87)

	% Agreement	*Kappa*	*(95% CI)*	*P value*
Animation	68.7	0.41	(0.28 to 0.54)	<0.01
Back-ground music	87.8	0.75	(0.64 to 0.86)	<0.01
Clinical feature	74.8	0.64	(0.59 to 0.69)	<0.01
Voice	98.5	0.91	(0.78 to 1.00)	<0.01
Age group	72.1	0.38	(-)	<0.01
Sex	97.0	0.87	(0.83 to 0.93)	<0.01
Country	99.2	0.85	(0.57 to 1.00)	<0.01
Topic in the title	81.7	0.04	(-0.15 to 0.23)	0.32
Presence of patient	92.4	0.76	(0.62 to 0.90)	<0.01
Presence of non-patient	63.4	0.24	(0.07 to 0.40)	<0.01
Demonstration	66.4	0.38	(0.25 to 0.51)	<0.01
Main idea	80.9	0.64	(0.55 to 0.80)	<0.01
Sound effect	87.8	0.22	(-0.03 to 0.47)	<0.01

4.3.3 Univariable analyses

Table 4.4 presents odds ratios of gaining high view counts for each exposure and confounder variable. Videos featuring people of working age (OR 6.6 [95%CI 2.3 to 19.4]) or females (13.7 [4.5 to 42.4]) were more likely to achieve high view counts. Short videos were more likely to gain a high view count than long videos (5.3 [2.7 to 10.1]). A line added to the scatter plot of video length and logarithm of view counts per day (figure 4.5) drew a gradual decline and the correlation coefficient showed weak negative correlation (r=-0.4) between the length and view counts. On the other hand, if someone was talking in the video, the video had an approximately 70% smaller chance of gaining a high view count (0.3 [0.1 to 0.7]). Moreover, the appearance of a person who is neither a patient nor their relative decreased the chance by 60% (0.4 [0.2 to 0.7]).

Table 4.4 Table 4.4 Odds ratios of gaining higher view counts per day

Variable	*High (>200)*	*Low (≤200)*	*OR*	*(95% CI)*	*P- value*
Back-ground music					
Present	28	69	1.4	(0.8-2.6)	0.21
Absent	37	131	1.0		
Sound effect					
Present	8	6	4.5	(1.5-13.9)	<0.01
Absent	57	194	1.0		
Voice					
Present	56	192	0.3	(0.1-0.7)	<0.01
Absent	9	8	1.0		
Animation					
Present	35	51	3.4	(1.9-6.2)	<0.01
Absent	30	149	1.0		
Main topic in the title					
Yes	60	174	1.8	(0.7-4.9)	0.25
No	5	26	1.0		
Valence of the context of the video					
Positive	54	165	1.0	(0.5-2.2)	0.92
Negative	11	35	1.0		
Length (seconds)					
Short (0-200)	33	26	5.3	(2.7-10.1)	<0.01
Long (201-900)	42	174	1.0		
Emotion					
Present	30	71	1.6	(0.9-2.8)	0.13
Absent	35	129	1.0		
Country					
Non-native English	0	5	0	(-)	0.20
Not specified	65	195	1.0		
Presence of patients or their relatives					
Present	10	41	0.7	(0.3-1.5)	0.36
Absent	55	159	1.0		
Presence of non-patients					
Present	37	153	0.4	(0.2-0.7)	<0.01
Absent	28	47	1.0		
Demonstration					
Present	31	67	1.8	(1.0-3.2)	0.04
Absent	34	133	1.0		

Table 4.4 Odds ratios of gaining higher view counts per day (*continued*)

Variable	*High (>200)*	*Low (≤200)*	*OR*	*(95% CI)*	*P- value*
Clinical feature					
Infectious disease	3	3	8.0	(1.34-46.2)	<0.01
Cancer	5	9	4.4	(1.3-15.7)	0.01
Cardiovascular disease	7	12	4.7	(1.5-14.4)	<0.01
Blood or autoimmune disease	1	2	4.0	(0.3-48.1)	0.24
Endocrine, nutritional or metabolism disease	1	10	0.8	(0.1-6.8)	0.81
Mental disorder	3	5	4.8	(1.0-23.1)	0.03
Pregnancy, childbirth	14	4	28.0	(6.2-125.6)	<0.01
Congenital malformation or disorder	2	5	3.2	(0.6-18.4)	0.17
Injury and poisoning	1	16	0.5	(0.1-4.1)	0.51
Other	14	22	5.1	(2.0-12.7)	<0.01
No specific disease	14	112	1.0		
Sex					
Male	0	1	0.0	(-)	0.62
Female	17	5	13.7	(4.5-42.4)	<0.01
No specific sex group	48	194	1.0		
Age group					
Children (0-15 years old)	2	7	1.0	(0.2-5.1)	0.97
Working age (16-64 years old)	11	6	6.6	(2.3-19.4)	<0.01
Older people (65+ years old)	0	0	-	(-)	-
No specific age group	52	187	1.0		
Main idea					
Basic knowledge of medicine	8	36	0.8	(0.3-1.8)	0.55
Information about a certain disease	17	25	2.4	(1.2-4.9)	0.02
Information about a certain treatment	40	139	1.0		

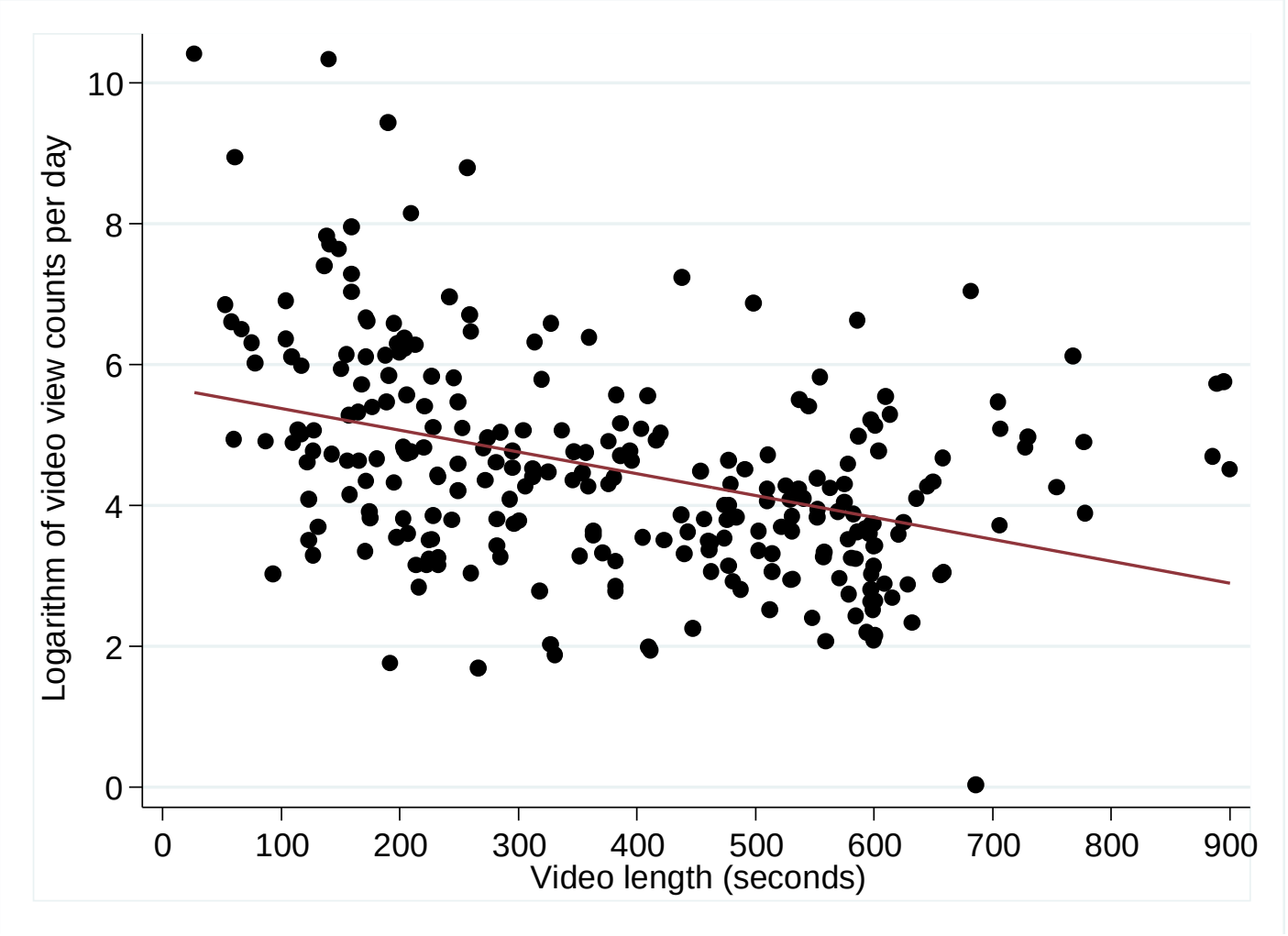

Figure 4.5 Scatter plot of video view counts per day (logarithm) and length

4.3.4 Multivariable analyses

Table 4.5 shows variation inflation factors (VIFs) of each variable. All variables except voice (VIF=16.1) had small VIFs, and I eliminated voice from the model. Table 4.6 summarises the results of the logistic regression analysis. Two variables, sex and country, were excluded from the model because there was no observation in one of the categories. According to the model, sound effect (OR 6.9 [95%CI 1.3 to 37.8]), short videos (10.3 [4.0 to 27.0]), emotion (2.6 [1.1 to 6.3]), demonstration (5.9 [1.9 to 18.7]) and information about a specific disease (3.9 [1.2 to 13.3]) increases the chance of gaining high view counts. Videos about cancer (13.54 [2.49 to 73.8]), mental disorders (14.75 [1.95 to 111.37]) and pregnancy or childbirth (9.13 [1.21 to 69.02]) are also more likely to be watched by many people.

Table 4.5 VIFs of each variable in first regression model

	VIF
Back-ground music	2.19
Sound effect	1.35
Voice	16.14
Animation	2.09
Impression total	2.04
Valence	
Positive	6.46
Negative	-
Main topic in the title	8.29
Length	
Short (0-200 seconds)	1.64
Age group	
Children (0-15 years old)	1.45
Working age (16-64 years old)	2.39
Older people (65+ years old)	-
No specific age group	-
Presentation1	
Presence of patients or their relatives	2.13
Presentation2	
Presence of non-patients	6.22
Presentation3	
Demonstration	3.11
Clinical feature	
Infectious disease	1.12
Cancer	1.22
Cardiovascular disease	1.54
Blood or autoimmune disease	1.14
Endocrine, nutritional or metabolism disease	1.22
Mental disorder	1.23
Pregnancy, childbirth	2.7
Congenital malformation or disorder	1.44
Injury and poisoning	1.32
Other	1.62
No specific disease	-
Main idea	
Basic knowledge	1.7
Specific disease	2.08
Specific treatment	-

Table 4.6 Summary statistics of the logistic regression model

Variable	*OR*	*(95%CI)*	*P value*
Back-ground music	1.4	(0.6-3.5)	0.44
Sound effect	6.9	(1.3-37.8)	0.03
Animation	1.9	(0.8-4.8)	0.16
Emotion	2.6	(1.1-6.3)	0.03
Valence			
Positive	1.1	(0.4-3.5)	0.82
Negative	1		-
Main topic in the title	1.3	(0.4-4.6)	0.71
Short (0-200 seconds)	10.3	(4.0-27.0)	<0.01
Age group			
Children (0-15 years old)	0.7	(0.1-5.3)	0.73
Working age (16-64 years old)	2.6	(0.4-18.6)	0.35
Older people (65+ years old)	-		-
No specific age group	1		
Patients or their relatives presenting	0.9	(0.3-3.1)	0.90
Non-patients presenting	0.8	(0.3-1.9)	0.54
Demonstration	5.9	(1.9-18.7)	<0.01
Clinical feature			
Infectious disease	6.9	(0.8-59.0)	0.08
Cancer	13.5	(2.5-73.8)	<0.01
Cardiovascular disease	2.4	(0.5-12.3)	0.30
Blood or autoimmune disease	1.4	(0.1-23.2)	0.81
Endocrine, nutritional or metabolism disease	3.4	(0.3-35.9)	0.31
Mental disorder	14.8	(2.0-111.4)	0.01
Pregnancy, childbirth	9.1	(1.2-69.0)	0.03
Congenital malformation or disorder	4.7	(0.5-43. 7)	0.18
Injury and poisoning	0.3	(0.03-3.3)	0.32
Other	5.7	(1.7-18.8)	<0.01
No specific disease	1		-
Main idea			
Basic knowledge of medicine	1.8	(0.4-7.2)	0.43
Information about a certain disease	3.9	(1.2-13.3)	0.03
Information about a certain treatment	1		-

4.4 Discussion

4.4.1 Principal findings

This is the first study to examine the association between characteristics of online medical videos and view counts. The results of the linear regression analyses are more valid than univariable analyses because each variable was adjusted for confounding by other variables. The results of multivariable analyses provided good evidence for strong associations between view counts and sound effect, emotional content, length and demonstration. This study also found that medical online videos about certain types of diseases are more likely to be watched by many people than those focused on general medical information or treatment methods. Online medical videos about cancer, mental disorders and childbirth were in particular strongly related to high view counts.

4.4.2 Strengths and weaknesses

Reverse causality is a main concern in a cross-sectional study. In this study, exposure and confounder variables were video characteristics and did not change after being uploaded on YouTube. View counts increased as a result of the video components and there was no chance that the outcome could affect the exposures or the confounders. Therefore, this study has no risk of reverse causality.

I minimised the risk of misclassification in the assessment of the objective exposure and confounding variables by having two independent assessors evaluate the same videos and resolving disagreements by discussion. However, I could not resolve disagreements in the

assessment of subjective exposure variables, which might have resulted in misclassification. This non-differential misclassification could have exaggerated or underestimated the effect of emotion and valence on view counts. The outcome was the number of views provided by YouTube and the chance of misclassification of the outcome was minimal.

It is understandable that the assessment of the subjective variables differs from one assessor to another. However, the assessment of the objective variables should have been consistent between the two assessors. The inter-rater agreement between JK and MH was low in some categories. This was presumably due to insufficient understanding of the definition of each variable prior to the assessment or low engagement with the task to assess the videos.

To reduce the risk of confounding, I included possible confounders in the regression analyses. However, including too many variables in one regression analysis led to low precision. In addition, although I included as many confounders as possible in the model, there is still the possibility that unknown factors confounded the association between the exposure variables and the outcome.

The algorithm by which YouTube ranks videos in search results is not publicly available. Nevertheless, the common understanding is that the algorithm changes from time to time[27]. Therefore, it is difficult to identify the factors that might cause a selection bias. The most recently known influential factor is “watch time”[27,28]. Watch time is “The amount of time

that a viewer has watched a video"[29]. YouTube rank videos that are watched by viewers for a long time higher than videos that have high view counts but watched for a short time. YouTube prioritises in suggested watch lists videos including key words in the title or tags and those that have longer time watched by viewers. This means videos that are catchy and attract viewers only for a short time will not be listed high in the search results. This study included only the first 725 videos out of 4,880,000 videos shown in the search results. These included videos were assumed to have the aforementioned characteristics. Therefore, the factors that were found associated with view counts in this study might apply only to videos that have relevant keywords (medical) in the title or tags and that are watched by viewers for a longer time than others. Discovering factors that affect view counts for videos retaining audiences well would be helpful in creating videos for dissemination of research findings.

4.4.3 Implications

I assume, from the results of this study, that medical online videos with the following factors are more likely to be watched by many people and therefore, suitable for disseminating medical information: less than three minutes long, inclusion of sound effects, emotional content, and demonstration of certain techniques.

4.4.4 Future research

The effect of the characteristics which were found associated with high view counts is still uncertain because there could be unknown confounders. Randomised controlled trials to

test the effect of each characteristic on view counts will avoid the problem of confounding. The effect of emotional content appeared to be promising but remained uncertain due to potential misclassification of whether the videos included emotional content or not. Moreover, the confidence interval of the risk ratio was broad and the lower confidence interval was close to one. Further research using a more reliable measurement of emotion and more accurate study design will allow evaluation of the effect of emotional content on view counts more precisely. In addition, the audience of the videos included in the current study is broad. To examine the potential of online videos to disseminate research findings among health care professionals, a randomised controlled trial targeting the specific population is required.

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5 Does caring lead to sharing? A pilot randomised controlled trial of the effect of emotional content on the sharing of an online video

5.1 Introduction

5.1.1 Background

The cross-sectional study presented in chapter 4 identified some characteristics of online videos that are associated with the number of views they receive. However, the results were imprecise and there was the possibility of confounding.

Recently, marketing and business literature has put considerable emphasis on the importance of a strong emotional narrative to encourage information sharing[1,2]. In my cross-sectional study, emotional content appeared to be associated with view counts, which is one of the indicators of the popularity of online videos. However, the effect of emotion might have been underestimated because of non-differential misclassification and may have been confounded by other factors. Therefore, it remains uncertain whether emotional content affects the number of views. A more valid way to examine the effect of emotion on view counts would be to conduct a randomised controlled trial (RCT).

Berger and Milkman conducted an RCT to examine the effect of emotional content on online information sharing among university students[3]. The study found that emotions, such as happiness or anger, encouraged information sharing. However, there has been no RCT assessing the effect of emotional content on dissemination of online medical videos

among health care professionals and researchers. A randomised controlled trial is therefore required.

In chapter 1, I focused on the results of the CRASH-2 trial and India since it is country which could benefit significantly from disseminating the results of the trial. However, in the main study, I shifted the focus to the WOMAN trial and broadened the focus to be worldwide.

The WOMAN trial is designed to test the effectiveness of tranexamic acid (TXA), which was used in the CRASH-2 trial, on post-partum haemorrhage. Therefore, the main message -the importance of introducing TXA- was the same. In addition, the WOMAN trial was active when I conducted the DIFFUSION trial and the opportunity was seen to assess the usefulness of disseminating a video about the WOMAN trial to advertise it and recruit more hospitals. Moreover, the WOMAN trial team had a contact list of doctors who had shown their interest in the trial previously and it was helpful for me to include the list in the DIFFUSION trial participant recruitment. Therefore, it was mutually beneficial for both trials if I made videos about the WOMAN trial and disseminated them in the DIFFUSION trial.

As regards target countries, chapter 1 showed that India could benefit significantly from introducing TXA. However, the intervention was an online tool and so I could disseminate the videos globally wherever the internet was available. Therefore, I did not limit the target to India and included any applicable countries in this study.

5.1.2 Aim of the study

To test the procedure of the main phase of the trial including the email-sending process and the use of a computer programme to record the access to the videos.

5.2 Methods

5.2.1 Study design and procedures

I conducted a two-arm randomised controlled trial to examine the effect of emotional content on the extent to which online videos are shared among health care professionals. I compared two videos about the WOMAN trial, both of which were about 2.5 minutes long, one of which scored higher in terms of emotional content than the other. The videos were identical apart from the intervention. I made the videos available to participants via YouTube, the most visited video sharing website[4] through an account I created for this study. I randomised eligible participants to either the intervention video or control video and sent an email message with a link to the allocated video. I asked them to watch the video and forward it to their colleagues if they found it helpful. The invitation email message is shown in appendix 5-A. I prepared a computer programme to monitor access to the videos.

I used Google mail merge to send out the email messages. It allows us to personalise certain parts of email subject line or main text, such as an addressee, when sending mass emails. As there is a limit to the number of emails that can be sent a day (100 emails a day), I created multiple google mail accounts to send out emails to the required number of participants. Sending the emails to one group after the other could affect the results as the participants in the former group will have more time to access the video. Therefore, I sent the email messages to both groups at the same time. As it was impossible to send emails using different Google mail accounts at the same time from one computer, I used two computers for sending email messages.

5.2.2 Participant entry

Sample size

Based on previous studies[5–9], I assumed that about 10% of emails would be forwarded (baseline). Assuming that the trial intervention increased forwarding from 10% to 17.5% (a 75% increase), then approximately 1000 participants, 500 in the intervention group and 500 in the control group, would be required to test the null hypothesis at the 5% significance level with 90% power.

Eligibility

Health care professionals and researchers in obstetrics and gynaecology worldwide with an email address apart from those in countries where the access to YouTube is banned (China[10], Iran[11], Pakistan[12], Turkmenistan[13]) were eligible. Although the result of this study could be applied to other video sharing website such as Youku in China, the video sharing website used for this study was YouTube. Participants in countries that cannot access YouTube were therefore excluded.

Enrolment procedure

I screened international journals in obstetrics and gynaecology published in 2013 and 2014 for participant email addresses. I included email addresses of the authors whose articles were published in the journals and who met the inclusion criteria. I also included health care professionals who had expressed an interest in the WOMAN trial.

5.2.3 Randomisation and allocation concealment

Three trial assistants collected email addresses and enrolled participants. After examining the applicability of the participants, the chief investigator assigned the included email addresses sequential numbers (ID numbers). An independent statistician randomised the ID numbers to either the intervention group or the control group with an allocation sequence generated with a computer random number generator (1:1 randomisation). The statistician was masked to the individual email addresses when randomising the ID numbers.

5.2.4 Blinding

As the two videos were noticeably different, participants could not be masked in this trial. However, each participant only received one of the videos, so in principle they were not able to tell if they received a video with more or less emotional content. The outcome assessor was masked to the response of each participant by using ID numbers instead of individual names or email addresses. The person who analysed the data was also masked to intervention allocation.

5.2.5 Interventions

Intervention arm: a short online video (2”43 minutes long) about the WOMAN trial with more emotional content (an interview with a postpartum haemorrhage survivor and her husband talking about their experience).

Control arm: a short online video (2”43 minutes long) about the WOMAN trial with less emotional content (the interviewer provides a second hand description of the experience of a postpartum haemorrhage survivor and her husband).

Validation of the intervention

I conducted a cross-over trial to examine the difference in the level of emotion that both videos aroused and ensure that the intervention video had more emotional content than the control video.

I randomly allocated participants to different orders to watch the two videos. Group 1 watched the control video first and the intervention video second. Group 2 watched the intervention video first. I asked the participants to score the level of emotion they felt while/after watching the videos using a nine point Likert scale (0 is none and 8 is strongest) for each of five different types of emotion: happiness, interest, relief, surprise and tension. I used a paired t-test as the primary test of statistical significance of the difference in emotion the two videos aroused. I also conducted a t-test to compare the mean of score difference for each of the five emotions between the two groups and examined the effect of order to watch the videos on the evaluation of emotions.

I randomised a total of 58 participants, who were researchers and research degree students at the London School of Hygiene & Tropical Medicine. All of them watched and evaluated

both videos. One person was randomised, but withdrew because she did not have the internet access in order to watch the videos. She watched neither of the videos. There were no additional withdrawals apart from this participant. All the other participants evaluated both videos.

Table 5.1 presents the average emotion scores for the intervention video and control videos. The intervention video aroused stronger emotions than the control video. Three out of five emotions in the intervention video scored approximately one point higher than the control video. This is more than a 10% increase in the level of emotion. Interest was the strongest emotion in the intervention video and showed the second largest difference between the two videos (intervention video: 6.0 points [95%CI 5.6 – 6.5], control video: 5.0 points [4.5 to 5.5], difference: 1.0 point [0.4 to 1.7], $p<0.01$). The scores for happiness were also high showing the largest difference between videos (3.9 points [3.2 to 4.6], 2.8 points [2.2 to 3.4], 1.1 points [0.4 to 1.8], $p<0.01$). The scores for surprise were the lowest among the five emotions but showed the third largest difference (2.8 points [2.2 to 3.3], 1.9 points [1.5 to 2.4], 0.8 points [0.1 to 1.5], $p=0.02$). There was less of a difference in relief (4.8 points [4.1 to 5.5], 4.4 points [3.8 to 5.1], 0.4 points [-0.5 to 1.2], $p=0.41$) and tension (3.7 points [3.1 to 4.3], 3.2 points [2.6 to 3.8], 0.5 points [-0.4 to 1.3], $p=0.26$). Overall, the intervention video scored higher in all types of emotion (figure 5.1) providing some evidence that the intervention video aroused more emotion than the control video.

The t-test did not show strong evidence that the order of watching the videos impacted on the evaluation of the emotions. However, figure 5.2 shows bigger difference between group 1 and 2 in the mean of score difference between the intervention video and the control video for relief (mean difference in group 1: 0.5 points [-0.6 to 1.7], group 2: 0.1 point [-1.3 to 1.6], p=0.65) and tension (0.7 points [-0.5 to 1.9], 0.2 points [-1.1 to 1.4], p=0.54). This implies that the participants who watched the control video first might have felt relief and tension more strongly than those who watched the intervention video first.

Table 5.1 Average score for five emotions

Variable	*Intervention video (95% CI)*	*Control video (95% CI)*	*Difference (95% CI)*	*P-value*
Happiness	3.9 (3.2 – 4.6)	2.8 (2.2 – 3.4)	1.1 (0.4 – 1.8)	<0.01
Interest	6.0 (5.6 – 6.5)	5.0 (4.5 - 5.5)	1.0 (0.4 – 1.7)	<0.01
Relief	4.8 (4.1 – 5.5)	4.4 (3.8 – 5.1)	0.4 (-0.5 – 1.2)	0.41
Surprise	2.8 (2.2 – 3.3)	1.9 (1.5 – 2.4)	0.8 (0.1 – 1.5)	0.02
Tension	3.7 (3.1 – 4.3)	3.2 (2.6 – 3.8)	0.5 (-0.4 – 1.3)	0.26

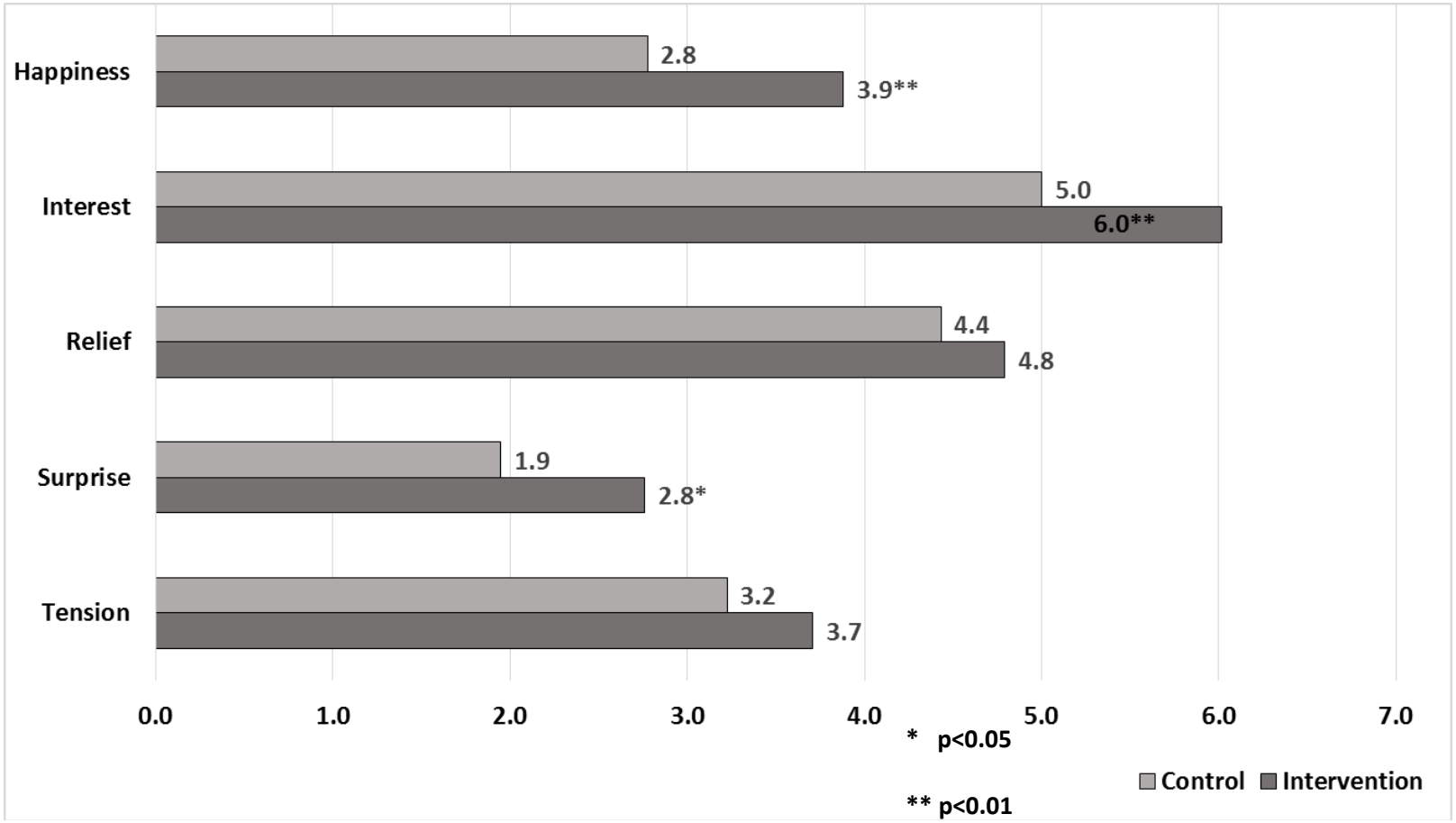


Figure 5.1 Scores for five emotions in the intervention and the control videos

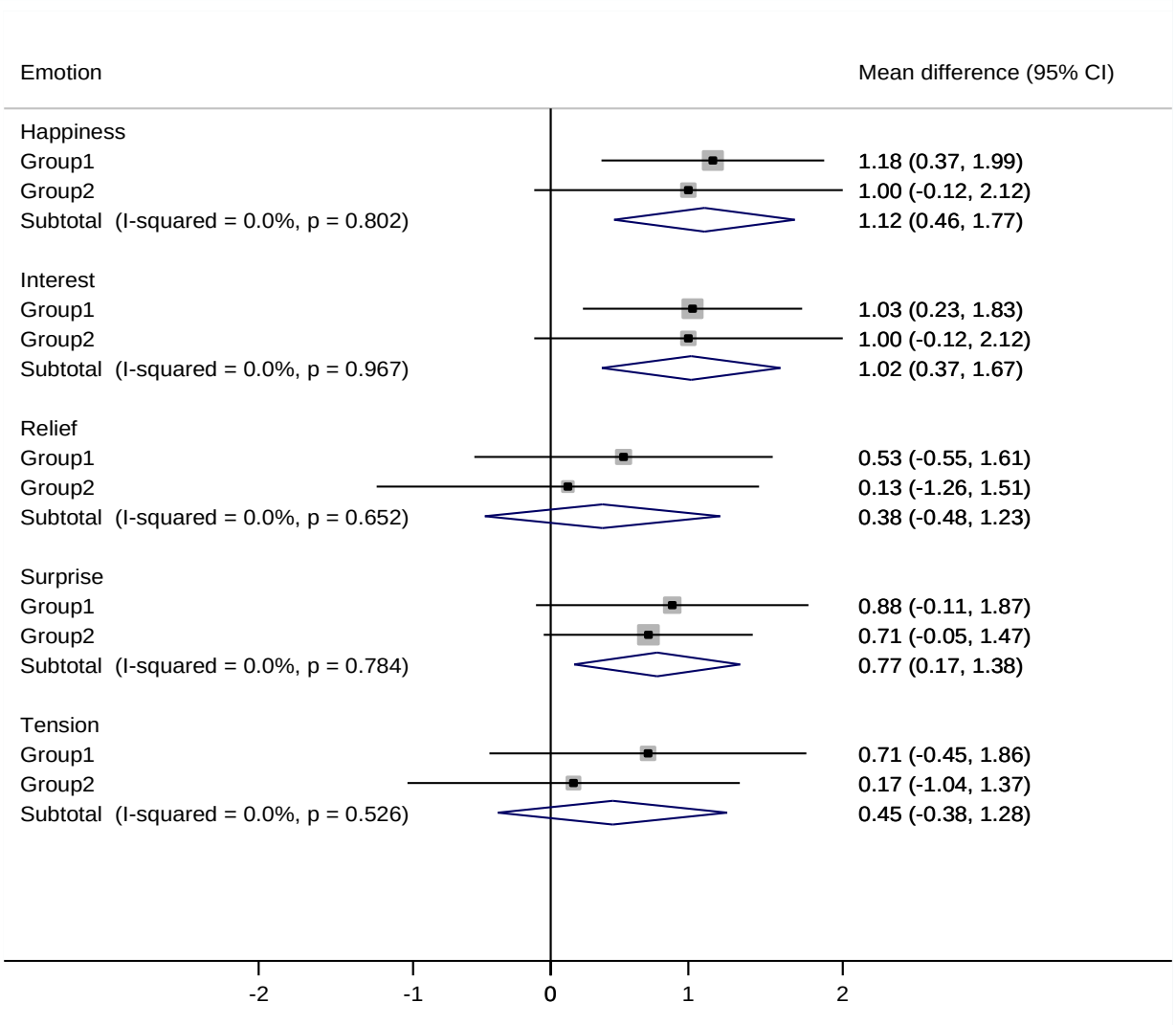


Figure 5.2 Results of the analyses for the five emotions

5.2.6 Outcomes

Primary outcome: video sharing

People disseminate an online video by sharing it. As such, assessing video sharing is the best way to examine the extent to which dissemination with an online video is achieved. The primary outcome was the number of participants who shared the videos in each group.

***Secondary outcome*:** number of views generated as a result of video sharing by each participant

In the event that some of the participants shared the videos, I also examined how strongly the video encouraged participants to share it, namely, the magnitude of the effect of the intervention. I assumed that the stronger the effect was, the more people the participants would share the video with. The number of views generated as a result of video sharing by each participant was considered as the indicator of the magnitude of the effect. In addition, examining the distribution of these numbers allows us to see the pattern of sharing each video generates. For example, one kind of video could be shared similarly by all viewers so that all participants shared the video with one or two people. On the other hand, another kind might be shared frequently by a few people but infrequently by the rest. Therefore, I also examined the distribution of the number of people that each participant shared the video with.

5.2.7 Outcome assessment

Figure 5.3 shows a model of dissemination of online videos. It was critical for the outcome assessment to identify access to the video by a unique individual. However, it was impossible to distinguish access by the same person from access by a different person. Therefore, I defined “access by a unique individual”, which was determined using the data from the four categories collected by the computer programme I prepared: ID number, IP address, type of device and date and time of access. Data in these categories were recorded only if they accessed the video regardless of how long they watched it. Therefore, this programme recorded video viewing rather than video sharing. I assumed video sharing based on the data on video viewing and that was the only way to measure the outcome.

During the randomisation process, I assigned each participant an individual number (ID number). I sent participants an email with a link to the allocated video. The last digits of the link were their ID numbers. The computer programme recorded access to the videos by ID numbers. The links were the only way to access the videos, so if the participants wanted to share the video, they needed to share the link. If the participant shared the personalised link and the person who received it clicked on the link to watch the video, the access was recorded with the same ID number. Therefore, if there was access recorded with the same ID number, it was either the participant who clicked on the link more than once or other persons who clicked on the link shared by the participant.

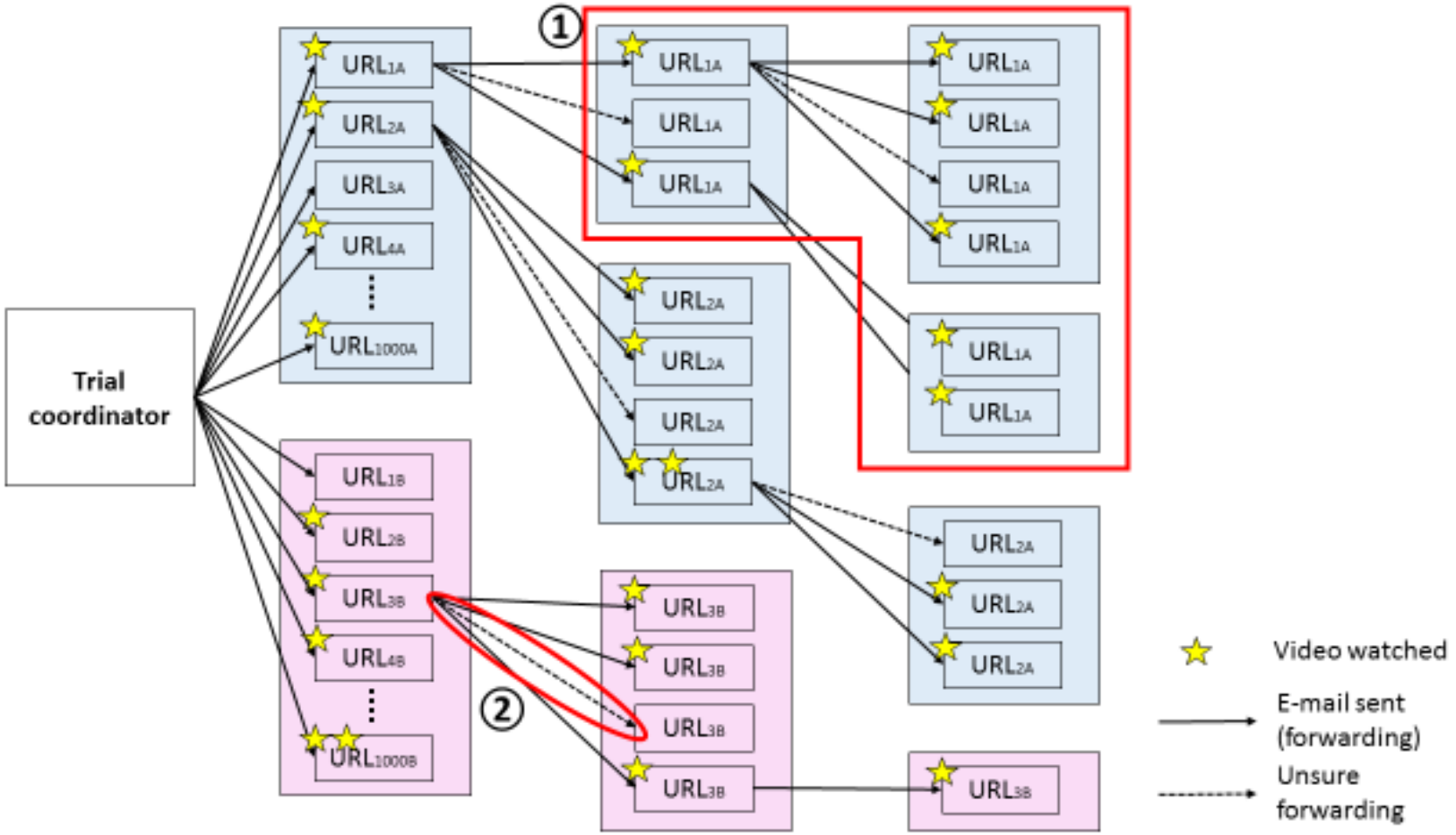


Figure 5.3 Model of dissemination of videos

Each electronic device connected to the internet is assigned a numerical label, called IP address. With an IP address, we are able to identify a device from which the user accessed a certain website. However, identifying a device does not necessarily mean identifying an individual because one person could access the video from different devices, such as computer and smartphone. If I defined access from different devices as access by different people when they were actually by one person, the number of access may be overestimated. Another issue is that we cannot always identify different devices from IP addresses because some organisations have only group IP address open to public but not individual IP address. In this case, if two people from one organisational computer network accessed the video from different devices, the access was recorded with the same IP address. Therefore, if I defined access with the same IP address as access by the same person when they were actually by different persons, the access was underestimated. There were different possible scenarios but I could not confirm which case each access was. I reflected these different scenarios in sensitivity analyses considering the type of device. In the main analysis, I identified an access by a unique individual based on the IP address. I selected the most likely scenario, which was that each participant watched the video from only one device and their IP address represented the individual device but not the organisation. Based on this assumption, I recognised access with different IP addresses as those from different individuals. If the IP addresses were the same, I counted the access as those from the same individual.

Figure 5.4 presents a flow chart for identification of access to the videos. I assessed the primary outcome, sharing, if there was access to the video with the same ID number by more than one unique individual. As for the secondary outcome, I counted the number of views generated as a result of video sharing by each participant by identifying access with the same ID number by unique individuals (① in figure 5.3).

The access time was recorded in Greenwich Mean Time (GMT) regardless of the countries where participants watched the videos. I assumed if the video did not play or the participants wanted to confirm the information in the video, they were likely to access the video again soon after the first time. Therefore, access less than five minutes apart were considered as access at the same time. The time of access was taken into consideration in the sensitivity analyses as well as the type of device.

Data collection started immediately after the emails were sent to the participants. The number of views that resulted from video sharing declines within 14 days of upload[14]. Therefore, I collected the data for 14 days. As I sent the videos in the afternoon of the 1st day, data collection ended at the same time on the 15th day of sending the email message. The messages were sent to the first group of participants on 11 April 2013 and data were collected until 28 April 2013, the 14 days after sending the emails to the last group of participants.

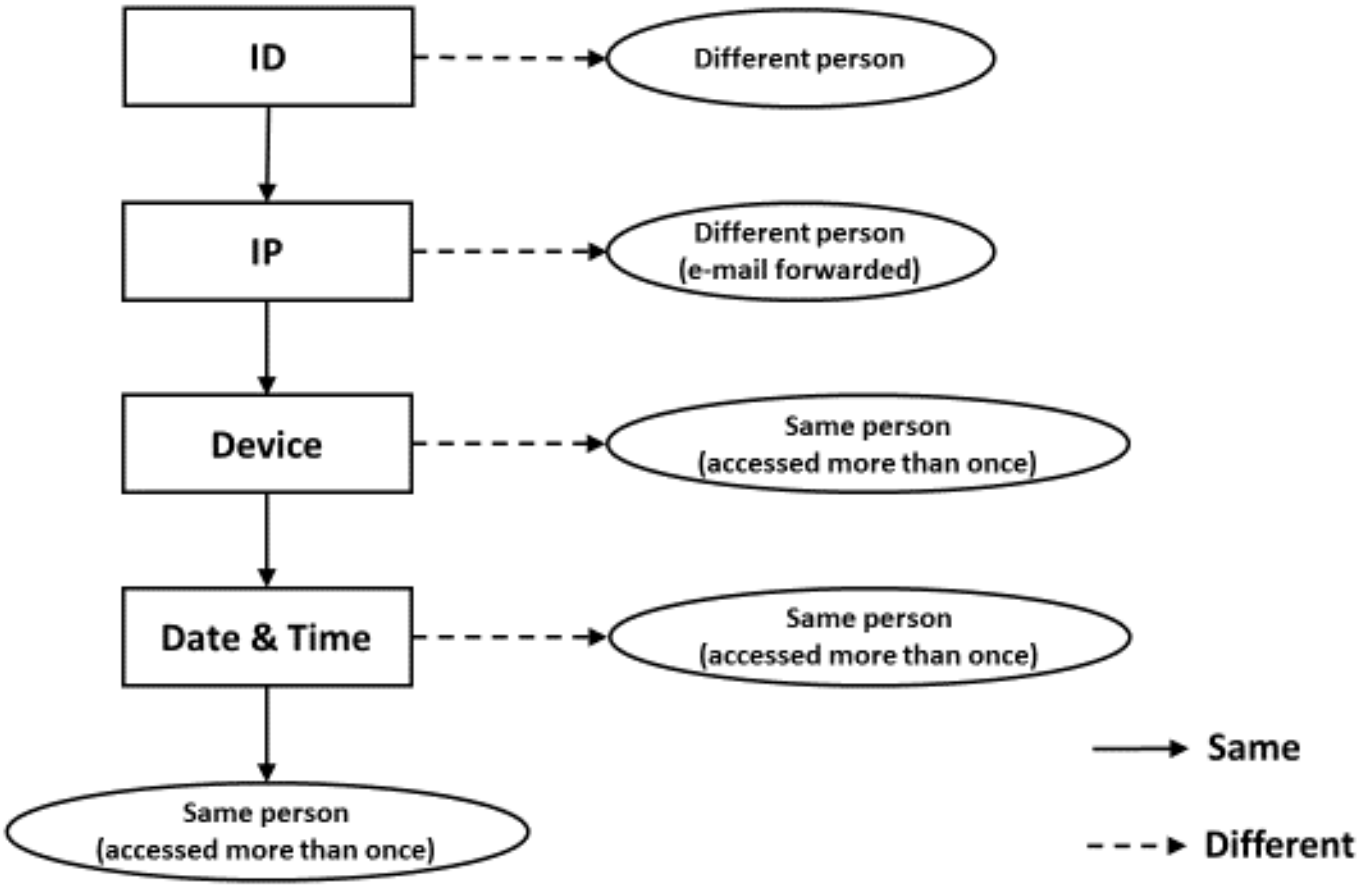


Figure 5.4 Flow chart for defining the access to the videos

5.2.8 Data analyses

I analysed the data of all participants randomised in this trial regardless of whether or not they watched the video, on an intention-to-treat (ITT) basis to test the effectiveness of the intervention. In addition, I analysed data of only those who watched the videos on a per-protocol (PP) basis to estimate the efficacy of the intervention.

Primary outcome

I used a standard χ^2 test as the primary test of statistical significance of the effect of the intervention on video sharing.

Secondary outcome

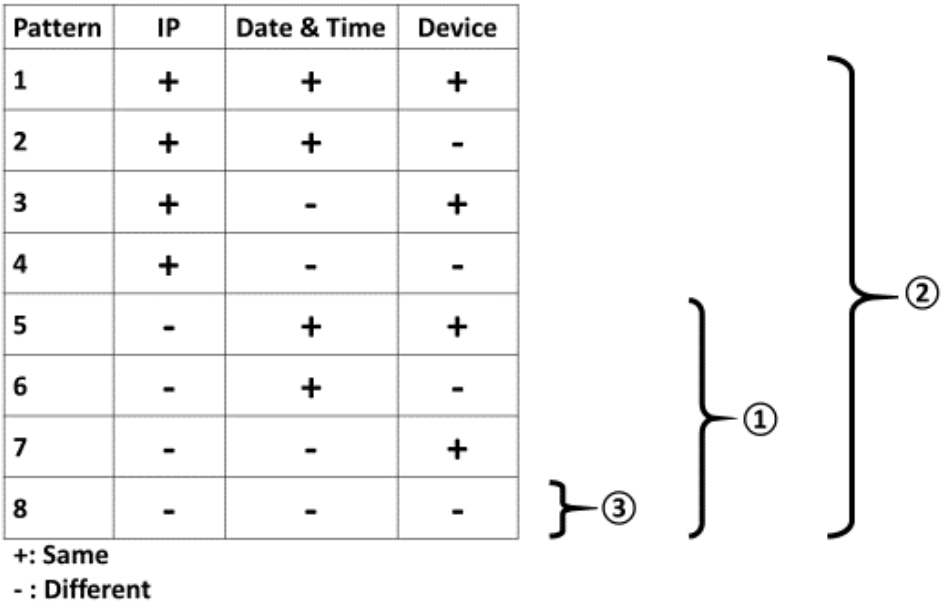
I conducted a t-test and Mood's median test to test the statistical difference in the mean and median of the number of views generated as a result of video sharing by each participant respectively. As for the pattern of sharing, I drew histograms and compared the distribution. As a test for the statistical difference in distribution, I conducted a Wilcoxon signed-rank test.

Sensitivity analyses

The effect of the intervention may vary according to the definition of an access by a unique individual. Therefore, I conducted sensitivity analyses for all outcomes using two different definitions of an access by a unique individual: most conservative definition and most liberal definition. I estimated the possible largest effect of the intervention and the difference in

the outcome between the two groups using the most liberal definition of sharing. Likewise, I estimated the possible smallest effect of the intervention and the difference in the outcome between the two groups using the most conservative definition.

Figure 5.5 shows different patterns of data from different categories. With the most liberal definition, I counted all as access by different persons (② in figure 5.5). With the most conservative definition, I counted it as access by different persons only if the data of IP address, date and time and type of device were all different (③ in figure 5.5).



①**main analyses**: pattern 1 - 4 defined as “access by the same person” and patterns 5 – 8 defined as “access by different persons”
②**most liberal (sensitivity analyses)**: all patterns defined as “access by different persons”
③**most conservative (sensitivity analyses)**: pattern 1 – 7 defined as “access by the same person” and only pattern8 defined as “access by different persons”

Figure 5.5 Different patterns of data and definition of access

5.2.9 Ethics

This study received ethical committee approval from the London School of Hygiene & Tropical Medicine (reference number 6537). This study is registered as Clinicaltrials.gov NCT02109159.

5.3 Results

5.3.1 Characteristics of participants and baseline comparisons

I randomly allocated a total of 2305 email addresses, 1152 of which were allocated to the intervention video and 1153 of which were allocated to the control video. Of those who were in the intervention group, 160 (13.9%) were in low income countries, 401 (34.8%) were in middle income countries and 591 (51.3%) were in high income countries. Of those who were in the control group, 128 (11.1%) were in low income countries, 443 (38.4%) were in middle income countries and 582 (50.5%) were in high income countries. Appendix 5-B presents a list of low, middle and high income countries.

Of those who were in the intervention group, 398 (34.6%) were from the WOMAN trial contact list and 754 (65.5%) were authors of published articles. On the other hand, 359 (31.1%) of the participants in the control group were from the WOMAN trial contact list and 794 (68.9%) were authors of articles published in international journals. Table 5.2 presents the baseline information of the participants who were allocated to the videos and who watched the videos.

Table 5.2 Baseline data – all participants randomised and who watched the videos

	Intervention video	*Control video*
All participants randomised	1152	1153
Country		
Low income countries	160 (13.9%)	128 (11.1%)
Middle income countries	401 (34.8%)	443 (38.4%)
High income countries	591 (51.3%)	582 (50.5%)
Source of contact		
WOMAN trial contact list	398 (34.6%)	359 (31.1%)
Journals	754 (65.5%)	794 (68.9%)
Participants who watched the video	160/1152 (13.9%)	161/1153 (14.0%)
Country		
Low income countries	18 (11.3%)	23 (14.3%)
Middle income countries	62 (38.8%)	69 (42.9%)
High income countries	80 (50.0%)	69 (42.9%)
Source of contact		
WOMAN trial contact list	55 (34.4%)	65 (40.4%)
Journals	105 (65.6%)	96 (59.6%)

Of the 1152 participants in the intervention group, 160 (13.9%) participants watched the video. Of the 1153 in the control group, 161 (14.0%) participants watched the video. Figure 5.6 presents a diagram of participant flow. Figure 5.7 shows the number of daily access to the videos. The number increased rapidly on the day the videos were sent to the participants and after that, the increase slowed down towards the 15th day.

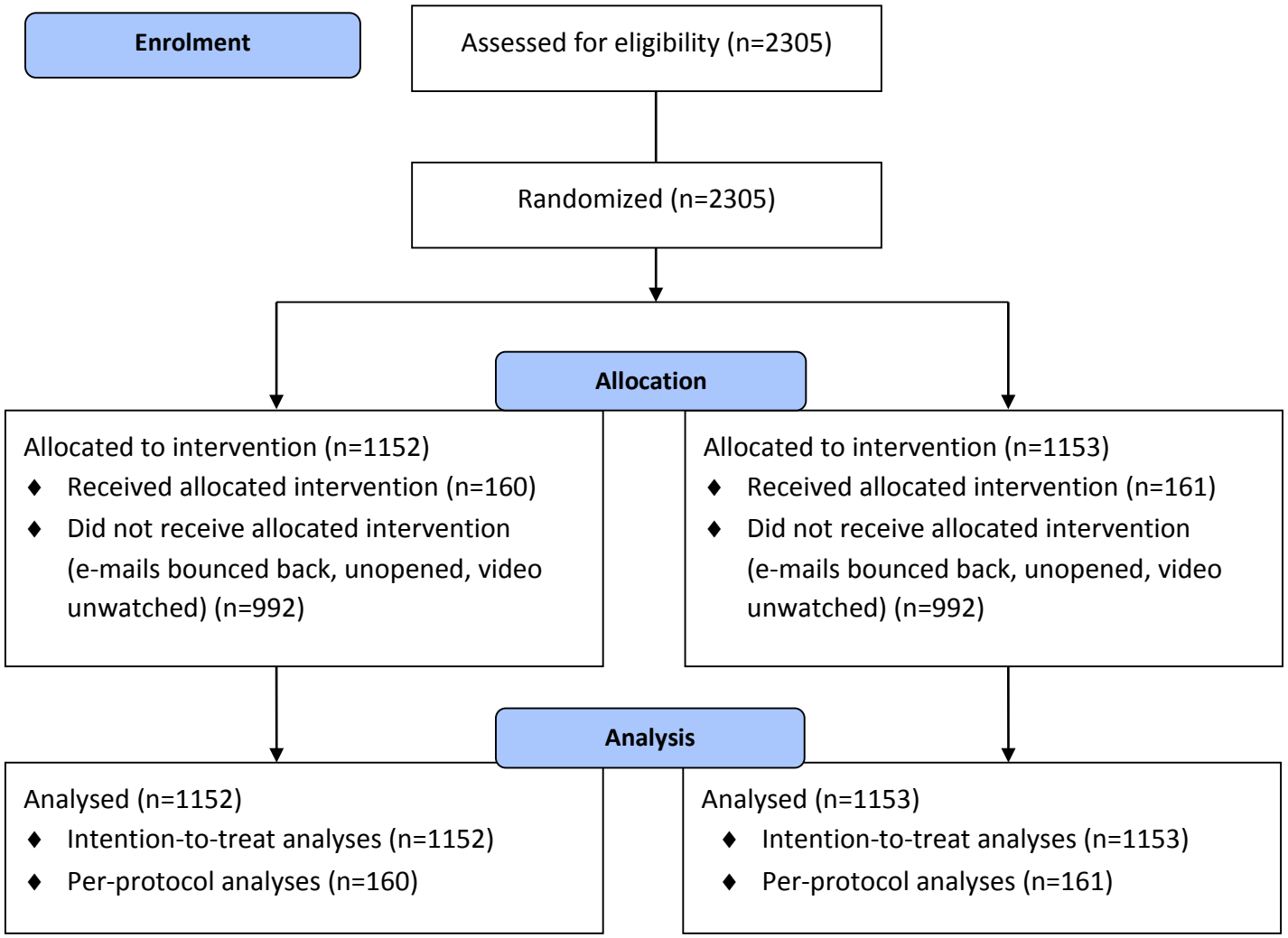


Figure 5.6 Flow diagram of participants

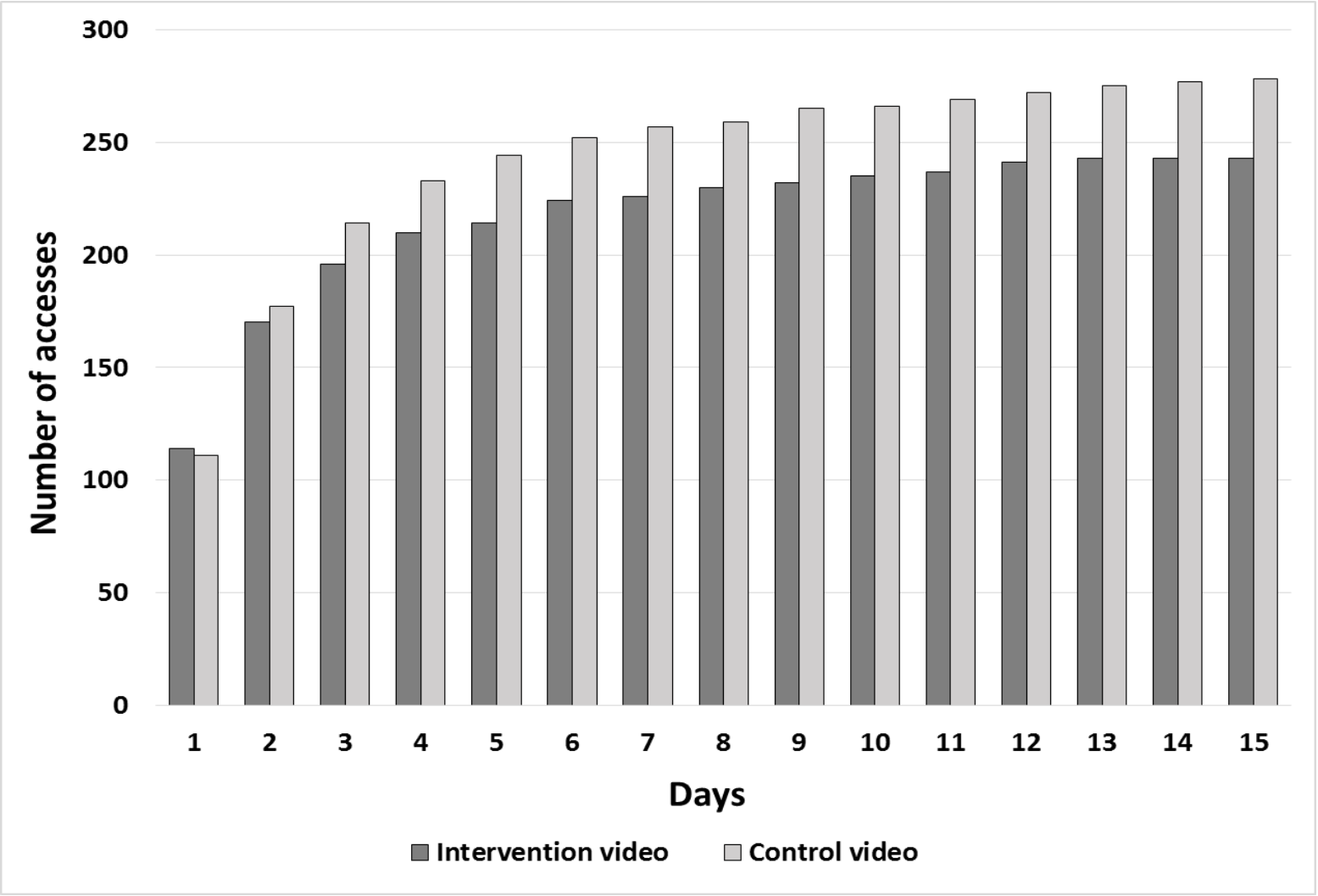


Figure 5.7 Cumulative number of access to the videos

5.3.2 Main analyses

Primary outcome

Of the 1152 participants who were randomised to the intervention video, 21 (1.8%) participants shared it and 26 (2.3%) of the 1153 participants who were randomised to the control video shared it (RR 0.8 [95%CI 0.5 to 1.4], p=0.46). Of the 160 participants who watched the intervention video, 21 (13.1%) participants shared it and 26 (16.1%) out of 161 participants who watched the control video shared it (0.8 [0.5 to 1.4], p=0.44). Table 5.3 summarises the results.

Table 5.3 Number of sharing

	Intervention video	*Control video*	*Relative risk (95%CI)*	*P-value*
Shared/allocated (ITT)	21/1152 (1.8%)	26/1153 (2.3%)	0.8 (0.5 to 1.4)	0.46
Shared/watched (PP)	21/160 (13.1%)	26/161 (16.1%)	0.8 (0.5 to 1.4)	0.44

Secondary outcome

The average number of views generated by participants in the intervention group was 0.03 (95%CI 0.02 to 0.05) and by those in the control group was 0.06 (0.009 to 0.1). The difference between the two groups was -0.03 (-0.08 to 0.02, p=0.29). The average number of views generated by the participants who watched the intervention video was 0.2 (0.1 to 0.3) and by those who watched the control video was 0.4 (0.06 to 0.8). The difference between the two groups was -0.2 (-0.6 to 0.18, p=0.29). Median was zero in both groups. Table 5.4 summarises the results.

Table 5.4 Mean number of views one participant generated

	Intervention video (95%CI)	*Control video (95%CI)*	*Difference (95%CI)*	*P-value*
Mean of views (ITT)	0.03 (0.02 to 0.05)	0.06 (0.009 to 0.1)	-0.03 (-0.08 to 0.02)	0.29
Mean of views (PP)	0.2 (0.1 to 0.3)	0.4 (0.06 to 0.8)	-0.2 (-0.6 to 0.18)	0.29

Figure 5.8 presents the distribution of the number of views generated by the participants who watched the videos. The histograms look similar except for one person in the control group, who generated 28 views. Most participants generated no views. The maximum number of views generated by each participant apart from the one was six. Wilcoxon signed-rank test did not show a statistically significant difference in the distribution of the number of views between the two groups (p=0.47).

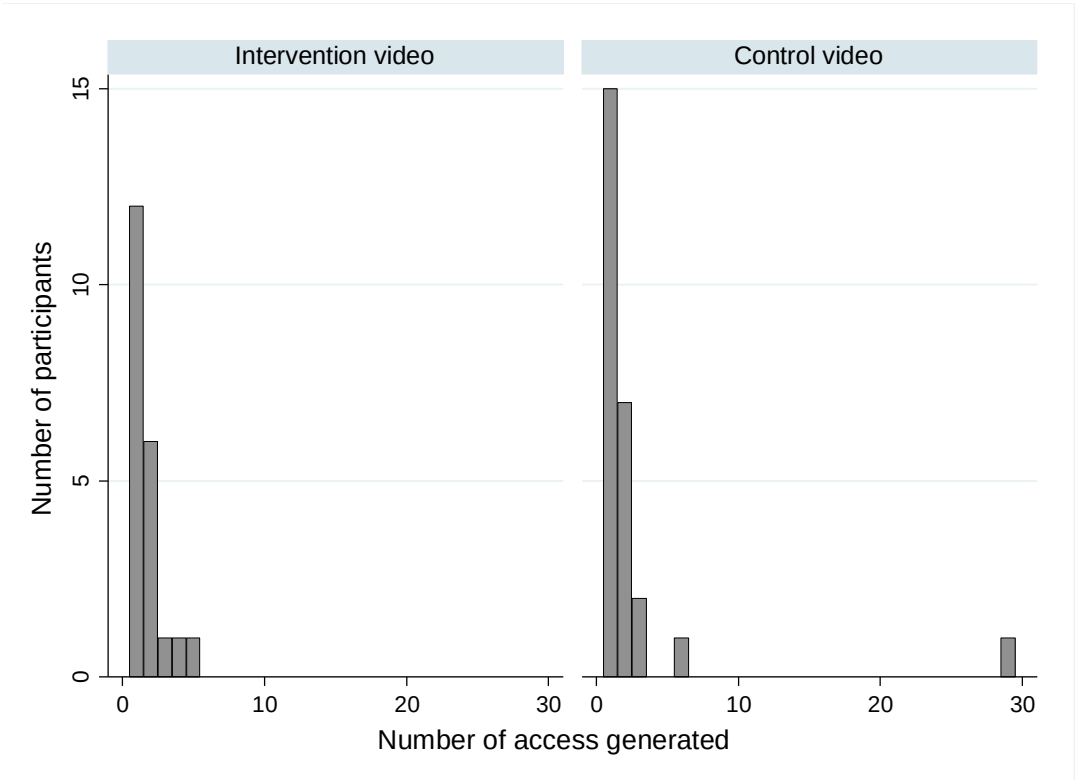


Figure 5.8 Number of views generated by participants who watched the videos

5.3.3 Sensitivity analyses

Primary outcome

Based on the most conservative definition of sharing, I found that 11 (0.95%) out of 1152 participants who were allocated to the intervention group shared the video and 14 (1.2%) out of 1153 participants who were randomised to the control group shared the video (RR 0.8 [95%CI 0.4 to 1.7], p=0.55). Based on the most liberal definition of sharing, I found that 37 (3.2%) participants in the intervention group and 43 (3.7%) participants in the control group shared the videos (0.9 [0.6 to 1.3], p=0.5). Therefore, the effect of the emotional content on sharing ranges from a decrease of 20% to a decrease of 10% based on an intention-to-treat (ITT) analysis.

Based on the most conservative definition of sharing, 11 (6.9%) out of 160 participants who watched the intervention video shared it and 14 (8.7%) out of 161 participants who were randomised to the control video shared it (RR 0.8 [95%CI 0.4 to 1.7], p=0.54). Based on the most liberal definition of sharing, 37 (23.1%) participants in the intervention group shared the videos and 43 (26.7%) participants in the control group (0.9 [0.6 to 1.3], p=0.46). Therefore, the effect of the emotional content on sharing ranges from a decrease of 20% to a decrease of 10% based on the per-protocol (PP) analysis. Table 5.5 summarises the results.

Table 5.5 Results of sensitivity analyses: video sharing

	Intervention video	*Control video*	*Relative risk (95%CI)*	*P-value*
Shared the video/allocated (ITT)				
Most conservative	11/1152 (1.0%)	14/1153 (1.2%)	0.8 (0.4 to 1.7)	0.55
Most liberal	37/1152 (3.2%)	43/1153 (3.7%)	0.9 (0.6 to 1.3)	0.5
Shared the video/watched (PP)				
Most conservative	11/160 (6.9%)	14/161 (8.7%)	0.8 (0.4 to 1.7)	0.54
Most liberal	37/160 (23.1%)	43/161 (26.7%)	0.9 (0.6 to 1.3)	0.46

Secondary outcome

Based on the most conservative definition of sharing, the average number of views generated by the participants in the intervention group was 0.01 (95%CI 0.004 to 0.018) and by those in the control group was 0.03 (0.00 to 0.06). The difference between the two groups was -0.02 (-0.05 to 0.01, p=0.23). Wilcoxon signed-rank test did not show a statistically significant difference in the distribution of the number of views generated by participants (p=0.54). Based on the most liberal definition of sharing, the average number of views generated by the participants in the intervention group was 0.07 (0.03 to 0.13) and by those in the control group was 0.1 (0.04 to 0.17). The difference in the mean number of views generated by each participant between the two groups was -0.03 (-0.11 to 0.05, p=0.47). Wilcoxon signed-rank test did not show a statistically significant difference in distribution of the number of views (p=0.42). The difference in the number of views generated ranges from -0.03 to -0.02 based on the ITT analyses.

The average number of views generated by the participants who watched the intervention video was 0.08 (0.03 to 0.13) and by those who watched the control video

was 0.22 (0.0003 to 0.43) based on the most conservative definition of sharing. The difference between the two groups was -0.14 (-0.36 to 0.09, p=0.23). The average number of views generated by participants who watched the intervention video was 0.52 (0.19 to 0.85) and by those who watched the control video was 0.73 (0.27 to 1.18) based on the most liberal definition of sharing. The difference between the two groups was -0.21 (-0.77 to 0.35, p=0.47). Therefore, the difference in the average number of views to the video generated by each participant ranges from -0.21 to -0.14 based on the PP analyses. Table 5.6 summarises the results.

Table 5.6 Results of sensitivity analyses: mean number of views one participant generated

	Intervention video (95%CI)	***Control video (95%CI)***	***Difference (95%CI)***	***P-value***
Mean of views (ITT)				
Most conservative	0.01 (0.004 to 0.018)	0.03 (0.0 to 0.06)	-0.02 (-0.05 to 0.01)	0.23
Most liberal	0.07 (0.03 to 0.12)	0.1 (0.04 to 0.17)	-0.03 (-0.11 to 0.05)	0.47
Mean of views (PP)				
Most conservative	0.08 (0.03 to 0.13)	0.22 (0.0003 to 0.43)	-0.14 (-0.36 to 0.09)	0.23
Most liberal	0.52 (0.19 to 0.85)	0.73 (0.27 to 1.18)	-0.21 (-0.77 to 0.35)	0.47

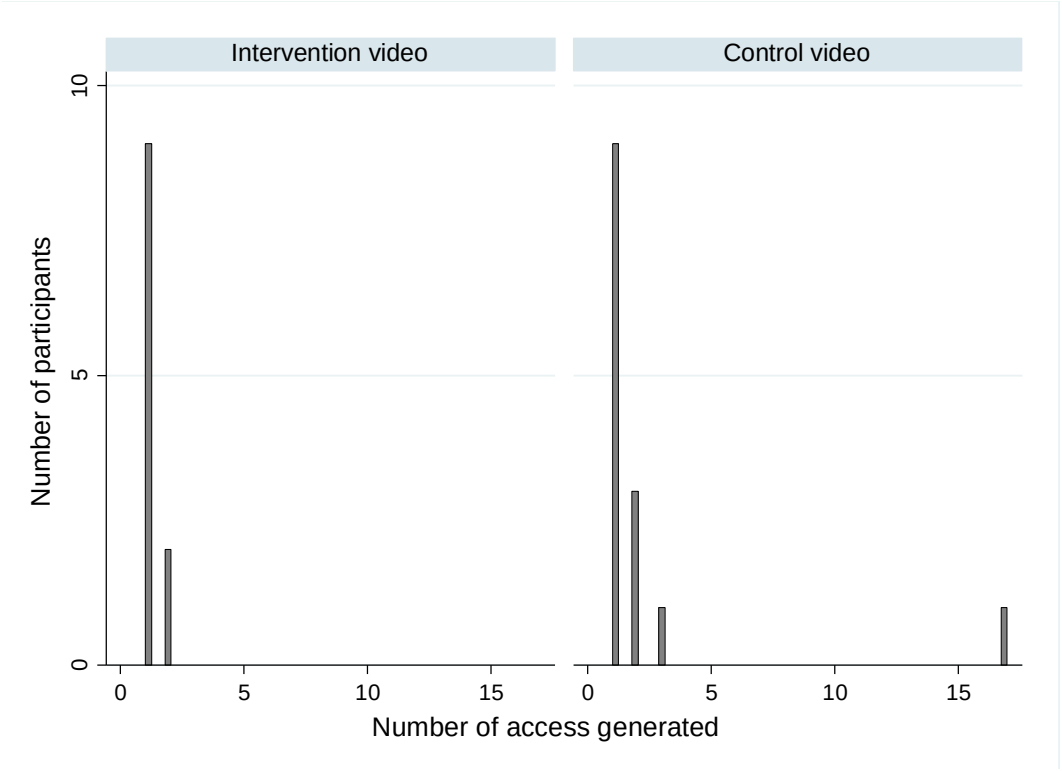


Figure 5.9 Distribution of the number of views each participant generated (based on the conservative definition of sharing)

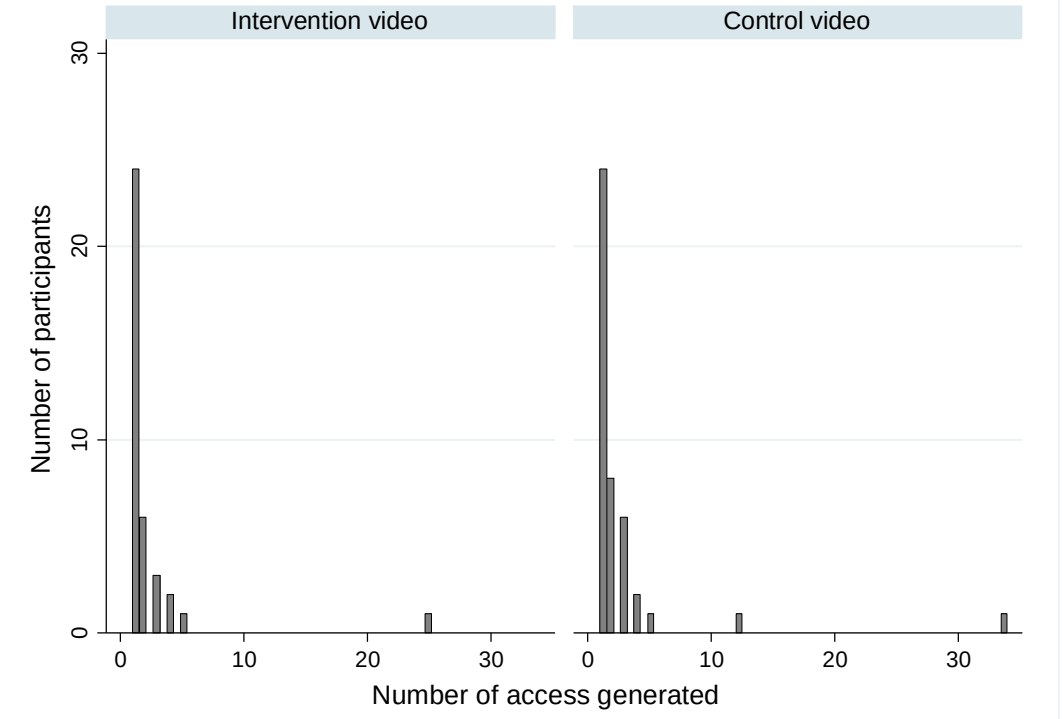


Figure 5.10 Distribution of the number of views each participant generated (based on the liberal definition of sharing)

5.4 Discussion

5.4.1 Principal findings

This study provides no reliable evidence that emotional content increases video sharing among health care professionals and researchers. The results were imprecise due to the low number of outcome events. Therefore, I cannot draw any reliable conclusions from this study and the effectiveness of emotional content on video sharing remains unclear.

5.4.2 Strengths and weaknesses

This study is the first study to examine the effectiveness of emotional content in an online video on video sharing among health care professionals empirically. Participants were randomised in a proper manner and this should avoid the problem of confounding.

However, this study has several weakness. Because not enough participants watched the videos, the number of outcome events was low. Many participants who received the email with the link to the video did not open the email or click on the link. As a result, the effective number of participants was much lower than the number of people who were randomised. I included more than 2300 participants based on the assumption that about half of the participants would watch the video. However, the actual video viewing rate was much lower than I had expected and only 321 of all participants (14%) watched the videos. The low video viewing rate resulted in the imprecise results.

As I could not monitor participants' email opening, it was difficult to know if the low video viewing rate was due to either low email opening rate or low link clicking rate.

Although I included participants from online journals in obstetrics and gynaecology, some of participants specialised in an area irrelevant to postpartum haemorrhage. The inclusion of participants outside of the target group may have contributed to the low video viewing rate.

Another limitation was in relation to the outcome assessment. Examining the access to the videos was the best available way to assess video sharing. However, if a participant forwarded the video link to another person, and that person did not click on it, that instance of sharing was not counted (② in figure 5.3). There might be forwarding that I could not see from the data of access to the videos. This leads to the underestimate of the effect of the intervention.

5.4.3 Implications

This study demonstrated that when disseminating an online video by email, it is difficult to get majority of the recipients to watch the video. Video viewing rate needs to be improved to achieve efficient online video dissemination by email. Firstly, the recipients of the email should be the right target population. If medical information is too specific, health care professionals from the same area might not be interested in the topic. Also, those who are in different area might show their interest. Therefore, selection of recipients requires careful examination of relevant population. Secondly, invitation emails should be attractive to encourage recipients to click on the link and watch the videos. Whether the recipient opens the email or not depends on the subject line and the sender. After opening the email, the body of the message becomes the critical part

to motivate the recipient to click on the link. Therefore, these three factors need to be planned elaborately.

5.4.4 Future research

As the results of this study were imprecise, another RCT with larger sample size is required. Studies to understand the cause of the low viewing rate and important factors to attract email recipients to click on the link might improve video viewing rate. There are two patterns that contribute to low video viewing rate: recipients read the email but do not click on the link or they do not even open the email. A study that provides email opening rate and link clicking rate would allow us to examine the reason for the low video viewing rate. In addition, an RCT comparing different subject lines and main texts will provide the idea of effective keywords and email format to attract the recipients to watch the video.

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6. Dissemination of Finding Fast Using Online videos (DIFFUSION) trial: main phase

6.1. Introduction

6.1.1. Background

In the previous chapter I reported the results of the pilot DIFFUSION trial. Because only 14% of randomised participants watched the videos, the number of outcome events (video sharing) was low and so the results were imprecise. Whilst there was no evidence that emotional content increased video sharing, I could not conclude that the intervention was ineffective.

Considering the low video viewing rate was one of the main causes of the small number of outcome events, there was a need to increase the number of participants who watch the videos in the main trial. There were two ways to achieve this: increase the sample size assuming the video viewing rate remains the same (14%) or to attempt to increase the viewing rate by improving the content of the invitation email. For the main phase of the trial I decided to use both methods: to increase the sample size and modify the invitation email.

6.1.2. Aim of the study

To assess the effectiveness of emotional content in an online video on video sharing.

6.2. Methods

6.2.1. Study design and procedures

Because the methods used in the main phase were similar to those used in the pilot phase, to avoid repetition, in this chapter I describe the differences between the pilot and the main phase. Briefly, in the pilot phase, I randomly allocated 2305 participants to two short videos about the WOMAN trial uploaded on YouTube. I included health care professionals and researchers in gynaecology and obstetrics apart from those who were in several countries where YouTube is banned. The videos were identical apart from the intervention, emotional content. An independent statistician randomised participants using a computer programme (1:1 randomisation). As I assigned each participant ID numbers, he did not see individual email addresses and intervention allocation when randomising them. I sent participants an email message with a link to the allocated video. I invited them to watch the video and forward it to their colleagues if they found it helpful. As the videos were apparently different, participant could not be blinded. I then assessed if the participants shared the video and how many people they shared the video with. I prepared a computer programme to monitor access to the videos. Data were collected until the 15th day of sending the invitation email. I assessed the outcome based on the information collected by the programme. The person who assessed the outcome and analysed the data was masked to the allocation.

In the pilot phase, I used Google mail merge service to send personalised mass email messages to trial participants from Gmail accounts created for the study under the name of Professor Ian Roberts from the London School of Hygiene and Tropical Medicine. In the main phase, I used a mass email service, called Campaign Monitor. The service

allowed us to send a personalised email from any email account that the sender wants to send an email from to a large number of recipients at once. I sent emails from an email account of the London School of Hygiene and Tropical Medicine under the name of Junko Kiriya, a PhD student. I assumed it was more likely that participants would open an email from a university account than from a Gmail account. I also altered the subject line and the main text of the email message to make them more attractive and encourage the recipients to open the message and click on the link to the videos. The new subject line and main text of the email message are shown in appendix 6-A.

6.2.2. Participant entry

Sample size

In the pilot phase, I estimated that approximately 1,000 participants, 500 in the intervention group and 500 in the control group, would be required to test the null hypothesis at the 5% significance level with 90% power assuming that the trial intervention increased video sharing from 10% to 17.5% (a 75% increase). For the main phase, assuming the same viewing rate as in the pilot phase (14%), I estimated that about 7,000 participants would be required to ensure that 1,000 people watch the videos.

Enrolment procedure

I collected email addresses from journals in midwifery, gynaecology and obstetrics published in 2013 and up until August 2014. I also included email addresses from the WOMAN trial contact list.

Interventions

***Intervention arm*:** a short online video (2”43 minutes long) about the WOMAN trial with more emotional content (an interview with a postpartum haemorrhage survivor and her husband in which they describe their experience).

***Control arm*:** a short online video (2”43 minutes long) about the WOMAN trial with less emotional content (the interviewer provides a second hand description of the experience).

Outcomes

***Primary outcome*:** video sharing

***Secondary outcome*:** number of views generated as a result of video sharing by each participant

I also examined the pattern of sharing using the secondary outcome as I did in the pilot study.

6.2.3. Outcome assessment

I measured video sharing and the number of views generated as a result of video sharing by each participant based on the data of access to the videos in four categories collected by the computer programme I prepared for this study: ID number, IP address, type of device and date and time of access. The emails were sent to the participants on 20 November and data were collected until 4 December 2014.

6.2.4. Other information

In the pilot phase, only the proportion of people who watched the video among all participants (video viewing rate) was available. However, the video viewing rate can be divided into two components: the proportion of people who opened the email among all recipients (email opening rate) and the proportion of people who clicked on the video link among those who opened the email (link clicking rate). Campaign Monitor provides analytics for the number of people who opened the email, which was unavailable in the pilot phase. Using these data, I could calculate the email opening rate and the link clicking rate. These rates help to understand whether the low video viewing rate was due to a low email opening rate or a low link clicking rate (or both).

Campaign Monitor Analytics also provides the number of emails that bounce back. It distinguishes temporary bounce backs from permanent ones. Temporary bounce back indicates that the email was blocked by the server and undelivered to the recipient's inbox. This means that the email address is valid but some issue prevented the email from reaching the inbox, for example because the inbox is full, the message size is too large or the mail server was temporarily down. Permanent bounce back indicates that the email address is invalid or no longer in use. As I obtained participants' email addresses from journal articles published over the last two years, it was likely that some of them were no longer in use due to the change of author's affiliation. Understanding what proportion of the email addresses bounced back helps to estimate the sample size or improve the proportion of valid contacts when planning another dissemination of online videos by email. There was a problem detecting participants' email opening by

Campaign Monitor due to a technical issue and the rate might have been underestimated.

6.2.5. Data analyses

I analysed the data of all participants randomised in this trial regardless of whether or not they watched the video, on an intention-to-treat (ITT) basis to test the effectiveness of the intervention. In addition, I analysed data of only those who watched the videos on a per-protocol (PP) basis to estimate the efficacy of the intervention.

Primary outcome

I used a standard χ^2 test as the primary test of statistical significance of the effect of the intervention on video sharing and calculated risk ratio with 95% confidence intervals (CIs).

Secondary outcome

I conducted a t-test and a Mood's median test to test the statistical difference in the mean and median of the number of views generated as a result of video sharing by each participant respectively. As for the pattern of sharing, I drew histograms and compared the distribution. As a test for the statistical difference in distribution, I conducted a Wilcoxon signed-rank test.

Sensitivity analyses

There was no way to detect an individual who accessed the videos. Therefore, I created our own definition of an access by a unique individual. There were different patterns of

the definition and the outcome varied according to the pattern. The estimate of the intervention effect also varied based on the number of outcome events. Therefore, I conducted sensitivity analyses to see the range that the effect varied using two different definitions of an access by a unique individual: most conservative definition and most liberal definition. I estimated the possible largest effect of the intervention and the difference in the outcome between the two groups using the most liberal definition of sharing. Likewise, I estimated the possible smallest effect of the intervention and the difference in the outcome between the two groups using the most conservative definition.

6.2.6. Ethics

The amendments made to the pilot phase were reported to the ethics committee of the London School of Hygiene & Tropical Medicine and all the changes were approved by the committee (reference number 8850). This study is registered as Clinicaltrials.gov NCT02109159.

6.3. Results

6.3.1. Characteristics of participants and baseline comparisons

I randomly allocated 8,353 email addresses, 4,178 of which were allocated to the intervention video and 4,175 of which were allocated to the control video. Of those in the intervention group, 464 (11.1%) were in low income countries, 934 (22.4%) were in lower-middle income countries, 507 (12.1%) were in upper-middle income countries and 2,273 (54.4%) were in high income countries. Of those in the control group, 457 (11.0%) were in low income countries, 844 (20.2%) were in lower-middle income countries and 543 (13.0%) were in upper-middle income countries and 2,331 (69.8%) were in high income countries. Appendix 6-B presents a list of low, lower-middle, upper-middle and high income countries. Of those in the intervention group 1,308 (31.3%) were from the woman trial contact list and 2,870 (68.7%) were authors of published articles. Of those in the control group 1,263 (30.3%) were from the woman trial contact list and 2,912 (69.8%) were authors of articles published in the international journals. Of the 4,178 participants in the intervention group, 221 (5.3%) participants watched the video and of the 4,175 in the control group, 215 (5.2%) participants watched the video. Figure 6.1 presents participant flow.

Table 6.1 presents the baseline information of the participants who were allocated to the videos and who watched the videos. Figure 6.2 shows the number of daily access to the videos. The number increased rapidly on the day the videos were sent to the participants and after that, the increase slowed down towards the 15th day.

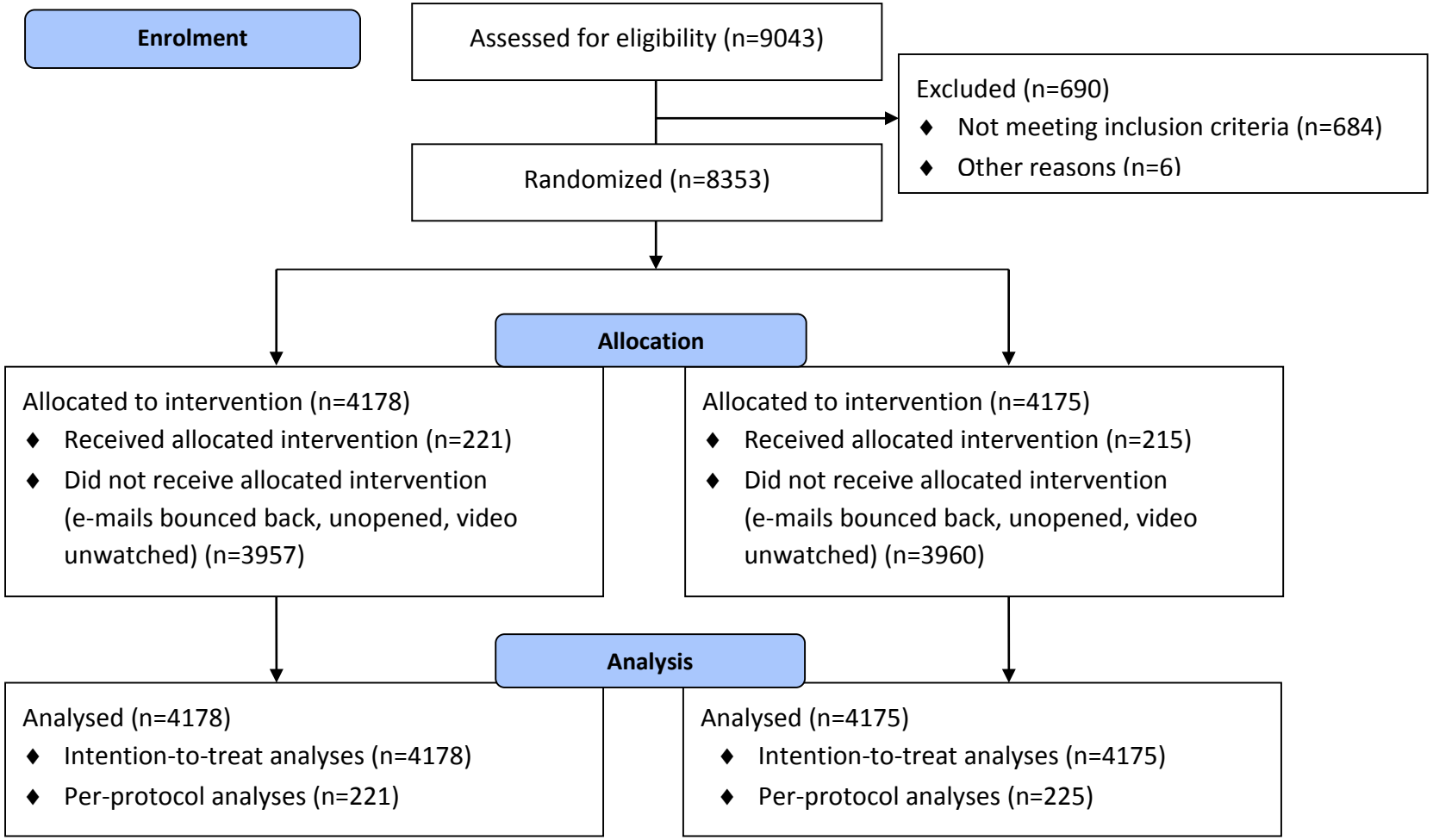

Figure 6.1 Flow diagram of participants

Table 6.1 Baseline data – all participants randomised and who watched the video

	Intervention video	*Control video*
All participants randomised	4178	4175
Country		
Low income countries	464 (11.1%)	457 (11.0%)
Lower-middle income countries	934 (22.4%)	844 (20.2%)
Upper-middle income countries	507 (12.1%)	543 (13.0%)
High income countries	2273 (54.4%)	2331 (55.8%)
Source of contact		
WOMAN trial contact list	1308 (31.3%)	1263 (30.3%)
Journals	2870 (68.7%)	2912 (69.8%)
Participants who watched the video	221/4,178(5.3%)	215/4,175 (5.2%)
Country		
Low income countries	41 (18.6%)	29 (13.5%)
Lower-middle income countries	67 (30.3%)	58 (27.0%)
Upper-middle income countries	26 (11.8%)	34 (15.8%)
High income countries	87 (39.4%)	94 (43.7%)
Source of contact		
WOMAN trial contact list	102 (46.2%)	89 (41.4%)
Journals	119 (53.9%)	126 (58.6%)

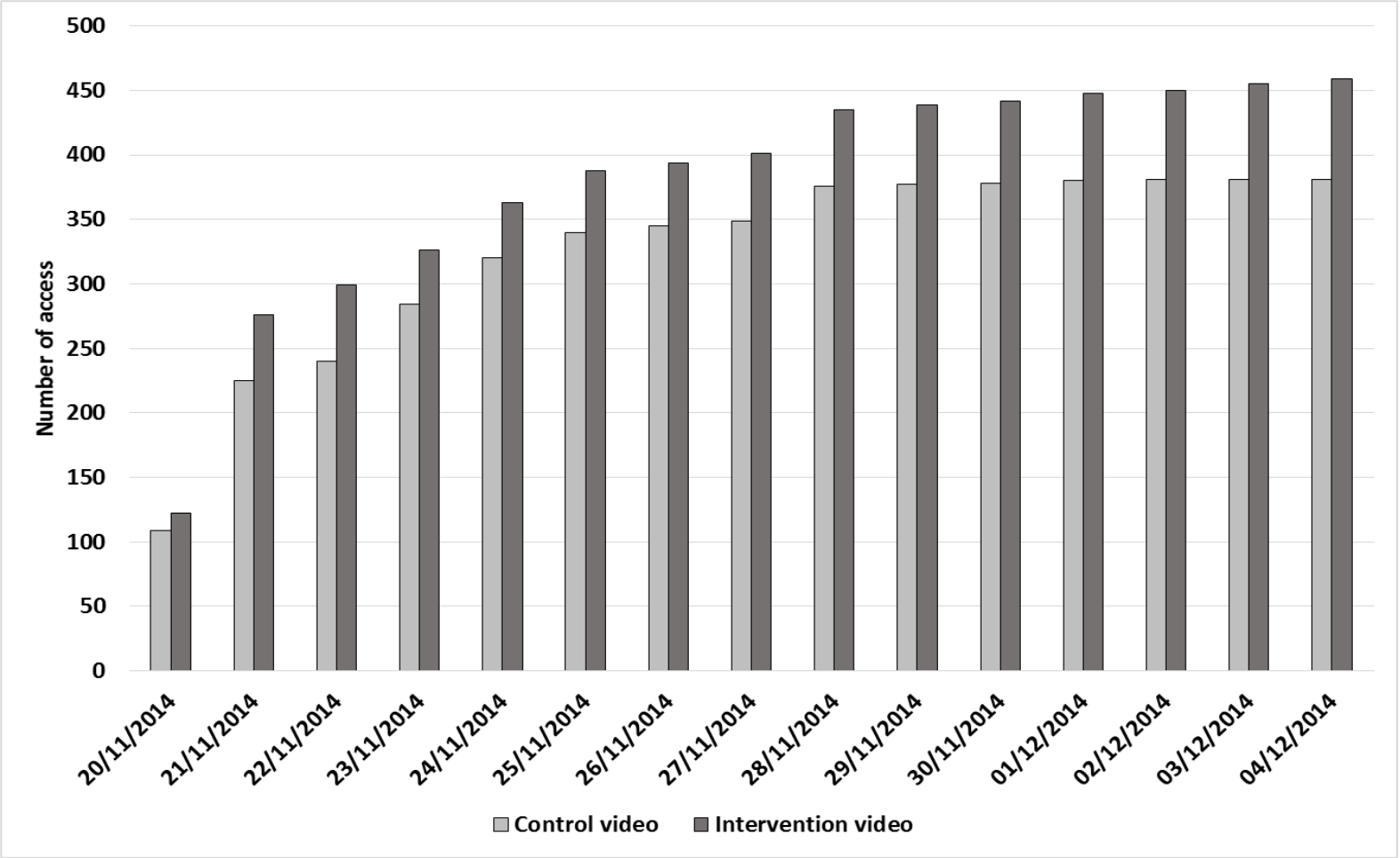

Figure 6.2 Cumulative number of access to the videos

6.3.2. Email bounce backs and email opening

The invitation email was not sent to 47 email addresses (21 in the intervention group and 26 in the control group) due to technical issues of Campaign Monitor. As a result, the email was sent to 4,157 email addresses in the intervention group and 4149 email addresses in the control group. In the intervention group, 351 (8.4%) emails bounced back, 72 of which were temporary and 279 were permanent. In the control group, 359 (8.7%) emails bounced back, 80 of which were temporary and 279 permanent. In the intervention group, 994 (23.9%) recipients opened the email and 1068 (25.7%) in the control group. The proportion of people who opened the email among all recipients (email opening rate) was 27.2%. The proportion of people who watched the video among those who opened the email (link clicking rate) was 21.1%. Consequently, 5.3% of those who the email was sent to (including the bounce backs) watched the videos. Table 6.2 summarises the number and rate of email receiving and opening and video views based on the data from Campaign Monitor analytics.

Table 6.2 Receiving and opening the email and watching the video

	Intervention group		*Control group*		*Total*	
Emails not sent/Randomised	21/4178	(0.5%)	26/4175	(0.6%)	47/8353	(0.6%)
Recipients/Randomised	4157/4178	(99.5%)	4149/4175	(99.4%)	8306/8353	(99.4%)
Bounced/All recipients	351/4157	(8.4%)	359/4149	(8.7%)	710/8306	(8.6%)
Unique opens/All recipients	994/4157	(23.9%)	1068/4149	(25.7%)	2062/8306	(24.8%)
Unopened/All recipients	2812/4157	(67.6%)	2722/4149	(65.6%)	5534/8306	(66.6%)
Opened/Received	994/3806	(26.1%)	1068/3790	(28.2%)	2062/7596	(27.2%)
Unopened/Received	2812/3806	(73.9%)	2722/3790	(71.8%)	5534/7596	(72.9%)
Watched/All recipients	221/4157	(5.3%)	215/4149	(5.2%)	436/8306	(5.3%)
Watched/Opened	221/994	(22.2%)	215/1068	(20.1%)	436/2062	(21.1%)

6.3.3. Main analyses

Primary outcome

Of the 4,178 participants who were randomised to the intervention video, 44 (1.1%) participants shared it, and of the 4,175 participants who were randomised to the control video 37 (0.9%) participants shared it (RR 1.2 [95%CI 0.8 to 1.8], p=0.44). Of the 221 participants who watched the intervention video, 44 (19.9%) participants shared it and of the 215 participants who watched the control video 37 (17.2%) participants shared it (1.2 [0.8 to 1.7], p=0.47). Table 6.3 summarises the results.

Table 6.3 Number of sharing

	Intervention video	***Control video***	***Relative risk (95%CI)***	***P-value***
Shared/allocated (ITT)	44/4178 (1.1%)	37/4175 (0.9%)	1.2 (0.8 to 1.4)	0.44
Shared/watched (PP)	44/221(19.9%)	37/215 (17.2%)	1.2 (0.8 to 1.7)	0.47

Secondary outcome

The average number of views generated as a result of video sharing by the participants in the intervention group was 0.04 (95%CI 0.01 to 0.07) and by those in the control group was 0.03 (0.01 to 0.05). The difference between the two groups was 0.01 (-0.02 to 0.04, p=0.53). The average number of views generated by the participants who watched the intervention video was 0.7 (0.2 to 1.2) and by those who watched the control video was

0.5 (0.2 to 0.9). The difference between the two groups was 0.2 (-0.5 to 0.8, p=0.56). Median was zero in both groups. Table 6.4 summarises the results.

Table 6.4 Mean number of views generated

	Intervention video (95%CI)	***Control video (95%CI)***	***Difference (95%CI)***	***P-value***
Mean of views (ITT)	0.04 (0.01 to 0.07)	0.03 (0.01 to 0.05)	0.01 (-0.02 to 0.04)	0.53
Mean of views (PP)	0.7 (0.2 to 1.2)	0.5 (0.2 to 0.9)	0.2 (-0.5 to 0.8)	0.56

Figure 6.3 presents the distribution of the number of views generated by participants. Most participants did not share the video. The histograms do not include those who did not share the videos. The two histograms look similar except for one person in the intervention group, who generated more than 50 views. Wilcoxon signed-rank test did not show a statistically significant difference in the distribution of the number of views between the two groups (p=0.44).

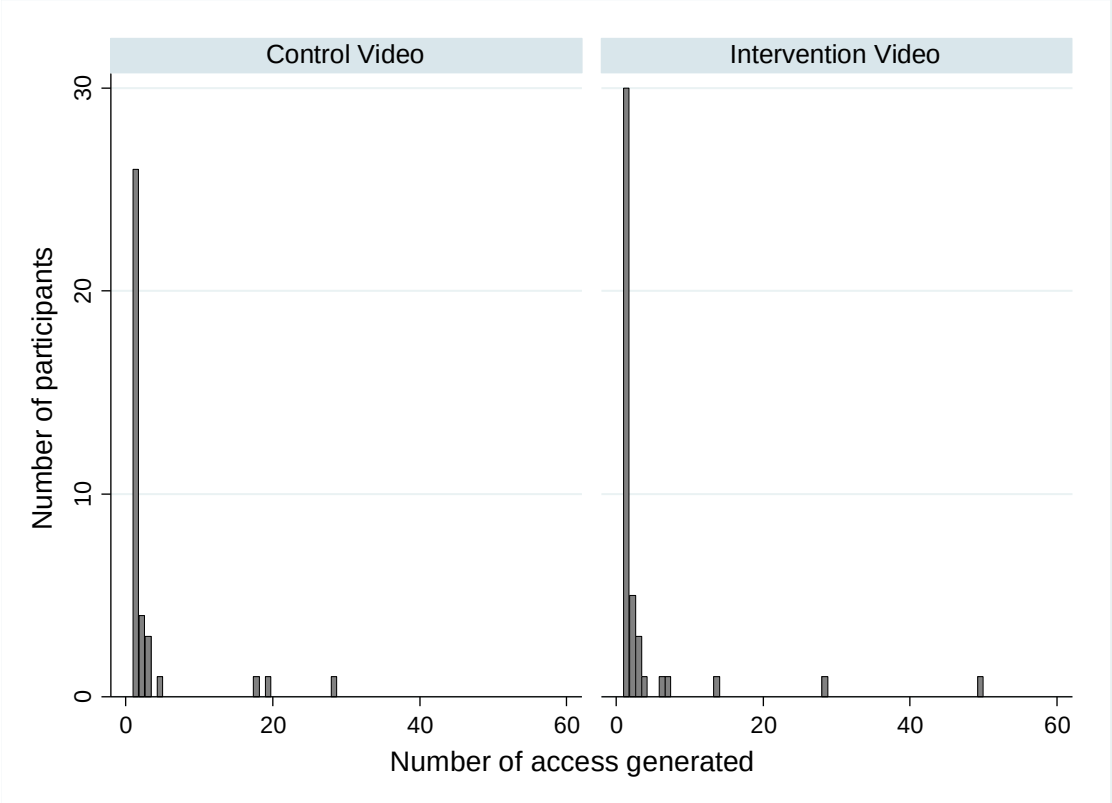

Figure 6.3 Distribution of the number of views each participant generated

6.3.4. Sensitivity analyses

Primary outcome

Based on the most conservative definition of sharing, I found that 18 (0.4%) out of 4,178 participants who were allocated to the intervention group shared the video, and 18 (0.4%) out of 4,175 participants who were randomised to the control group shared the video (RR 1.0 [95%CI 0.5 to 1.9], p=0.998). Based on the most liberal definition of sharing, I found that 62 (1.5%) participants in the intervention group and 62 (1.5%) participants in the control group shared the videos (1.0 [0.7 to 1.4], p=0.997). The effect of the emotional content on sharing did not vary based on an intention-to-treat (ITT) analysis.

Based on the most conservative definition of sharing, 18 (8.1%) out of 221 participants who watched the intervention video shared it and 18 (8.4%) out of 215 participants who were randomised to the control video shared it (RR 0.97 [95%CI 0.5 to 1.8], p=0.93). Based on the most liberal definition of sharing, 62 (28.1%) participants in the intervention group shared the videos and 62 (28.8%) participants in the control group (0.97 [0.7 to 1.3], p=0.86). The effect of the emotional content on sharing again did not vary based on the per-protocol (PP) analysis. Table 6.5 summarises the results.

Table 6.5 Results of sensitivity analyses: video sharing

	Intervention video	***Control video***	***Relative risk (95%CI)***	***P-value***
Shared/allocated (ITT)				
Most conservative	18/4178 (0.4%)	18/4175 (0.4%)	1.0 (0.5 to 1.9)	0.998
Most liberal	62/4178 (1.5%)	62/4175 (1.5%)	1.0 (0.7 to 1.4)	0.997
Shared/watched (PP)				
Most conservative	18/221 (8.1%)	18/215 (8.4%)	0.97 (0.5 to 1.8)	0.93
Most liberal	62/221 (28.1%)	62/215 (28.8%)	0.97 (0.7 to 1.3)	0.86

Secondary outcome

Based on the most conservative definition of sharing, the average number of views generated by the participants in the intervention group was 0.02 (95%CI 0.003 to 0.03) and by those in the control group was 0.01 (0.003 to 0.02). The difference between the

two groups was 0.01 (-0.008 to 0.02, p=0.39). Wilcoxon signed-rank test did not show a statistically significant difference in the distribution of the numbers of views generated (p=0.99). Based on the most liberal definition of sharing, the average number of views generated by the participants in the intervention group was 0.06 (0.02 to 0.09) and by those in the control group was 0.04 (0.02 to 0.06). The difference between the two groups was 0.02 (-0.03 to 0.06, p=0.44). Wilcoxon signed-rank test did not show a statistically significant difference in the distribution of the numbers of generated (p=0.92). The difference in the number of views generated by participants varied from 0.01 to 0.02 based on the ITT analyses.

The average number of views generated as a result of video sharing by those who watched the intervention video was 0.3 (0.06 to 0.5) and by participants who watched the control video was 0.2 (0.06 to 0.3) based on the most conservative definition of sharing. The difference between the two groups was 0.1 (-0.2 to 0.4, p=0.41). The average number of views generated by those who watched the intervention video was 1.1 (0.4 to 1.8) and by participants who watched the control video was 0.8 (0.3 to 1.2) based on the most liberal definition of sharing. The difference between the two groups was 0.3 (-0.05 to 1.1, p=0.47). The difference in the average number of views generated by each participant ranges from 0.1 to 0.3 based on the PP analyses.

Table 6.6 summarises the results. Figure 6.4 and 6.5 show the distribution of the number of views generated by participants based on the most conservative definition and the

most liberal definition respectively. Participants who did not share the videos are not included in the histogram.

Table 6.6 Results of sensitivity analyses: mean number of views generated

	Intervention video (95%CI)	***Control video (95%CI)***	***Difference (95%CI)***	***P-value***
Mean of views (ITT)				
Most conservative	0.02 (0.003 to 0.03)	0.01 (0.003 to 0.02)	0.006 (-0.008 to 0.02)	0.39
Most liberal	0.06 (0.02 to 0.09)	0.04 (0.02 to 0.06)	0.02 (-0.03 to 0.06)	0.44
Mean of views (PP)				
Most conservative	0.3 (0.06 to 0.5)	0.2 (0.06 to 0.3)	0.1 (-0.2 to 0.4)	0.41
Most liberal	1.1 (0.4 to 1.8)	0.8 (0.3 to 1.2)	0.3 (-0.5 to 1.1)	0.47

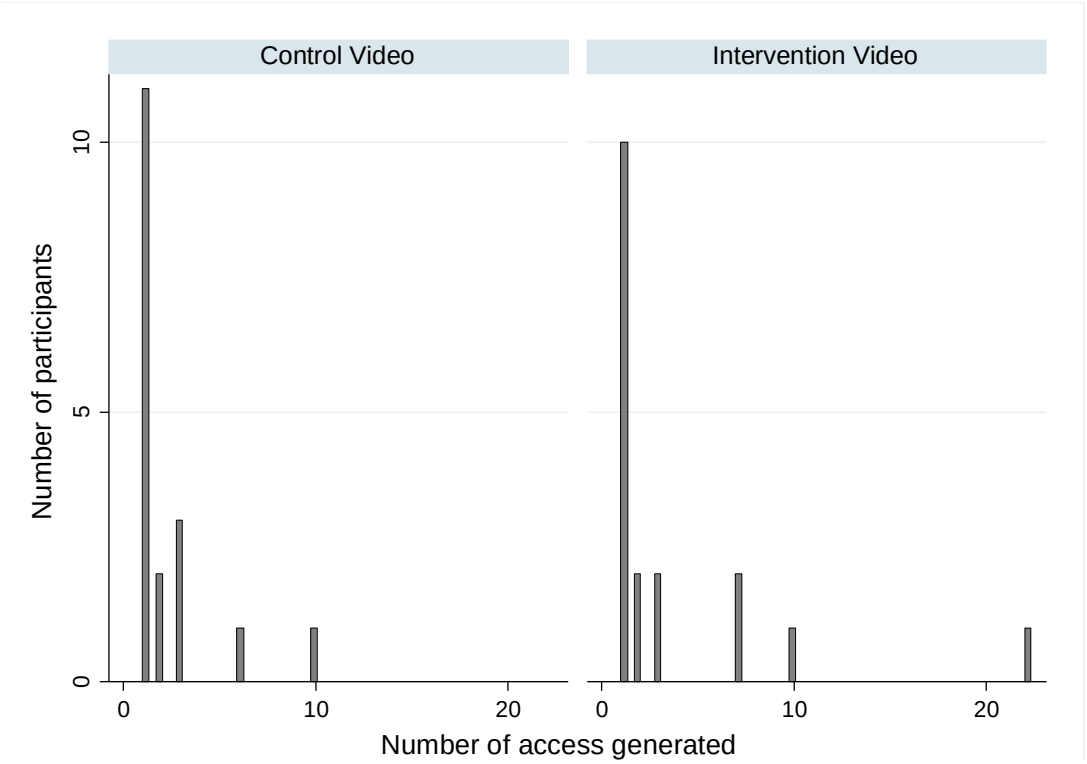

Figure 6.4 Distribution of the number of views each participant generated (based on the conservative definition of sharing)

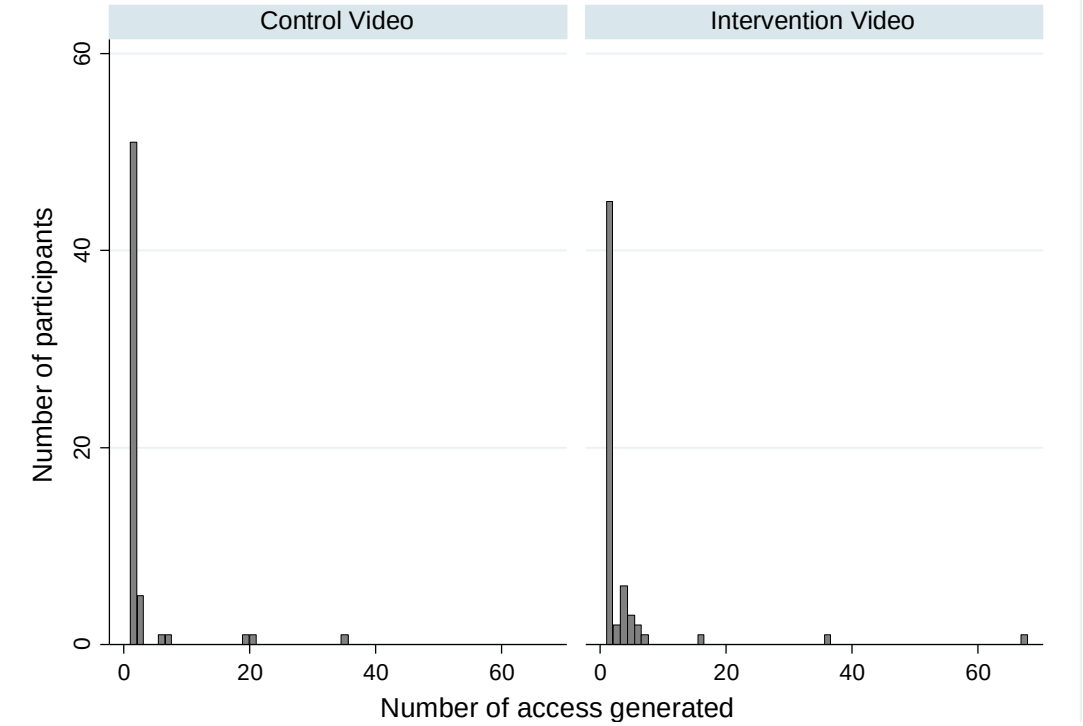

Figure 6.5 Distribution of the number of views each participant generated (based on the liberal definition of sharing)

6.4. Discussion

6.4.1. Principal findings

The results of the main phase of the DIFFUSION trial were similar to those of the pilot phase. Although I altered the email content to encourage the recipients to watch the videos, the video viewing rate was lower than that in the pilot phase, which resulted in the small number of outcome events and low precision. In the pilot phase, it was unclear whether the reason for the low video viewing rate was because most participants did not open the email or because they did not click on the link in the email. In the current study, I obtained the data about participants' email opening which were unavailable in the previous study. Based on the analytics, I found that the email opening rate was about 30% and link clicking rate was about 20%. Consequently, only 6% of all randomised participants watched the videos, which was less than a half of the video viewing rate in the pilot phase (14%).

6.4.2. Strengths and weaknesses

In this study, the participants were randomised in a proper manner and allocation was concealed at the time of randomisation by masking the statistician who randomised participants using ID numbers. Although participants cannot be blinded in trials using educational materials, this trial has less risk of bias as participants would not realise what the intervention was because they received only one video and did not see the difference between the two videos.

As there was no way to detect sharing precisely, I defined “an access by an individual” as “an access from a different IP address” for the outcome assessment. This raised the risk of misclassification in the outcome assessment and sharing might have been over or under-estimated. However, I used the best available data to assess the outcome as close to the true outcome as possible. In addition, I attempted to see possible different results by conducting sensitivity analyses.

The main weakness of this study is the imprecision of the point estimates. Although the probability of sharing was higher than expected, the number of outcome events was low because only a small proportion of participants watched the videos. Therefore, once again, I cannot draw any reliable conclusions about the effectiveness of emotional content in an online video on sharing in the current study. Our current results are compatible with both a small decrease in sharing and a modest increase.

Although this study has less risk of bias than usual trials of educational materials, in the event that a participant watched both videos or received the same email shared by another participant, they might have reacted in a different way. For example, those who have already received the email with the link to the control video could have received another email with the link to the intervention video from other participants or those who received the shared video. If they thought they received the same video, they might have not watched it, which could have affected the outcomes.

6.4.3. Implications

The DIFFUSION trial showed that conducting a randomised controlled study including the assessment of video sharing is challenging. We cannot track email forwarding and the only way to judge whether or not the video was shared was to analyse the access to the videos. However, online activities are mostly done anonymously and it is impossible to distinguish access by an individual from access by another. Asking participants if they shared the video might affect the outcome as the question itself could encourage them to share it. Unless a way to precisely detect video sharing, studies examining video sharing are inevitably prone to outcome misclassification.

I learnt from this trial that both email opening rate and link clicking rate contributed to the low video viewing rate when disseminating an online video by email. Hence, dissemination of online videos via email might be inefficient unless a better way is developed for improving email opening and link clicking rates. Alternatively, targeting a population that is more suitable for email dissemination might increase the video viewing rate. Newsletters are now digitalised and many people receive newsletters by email. Those who subscribe to a newsletter are more likely to open emails from the organisation they are registered with and watch videos distributed by them. In addition, registered emails are mostly valid and the email will not bounce back. Given approximately 10% of all the emails sent out bounced back in the current study, having almost no bounce back makes the email dissemination a lot more efficient. Therefore,

establishing a group with a mass email service and embedding a video link in a newsletter to subscribers may greatly improve video viewing rate.

Before conducting the trial, the email was considered to be merely a tool to deliver the videos. However, it turned out to be a very important aspect of the ability to carry out and thus assess the intervention, since the number of people who opened the email and clicked on the link affected how many people received the intervention. One of the reasons the video watching rate decreased from the pilot trial might be because most of the participants in the main trial overlapped with those from the pilot trial; when creating the distribution list for the main trial, I selected only those who had not opened the email in the pilot study, however those recipients might have been the ones least likely to open emails from strangers. Another possible reason is because the name under which the email was sent changed from that of a professor in the pilot study to that of a PhD student in the main study. It is likely that participants in the pilot trial opened the invitation email as it was from a well-known professor at the London School of Hygiene and Tropical Medicine. Whereas, it is likely the participants in the main trial could have ignored the invitation email since it was from an unknown person. In retrospect, more attention should have been paid during the process of developing the invitation email to the name under which the emails were sent, which email addresses were used, and the subject line and main text of the email.

I selected email as a method of sending videos to participants in order to randomise the participants, monitor their access to the videos and obtain individual data. However, there are other ways of distributing online videos, for example, embedding the video on a blog and uploading it on a social networking service. If randomisation and data collection are unnecessary or other strategies to achieve randomisation, data monitoring and the collection of individual data are available, better online tools can be used to have videos watched by larger population.

6.4.4. Future research

To obtain a more precise estimate of the effect of an emotional online video on sharing, another RCT with a sufficient number of people who watch the videos is required. As learnt from the pilot and the main phases of this trial, improving video viewing rate is still difficult. Therefore, focusing the study population on those who are at higher chance of clicking a link in an email might have more impact on the video viewing rate. It will be more efficient to create a group with a mass email service and distribute intervention videos in a newsletter to subscribers who will serve as participants. However, this method takes time to achieve a certain number of subscribers and involves other activities such as setting up the group and sending newsletters periodically. Alternatively, an existing group using mass emailing service in the area related to the video topic could be used.

To improve the video viewing rate when conducting another trial using emails, we need to explore factors in email subject lines and main texts that encourage recipients to open it and click on the link. A study to test the association between email contents and the email opening and link clicking rates is therefore, required.

I selected email as a method of sending videos to participants in order to randomise the participants, monitor their access to the videos and obtain individual data. However, there are other ways of distributing online videos, for example, by embedding the video in a blog or uploading it on social media. If randomisation and data collection are unnecessary, or if other strategies to achieve randomisation, data monitoring and the collection of individual data are available, better online tools can be used to enable viewing of videos by a larger population. A study using social media such as Facebook and twitter could provide useful information.

7 Discussion and conclusion

7.1 Principal findings

This thesis describes efforts to identify an effective way to disseminate research findings world-wide. First, I illustrated the importance of rapid dissemination using the results of the CRASH-2 trial as an example. I showed that implementation of the CRASH-2 trial results world-wide could prevent up to 90,000 premature deaths each year. The largest number of lives saved would be in India, China, Russia, Brazil and the United States. In India, about 27,000 deaths might be averted every year. These results point to the importance of fast dissemination of research so that new treatments can be implemented as soon as possible.

I explored the methods currently used for information dissemination and found nearly 60 different strategies. These include lectures, workshops and sending guidelines by mail. I then examined their relative effectiveness by conducting a systematic review of randomised controlled trials. I found 19 randomised controlled trials on the relative effectiveness of different dissemination strategies. Most were at high risk of bias and overall there was no reliable evidence that any particular strategy was more effective than another.

Given the need for rapid global dissemination, I considered the internet to be the most efficient dissemination method since it allows fast and inexpensive information sharing. Online videos are the main method of information sharing. However, I could find no

studies examining the use of online videos as a dissemination method for health care professionals. Therefore, I examined the potential of online videos as a new dissemination method.

One way to measure the popularity of an online video is to assess its view count. This is the number of people who started watching the video and indicates the extent to which the video was disseminated. To identify factors that increase the popularity of online medical videos, I conducted a cross-sectional study of medical videos on YouTube to examine the association between video characteristics and view counts. Online videos that were shorter than about three minutes, had sound effects, included emotional content, or demonstrated certain techniques were more likely to be watched by a large number of people. However, the confidence intervals were wide and there was a chance of confounding.

In the business and marketing literature there has been considerable emphasis on the importance of use of emotional narrative to activate word-of-mouth sharing and to persuade people[1,2]. According to the case studies presented in this literature, the more emotion a story arouses in listeners, the more successful the strategies will be. Because this claim seemed to be plausible and was consistent with the results of my cross-sectional study, I examined this factor in further work.

I designed and conducted a randomised controlled trial (DIFFUSION trial) to examine the effectiveness of emotional content in an online medical video on the extent to which the video was disseminated. First, I conducted a pilot trial to test the procedures. I randomly allocated around 2,300 participants (1,150 in each group) to receive a link to one of two short videos identical apart from the intervention (emotional content). I sent video links to participants by email and asked them to share the video if they found it helpful. Unfortunately, only 320 participants watched the videos and the number of outcome events (video sharing) was low, which resulted in an imprecise effect size. Therefore, I could not draw any conclusions about the effectiveness of emotional content from this trial. Nevertheless, I learnt an important lesson about the use of online videos as a dissemination strategy. Before a video can have any effect, people must be persuaded to watch it. In particular, the email message must be sufficiently enticing to encourage the recipients to open it and click on the video link.

Consequentially, I revised the subject line and main text of the invitation email and enlarged the sample size to ensure more participants open the email and watch the videos. I also changed the personalised mass emailing service to Campaign Monitor, which was more useful because it was more user-friendly and provided information on email delivery and opening by the participants. In the main phase of the trial, I randomised around 8400 participants, 4200 in each group. However, the video viewing rate was again low and only about 400 participants watched the videos. Of those who watched the videos, about 80 participants shared the videos. The results, albeit

imprecise, showed no strong evidence for the effectiveness of emotional content on the sharing of an online video.

7.2 Strengths and weaknesses of the study

To estimate the number of premature deaths averted by introducing tranexamic acid, the number of traumatic deaths due to bleeding, the proportion of in-hospital deaths among all deaths and the relative risk reduction in haemorrhagic death were required. These numbers were calculated based on data from WHO death estimates, the CRASH-2 trial results and the studies found in a systematic review. The WHO and the CRASH-2 trial data were collected in various countries world-wide. The systematic review also covered a broad range of studies using different databases without any language restrictions. These were the best available data for the estimate. However, the systematic review found a limited number of studies that provided eligible data and they were mostly from developed countries. They may not reflect the situation in developing countries where a large number of haemorrhagic deaths occur. In addition, the WHO estimates might have been affected by the quality of data from countries that have poor coverage by their mortality registration system. There are nine categories of the causes of death in the WHO death estimates. When calculating the number of haemorrhage in traumatic deaths, I classified the categories into blunt and penetrating trauma. It is likely that each category includes both injury mechanisms. Therefore, there is a chance that I misclassified some deaths into the incorrect injury mechanism.

I conducted a systematic review of the effectiveness of currently-used dissemination methods. It is the most recent systematic review that gives a good coverage of studies on dissemination methods for health care professionals searched in nine databases. However, despite the broad coverage of the search, I found a small number of studies and their methods were diverse. I could not synthesise the results of the included studies due to the non-comparability of the study methods. Moreover, the quality of the studies was poor and none of them provided strong evidence for an effective dissemination method.

I then conducted a cross-sectional study to examine the associations between online video components and the number of views. Reverse causality often emerges as main concern of this study design. Nevertheless, my study did not have this problem because the online video components were fixed when the videos were made and did not change. The number of views increases as a result of people watching the videos with the fixed components. Therefore, the outcome could not affect the exposures. This study attempted to reduce the risk of confounding by using multiple linear regression analyses. However, testing more than 15 variables in one model resulted in broad confidence intervals and there is still the possibility that unknown confounding factors affected the results. In addition, there is a chance that unknown confounders affected the results.

Finally, I conducted a randomised controlled trial. It was the first randomised trial to examine empirically the effectiveness of emotional content in an online video on sharing

among health care professionals. However, the main weakness of the trial was the low number of people who watched the videos. There were two steps for the participants to receive the intervention: open the invitation email and click the link to the video. Most of the participants did not reach the second step and I found a large gap between the number of all participants randomised to the interventions and the number of participants who actually received the interventions. The video viewing rate of the main phase was lower than that of the pilot study and it was difficult to estimate appropriate sample size prior to the main trial to ensure enough participants experienced the intervention. The low video viewing rate resulted in imprecise effect size.

7.3 Recommendations

7.3.1 Implications

In this thesis, I showed the importance of rapid dissemination of research findings. In my attempt to identify the most effective dissemination methods, I explored currently used dissemination methods. However, I found few studies on the topic and none of them provided evidence for the effectiveness of the methods used. Therefore, I sought to find a better way to disseminate research findings to health care professionals. As online videos are a popular and useful means for spreading information, I examined the factors in an online video that affected its popularity. Emotional content appeared to be associated with high view counts. I then conducted a randomised controlled trial to test if emotional content would encourage online video viewers to share it. The results provided no evidence for the effectiveness of emotional content on video sharing.

An important weakness of my randomised controlled trial was the low statistical power. Because a small proportion of email recipients opened the email message and even fewer watched the video, the effective sample size was substantially lower than anticipated. As a result, the present study provides no reliable evidence that emotional content increases forwarding of videos. However, absence of evidence must not be confused with evidence of absence and it is important to note that the trial was unable to confirm or refute a modest but potentially important impact on video forwarding.

My results underscore in this method of dissemination the importance of ensuring that email recipients open the message and click on the video link. Indeed, these two issues might be more challenging to overcome than encouraging recipients to share a video. In my trial, although the video viewing rate was unexpectedly low, the sharing rate was higher than expected. Only about 25% of those who received the invitation email in the main trial opened it, which could have been due to the change in the name of the sender of the email. In his conceptual model of "active dissemination" (figure 7.1), Lomas lists "credible dissemination body" as an element to promote dissemination[30]. He claims that the role of the credible dissemination body is to synthesise and distillate research information and make it more accessible for practitioners. This can be interpreted in a different way such that practitioners tend to obtain important information and new evidence from reliable organisations/people. In the DIFFUSION trial, the video viewing rate dramatically dropped by more than half when I changed the sender's name from the name of a professor to the name of a PhD student at LSHTM. As the number of

participants who opened the email was unavailable in the pilot trial, I cannot compare the email opening rate and find out if the name of the email sender affected the email opening rate, link clicking rate, or both. However, it is clear that the name of the email sender does not affect the effect of emotional content as total video sharing rate did not decrease and it rather increased in the main trial.

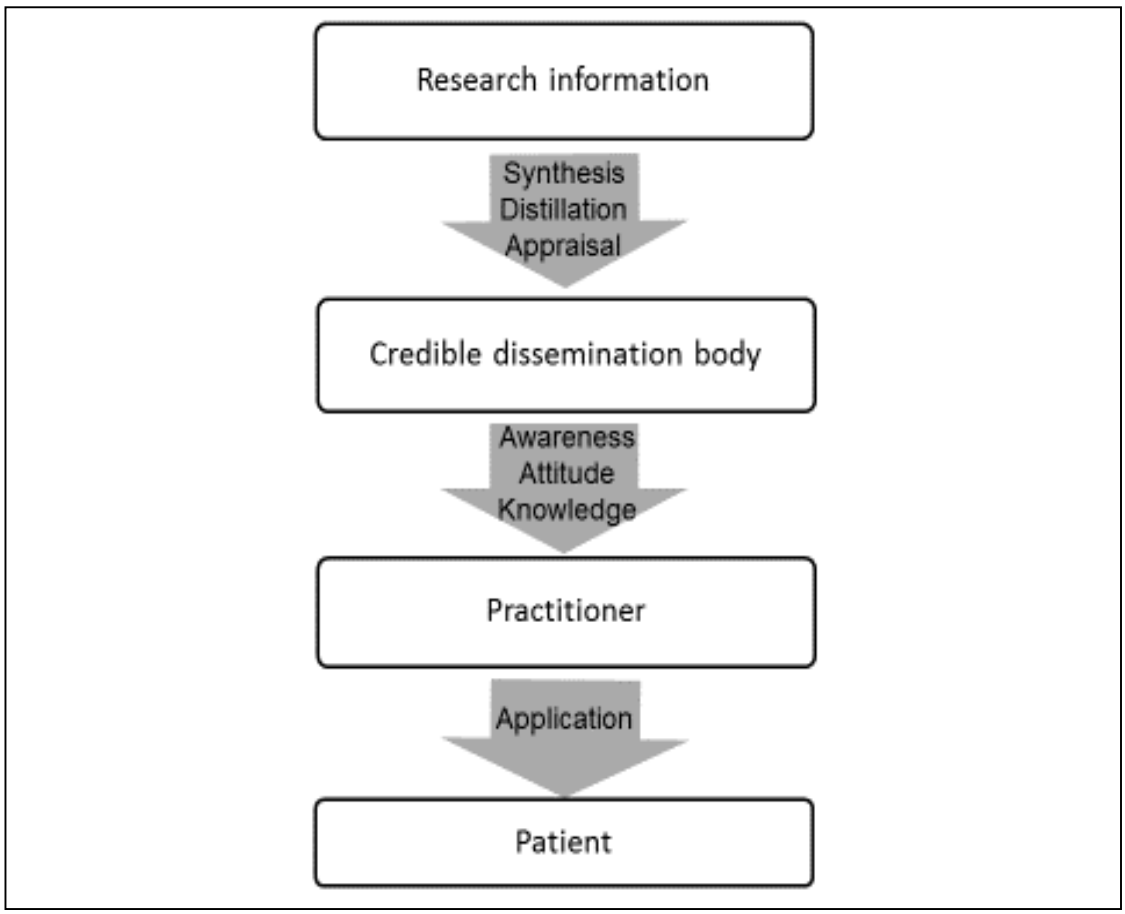

Figure 7.1 Active dissemination model (adopted from p442, Lomas 1993)

Wilson et al. reviewed and summarised conceptual frameworks related to knowledge translation[31]. Among what they found is the question-based approach by Jacobson,

Butterill and Goering[32]. Their framework consists of five factors: the user group, the issue, the research, the researcher-user relationship and dissemination strategies. The problem I had in the trial might be the case of the fourth factor, the researcher-user relationship. The facts that the videos sent via email from the professor was viewed by more participants and that the videos were viewed by more participants who were from the WOMAN trial contact list show that if there is some connection between the sender and the receiver of the information, the receiver pays more attention to it. Secondary dissemination has fewer problems with this factor as the participants must have sent the email to those they already had some kind of relationship with and the receivers are more likely to open the email as it was sent from someone of their acquaintance. Therefore, in the primary dissemination, email opening and video viewing rates might increase if the "seeding" is focused on those who have connection with the information sender rather than sending a mass-email to a large random population.

Another reason for the small number of outcome events might be the information delivered to them by the videos used in this study. Laswell describes important five factors that are important for communication in the format of a question, "Who says what in which channel to whom with what effect?"[33]. McGuire elaborated this sentence rewording these five interrogatives: the source of communication, the message to be communicated, the channels of communication, the characteristics of the audience (receiver), and the setting (destination) in which the communication is received[34,35]. The content of the intervention and control videos corresponds to "the message to be

communicated" of these domains. Since the WOMAN trial was ongoing while I conducted this study, I could not include information about the study results and findings. Rather, the videos became more like an advertisement to recruit hospitals in the trial. I wrote in the invitation email that "If you find it useful please share this email to any colleagues who you think might be interested in the WOMAN trial". The participants might not have found it useful as it did not contain helpful information such as new evidence from the trial, which could have negatively impacted video forwarding in both groups.

7.3.2 Future research

The estimate of the number of preventable premature deaths was imprecise because data were insufficient. Data on the number of in-hospital deaths due to traumatic haemorrhage from more countries are necessary to improve the estimate. The relative risk reduction changes according to the time between the injury and the introduction of tranexamic acid to the patient. Therefore, the relative risk reduction to apply to the formula is amendable if data on the time of patients' arrival to hospitals are available. National surveys to collect these data in each country provide more precise country specific estimate and hence, more accurate global estimates.

The first chapter of this thesis illustrated the importance of efficient and rapid dissemination of research findings, and the third chapter showed that this area has not been fully explored. In particular, most randomised controlled trials conducted to date

do not present valid results. More accurate trials of various dissemination methods including conventional and new strategies are required to shorten the time taken before research finding are brought into practice.

To examine the effectiveness of emotional content on video forwarding more precisely, further study with sufficient number of participants watching the videos is required. As distributing videos by e-mail is not efficient, another dissemination method to track individual access to the videos should be used in a new study. In addition, the detection of sharing depended on the definition of access by a unique individual. Therefore, a study with a robust design to detect video sharing more precisely is required.

To improve video viewing rate, strategies such as including an attractive subject line and incorporating an engaging main text could be utilised. A study to explore factors in an email subject line and main text that encourage email recipients to open the email and click the video link may provide useful information to develop the strategies.

Qualitative or quantitative studies on the decision making process in relation to opening emails and clicking on video links are required to understand why participants open invitation emails and what causes them to click links included in them.

As the content of the intervention and control videos might have been one of the reasons for low video forwarding, another trial with videos containing research findings

is suggested. The proposed trial could elucidate the factors influencing the sharing of videos in this context and provide new scientific evidence for the impact of “the message to be communicated” on persuasive communication.

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Appendices

Appendix 1-A Search strategies for the systematic review

MEDLINE

1 exp "Wounds and Injuries"/mo [Mortality]

2 ((injur* or trauma*) and (death* or mortality or fatal* or epidemiolog* or burden)).ti.

3 1 AND 2

Limit to 2004 onwards

EMBASE

1 mortality/ OR death/ OR cause of death/

2 injury/ or blunt trauma/ or multiple trauma/ or traumatic shock/

3 1 AND 2

4 ((injur* or trauma*) and (death* or mortality or fatal* or epidemiolog* or burden)).ti.

5 3 AND 4

Limit to 2004 onwards

CAB Abstracts

1 exp injuries/

2 (injur* or trauma*).ti.

3 1or 2

4 (death* or mortality or fatal* or epidemiolog* or burden).ti.

5 3 and 4

Limit 2004 onwards

Appendix 1-B Characteristics of identified articles

Author, year	Country	Design	Deaths(n)	Deaths in-hospital(%)	Bleeding in Blunt(%)	Bleeding in Penetrating(%)
Boulanger 2007	USA	Trauma-registry based study; 2000-2004	7362	-	19.6	56.3
CRASH-2 2010	Worldwide	Randomised controlled trial; 2005-2010	1618	-	28.2	59.6
Demetriades 2004	USA	Trauma-registry based study; 1993-2002	2648	33.4	-	-
Demetriades 2005	USA	Trauma registry and emergency medical services records based study; Jan 2000-Dec 2002	4151	79.6	-	-
Di Barolomeo 2004	Italy	Prospective population-based study; March 1998-Feb 1999	286	37.8	-	-
Dutton 2010	USA	Trauma-registry based study; July 1996-June 2008	2327	-	18.5	46.6
Evans 2010	Australia	Prospective study of autopsies reports and medical records; Feb 2005-Jan 2006	175	61.1	-	-
Gilroy 2005	UK	Retrospective study of in-hospital deaths; 2001	94	-	13.8	-

Author, year	Country	Design	Deaths(n)	Deaths in-hospital(%)	Bleeding in Blunt(%)	Bleeding in Penetrating(%)
Gomez de Segura Nieva 2009a	Spain	Prospective study of severe multiple injury patients; April 2001-March 2002	165	27.3	-	-
Gomez de Segura Nieva 2009b	France	Prospective study of severe multiple injury patients; April 2001-March 2002	151	33.8	-	-
Gomez 2010	Canada	Retrospective population-based study; 2002-2003	3486	46.2	-	-
Masella 2008	Brazil	Retrospective population based study; Jan 2000 – Dec 2001	787	43.1	-	-
Meel 2004	South Africa	Retrospective study of medico-legal autopsies; 1997-1998	274	25.9	-	-
Meisler 2010	Denmark	Prospective population based study; 2006	2068	41.7	-	-
Nizamo 2006	Mozambique	Respective review of registered deaths; 2000	1135	38.8	-	-
Potenza 2004	USA	Retrospective population based study; 1987-1997	14767	27.9	-	-
Singh 2008	India	Retrospective study of autopsy reports; Jan 2001-Dec 2003	344	75.8	-	-

Author, year	Country	Design	Deaths(n)	Deaths in-hospital(%)	Bleeding in Blunt(%)	Bleeding in Penetrating(%)
Soreide 2007	Norway	Retrospective review of autopsy reports; 1996-2004	260	48.1	-	-
Tien 2007	Canada	Retrospective study of in-hospital deaths; 1999-2003	558	-	8.5	61.6

Appendix 1-C Variables used for estimation

	Hospital mortality (%)	*Bleeding in blunt deaths (%)*	*Bleeding in penetrating deaths (%)*
Studies (n)	14	5	4
Mean (95% CI)	44.3 (34.5-54.1)	17.7 (8.6-26.8)	56.1 (46.9-65.2)
Crude(95% CI)	39.4 (38.7-40.0)	19.8 (19.1-20.6)	50.8 (49.3-52.4)
Median(IQR)	40.3 (33.5-47.6)	18.5 (13.8-19.6)	57.9 (53.9-60.1)
Freeman-Tukey – FEM(95% CI)	39.2 (38.7-39.9)	19.8 (19.0-20.6)	53.7 (51.6-55.7)
Freeman-Tukey – REM(95% CI)*	44.4 (33.4-55.6)	17.7 (13.0-22.9)	55.3 (48.5-61.9)
Inverse variance – FEM(95% CI)	40.4 (39.8-40.9)	19.1 (18.3-19.9)	53.7 (51.6-55.7)
Inverse variance – REM(95% CI)	44.3 (32.6-56.1)	17.9 (12.6-23.3)	55.3 (48.6-62.0)

* Estimates for primary analysis

FEM: Fixed effect model, REM: Random effect model

Appendix 1-D Search terms and strategy

1. (disseminat*[text word] OR diffuse*[text word] OR share[text word] OR sharing[text word] OR spread*[text word] OR exchang*[text word]) ADJ2 (finding*[text word] OR result*[text word] OR information[text word])
2. (knowledge[text word] OR information[text word]) ADJ1 (management[text word] OR transfer[text word] OR translation[text word])
3. (1 OR 2) ADJ2 (method*[text word] OR way*[text word] OR tool*[text word])

In the Cochrane library search, the Boolean operator "ADJ" was replaced with "NEAR". As the Campbell library search does not have such Boolean operator as "ADJ" or "NEAR", "AND" was used to substitute for them.

Appendix 1-E Search terms and strategy for Google search

disseminat* AND (method* OR tool*)

Appendix 2-A Search strategies for identification of records

Ovid (MEDLINE, EMBASE, HMIC and Global Health)

1. (stud$3 OR research$2) ADJ2 (finding$1 OR result$1 OR information) [text word]
2. (disseminat$3 OR spread$3 OR diffus$3 OR transfer$4 OR translat$3 OR share OR sharing OR exchang$3)[text word]
3. 1 ADJ2 2
4. (knowledge OR information OR innovation)[text word]
5. (disseminat$3 OR spread$3 OR diffus$3 OR transfer$4 OR translat$3 OR share OR sharing OR exchang$3 OR management OR brokering OR mobili#ation) [text word]
6. 4 ADJ2 5
7. [Subject headings] for "diffusion of innovation"
8. 3 OR 6 OR 7
9. (medic$3 OR clinical) [text word]
10. 8 AND 9
11. (advice network$3 OR advocate$1 OR audio visual aid$1 OR audio visual production$1 OR audio visual medi$2 OR (audit ADJ2 feedback) OR blog$4 OR book$1 OR booth$1 OR bulletin$1 OR CD-ROM$1 OR cellular phone$1 OR clinical audit OR CME OR communications medi$2 OR community network$1 OR conference$1 OR congress$2 OR continuing dental education OR continuing medical education OR continuing nursing education OR continuing pharmacy education OR database$1 OR dental audit OR distance teaching OR digital librar$3 OR digital medi$2 OR distance education OR distance learning OR educational material$1 OR educational meeting$1 OR educational outreach OR educationally influential OR electronic bulletin$1 OR electronic journal$1 OR electronic librar$3 OR electronic mail$1 OR electronic publication$1 OR email$1 OR e-mail$1 OR exhibit$4 OR facebook OR facsimile$1 OR fair$1 OR fax$2 OR feedback OR guideline$1 OR hand held computer$1 OR hand-held computer$1

OR information sharing group$1 OR instant messaging OR instructional film$1 OR instructional video$1 OR interactive tutorial$1 OR inventor$3 OR invited lecture$1 OR journal$1 OR local opinion leader$1 OR magazine$1 OR mail$1 OR mailing list$1 OR mass communication OR mass medi$2 OR medical audit OR mobile phone$1 OR mobile telephone$1 OR monograph$1 OR newsletter$1 OR newspaper$1 OR nursing audit OR on-line database$1 OR on-line message board$1 OR on-line tool$1 OR pamphlet$1 OR PDA OR periodical$1 OR personal communication$1 OR personal digital assistance OR personal digital assistant OR pharmaceutical audit OR podcast$1 OR poster$1 OR presentation$1 OR press release$1 OR print material$1 OR public event$1 OR publication$1 OR radio$1 OR reminder$1 OR report$1 OR seminar$1 OR smartphone application$1 OR social medi$2 OR social network$3 OR teleconference OR telefacsimile$1 OR telephone$1 OR television$1 OR text messaging OR TV$1 OR twitter OR university extension agenc$3 OR video conferencing OR video game$1 OR video$1 OR video-audio medi$2 OR vodcast$1 OR web based tool$1 OR web-based tool$1 OR webcast$1 OR website$1 OR wiki$1 OR word of mouth OR word-of-mouth OR workshop$1 OR world wide web application$1) [text word]

12. [Subject headings] for “dissemination methods”
13. 11 OR 12
14. 10 AND 13
15. (controlled trial$1 OR controlled stud$3 OR before-and-after stud$3 OR (before ADJ2 after ADJ2 stud$3)) [text word]
16. 14 AND 15
17. limit 16 to publication year between 1992 and current
18. limit 17 to journal articles

Appendix 3-A Search strategies for identification of records *(continued)*

CINAHL (EBSCO Host)

1. (stud* OR research*) N2 (finding* OR result* OR information) [text word]
2. (disseminat* OR spread* OR diffus* OR transfer* OR translat* OR share OR sharing OR exchang*)[text word]
3. 1 N2 2
4. (knowledge OR information OR innovation)[text word]
5. (disseminat* OR spread* OR diffus* OR transfer* OR translat* OR share OR sharing OR exchang* OR management OR brokering OR mobili?ation) [text word]
6. 4 N2 5
7. [Subject headings] for "diffusion of innovation"
8. 3 OR 6 OR 7
9. (medic* OR clinical) [text word]
10. 8 AND 9
11. (advice network* OR advocate* OR audio visual aid* OR audio visual production* OR audio visual media OR audio visual medium OR (audit W2 feedback) OR blog* OR book* OR booth* OR bulletin* OR CD-ROM* OR cellular phone* OR clinical audit OR CME OR communications media OR communications medium OR community network* OR conference* OR congress* OR continuing dental education OR continuing medical education OR continuing nursing education OR continuing pharmacy education OR database* OR dental audit OR distance teaching OR digital librar* OR digital media OR digital medium OR distance education OR distance learning OR educational material* OR educational meeting* OR educational outreach OR educationally influential OR electronic bulletin* OR electronic journal* OR electronic librar* OR electronic mail* OR electronic publication* OR email* OR e-mail* OR exhibit* OR facebook OR facsimile* OR fair* OR fax* OR feedback OR guideline* OR hand held computer* OR hand-held computer* OR information sharing group* OR instant messaging OR instructional film* OR instructional video* OR interactive tutorial* OR

inventor* OR invited lecture* OR journal* OR local opinion leader* OR magazine* OR mail* OR mailing list* OR mass communication OR mass media OR mass medium OR medical audit OR mobile phone* OR mobile telephone* OR monograph* OR newsletter* OR newspaper* OR nursing audit OR on-line database* OR on-line message board* OR on-line tool* OR pamphlet* OR PDA OR periodical* OR personal communication* OR personal digital assistance OR personal digital assistant OR pharmaceutical audit OR podcast* OR poster* OR presentation* OR press release* OR print material* OR public event* OR publication* OR radio* OR reminder* OR report* OR seminar* OR smartphone application* OR social media OR social medium OR social network* OR teleconference OR telefacsimile* OR telephone* OR television* OR text messaging OR TV* OR twitter OR university extension agenc* OR video conferencing OR video game* OR video* OR video-audio medium OR video-audio media OR vodcast* OR web based tool* OR web-based tool* OR webcast* OR website* OR wiki* OR word of mouth OR word-of-mouth OR workshop* OR world wide web application*) [text word]

12. [Subject headings] for “dissemination methods”
13. 11 OR 12
14. 10 AND 13
15. (controlled trial* OR controlled stud* OR before-and-after stud* OR (before W2 after W2 stud*)) [text word]
16. 14 AND 15
17. limit 16 to publication year between 1992 and current
18. limit 17 to journal articles

Appendix 3-A Search strategies for identification of records *(continued)*

Cochrane library

1. (studies OR researches) NEAR/2 (findings OR results OR information) [text word]
2. (disseminat* OR spread* OR diffus* OR transfer* OR translat* OR share OR sharing OR exchang*)[text word]
3. 1 NEAR/2 2
4. (knowledge OR information OR innovation)[text word]
5. (disseminat* OR spread* OR diffus* OR transfer* OR translat* OR share OR sharing OR exchang* OR management OR brokering OR mobili?ation) [text word]
6. 4 NEAR/2 5
7. [Subject headings] for "diffusion of innovation"
8. 3 OR 6 OR 7
9. (medic* OR clinical) [text word]
10. 8 AND 9
11. (advice networks OR advocates OR audio visual aids OR audio visual productions OR audio visual media OR audio visual medium OR (audit NEAR/2 feedback) OR bloggs OR blog OR books OR booths OR bulletins OR (CD NEXT ROMs) OR (cellular NEXT phones) OR clinical audit OR CME OR communications media OR communications medium community networks OR conferences OR congresses OR continuing dental education OR continuing medical education OR continuing nursing education OR continuing pharmacy education OR databases OR dental audit OR distance teaching OR digital libraries OR digital media OR digital medium OR distance education OR distance learning OR educational materials OR educational meetings OR educational outreach OR educationally influential OR electronic bulletins OR electronic journals OR electronic libraries OR electronic mails OR electronic publications OR emails OR (e NEXT mails) OR exhibit* OR facebook OR facsimiles OR fairs OR faxes OR feedback OR guidelines OR hand held computers OR (hand NEXT held computers) OR information sharing groups OR instant messaging OR instructional films OR instructional videos OR

interactive tutorials OR inventories OR invited lectures OR journals OR local opinion leaders OR magazines OR mails OR mailing lists OR mass communication OR mass media OR mass medium OR medical audit OR (mobile NEXT phones) OR (mobile NEXT telephones) OR monographs OR newsletters OR newspapers OR nursing audit OR on-line databases OR on-line message boards OR on-line tools OR pamphlets OR PDA OR periodicals OR personal communications OR (personal NEXT digital NEXT assistance) OR (personal NEXT digital NEXT assistant) OR pharmaceutical audit OR podcasts OR posters OR presentations OR press releases OR print materials OR public events OR publications OR radios OR reminders OR reports OR seminars OR smartphone applications OR social media OR social medium OR social networks OR teleconference OR telefacsimiles OR telephones OR televisions OR text messaging OR TVs OR twitter OR university extension agencies OR video conferencing OR video games OR videos OR video NEXT audio medium OR (video NEXT audio media) OR vodcasts OR (web NEXT based tools) OR webcasts OR websites OR wikis OR (word NEXT of NEXT mouth) OR workshops OR (world NEXT wide NEXT web applications)) [text word]

12. [Subject headings] for “dissemination methods”
13. 11 OR 12
14. 10 AND 13
15. (controlled trials OR (before NEAR/2 after studies)) [text word]
16. 14 AND 15
17. limit 16 to publication year between 1992 and current
18. limit 17 to Trials

Appendix 3-A Search strategies for identification of records *(continued)*

Campbell library

1. (studies OR researches) AND (findings OR results OR information) [text word]
2. (disseminat* OR spread* OR diffus* OR transfer* OR translat* OR share OR sharing OR exchang*)[text word]
3. 1 AND 2
4. (knowledge OR information OR innovation)[text word]
5. (disseminat* OR spread* OR diffus* OR transfer* OR translat* OR share OR sharing OR exchang* OR management OR brokering OR mobili?ation) [text word]
6. 4 AND 5
7. [Subject headings] for "diffusion of innovation"
8. 3 OR 6 OR 7
9. (medic* OR clinical) [text word]
10. 8 AND 9
11. (advice network* OR advocate* OR audio visual aid* OR audio visual production* OR audio visual media OR audio visual medium OR (audit AND feedback) OR blog* OR book* OR booth* OR bulletin* OR CD-ROM* OR cellular phone* OR clinical audit OR CME OR communications media OR communications medium OR community network* OR conference* OR congress* OR continuing dental education OR continuing medical education OR continuing nursing education OR continuing pharmacy education OR database* OR dental audit OR distance teaching OR digital librar* OR digital media OR digital medium OR distance education OR distance learning OR educational material* OR educational meeting* OR educational outreach OR educationally influential OR electronic bulletin* OR electronic journal* OR electronic librar* OR electronic mail* OR electronic publication* OR email* OR e-mail* OR exhibit* OR facebook OR facsimile* OR fair* OR fax* OR feedback OR guideline* OR hand held computer* OR hand-held computer* OR information sharing group* OR instant messaging OR instructional film* OR instructional video* OR interactive tutorial* OR

inventor* OR invited lecture* OR journal* OR local opinion leader* OR magazine* OR mail* OR mailing list* OR mass communication OR mass media OR mass medium OR medical audit OR mobile phone* OR mobile telephone* OR monograph* OR newsletter* OR newspaper* OR nursing audit OR on-line database* OR on-line message board* OR on-line tool* OR pamphlet* OR PDA OR periodical* OR personal communication* OR personal digital assistance OR personal digital assistant OR pharmaceutical audit OR podcast* OR poster* OR presentation* OR press release* OR print material* OR public event* OR publication* OR radio* OR reminder* OR report* OR seminar* OR smartphone application* OR social media OR social medium OR social network* OR teleconference OR telefacsimile* OR telephone* OR television* OR text messaging OR TV* OR twitter OR university extension agenc* OR video conferencing OR video game* OR video* OR video-audio medium OR video-audio media OR vodcast* OR web based tool* OR web-based tool* OR webcast* OR website* OR wiki* OR word of mouth OR word-of-mouth OR workshop* OR world wide web application*) [text word]

12. 10 AND 11 (No result)

Appendix 3-A Search strategies for identification of records *(continued)*

Web of knowledge search (Web of Science)

1. ((stud* OR research*) NEAR/2 (finding* OR result* OR information)) NEAR/2 (disseminat* OR spread* OR diffus* OR transfer* OR translat* OR share OR sharing OR exchang*)[text word]
2. (knowledge OR information OR innovation) NEAR/2 (disseminat* OR spread* OR diffus* OR transfer* OR translat* OR share OR sharing OR exchang* OR management OR brokering OR mobili?ation) [text word]
3. 1 OR 2
4. (medic* OR clinical) [text word]
5. 3 AND 4
6. (advice network* OR advocate* OR audio visual aid* OR audio visual production* OR audio visual media OR audio visual medium OR (audit NEAR/2 feedback) OR blog* OR book* OR booth* OR bulletin* OR CD-ROM* OR cellular phone* OR clinical audit OR CME OR communications media OR communications medium OR community network* OR conference* OR congress* OR continuing dental education OR continuing medical education OR continuing nursing education OR continuing pharmacy education OR database* OR dental audit OR distance teaching OR digital librar* OR digital media OR digital medium OR distance education OR distance learning OR educational material* OR educational meeting* OR educational outreach OR educationally influential OR electronic bulletin* OR electronic journal* OR electronic librar* OR electronic mail* OR electronic publication* OR email* OR e-mail* OR exhibit* OR facebook OR facsimile* OR fair* OR fax* OR feedback OR guideline* OR hand held computer* OR hand-held computer* OR information sharing group* OR instant messaging OR instructional film* OR instructional video* OR interactive tutorial* OR inventor* OR invited lecture* OR journal* OR local opinion leader* OR magazine* OR mail* OR mailing list* OR mass communication OR mass media OR mass medium OR medical audit OR mobile phone* OR mobile telephone* OR

monograph* OR newsletter* OR newspaper* OR nursing audit OR on-line database* OR on-line message board* OR on-line tool* OR pamphlet* OR PDA OR periodical* OR personal communication* OR personal digital assistance OR personal digital assistant OR pharmaceutical audit OR podcast* OR poster* OR presentation* OR press release* OR print material* OR public event* OR publication* OR radio* OR reminder* OR report* OR seminar* OR smartphone application* OR social media OR social medium OR social network* OR teleconference OR telefacsimile* OR telephone* OR television* OR text messaging OR TVs OR TV OR twitter OR university extension agenc* OR video conferencing OR video game* OR video* OR video-audio medium OR video-audio media OR vodcast* OR web based tool* OR web-based tool* OR webcast* OR website* OR wiki* OR word of mouth OR word-of-mouth OR workshop* OR world wide web application*) [text word]

7. 5 AND 6
8. (controlled trial* OR controlled stud* OR before-and-after stud* OR (before NEAR/2 after NEAR/2 stud*)) [text word]
9. 7 AND 8
10. limit 9 to publication year between 1992 and current
11. limit 10 to journal articles

Appendix 3-A Search strategies for identification of records *(continued)*

Scopus search (Scirus)

1. ((stud* OR research*) W/1 (finding* OR result* OR information)) W/1 (disseminat* OR spread* OR diffus* OR transfer* OR translat* OR share OR sharing OR exchang*)[text word]
2. (knowledge OR information OR innovation) W/1 (disseminat* OR spread* OR diffus* OR transfer* OR translat* OR share OR sharing OR exchang* OR management OR brokering OR mobili?ation) [text word]
3. 1 OR 2
4. (medic* OR clinical) [text word]
5. 3 AND 4
6. (advice network* OR advocate* OR audio visual aid* OR audio visual production* OR audio visual media OR audio visual medium OR (audit PRE/2 feedback) OR blog* OR book* OR booth* OR bulletin* OR CD-ROM* OR cellular phone* OR clinical audit OR CME OR communications media OR communications medium OR community network* OR conference* OR congress* OR continuing dental education OR continuing medical education OR continuing nursing education OR continuing pharmacy education OR database* OR dental audit OR distance teaching OR digital librar* OR digital media OR digital medium OR distance education OR distance learning OR educational material* OR educational meeting* OR educational outreach OR educationally influential OR electronic bulletin* OR electronic journal* OR electronic librar* OR electronic mail* OR electronic publication* OR email* OR e-mail* OR exhibit* OR facebook OR facsimile* OR fair* OR fax* OR feedback OR guideline* OR hand held computer* OR hand-held computer* OR information sharing group* OR instant messaging OR instructional film* OR instructional video* OR interactive tutorial* OR inventor* OR invited lecture* OR journal* OR local opinion leader* OR magazine* OR mail* OR mailing list* OR mass communication OR mass media OR mass medium OR medical audit OR mobile phone* OR mobile telephone* OR

monograph* OR newsletter* OR newspaper* OR nursing audit OR on-line database* OR on-line message board* OR on-line tool* OR pamphlet* OR PDA OR periodical* OR personal communication* OR personal digital assistance OR personal digital assistant OR pharmaceutical audit OR podcast* OR poster* OR presentation* OR press release* OR print material* OR public event* OR publication* OR radio* OR reminder* OR report* OR seminar* OR smartphone application* OR social media OR social medium OR social network* OR teleconference OR telefacsimile* OR telephone* OR television* OR text messaging OR TVs OR TV OR twitter OR university extension agenc* OR video conferencing OR video game* OR video* OR video-audio medium OR video-audio media OR vodcast* OR web based tool* OR web-based tool* OR webcast* OR website* OR wiki* OR word of mouth OR word-of-mouth OR workshop* OR world wide web application*) [text word]

7. 5 AND 6
8. (controlled trial* OR controlled stud* OR before-and-after stud* OR (before W/1 after W/1 stud*)) [text word]
9. 7 AND 8
10. limit 9 to publication year between 1992 and current
11. limit 10 to journal articles

Key words that are related to the methods identified in chapter 3 were added.

Although “play in a theatre” was identified in the previous chapter, the word “play” may result in the vast amount of search results as it has other meanings and is used often in reports. Therefore, this knowledge transfer method will not be included in the search. As the study that used this unique method has already been identified in the previous chapter, the eligibility of the study will assessed separately.

Appendix 2-B Subject headings of each database

Medline (MeSH)

Information dissemination, Diffusion of innovation

blogging	books	cellular phone
clinical (medical, nursing, dental) audit	communications media	community networks
computers, handheld	congresses as topic	databases as topic
education	education, distance	education, medical (nursing, pharmacy, dental), continuing
electronic mail	exhibits as topic	feedback
guidelines as topic	instructional films and videos	interactive tutorial
internet	journal article	libraries, digital
mass media	newspapers	pamphlets
periodicals as topic	postal service	posters as topic
radio	reminder systems	research report
social media	social networking	telefacsimile
telephone	television	text messaging
video conferencing	video-audio media	webcasts as topic

Appendix 3-B Subject headings of each database *(continued)*

Embase (EMtree)

Information dissemination, Mass communication (diffusion of innovation)

audiovisual aid	Blogging (categorised as internet)	Book
computers, handheld (categorised as microcomputer)	data base	education, medical, continuing (categorised as medical education)
electronic bulletin board	electronic publication (categorised as publication)	Exhibits (categorised as publication)
e-mail	fax	internet
library	mass communication	mass medium
medical audit	mobile phone	Newspapers (categorised as publication)
periodicals as topic (categorised as publication)	personal digital assistant	postal mail
practice guideline	Radio (categorised as telecommunication)	reminder system
scientific literature	social media	social network
teleconference	telephone	television
text messaging	video conferencing	webcast
workshop		

Appendix 3-B Subject headings of each database *(continued)*

HMIC (MeSH)

Dissemination of information, Current dissemination of information, Dissemination of research, Research findings, Information transfer, Information exchange

audiovisual media	blogging	books
clinical (Medical, Nursing, Pharmaceutical) audit	clinical guidelines	continuing medical education
databases	digital media	distance learning
electronic journals	email	facsimile transmission
feedback	instant messaging	internet
internet websites	libraries, digital	mail
mass communication	mass media	medical conferences
mobile telephones	newspapers	pamphlets
periodicals	personal digital assistants	podcasts
radio	research reports	social networking (social networks)
telephones	television	text messaging
training workshops	videoconferencing	vodcasts
wikis		

Appendix 3-B Subject headings of each database *(continued)*

Global Health (MeSH)

Diffusion of information (information dissemination), Diffusion of research

audio visual aids	books	conferences
continuing education	databases	distance teaching
feedback	guidelines	internet
journals	mass media	mobile telephones
newsletters	newspapers	posters
radio	reports	telephones
television	workshops (programs)	

Appendix 3-B Subject headings of each database *(continued)*

CINAHL (MeSH)

Diffusion of innovation

audiovisual production	audit	blogs
books	bulletin boards (electronic bulletin boards)	clinical conferences
communications media	computers, hand-held	databases
education, Medical (Nursing), continuing	electronic journals	electronic mail
exhibits	feedback	instant messaging
internet	libraries, electronic	mail
newsletters	newspapers	pamphlets
posters	practice guidelines	print materials
radio	reminder systems	reports
seminars and workshops	serial publications	social media
social networking	teleconferencing	telefacsimile
telephone	television	text messaging
videoconferencing	wireless communications (for cellular phone)	world wide web applications (for webcasting)

Appendix 3-B Subject headings of each database (*continued*)

Cochrane Library (MeSH)

Information dissemination, Diffusion of innovation

blogging	books	cellular phone
clinical (medical, nursing, dental) audit	communications media	community networks
computers, handheld	congresses as topic	databases as topic
education	education, distance	education, medical (nursing, pharmacy, dental), continuing
electronic mail	exhibits as topic	feedback
guidelines as topic	instructional films and videos	interactive tutorial
internet	journal article	libraries, digital
mass media	newspapers	pamphlets
periodicals as topic	postal service	posters as topic
radio	reminder systems	research report
social media	social networking	telefacsimile
telephone	television	text messaging
videoconferencing	video-audio media	webcasts as topic

Campbell Library (UK Archival Thesaurus)

Dissemination of knowledge, Dissemination of research, Information dissemination, Diffusion of innovations, Information transfer, Know-how transfer

Appendix 2-C Characteristics of included studies (ordered by study ID)

Study ID/Country	Study type	Participants	Type of intervention	Outcome
Amsallem 2007 France	C-RCT	Cardiologists	Intervention A: active - two hours of knowledge brokers' visits + published reports + discussion Intervention B: passive - educational material available on the study website every week Control: not mentioned	Mean score of a multiple choice questionnaire assessing knowledge of standardised summary of systematic reviews in cardiology
Butzlaff 2004 Germany	RCT	General practitioners	Intervention: web-based and CD-ROM version of guideline Control: not mentioned	Median number of correctly answered questions in a multiple choice questionnaire assessing knowledge of guidelines
Carroll 2011 Canada	RCT	Family physicians	Intervention: workshops + portfolio of primary care-appropriate genetics tools + responsive timely knowledge support service (sent by e-mail or fax) Control: educational materials	Number of participants who answered correctly each of three questions about genetics

Study ID/Country	Study type	Participants	Type of intervention	Outcome
Chan 1999 Canada (on-line)	RCT	Family physicians	Intervention: Problem-based small-group learning (PBSGL) via internet Control: Similar educational resources via internet but without small-group interaction	The total score of pre- and post-test score of multiple choice questionnaire assessing knowledge of depression in the elderly
Dimeff 2011 USA	RCT	Clinicians	Intervention: e-learning course Control: manual	Mean proportion of correct answers in a 23-item multiple choice test for knowledge of Dialectical Behaviour Therapy
Downs 2003 UK	C-RCT	General Practitioners Nurses	Intervention A: practice-based workshops Intervention B: electronic tutorial on a CD-ROM Intervention C: decision support system in a medical record software Control: no intervention	Mean score of a 14-tiem multiple choice questions about Alzheimer's Disease knowledge

Study ID/Country	Study type	Participants	Type of intervention	Outcome
Elliott 1997 USA	C-RCT	Physicians Nurses	Intervention: community opinion leaders took two-day minifellowship (didactic presentations, clinical preceptorships with experiential clinical rounds) and conducted an outreach programme Control: not mentioned	Mean score of a 15-item questionnaire assessing knowledge of cancer pain management
Hagemeister 2008 Germany	RCT	General practitioners	Intervention A: seminar about a guideline Intervention B: interactive guideline Intervention C: printed guideline Control: not mentioned	Proportion of participants who scored five or more in eight question tests about knowledge of a guideline for diagnosis and treatment of hypertension

Study ID/Country	Study type	Participants	Type of intervention	Outcome
Harned 2011 USA	RCT	Mental health care providers	Intervention A: interactive multimedia on-line training Intervention B: interactive multimedia on-line training + motivational interviewing-based intervention Control: placebo control on-line training	Mean proportion of correct answers in a 27-item multiple choice test assessing knowledge of therapy for anxiety disorders
Kirshbaum 2008 UK	C-RCT	Nurses	Intervention: targeted booklet Control: not mentioned	Number of participants who correctly answered each of 17 questions about knowledge of breast cancer
Liaw 2008 Australia	C-RCT	General practitioners	Intervention: small group education workshops + locally adapted guidelines Control A: locally adopted guidelines only Control B: alternative education programme (without any adopted resource material)	Proportion of correct answers in a 21-item true/false test assessing knowledge of asthma management

Study ID/Country	Study type	Participants	Type of intervention	Outcome
Margalit 2005 Israel	RCT	General practitioners	Intervention: interactive continuing medical education Control: didactic lectures	Mean proportion of correct answer in a 194-item open question assessing knowledge of bio-psychosocial-oriented primary care
Santoso 1996 Indonesia	C-RCT	Prescribers	Intervention A: small group face-to-face discussion + booklet Intervention B: formal seminar + booklet Control: participants did not attend any educational programme	Mean score of a 10 score test assessing knowledge of the treatment of diarrhoea in children
Searle 2002 Australia	C-RCT	Gynaecology specialists	Intervention: educational strategy (evidence-based guidelines, workshop, opinion leaders) Control: not mentioned	Median score of a questionnaire including open-ended questions and clinical scenarios related to dysfunctional uterine bleeding

Study ID/Country	Study type	Participants	Type of intervention	Outcome
Shirazi 2009 Iran	RCT	General practitioners	Intervention: interactive education in differently sized groups based on the level of readiness to change Control: conventional teacher-centred educational methods	Mean score of multiple choice and Likert scale questionnaire, case vignettes and essay question assessing knowledge of depression management
Tanna 2011 Worldwide	RCT	Physicians Other medical rofessionals	Intervention: e-mail alert with intervention articles Control: e-mail alert without intervention articles	Mean knowledge score of a questionnaire about recently published articles related to nephrology
Van der Sanden 2005 The Netherlands	RCT	Dentists	Intervention: clinical practice guidelines Control: not mentioned	1. Mean number of wrong treatment decision, 2. Mean percentage of correct decision for lower third molar management

Study ID/Country	Study type	Participants	Type of intervention	Outcome
Vollmar 2007 Germany	C-RCT	General practitioners	Intervention: three-hour training + two-hour extra training Control: three-hour training only	Mean score of a 20-item multiple choice question assessing knowledge of dementia diagnosis and dementia therapy

Appendix 2-D Risks of bias of included studies (ordered by study ID)

Amsallem 2007

Methods	C-RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Computerised algorithm	Low
Allocation concealment	Centrally randomised at the coordinating centre	Low
Blinding of participants	Not mentioned but blinding is impossible when the intervention is educational materials or courses	High
Blinding of outcome assessment	The marking method of assessment and if outcome assessment was blinded are not mentioned	Unclear
Incomplete outcome data	The number of participants randomised and analysed are the same	Low
Selective reporting	Protocol is not published	Low
	Pre-specified outcome measures and results are reported	
Other sources of bias	Cluster of physicians to minimise contamination bias	Low
Recruitment bias	Participants were recruited at the same time as clusters and randomisation was conducted after recruitment	Low
Baseline imbalance	Difference in baseline knowledge was not statistically significant	Low
Loss of clusters	No withdrawal	Low

Incorrect analysis	Analyses were done at department and physician level within-group difference was compared between-group difference	Low

Butzlaff 2004

Methods	RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Computer-generated allocation	Low
Allocation concealment	Not mentioned	Unclear
Blinding of participants	Not mentioned but blinding is impossible when the intervention is educational materials or courses	High
Blinding of outcome assessment	Outcome was assessed using multiple choice questionnaires, which is objective.	Low
Incomplete outcome data	Three GPs in the intervention group dropped out but no explanation	Unclear
Selective reporting	Protocol is not published Outcomes are not well pre-specified but explained in the result section	Unclear
Other sources of bias	Block randomisation with regard to single or group practice to avoid individual knowledge transfer	Low

Carroll 2011

Methods	RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Random number sequence	Low
Allocation concealment	Not mentioned	Unclear
Blinding of participants	Participants could not be blinded to their study allocation	High
Blinding of outcome assessment	Data entry was blinded and completed independently	Low
	analysis was not blinded	
	Interpretation was done by research team blinded to randomisation group	
Incomplete outcome data	Participants in the control group were more likely to drop out and did not complete the second test	Unclear
	The reason for the imbalance in outcome data is not provided	
	No significant demographic difference was found between groups	
Selective reporting	Protocol is not published	Low
	Pre-specified outcome measures and results are reported	
Other sources of bias	Only one participant per practice to minimise contamination and avoid clustering of observations	Low

Chan 1999

Methods	RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Not mentioned	Unclear
Allocation concealment	Not mentioned	Unclear
Blinding of participants	Not mentioned	Unclear
Blinding of outcome assessment	Not mentioned	Unclear
Incomplete outcome data	Reasons for four withdrawals are explained and none of them seems to be affected by the intervention or to affect the results	Low
Selective reporting	Protocol is not published	Low
	Pre-specified outcome measures and results are reported	

Dimeff 2011

Methods	RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Minimization random assignment procedure	Low
	(matched on educational degree)	
Allocation concealment	Not mentioned	Unclear

Blinding of participants	Not mentioned but blinding is impossible when the intervention is educational materials or courses	High
Blinding of outcome assessment	Research assistants who did follow-up assessments were blinded to training condition	Low
Incomplete outcome data	No between-condition differences were found in rates of assessment completion	Low
	Power analyses indicated the sample size was enough to detect between small and medium effect sizes	
Selective reporting	Protocol is not published	Low
	Pre-specified outcome measures and results are reported	

Downs 2003

Methods	C-RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Not mentioned	Unclear
Allocation concealment	Not mentioned	Unclear
Blinding of participants	Participants were blinded at the first knowledge assessment but not blinded to the allocation at the second assessment	High

Blinding of outcome assessment	Not mentioned	Unclear
	Wording was allowed in the tests, which might have caused subjective assessment in case the assessors were not blinded	
Incomplete outcome data	79 data sets were missing in the post-intervention assessment	Low
	To reduce the chance that the scores were biased towards higher scores, intention to treat analysis was conducted	
Selective reporting	Protocol had not been published. All research questions stated in the method section were answered in the result section	Low
Recruitment bias	Recruited practices were free to nominate practitioners and the method of allocation concealment was not mentioned in the report	Unclear
	There was a chance practitioners were selectively recruited in case the practices knew their allocation	
Baseline imbalance	Participants were mostly similar at the beginning of the study	Low
	Participants in the decision support system and the control group reported higher IT competency than those in the workshop and the CD-ROM group	
Loss of clusters	One practice withdrew before any data could be collected, but the reason was not reported	Unclear
Incorrect analysis	Cluster effect was taken into account	Low

Elliott 1997

Methods	C-RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Not mentioned	Unclear
Allocation concealment	Not mentioned	Unclear
Blinding of participants	Not mentioned but blinding is impossible when the intervention is educational materials or courses	High
Blinding of outcome assessment	Outcome was assessed using five-scale questionnaires, which is objective.	Low
Incomplete outcome data	Although 21 physicians and 27 nurses did not complete follow-up survey, details are not mentioned	Unclear
Selective reporting	Protocol is not published	Low
	Pre-specified outcome measures and results are reported	
Recruitment bias	Recruitment was done by the Telephone Survey Centre based on criteria	Low
Baseline imbalance	Groups were pair-matched and survey at baseline did not show difference between those groups	Low
Loss of clusters	No withdrawal	Low
Incorrect analysis	Intra-class correlation was taken into account	Low

Hagemeister 2008

Methods	RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Not mentioned	Unclear
Allocation concealment	Not mentioned	Unclear
Blinding of participants	Not mentioned but blinding is impossible when the intervention is educational materials or courses	High
Blinding of outcome assessment	Not mentioned	Unclear
Incomplete outcome data	There were no relevant differences in demographic data and physician data for responders and non-responders to the questionnaire	Low
Selective reporting	Protocol is not published	High
	Outcomes are not pre-specified and what is explained in the statistical method section is not explained in the results	

Harned 2011

Methods	RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Randomization minimization procedure	Low
Allocation concealment	Not mentioned	Unclear

Blinding of participants	Not mentioned but blinding is impossible when the intervention is educational materials or courses	High
Blinding of outcome assessment	As all measures involved self-report, there were no blinded assessments	High
Incomplete outcome data	No drop-out or missing data from baseline, post-test to one-week follow up	Low
	No significant baseline between-condition differences on any outcome variable	
Selective reporting	Protocol is not published	Low
	Pre-specified outcome measures and results are reported	
Other sources of bias	To ensure participants had minimal prior exposure to ET, some exclusion criteria were set	Low

Kirshbaum 2008

Methods	C-RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Not mentioned	Unclear
Allocation concealment	Not mentioned but blinding is impossible when the intervention is educational materials or courses	Unclear
Blinding of participants	Not mentioned	High
Blinding of outcome assessment	Multiple choice questions were used, which is objective	Low

Incomplete outcome data	12 participants did not complete the follow-up test, but no explanation or interpretation about that	Unclear
Selective reporting	Protocol is not published	Low
	Pre-specified outcome measures and results are reported	
Recruitment bias	Recruitment was done before randomisation	Low
Baseline imbalance	Only one difference between groups but it was judged as negligible	Low
Loss of clusters	Not mentioned	Unclear
Incorrect analysis	Clustered regression analyses were done	Low

Liaw 2008

Methods	C-RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Random number table	Low
Allocation concealment	Not mentioned	Unclear
Blinding of participants	GPs and investigators could not be blinded to the allocation of GPs	High
Blinding of outcome assessment	True/false statements were used, which is objective	Low
Incomplete outcome data	More lost-to-follow-ups in the control group but no description about the effect	Unclear
Selective reporting	Protocol is not published	Low
	Pre-specified outcome measures and results are reported	

Recruitment bias	Recruitment was done before randomisation	Low
Baseline imbalance	All groups were well balanced at baseline except for years in general practice	Low
Loss of clusters	One from intervention group two from control group	Unclear
Incorrect analysis	Mean cluster score was used to allow for clustering effect	Low

Margalit 2005

Methods	RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Not mentioned	Unclear
Allocation concealment	Not mentioned	Unclear
Blinding of participants	Not mentioned but blinding is impossible when the intervention is educational materials or courses	High
Blinding of outcome assessment	Not mentioned	Unclear
Incomplete outcome data	No withdrawal	Low
Selective reporting	Protocol is not published	Low
	Pre-specified outcome measures and results are reported	

Santoso 1996

Methods	C-RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Not mentioned	Unclear
Allocation concealment	Not mentioned	Unclear
Blinding of participants	Not mentioned	High
Blinding of outcome assessment	The tests were based on 0-10 point scores attained from a standardised questionnaire and gave a subjective evaluation.	Low
Incomplete outcome data	Withdrawals were not mentioned	Unclear
Selective reporting	Protocol is not published	Low
	Outcomes that were described in the method section are mentioned in the result section	
Recruitment bias	Details of recruitment were not mentioned	Unclear
Baseline imbalance	Comparison at baseline in terms of characteristics and knowledge of participants was not mentioned	Unclear
Loss of clusters	Not mentioned	Unclear
Incorrect analysis	Whether cluster effect was taken into account during data analyses was not mentioned	Unclear

Searle 2002

Methods	C-RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Not mentioned	Unclear
Allocation concealment	Selection of an opaque envelope by an independent third party	Low
Blinding of participants	Not mentioned but blinding is impossible when the intervention is educational materials or courses	High
Blinding of outcome assessment	Not mentioned	Unclear
Incomplete outcome data	Reason for missing data is not mentioned	Unclear
Selective reporting	Protocol is not published	High
	One outcome (attitudes and practices related to education) is not mentioned in the results	
Recruitment bias	Randomisation was conducted after recruitment of participants	Low
Baseline imbalance	Although the authors stated that specialists in intervention group had significantly more years of experience than those in control group, the difference did not seem to be a source of selection bias	Low
Loss of clusters	No withdrawal	Low
Incorrect analysis	Intra cluster correlation was calculated and cluster effect was taken into consideration	Low

Shirazi 2009

Methods	RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Not mentioned	Unclear
Allocation concealment	Not mentioned	Unclear
Blinding of participants	Not mentioned	Unclear
Blinding of outcome assessment	One of the assessment methods was scored by a researcher and the scores were compared with those by a psychiatrist. The results highly correlated but if both of them were blinded was not mentioned	Unclear
Incomplete outcome data	No withdrawal	Low
Selective reporting	Protocol is not published Pre-specified outcome measures and results are reported	Low

Tanna 2011

Methods	RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Not mentioned	Unclear
Allocation concealment	Not mentioned	Unclear
Blinding of participants	Not mentioned but blinding is impossible when the intervention is educational materials or courses	High

Blinding of outcome assessment	Scoring was done with five-point scale, which is objective	Low
Incomplete outcome data	No withdrawal	Low
Selective reporting	Protocol is not published	Low
	Pre-specified outcome measures and results are reported	

Van der Sanden 2005

Methods	RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Random number table	Low
Allocation concealment	Not mentioned	Unclear
Blinding of participants	Not mentioned but blinding is impossible when the intervention is educational materials or courses	High
Blinding of outcome assessment	The assessment was done compared with guideline, which is objective	Low
Incomplete outcome data	Small difference in withdrawal between the two groups and seems to have little impact	Low
Selective reporting	Protocol is not published	Low
	Outcomes were mentioned in the data analysis section and results were presented	

Vollmar 2007

Methods	C-RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Not mentioned	Unclear
Allocation concealment	Not mentioned	Unclear
Blinding of participants	Not mentioned but blinding is impossible when the intervention is educational materials or courses	High
Blinding of outcome assessment	Outcome assessment was done using multiple choice questionnaires, which is objective.	Low
Incomplete outcome data	The reason why participants did not take the 2nd test is not clear	Unclear
Selective reporting	Protocol is not published	Low
	Pre-specified outcome measures and results are reported	
Recruitment bias	Not mentioned	Unclear
Baseline imbalance	The scores were nearly the same between intervention and control groups at baseline	Low
Loss of clusters	It is not clear if the withdrawals were individuals or clusters	Unclear
Incorrect analysis	It seems cluster affect was not taken into account in the statistical analyses	High

Vollmar 2010

Methods	C-RCT	
Risk of bias		
Item	**Description**	**Judgement**
Random sequence allocation	Not mentioned	Unclear
Allocation concealment	Sealed opaque envelopes	Low
Blinding of participants	Not mentioned but blinding is impossible when the intervention is educational materials or courses	High
Blinding of outcome assessment	Multiple choice questions were used, which is objective	Low
Incomplete outcome data	Difference in the number of withdrawal but no explanation or interpretation	Unclear
Selective reporting	Study protocol available and everything is pre-specified	Low
Recruitment bias	Participants were recruited at the same time as clusters and randomisation was conducted after recruitment	Low
Baseline imbalance	No difference was seen in terms of characteristics and knowledge	Low
Loss of clusters	No withdrawal	Low
Incorrect analysis	ANCOVA was conducted to take cluster effect into account	Low

Appendix 3-A Definition and categories of variables

Exposure

- Valence of the context of the video
    1. Negative
    2. Positive
- Emotions: any kind of emotion that the video arouses
    0. Absent
    1. Present
- Animation or computer graphics: animation of pictures or computer graphics is used to explain a procedure of treatment or process of a disease. Animation of letters is not included.
    0. Absent
    1. Present
- BGM: back ground music is used during the main part of the video not as a primary content of the video. Using music only at the beginning as an introduction is not included.
    0. Absent
    1. Present
- Sound effects: sounds are used to emphasise a particular moment or movement.
    0. Absent
    1. Present

- Voice: any subject uses voice such as talking or singing.
    0. Absent
    1. Present

- Main topic in the title: the main topic (disease or treatment) is in the title as keywords
    0. No
    1. Yes

Outcome

- View counts: the number of views shown underneath a video clip. This shows the number of people who started watching the video and does not mean the number of people who completed watching it.

Confounder

- Clinical feature of disease addressed by the video
    1. Infectioous diseases (tuberculosis, SARS, HIV/AIDS, diarrhoea)
    2. Cancers (breast cancer, luekaemia)
    3. Cardiovascular diseases (myocardial infarction)
    4. Blood or autoimmune diseases (anaemia, leukaemia)
    5. Endocrine, nuturitional or metabolism diseases (diabetes, malnutrition, obesity, anorexia)
    6. Mental disorders (schizophrenia, depression)
    7. Pregnancy, childbirth and reproductive health (complications of labour, postpartum)
    8. Congenital malformations or disorders
    9. Injury and poisoning
    10. Other
    11. No specific disease

- Age group the topic is about
    1. Children: 0-15 years old
    2. Working age: 16-64 years old
    3. Older people: 65+ years old
    4. No specific age group

- Sex group the topic is about
    1. Male
    2. Female
    3. No specific sex group

- Country in which the issue is set
    1. Not specified
    2. Non-native English speaking countries (countries other than Australia, Canada, Ireland, New Zealand, United Kingdom, United States of America)

- Main idea
    1. Basic knowledge of medicine, biology or pharmacy
    2. Information about a certain disease
    3. Information about a certain examination, treatment or medication

- Presentation of content1: Patients or their relatives speaking or presenting
    0. No
    1. Yes

- Presentation of content2: Person who is not a patient or their relatives speaking or presenting
    0. No
    1. Yes

- Presentation of content3: Demonstration [a]
    0. No
    1. Yes

[a] Demonstration includes an actual operation or other visual ways to explain how to implement a treatment. Explaining with animation or computer graphics is included in demonstration, but on blackboard is not categorised as demonstration.

Appendix 3-B Options for YouTube video search

Search option	*Alternatives*
Result type	All
	Videos *
	Channels
	Playlists
Sort by	Relevance *
	Uploaded date
	View count
	Rating
Uploaded date	Anytime *
	Today
	This week
	This month
Categories	All *
	Film & Animation
	Education
	News & Politics
	Comedy
	Science & Technology
Duration	All *
	Short (~4 minutes)
	Long (20~ minutes)
Features	All *
	Closed captions
	HD (high definition)
	Partner videos
	Rental
	WebM

*Selected search option

Appendix 3-C View of YouTube video on the website

Appendix 4-A Subject line and main text of the e-mail sent to the participants

Subject line: the woman trial (London School of Hygiene and Tropical Medicine)

Dear [Title. Last name],

We are conducting the WOMAN trial, a large clinical trial to find a better way to reduce postpartum haemorrhage deaths.

We have created a short video about the trial.

Please follow the link below and watch the video.

[Link to the video]

If you find it helpful, please forward the link to colleagues.

Thank you for your help.

Best wishes,

Junko Kiriya

The WOMAN trial coordinating centre

Appendix 4-B Classification of countries by economy

Low income countries	Bangladesh, Burkina Faso, Cambodia, Democratic Republic of Congo, Ethiopia, Malawi, Niger, Tanzania, Uganda, Zimbabwe
Middle income countries	Argentina, Brazil, Bulgaria, Cameroon, Colombia, Egypt, Ghana, Guatemala, Hungary, India, Jamaica, Lebanon, Malaysia, Mexico, Morocco, Nigeria, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Romania, Serbia, South Africa, Sri Lanka, Sudan, Thailand, Tunisia, Turkey, Zambia
High income countries	Australia, Austria, Belgium, Canada, Chile, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Israel, Italy, Japan, Jordan, Korea, Malta, New Zealand, Norway, Poland, Portugal, Russia, Saudi Arabia, Singapore, Slovakia, Slovenia, Spain, Sweden, Switzerland, the Netherland, UK, United Arab Emirates, Uruguay, USA

Chapter5

Appendix 5-A Subject line and main text of the e-mail sent to the participants

Subject line: Could an effective treatment for post-partum haemorrhage be on the horizon?

Dear Dr [lastname],

I work on the WOMAN trial, a large clinical trial of the effect of a clot stabilising drug called tranexamic acid on the risk of death after postpartum bleeding.

In our previous large trial called CRASH-2, we found that this drug significantly reduced the risk of death after traumatic bleeding and so we hope it will also save lives in women who are bleeding after childbirth.

We have made a short video to let people know about the WOMAN trial and we would be grateful if you watch it by clicking the link below.

[link to the video]

If you find it useful please share this e-mail to any colleagues who you think might be interested in the WOMAN trial.

Thank you for your help.

Kind regards,
Junko Kiriya

The Woman Trial
Clinical Trials Unit | Faculty of Epidemiology & Population Health | London School of Hygiene & Tropical Medicine | Keppel Street, London WC1E 7HT, UK | tel +44(0)20 7299 4684 | fax +44(0)20 7299 4663
http://ctu.lshtm.ac.uk/
http://womantrial.lshtm.ac.uk/
https://twitter.com/CTU_LSHTM

Appendix 5-B Classification of countries by economy

Low income countries	Afghanistan, Bangladesh, Benin, Burkina Faso, Burundi, Cambodia, Chad, Democratic Republic of Congo, Ethiopia, Gambia, Haiti, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Myanmar, Nepal, Niger, Republic the Guinée, Rwanda, Sierra Leone, Tanzania, Uganda, Zimbabwe
Lower-middle income countries	Bolivia, Cameroon, Cote d'Ivoire, Djibouti, Egypt, El Salvador, Ghana, Guatemala, Honduras, India, Indonesia, Kosovo, Laos, Nigeria, Papua New Guinea, Palestine, Paraguay, Philippines, Republic of Moldova, Senegal, Sri Lanka, Sudan, Swaziland, Syria, Ukraine, Vietnam, Yemen, Zambia
Upper-middle income countries	Albania, Angola, Argentina, Brazil, Botswana, Bulgaria, Colombia, Cuba, Ecuador, Gabon, Hungary, Iraq, Jamaica, Lebanon, Libya, Macedonia, Malaysia, Mexico, Morocco, Namibia, Panama, Peru, Romania, Saint Vincent and the Grenadines, Serbia, South Africa, Thailand, Tunisia, Turkey,
High income countries	Australia, Austria, Barbados, Belgium, Canada, Chile, Croatia, Czech Republic, Cyprus, Denmark, Finland, France, French Guiana, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Jordan, Korea, Kuwait, Latvia, Lithuania, Malta, New Zealand, Norway, Oman, Poland, Portugal, Qatar, Russia, Saudi Arabia, Singapore, Slovakia, Slovenia, Spain, Sweden, Switzerland, Taiwan, The Netherland, UK, United Arab Emirates, Uruguay, USA, West Indies