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Master thesis

Interventions to improve the uptake of guidelines in nursing homes: a systematic review

Tiltak for å fremme bruk av retningslinjer i sykehjem: en systematisk oversikt

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PREFACE

Early during my studies, I became interested in research methodology and knowledge translation. So when looking for a project for my master's thesis it was quite obvious for me to do a systematic review. When it was time to choose, an ongoing project at the Centre for Evidence-Based Practice, Bergen University College, was in need for a systematic review in the field of knowledge translation in nursing homes. As a director of nursing interested in geriatric nursing, it came just in time and fitted my needs and interests. I was told that doing this systematic review could be quite challenging, and I was given time for consideration. And challenging it was. Much more than I imagined in advance. But it was also highly interesting and instructive. During the process, I have acquired a lot of new knowledge in research methodology, and I have also gained a deeper insight into the scientific domain of knowledge translation.

First, I would like to thank my supervisor Birgitte Graverholt, associate professor at the Centre for Evidence-Based Practice, Bergen University College, for the patient guidance, the encouragement and advice she has provided during my studies. I had the rare luck to have a supervisor who cared and believed in me. I would also like to thank my co-advisor Hans Lund, professor at the Centre for Evidence-Based Practice, Bergen University College, for contributing with his experience and support. In addition, I have to thank Birgitte Espehaug, professor at the Centre for Evidence-Based Practice, Bergen University College, for helpful advice on statistics. Finally, a big thanks goes to my wife Anja for patience and love.

Fedje, May 2015

Heinz Diehl

SAMMENDRAG

Denne mastergradsoppgaven består av en systematisk oversiktsartikkel og en innledningsdel. Innledningsdelen gir en detaljert beskrivelse av bakgrunnen, metodene som ble brukt samt funnene og avslutter med en omfattende drøfting av metodene og resultatene. Den systematiske oversiktsartikkelen ligger ved til slutt.

Bakgrunn

Forskning på tiltak for implementering av retningslinjer er hovedsakelig gjennomført i felt som skiller seg signifikant fra et sykehjem og er derfor lite overførbar. Formål med denne oversikten var å foreta en systematisk gjennomgang av effekten av tiltak for implementering av retningslinjer i sykehjem.

Metode

Et systematisk litteratursøk ble gjort i Cochrane Library, CINAHL, Embase, MEDLINE, DARE, HTA, CENTRAL, SveMed+ and ISI Web of Science i mai 2014. Det ble også gjort referanse- og siteringssøk. Studier ble inkludert om de evaluerte tiltak for å implementere retningslinjer i sykehjem. Inkluderte studiedesign var systematiske oversikter, randomiserte kontrollerte forsøk, ikke-randomiserte kontrollerte forsøk, kontrollerte før-etter studier og avbrutte tidsserier. For å vurdere risiko for skjevheter i de inkluderte studiene ble verktøyet for vurdering av risiko for skjevheter til Cochrane EPOC gruppen benyttet. Kvaliteten på den samlete dokumentasjonen er vurdert ved bruk av GRADE.

Resultater

Fire klyngerandomiserte studier som til sammen evaluerte fire ulike implementeringsstrategier møtte inklusjonskriteriene. Én studie rapporterte en liten statistisk signifikant effekt på profesjonell praksis, og to studier påviste en liten til moderat statistisk signifikant effekt på pasientutfall. Kvaliteten på den samlete dokumentasjonen var lav eller veldig lav for alle sammenligninger.

Konklusjon

Lite er kjent hvordan bruken av retningslinjer i sykehjem kan fremmes, og dokumentasjonsgrunnlaget for å støtte eller fraråde bruk av spesifikke strategier for implementering av retningslinjer er ufullstendig. Det er behov for mer implementeringsforskning for å sikre høykvalitets behandling og pleie i sykehjem.

Nøkkelord: Sykehjem; Retningslinjer; Kunnskapsoverføring; Systematisk oversikt.

ABSTRACT

This master thesis consists of a systematic review article and an accompanying introduction. The introduction provides a detailed description of the background, the methods used and the findings. It finishes with an extensive discussion of the methods and results. The systematic review article is attached at the end.

Background

Research on guideline implementation strategies has mostly been conducted in settings which differ significantly from a nursing home setting and is therefore hardly transferable. The objective of this study was to systematically review the effects of interventions to improve the implementation of guidelines in nursing homes.

Methods

A systematic literature search was conducted in the Cochrane Library, CINAHL, Embase, MEDLINE, DARE, HTA, CENTRAL, SveMed+ and ISI Web of Science in May 2014. Reference screening and a citation search were performed. Studies were eligible if they evaluated any type of guideline implementation strategy in a nursing home setting. Eligible study designs were systematic reviews, randomised controlled trials, non-randomised controlled trials, controlled before-after studies and interrupted-time-series studies. The EPOC risk of bias tool was used to evaluate the risk of bias in the included studies. The overall quality of the evidence was rated using GRADE.

Results

Four cluster-randomised controlled trials met the inclusion criteria, evaluating a total of four different multifaceted implementation strategies. One study reported a small statistically significant effect on professional practice, and two studies demonstrated small to moderate statistically significant effects on patient outcome. The overall quality of the documentation for all comparisons was low or very low using GRADE.

Conclusions

Little is known about how to increase guideline adherence in nursing homes, and the evidence to support or discourage particular interventions is inconclusive. More implementation research is needed to ensure high quality of care in nursing homes.

Keywords: Nursing homes; Guideline adherence; Knowledge translation; Systematic review.

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1. INTRODUCTION

The proportion of older people worldwide is rapidly rising and by 2040 people aged 80 years or older will represent more than 5% of the global population (Kinsella & He, 2008, p. 1). Consequently, the need for long-term care will increase and place considerable pressure on healthcare delivery, which in turn will lead to a nearly exponential growth in terms of cost (Spillman & Lubitz, 2000).

Although the provision of long-term care varies considerably across the countries in the Organisation for Economic Cooperation and Development (OECD), nursing homes remain an important cornerstone in the provision of long-term care for the frailest old. The nursing home population is characterised by a high level of disability, combined with multiple chronic diseases and advanced care needs (Colombo et al., 2011, chap. 1.3; Rechel et al., 2009).

The quality of care in nursing homes is an ongoing concern for governments, caregivers and clients themselves (Kirkevold & Engedal, 2008; Castle & Ferguson, 2010). One particular issue of concern is the lack of implementing current evidence into daily care routines. This reflects a need for effective implementation strategies that can help decision makers and clinicians to get current best evidence implemented into daily care routines (Grol & Grimshaw, 1999).

The research-practice gap is neither unique for nursing homes nor new. Translating research into daily care has consistently been found to be generally poor, despite the potential that high quality research evidence has to improve professional practice and patient outcome (Woolf et al., 1999; Green & Seifert, 2005; Grol & Grimshaw, 2003). It may take as long as an average of 17 years to move from evidence to practice (Westfall et al., 2007).

Clinical practice guidelines (hereafter referred to as "guidelines") are "statements that include recommendations intended to optimize patient care that are informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options" (Institute of Medicine, 2011). Guidelines based on the best evidence available aim to reduce the research-practice gap, provide decision support for healthcare personnel and counteract unwarranted variation in healthcare delivery (Grimshaw & Russell, 1993; Thomas et al., 1999). Still, even if the development of guidelines is an important first step in transferring knowledge into practice, guideline distribution is rarely enough. Rather, if and to what extent a guideline will be integrated into daily care routines depends heavily on the impact of the

implementation strategy (Waddell, 2002).

2. BACKGROUND

Modern societies rely on the use of scientific knowledge to maintain and improve prosperity and social well-being, actually to such a degree that the term "knowledge society" has been shaped (Stehr, 2007). Active development and sharing of knowledge for the benefit of all are the hallmarks of the knowledge society (Castelfranchi, 2007). However, the failure to transfer this knowledge into practice is well documented, not least in the health sector (Agency for Healthcare Research and Quality, 2001; Westfall et al., 2007). As a consequence, many patients receive care without documented effect and sometimes treatment that is unnecessary or even harmful (Grol, 2001; Grimshaw et al., 2012).

The scientific domain of knowledge transfer strategies has evolved tremendously over the last decade in order to address this research-practice gap (Graham et al., 2006). Although this domain has many names to it, such as knowledge transfer, knowledge uptake, implementation science and diffusion of innovations (McKibbon et al., 2010), *knowledge translation* (KT) is the term used in this thesis. The Canadian Institutes of Health Research (Government of Canada, 2014) define knowledge translation as

> *a dynamic and iterative process that includes synthesis, dissemination, exchange and ethically-sound application of knowledge to improve the health of Canadians, provide more effective health services and products and strengthen the health care system.*

The origin of KT goes back to 1943 where Ryan and Gross studied how the farmers in rural Iowa adopted the diffusion of hybrid-seed corn, which led to a significant raise in agricultural productivity (Rogers, 2003, pp. 31-33). As the "most influential diffusion study of all time", it formed the elements of Roger's diffusion of innovations model (Rogers, 2003, p. 31; Valente & Rogers, 1995).

Later on, Archie Cochranes trailblazing work led to the establishment of evidence-based practice in 1992 (Evidence-Based Medicine Working Group, 1992) and the Cochrane Collaboration in 1993, supporting clinical decision making by providing systematic reviews on the effects of healthcare interventions (Cochrane Collaboration, 2014). Only one year later, the Cochrane Effective Practice and Organisation of Care review group was founded, with the overall aim to evaluate the effects of interventions to translate knowledge into practice

(Cochrane Effective Practice and Organisation of Care group [EPOC], 2012).

One of the major barriers to translate knowledge into practice is the huge amount of research articles (Grimshaw et al., 2012; Grol & Grimshaw, 2003), because it imposes much work on healthcare professionals to find, critically appraise and sum up the best evidence available while having to make everyday clinical decisions at the same time. The development of synthesised evidence such as guidelines is supposed to ease this burden.

Guidelines are an important tool for knowledge translation because they reflect a synthesis of the best evidence available, expert knowledge and patient preferences (Grol, Wensing & Eccles, 2005, p. 71, pp. 81-83). To be used, a guideline has to be published and spread (dissemination), then it must be accepted (adoption), and finally its recommendations must be integrated into daily practice (implementation).

One of the most commonly used classifications of implementation strategies is the EPOC taxonomy of interventions (EPOC, 2013a). Accordingly, implementation strategies could be professional, organisational, financial or regulatory interventions. A comprehensive list of the EPOC taxonomy of interventions is available in the EPOC Data Collection Checklist (Ibid.)

Implementation translation strategies in the care of older adults are predominantly targeting healthcare professionals, both as a single or multifaceted intervention, which is an "intervention combining two or more components" (Boström et al., 2012; EPOC 2013a). Organisational, financial and regulatory interventions are rarely used within this context (Boström et al., 2012). While both single and multifaceted interventions are effective in some situations, they are not in others. There are "no magic bullets" (Oxman et al., 1995). This stresses the need to evaluate implementation strategies within the specific setting they are intended to be used in.

2.1 Effects of guideline implementation strategies

In a large systematic review, Grimshaw et al. (2004) summarised studies of the effectiveness of guideline dissemination and implementation strategies on professional practice and patient outcome. The methodological quality of the studies in this review was low, and the documented effects on professional practice and patient outcomes were small to moderate (Ibid.). Moreover, this review must be considered outdated as the literature search includes studies published no later than 1998. In conclusion, Grimshaw et al. (2004) found that audit

and feedback, educational interventions, computerised decision support systems, financial incentives and multifaceted strategies may improve guideline implementation, although none was more effective than the others.

Of the 235 studies included in Grimshaw et al. (2004), only four were conducted in nursing homes (Avorn et al., 1992; Ray et al., 1993; Schmidt et al., 1998; Shorr, Fought & Ray, 1994). Two of these studies evaluated the effects of interventions to reduce the use of anti-psychotic drugs, but were not explicit about the guideline to be implemented (Avorn et al., 1992; Ray et al., 1993). It remains therefore unclear if and to what degree they actually evaluated guideline implementation strategies. The third study evaluated the effect of monthly multidisciplinary team meetings on adherence to prescribing guidelines and found a significant decrease in prescribing rates of anti-psychotic drugs (Schmidt et al., 1998). The fourth study describes the changes in prescribing of anti-psychotic drugs following a new law (Shorr, Fought & Ray, 1994).

Another systematic review evaluated the implementation of guidelines in allied health professions (Hakkennes & Dodd, 2008). None of the 14 included studies was conducted in a nursing home setting. The effects were small to moderate and varied between the interventions. There was also variability in the methodological quality of the included studies. Hakkennes & Dodd (2008) concluded that there is no evidence to recommend any implementation strategy for allied health professionals. Furthermore, they highlighted the importance of identifying barriers to change in a particular setting, and building an implementation strategy which deals with these barriers.

A systematic review over secondary evidence evaluated the effectiveness of guideline implementation strategies (Prior, Guerin & Grimmer-Somers, 2008). Of the included 33 systematic reviews, none evaluated the effects of guideline implementation strategies in nursing homes. The authors concluded that multifaceted implementation strategies facilitating active clinician engagement can improve guideline adherence. Moreover, they also found that identifying and addressing barriers to change in a particular setting facilitates guideline adherence, which underpins the findings of Hakkennes & Dodd (2008).

Another systematic review evaluated the effectiveness of guideline implementation and dissemination strategies on team-based practice and patient outcomes (Medves et al., 2010). None of the 88 included studies was conducted in a nursing home setting. In conclusion, the

authors found that whole team involvement may promote guideline implementation and subsequently lead to improved patient outcomes.

Within the last decade, the Cochrane EPOC review group has done some important reviews on the effects of interventions on professional practice and patient outcome, which also cover guideline implementation strategies (Flodgren et al., 2011; Forsetlund et al., 2009; Giguère et al., 2012; Ivers et al., 2012; O'Brien et al., 2007; Shojania et al., 2009). Only O'Brien et al. (2007) contains studies which evaluated the effectiveness of guideline implementation strategies in nursing homes (Crotty et al., 2004; Schmidt et al., 1998). Crotty et al. (2004) evaluated the impact of guideline-based educational outreach visits combined with audit and feedback and found no effect on fall reduction and stroke prevention. The participating nursing homes differed substantially in the level of care provided and no separate outcomes were reported, making it impossible to attribute the results of this study to the nursing home setting relevant for this systematic review. The second study is described previously in this chapter (Schmidt et al., 1998).

2.2 Effects of guideline implementation strategies in nursing homes

In a preliminary search, I could not identify published reviews which has investigated the effect of guideline implementation strategies in nursing homes. A scoping review of systematic reviews on knowledge translation in older adults by Boström et al. (2012) included 53 systematic reviews. Most of the in total 1709 studies included in these reviews were conducted in a primary care or outpatient setting. Only 30 were conducted in nursing homes. Due to the nature of a scoping review, Boström et al. (2012) did not assess the quality of the included studies, and some relevant databases were not searched. Thus, no conclusion can be drawn from this review about the effects of guideline implementation strategies. Furthermore, knowledge translation literature lacks a standardised indexation, and an inconsistent use of many different terms to describe KT articles is common practice (Boström et al.,2012; McKibbon et al., 2010). For that reason, there will very likely be articles which the authors of the included systematic reviews did not find.

As shown, research on guideline implementation strategies and knowledge translation in older adults has mostly been conducted in either a primary care setting other than nursing homes or in a specialist care, hospital care or outpatient setting. These differ from a nursing home setting both in the characteristics of the population, the skill mix, the staffing, available

resources and the working environment (Boström et al., 2012; Harrington & Swan, 2003). Such factors have been shown to play an important role in the uptake of evidence from health research (Cummings et al., 2007; Francke et al., 2008). Thus, while implementation strategies from other settings may serve as conceptions for the nursing home setting, they will most likely not be transferable to it. Consequently, there is a demand for evidence-based guideline implementation strategies specifically in nursing homes.

Care providers in nursing homes that struggle to implement guidelines could benefit from a better understanding of what actually works to enhance guideline adherence. As a result, society could benefit from the associated economic savings. And most important, improved quality of care together with reduced unwarranted variation in healthcare delivery could result in a better life for our "oldest old". The aim of this study is, therefore, to establish an evidence-base for guideline implementation strategies in nursing homes.

3. OBJECTIVES AND RESEARCH QUESTION

The objective of this study is to summarise the effects of interventions to improve the implementation of guidelines in nursing homes, and the research question is "*What are the effects of interventions to improve the implementation of guidelines in nursing homes?*"

The scope of the review question was defined based on recommendations by the Cochrane EPOC review group (2012), which recommends to prefer a broader scope of a review question over a narrow one. Defining the scope too narrow could rather result in a subgroup analysis of a broader review question or even in an empty review because no studies being identified for inclusion (Ibid.). While a more narrow scope could be easier manageable by a review team, its results could also be less or not generalisable (O'Connor, Green & Higgins, 2011, chap. 5.6). According to the Cochrane EPOC review group (2012), a convincing explanation for narrowing the scope of a review question would be a setting "in which the same interventions would function differently, so that the evidence would be unlikely to be transferable", which I pointed out for the nursing home setting.

4. METHODS

A systematic review aims to collect, appraise and synthesise all available studies relevant to a specific research question. It follows strict, reproducible and systematic methods in order to minimise bias, with the overall aim to provide reliable results which can inform practice

(Green et al., 2011, chap. 1.2.2). Therefore, a systematic review was judged to be the best suited method to answer the research question of this thesis. A protocol containing the methodological framework for the design and the stages of this systematic review is published in PROSPERO and available in Appendix I. Recommendations from the Cochrane Collaboration (Higgins & Green, 2011), the Centre for Reviews and Dissemination (CRD) (2009) and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Liberati et al., 2009) guided this review in order to achieve a transparent and methodologically sound process.

The Cochrane Collaboration recommends that a systematic review is conducted by a review team or at least more than one reviewer, in order to minimise the chance of introducing errors into the review process (Higgins & Green, 2011, chap. 2.3.4.1). Thus, some of the steps in this review were performed by two reviewers, as consecutively shown in this methods section.

4.1 Eligibility criteria

Explicit inclusion and exclusion criteria should reflect the focus of the research question and define which studies are eligible for inclusion (O'Connor, Green & Higgins, 2011, chap. 5.1.2). It is recommended to use the PICOS elements when defining the eligibility criteria (CRD, 2009, p. 6). PICOS is an acronym for participants, intervention, comparator, outcome and study design. Table I shows the PICOS elements for this review.

Table I - PICOS

Population (**P**)	Intervention (**I**)	Comparison (**C**)	Outcome (**O**)	Study design (**S**)
Healthcare personnel working in a nursing home	Any guideline implementation strategy	Care as usual, any guideline implementation strategy	Professional practice, patient outcome	Systematic reviews, randomised controlled trials, controlled before-after studies, interrupted-time-series studies

4.1.1 Types of participants

Many different healthcare professionals work in nursing homes and they all are relevant target groups for different guidelines. Hence, the included participants were not limited to any specific healthcare profession.

Nursing homes are defined as long-term institutions for the aged providing 24-hour nursing

care. These are nursing homes (UK terminology), skilled-nursing facilities (US terminology) and aged-care facilities providing high-level care (Australian terminology). Studies conducted in institutions with obviously lower level of care were excluded, because their results will hardly be transferable to a nursing home setting.

4.1.2 Types of interventions

According to the EPOC taxonomy, interventions could be professional, organisational, financial and regulatory (EPOC, 2013a). When evaluating patient outcome as a measure for guideline adherence, it is important that the guidelines to be implemented are effective in order to achieve measurable results. Thus, the guidelines subject to implementation had to be based on a review of the literature, their recommendations had to be tied to the findings of the literature search and they had to be publicly available (AGREE Next Steps Consortium, 2013). Consequently, studies which were not explicit about the guideline to be implemented were excluded. To facilitate replicability and proper data synthesis, the intervention had to be clearly described.

4.1.3 Types of comparisons

Comparisons were care as usual, as well as any implementation strategy aimed at promoting the use of guidelines, both as a single or multifaceted intervention.

4.1.4 Types of outcomes

Studies were included if they reported objective measures of professional practice or patient outcomes (EPOC, 2013a), the primary outcomes of this review. Professional practice could be a change in daily care routines in accordance with recommendations from guidelines. Patient outcomes could be physical health, psychological health or psychosocial health. Secondary outcomes were subjective outcome measures as for example a change in knowledge, attitudes or the residents satisfaction, because they can provide valuable information on possible barriers and facilitators to implementation. Due to their subjective nature, they are however not reliable enough as a measure for guideline implementation. Hence, studies which only reported subjective outcomes were excluded.

4.1.5 Types of study design

The research question of this systematic review is about the effects of healthcare

interventions. A randomised controlled trial (RCT) is the most robust study design to produce reliable evidence to address such questions (O'Connor, Green & Higgins, 2011, chap. 5.5). Consequently, I decided to include RCTs. In an RCT, the participants are randomly assigned to two or more groups in order to minimise systematic differences between the groups (Polit & Beck, 2012, pp. 202-206). Such differences can introduce systematic error, leading to a deviation from the true effects of an intervention (Higgins, Altman & Sterne, 2011, chap. 8.2.1). A cluster-randomised controlled trial (cluster-RCT) is an RCT variation where clusters of participants are randomised into different treatment groups (Polit & Beck, 2012, pp. 209-210), for example wards from nursing homes or even whole nursing homes.

When evaluating implementation strategies, however, it is often impossible to conduct an RCT (EPOC, 2013b). There are also cases where it is difficult to randomise, or where ethical or practical reasons impede randomisation (Eccles et al., 2003). Depending on the focus of the review question, the Cochrane EPOC review group (2013b) recommends to consider inclusion of studies with other non-randomised experimental design. The scoping search for this systematic review identified a distinct amount of such studies. For that reason, and considering the general scarcity of KT studies conducted in nursing homes, I decided to include non-randomised controlled trials, controlled before-after studies (CBA) and interrupted-time-series (ITS) studies as well.

Non-randomised controlled trials involve an intervention and control group, but lack randomisation (Polit & Beck, 2012, pp. 217). In CBA studies, one group receives an intervention and another group does not, serving as a control. Data is collected both at baseline and post-intervention (Ibid., pp. 217-219). In an ITS study, no control group exists, and outcome measurement is done multiple times before and after intervention onset (Ibid., pp. 219-220). Missing randomisation makes those study designs prone to systematic error.

This being the case, ITS studies to be included were required to have at least three measure points before and after the intervention, as well as a clearly defined entry point for the intervention. Otherwise it would be difficult or even impossible to identify a stable effect estimate in such studies (Eccles et al., 2003).

Additionally, I decided to include systematic reviews, because they can be a comprehensive source of relevant studies. To be included, they had to provide a risk of bias assessment of all included studies. Studies with a design not mentioned in this chapter were excluded, because

they do not provide the methodological strength and robustness needed to address the objective of this systematic review.

4.2 Literature search

4.2.1 Databases and other information sources

Appropriate information sources were chosen with the assistance of a research librarian and based on recommendations by the Cochrane Collaboration (Lefebvre, Manheimer & Glanville, 2011, chap. 6.2). A search was conducted in CINAHL, Embase, MEDLINE, SveMed+, ISI Web of Science, the "Database of Abstracts of Reviews of Effects" (DARE) and the "Health Technology Assessment Database" (HTA). Within the Cochrane Library, the "Database of Systematic Reviews" (CDSR) and the "Central Register of Controlled Trials" (CENTRAL) were searched. To reduce the potential impact of publication bias on this systematic review (Song et al., 2010), I searched the grey literature in ClinicalTrials, OpenGrey and PROSPERO. In addition, I browsed systematic reviews of the Cochrane EPOC review group as they generally have a broad scope and could therefore contain nursing home studies. Furthermore, I screened the reference lists of the included studies and conducted a citation search in ISI Web of Science based on the included studies. To overcome a potential indexing flaw in knowledge translation studies (Boström et al., 2012), the included studies were screened on additional relevant search terms not present in the current search strategies. It was planned to re-run the current search strategies with the new search terms applied, and to match up the new results against the present search results.

4.2.2 Search strategies

The search strategies were developed with advice of a research librarian (Lefebvre, Manheimer & Glanville, 2011, chap. 6.3.1). The PICOS elements together with the inclusion and exclusion criteria helped me to define the focus of this review. However, it can be counter-productive to use all PICOS elements when developing a search strategy (Ibid., chap. 6.4.2). The Cochrane Collaboration recommends to develop search strategies based on the population or the particular setting, the intervention and the types of study design in order to maintain high sensitivity (Ibid.). Therefore, I decided to identify keywords and subject headings for the nursing home setting as well as for different guideline implementation and knowledge translation activities and components. To match the desired types of study design,

the use of a methodological search filter (hereafter called "search filter") is recommended (Ibid.), so I contacted the Norwegian Cochrane EPOC review group for appropriate search filters.

First, I developed the search strategy for MEDLINE. I used different dictionaries to identify keywords which cover the nursing home setting and the MeSH browser of the National Library of Medicine to identify relevant subject headings. Using keywords alongside subject headings is crucial, because not every indexed article is assigned to a subject heading. Thus, exclusively relying on subject headings without using additional keywords would inevitably result in missing relevant studies. Then, I combined all identified keywords and subject headings and ran a test search in MEDLINE. The first 20 articles were screened for new nursing home keywords and subject headings.

Because there is no standard terminology for knowledge translation or guideline implementation, using dictionaries is not sufficient to identify relevant keywords. Graham, Straus & Tetroe (2013, pp. 71-72) provide a comprehensive list of keywords and subject headings for knowledge translation activities and components, which also covers guideline implementation. In addition, McKibbon, Lokker & Mathew (2013) maintain the knowledge translation wiki "WhatisKT", which holds a rapidly growing list of knowledge translation and guideline implementation keywords and subject headings. When developing the search strategy for MEDLINE, I relied on terms from these two resources.

The search filters for CINAHL, Embase and MEDLINE provided upon request from the Norwegian Cochrane EPOC review group capture the primary study designs eligible for inclusion in this review, but explicitly exclude systematic reviews. So I removed that part and applied the "Centre for Reviews and Dissemination Strategy 2.1" methodological search filter for MEDLINE (Lee et al., 2012) on top of the EPOC MEDLINE search filter to also catch systematic reviews.

The first draft of the MEDLINE search strategy was tested several times to see if it worked as expected and to identify potential flaws. Then, the MEDLINE search strategy was adapted to CINAHL, the "Cochrane Database of Systematic Reviews" (CDSR) and the "Central Register of Controlled Trials" (CENTRAL) within the Cochrane Library, Embase and ISI Web of Science.

The EPOC search filters for CINAHL and Embase were used in the same way as described

for MEDLINE. In addition, I applied "Wong's best sensitivity search filter" for systematic reviews to the CINAHL search strategy and the "Best optimization search filter" by Wilczynski and Haynes to the Embase search strategy (Lee et al., 2012). For ISI Web of Science, I developed a search filter based on a combination of relevant terms from the EPOC search filters and search filters for systematic reviews evaluated by Lee et al. (2012). CDSR and CENTRAL contain only studies with a relevant design, and therefore no search filter was needed.

It is possible to search multiple databases sharing the same search interface (such as Ovid MEDLINE and Ovid Embase) with only one search strategy at the same time. However, I developed separate search strategies for every database, because different databases use different subject headings. As an example, the MeSH term "guideline adherence" used in MEDLINE correlates with the Emtree term "protocol compliance" in Embase. Using the appropriate subject headings within the respective databases contributes to a more precise search with higher sensitivity.

In opposition to the highly advanced search engines of interfaces such as Ebscohost, Ovid and the Cochrane Library, the search engines of the "Database of Abstracts of Reviews of Effects" (DARE), the "Health Technology Assessment Database" (HTA), SveMed+, ClinicalTrials, OpenGrey and PROSPERO merely provide basic functionality. The search strategies for these databases, although originating from the initially developed MEDLINE search strategy, are therefore based on a combination of the most relevant keywords and subject headings where available and as appropriate. No search filter was applied, because the number of hits while testing the search strategies appeared to be manageable.

All search strategies were pilot-tested prior to the final searches. Their applicability and feasibility was evaluated and re-adjusted where necessary. A research librarian from the Norwegian Knowledge Centre for the Health Services reviewed the final search strategies, which are available in Appendix II.

4.2.3 Search for studies and reference managing

The final searches were carried out on 21st May 2014. All databases were searched from their inception, without any language or document format restrictions (Lefebvre, Manheimer & Glanville, 2011, chap. 6.4.9). In accordance with the recommendations of a research librarian, a limiter excluding MEDLINE-indexed articles from the results in CINAHL, Embase and ISI

Web of Science was applied. Otherwise, the amount of duplicates would have substantially increased. Because the search strategies for these databases were directly derived from the MEDLINE search strategy, the research librarian judged the risk of missing relevant articles to be negligible.

All references were imported into reference management software. Duplicates were removed, multiple records of the same study were linked together and all references were sorted into a list containing the author's names, the titles and abstracts. To ensure precise and easy identification throughout the review process, a unique numerical ID was assigned to every listed record.

4.3 Study selection

It is crucial that reviewers performing study selection have a common understanding of the inclusion and exclusion criteria in order to minimise the risk of erroneously excluding relevant articles (Higgins & Deeks, 2011, chap. 7.2.4). Therefore, the inclusion and exclusion criteria were discussed with a second reviewer prior to study selection.

Two reviewers carried out the study selection process in two steps. First, based on the inclusion and exclusion criteria defined in the protocol, we independently examined the titles and abstracts of the identified references and sorted them into the categories "included", "unclear" or "excluded". When we needed more information, we sorted the reference into the "unclear" category. We were generally over-inclusive in order to minimise the risk of missing relevant articles. Then, we compared the results of our individual screenings. Plain oversight was the major cause of different classifications, which we resolved by discussion and consensus. Finally, only references sorted into the "excluded" category were excluded in this step of the study selection process.

The results of the screening of the first 200 references were used to calculate a quadratic weighted kappa to evaluate inter-rater agreement (Appendix III). Inter-rater agreement is the degree to which two reviewers make conforming decisions (Cohen, 1968). Low inter-rater agreement thus indicates the need for a clarification of the inclusion and exclusion criteria to reduce misunderstandings before proceeding with study selection. A quadratic weighted kappa was chosen to penalise disagreements based on their magnitude (Ibid.). The weighting pattern of a standard kappa treats all disagreement as equal. A study rated as "included" by one and "excluded" by another reviewer, however, reflects more disagreement than an "excluded" or

"included" versus "unclear" rating.

In the second step in study selection, the full-text of the potentially relevant studies was retrieved, which we again screened independently and sorted into the categories "included, "unclear" or "excluded". Many studies involved the use of guidelines, but did not actually test their implementation and were thus excluded. We resolved any discrepancy by discussion and consensus. Authors of studies sorted into the "unclear" category were contacted to provide missing information. If no information was retrieved, we excluded the study. The remaining articles were included for critical appraisal and data abstraction.

4.4 Risk of bias assessment

The CRD (2009, chap. 1.3.3) describes that data abstraction and critical appraisal depend on each other and are often performed in parallel, which also was the case for this systematic review. In this thesis, the critical appraisal is described before the data abstraction, without implying any chronological order.

Often, the terms "critical appraisal" and "assessment of methodological quality" are used interchangeably (Higgins, Altman & Sterne, 2011, chap. 8.2.2). However, while the term “methodological quality” refers to the degree of methodological standard a study is conducted to, a study conducted to the highest methodological standard can still have major bias (Ibid.). Bias is a systematic error leading to a distortion of the true effect of an intervention (Ibid., chap. 8.2.1). So in order to assess the quality of the included studies, I assessed their risk of bias.

To assess the risk of bias, the use of a risk of bias tool is recommended (Higgins, Altman & Sterne, 2011, chap. 8.3.1). While the Cochrane Collaborations risk of bias tool is developed with mainly parallel group, individually randomised trials in mind (Sterne, 2013), the EPOC risk of bias tool (EPOC, 2013c) has several advantages over it. It is extended to the assessment of cluster-RCTs which we expected to find most frequently, and it also contains quality criteria for the assessment of CBA and ITS studies. Thus, we used the EPOC risk of bias tool to assess the risk of bias in the included primary studies.

The EPOC risk of bias tool contains nine standard quality criteria for RCT, NRCT and CBA studies and seven quality criteria for ITS studies. To assess the risk of bias in included systematic reviews I planned to use the AMSTAR measurement tool, because it has proven

reliability and validity (Shea et al., 2009). Because all studies included in this review were cluster-RCTs, a short description of the nine quality criteria of the EPOC risk of bias tool for this design is provided in the next chapters.

The first criterion, allocation sequence generation, is about how researchers ensure random assignment of the participants to either the intervention or control group. When properly randomised, there is a bigger chance that all known and unknown potentially confounding factors are balanced between the groups, which reduces systematic error (Polit & Beck, 2012, pp. 206-208). Notably when conducting a cluster-RCT, proper randomisation alone may sometimes not be sufficient. Some of the clusters could share similarities, as for example nursing homes from the same geographic area most likely share the same culture. Stratification could therefore be necessary before randomisation. Stratification is to sort institutions sharing similarities into subgroups (strata) and to randomly select from them (Ibid., p. 281). Therefore, we evaluated the reliability of the randomisation procedure and if stratification was needed and done.

The second criterion, allocation concealment, assesses whether the generated allocation sequence remains unrevealed, preventing those who recruit participants from knowledge of the assignment (Schulz & Grimes, 2002). Especially in cluster-RCTs, broken allocation concealment may introduce recruitment or selection bias when participants are allocated after randomisation of the clusters (Ibid.). Therefore, we evaluated if the authors performed cluster allocation, if they allocated all participants at the start of the study and who performed the allocation.

The third criterion, baseline outcome measurement, is about judging the balance in baseline performance between groups. Significant imbalance may introduce selection bias, as for example high adherence to a guideline in one group at baseline. Improvement would hardly be possible, leading to a biased effect estimate in disfavour of this group. Thus, we evaluated if baseline outcome was measured, if baseline performance was imbalanced between the groups and if it was statistically corrected for it.

The fourth criterion is about baseline characteristics. Although randomised properly, there is no guarantee that participant characteristics are distributed equally between the groups (Polit & Beck, 2012, p. 247). Significant differences in key baseline characteristics can make both groups less or even not comparable. Accordingly, we evaluated if baseline characteristics

were assessed and reported, if the groups were similar at the start of the study and if statistically significant baseline differences were explained and accounted for in the analysis.

The fifth criterion deals with incomplete outcome data. If participants withdraw from a study, missing outcome data can reduce the power to discover statistically significant differences, and the effect estimates can be biased due to the introduction of non-random differences between the groups (attrition bias). The severity of bias is then proportional to the total amount of missing outcome data and the extent of difference in missing outcome data between both groups (Higgins, Altman & Sterne, 2011, chap. 8.13.1). An intention-to-treat (ITT) analysis is the "state of the art" method to deal with missing outcome data by analysing all participants within the groups they were allocated to, irrespective of the intervention they received (Ibid.). Hence, we evaluated the extent of missing data, if missing data were explained and how missing data were dealt with in the analysis.

The sixth criterion is about blinded outcome assessment. When evaluating interventions such as the implementation of guidelines, it is impossible to blind those providing and receiving the intervention (Polit & Beck, 2012, p. 212). However, in most cases it is possible to blind those who assess outcome data, which is particularly important if outcomes are subjective. Not blinding the outcome assessors can lead to systematic differences in outcome assessment (detection bias) (Ibid.). Consequently, we evaluated if the outcome variables were assessed blindly and if the outcomes were objective.

The seventh criterion discusses protection against contamination. Contamination happens when participants in one group are aware of and influenced by the intervention provided to the other group, which can lead to a dilution of the true effect estimate (contamination bias). For that reason, we evaluated if some of the clusters were sharing the same location, for example two wards within the same nursing home, and if healthcare personnel was both working in wards from the intervention and the control group.

The eight criterion deals with selective outcome reporting. Reporting bias can arise if authors do not report all findings of a study, for example when favourable results are reported while unfavourable or non-significant results are omitted (Chan, 2008). Reporting bias can be detected by comparing the outcomes to be assessed with those actually reported in the results section of the final paper, either by reading the studies protocol or its methods section. Hence, we evaluated if all outcomes specified in the methods section were reported in the results

section of the included studies.

The last criterion in the EPOC risk of bias tool encourages to evaluate other sources of bias not covered by the previous criteria. In cluster-RCTs, healthcare personnel within the same cluster may affect each others behaviour by sharing the same information, the same culture and following the same routines. Thus, their characteristics and performance tends to be more similar compared with randomly assigned individuals, leading to bias when treating all observations as if they were independent (Wears, 2002). Not taking into account their clustered nature, confidence intervals would erroneously be too narrow and p-values too small (Higgins, Deeks & Altman, 2011, chap. 16.3.2). At worst, results may be reported as statistically significant when in fact they are not. Consequently, we evaluated if clustering was accounted for in the data analysis.

Based on the eight criteria presented above, two reviewers independently evaluated the overall risk of bias in every included study having either low, unclear or high risk of bias. The results were discussed and discrepancies were resolved by consensus or by consulting a third reviewer. We did not merely base our final judgements on the amount of criteria evaluated as high, unclear or low risk of bias. Rather, the final judgement of the overall risk of bias is based on an evaluation of the likeliness and severity of the detected bias in particular, for every included study.

4.5 Data abstraction

It is highly recommended to use a data abstraction form which is specifically tailored to the review question (Higgins & Deeks, 2011, chap. 7.5.1; CRD, 2009, chap. 1.3.3). The EPOC data abstraction form is a worksheet template for data abstraction specifically designed for systematic reviews within the field of implementation science (EPOC, 2013d). Thus, I used the EPOC data abstraction form and customised it to the particular focus of this systematic review. Two reviewers pilot-tested the data abstraction form and filled in data from one of the included studies, discussed the results and refined some of the items to better suit the tables and analyses to be carried out (CRD, 2009, chap. 1.3.3).

After the data abstraction form was finalised (Appendix IV), I extracted data from the included studies. A second reviewer checked the results and we resolved discrepancies by discussion and consensus (Higgins & Deeks, 2011, chap. 7.6.2).

Data items collected were the full references, setting, study characteristics, objectives and the study design. Furthermore, data on the participating healthcare personnel and residents, the intervention, control intervention and the outcomes were extracted. Results and outcome measures were only extracted for outcomes within the scope of this systematic review.

During data abstraction, the authors of two included studies were contacted by email in order to provide missing information (Liberati et al., 2009). De Visschere et al. (2012) lacked information on the control intervention, and the guideline used in Köpke et al. (2012) could not be retrieved. Both authors responded quickly and provided the missing information.

The authors of a third study were contacted (Ward et al., 2010), because no numerical result for the main outcome was provided in the article and it was unclear if the results were corrected for cluster. Because the authors were non-responsive but sufficient data was available in the article, I calculated a cluster-corrected relative risk based on the effective sample size (Table II) as recommended by the Cochrane Statistical Methods Group (Higgins, Deeks & Altman, 2011, chap. 16.3.4-16.3.5). This procedure was discussed with a statistician at Bergen University College on its appropriateness and usability prior to use.

Table II – Calculation of effective sample size

$S_{eff} = \frac{S_{act}}{\left(1+\left(\frac{(N_i+N_c)}{(N_{Ci}+N_{Cc})}-1\right)\right) ICC}$	S_{eff} = Effective sample size S_{act} = Actual sample size N_i, N_c = Number of participants in intervention, control group N_{Ci}, N_{cc} = Number of clusters in intervention, control group ICC = Intra-cluster correlation coefficient

(Higgins, Deeks & Altman, 2011, chap. 16.3.4-16.3.5)

The effective sample size is the actual sample size of a study reduced by the design effect (Killip, 2004). The design effect is a correction factor which takes into account intra-cluster correlation and the average cluster size (Ibid.). To calculate the design effect, I calculated the average cluster size and borrowed the missing intra-cluster correlation coefficient (ICC) from Sawka et al. (2010), a scoping review over studies evaluating the same outcome as Ward et al. (2010). "The ICC is a measure of relatedness of clustered data" (Killip, 2004). Borrowing an ICC from similar studies is common practice when no ICC is provided (Higgins, Deeks & Altman, 2011, chap. 16.3.4). Then, a cluster-corrected relative risk was calculated using the statistical software R (R Foundation for Statistical Computing, 2014).

The main results in Köpke et al. (2012) were recalculated using the same method, because the reported odds ratio is not as intuitively understandable to the reader as a relative risk (Polit &

Beck, 2012, p. 395). The necessary ICC was available in the article.

Again, the same procedure was done for the results in Van Gaal et al. (2011a). The authors reported percentual effect estimates while they provided enough data to recalculate a cluster-corrected relative risk. In this case, the ICC was found in the study protocol (Van Gaal et al., 2009). Appendix V shows all statistical calculations in detail.

4.6 Data synthesis

After data are abstracted, they must be synthesised to be able to draw meaningful and reliable conclusions. A data synthesis should contain information on the effect of an intervention and its size, the consistency of the effect across the studies and the robustness of the evidence the effects are based on (Deeks, Higgins & Altman, 2011, chap. 9.1.2).

Meta-analysis, which is "the statistical combination of results from two or more separate studies", is the preferable method to combine and present the results from multiple studies in a systematic review (Deeks, Higgins & Altman, 2011, chap. 9.1.2). However, when clinical or methodological heterogeneity across studies impedes meta-analysis, a narrative synthesis should be carried out (Ibid.). A narrative synthesis is a descriptive approach using words and tables to summarise and explain the results of the included studies (CRD, 2009, chap. 1.3.5.1). Due to its more subjective nature, the method used for a narrative synthesis should be systematic and transparent (Ibid.). On that account, CRD's (2009, chap. 1.3.5.1) framework for narrative synthesis was used because it provided the rigour and transparency necessary for this systematic review. It consists of four steps, which are shortly explained in the next four chapters.

4.6.1 Developing a theory

Guideline implementation strategies are complex interventions and, as such, depend on a plethora of different factors. Guideline implementation also involves a broad range of stakeholders like various healthcare professions, providers and users. In order to demonstrate how guideline implementation could be associated with its outcomes, I created a model based on the results of a systematic review on the topic (Squires et al. 2011), social behavioural theory and personal experience using a diagrammatic map. The model tries to visualise how guideline implementation may work, why and for whom (CRD, 2009, chap. 1.3.5.1).

4.6.2 Developing a preliminary synthesis

After data abstraction, I summarised the findings from the included studies in a table of study characteristics (CRD, 2009, p. 50). Its compressed structure facilitates the discovery of similarities and differences between the studies. However, the way study characteristics are presented in a table may influence the reader's perceptions of correlation, and an additional narrative interpretation is therefore necessary (Ibid., p. 51).

4.6.3 Exploring relationships within and between studies

Based on the developed theory, I tried to identify relationships between the results and characteristics which may facilitate or impede guideline implementation, both within and across the included studies. To understand how and why an intervention was effective or not, I focused on characteristics and patterns which might explain those relationships (CRD, 2009, p. 51).

4.6.4 Assessing the robustness of the synthesis

When drawing conclusions from a narrative synthesis, the level of confidence in the results is crucial (CRD, 2009, p. 53). Accordingly, I used the "Grading of Recommendation, Assessment, Development and Evaluation" (GRADE) approach to evaluate the overall quality of the evidence. GRADE is a transparent and systematic framework to evaluate the quality and strength of evidence for each outcome across studies (Guyatt et al., 2011a) as illustrated in Table III .

Every single outcome was evaluated individually and the overall confidence in the estimates was rated either very low, low, moderate or high. An RCT starts with a high rating, while other designs start low. Of the eight criteria to be evaluated, five can lead to downgrading. These are risk of bias, inconsistency of the results across the included studies, the degree of heterogeneity of the target population (indirectness), imprecision of the effect estimates and the presence of publication bias (Balshem et al., 2011). Criteria which may lead to upgrading are a large effect and strong correlation of the intervention with the outcomes (Guyatt et al., 2011a). The software "GRADEpro" was used to rate the confidence in the results of every outcome, to create an evidence profile and a "summary of findings" table (Schünemann et al., 2011, chap. 11.5). Finally, a second reviewer checked the results of the GRADE assessment. We resolved discrepancies by discussion and consensus.

Table III – GRADE criteria for rating the quality of evidence

Study design	Initial quality of the evidence	Lower if	Higher if	Quality of documentation
Randomised trials Observational studies	High Low	Risk of bias *-1 serious* *-2 very serious* Inconsistency *-1 serious* *-2 very serious* Indirectness *-1 serious* *-2 very serious* Imprecision *-1 serious* *-2 very serious* Publication bias *-1 likely* *-2 very likely*	Large effect *+1 large* *+2 very large* Dose response *+1 Evidence of a gradient* All plausible residual confounding *+1 Would reduce a demonstrated effect* *+1 Would suggest a spurious effect if no effect was observed*	**High** *True effect is close to effect estimate* **Moderate** *True effect most likely close to effect estimate, but can differ* **Low** *True effect may be substantially different* **Very low** *True effect is likely to be substantially different*

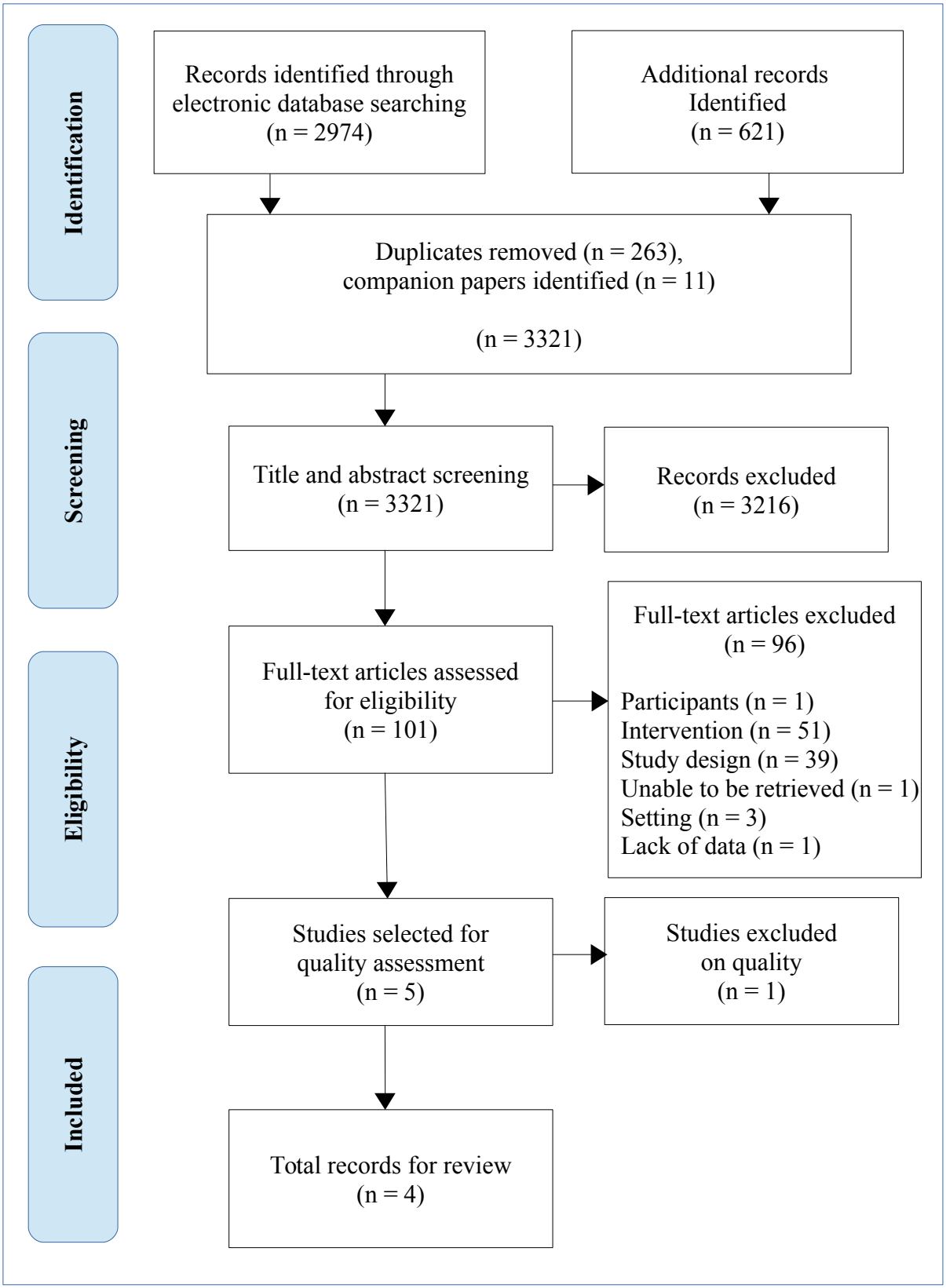
(Balshem et al., 2011)

5. RESULTS

The literature search resulted in 3595 potentially relevant references. After duplicates were removed, we screened the titles and abstracts of 3321 references. Inter-rater agreement based on the screening of the first 200 references was strong ($\kappa = 0.81$) (McHugh, 2012). We assessed 101 full-text articles for eligibility and excluded 96. Of the remaining five articles, we excluded one after critical appraisal (Colón-Emeric et al., 2007). Appendix VI holds a list of all excluded studies together with the reason for their exclusion. The references of the excluded studies are available in Appendix VII. The whole study selection process is visualised in Figure I. The screening of the included studies revealed no new search terms.

Finally, we included four cluster-RCTs (De Visschere et al., 2012; Köpke et al., 2012; Ward et al., 2010; Van Gaal et al., 2011a; Van Gaal et al., 2011b). Van Gaal et al. (2011a) and Van Gaal et al. (2011b) are part I and II of the same study evaluating patient outcome (a) and professional practice (b) respectively. Two of the included studies evaluated the effects of a professional-organisational intervention (De Visschere et al., 2012; Ward et al., 2010), and another two included studies tested a professional intervention (Köpke et al., 2012; Van Gaal et al., 2011a,b).

Figure I – Flowchart study selection



5.1 Description of the included studies

A detailed description of the characteristics of the included studies is available in Appendix VIII.

5.1.1 Participating providers

Three studies included nurses, certified nurse assistants (CNA) and nurse assistants (De Visschere et al., 2012; Köpke et al., 2012; Ward et al., 2010). Ward et al. (2010) included also physicians and "other nursing home staff". Van Gaal et al. (2011a,b) included only nurses. In Köpke et al. (2012), the nurses had three years and the CNAs one year of vocational training. The nurse assistants were untrained. De Visschere et al. (2012), Ward et al. (2010) and Van Gaal et al. (2011a,b) did not state the level of vocational training of the included healthcare providers.

5.1.2 Participating residents

The studies included nursing home resident with mean age of 84 years (De Visschere et al., 2012; Köpke et al., 2012), 85.5 years (Ward et al., 2010) and 78 years (Van Gaal et al., 2011a,b). Van Gaal (2011a,b) included also hospital patients, but reported separate data for the hospital and the nursing home setting throughout the whole study. That allowed me to include the nursing home part in this systematic review. The mean age of all included residents varied from 78 (Van Gaal et al., 2011a,b) to 85.5 years (Ward et al., 2010).

In Köpke et al. (2012), 73% of the residents were considerably to severely impaired and about 25% were either self-reliant or totally impaired. In Ward et al. (2010), about 70% of the residents were "able to stand or walk with or without assistance", while in Van Gaal (2011a,b) on average 50% of the residents were physically impaired to an unknown degree. In De Visschere et al. (2012), on average 59% of the included residents were moderately to highly care-dependent.

87% of the residents in De Visschere et al. (2012) and 64% in Köpke et al. (2012) were cognitively impaired. In Ward et al. (2010), on average 21% of the residents received dementia-specific care. Van Gaal (2011a,b) excluded cognitively impaired residents.

De Visschere et al. (2012) was conducted in Belgium and Köpke et al. (2012) in Germany. Ward et al. (2010) was carried out in Australia and Van Gaal et al. (2011a,b) in the Netherlands. There is a total of 9750 participating residents from the included studies, varying

from 297 (De Visschere et al., 2012) to 5391 (Ward et al., 2010).

5.1.3 Interventions and comparators

Appendix IX holds detailed information on the interventions of the included studies. All included studies evaluated multifaceted implementation strategies, but none reported which elements were regarded most important. All interventions targeted the healthcare personnel. De Visschere et al. (2012) additionally addressed the director of nursing. Only Köpke et al. (2012) reported on a theoretical framework for the implementation strategy, the theory of planned behaviour. It states that attitudes towards behaviour, subjective norms and perceived behavioural control, influenced by actual behavioural control, are strong predictors of the occurrence of a certain behaviour (Ajzen, 2003).

Education meetings and the distribution of educational material were a part in all interventions. De Visschere et al. (2012) and Ward et al. (2010) also used clinical multidisciplinary teams. Additionally, De Visschere et al. (2012) used a local consensus process and patient incentives, Van Gaal et al. (2011a,b) used audit and feedback and Köpke et al. (2012) used supportive material.

There was significant variation in frequency and duration of intervention delivery. While most of the intervention components were applied at study start, bedside-support (De Visschere et al., 2012), team and network meetings (De Visschere et al., 2012; Ward et al. 2010) and chart feedback (Van Gaal et al., 2011a,b) were periodically repeated throughout the whole intervention periods.

Three included studies compared a multifaceted guideline implementation strategy with care as usual (Köpke et al., 2012; Van Gaal et al., 2011a,b; Ward et al., 2010). Köpke et al. (2012) provided additional standard information on the topic of the main outcome to the control group. De Visschere et al. (2012) used guideline dissemination as the control intervention.

5.1.4 Outcomes and outcome measures

None of the included studies reported on subjective outcome measures, the secondary outcomes of this review. The outcomes in the included studies differed, with the exception that both Van Gaal et al. (2011a,b) and Ward et al. (2010) amongst others evaluated fall rates. Köpke et al. (2012) also evaluated the rates of falls, fall related fractures and prescription rates of psychotropic medicine, which however were disregarded because they were not in the

scope of the guideline subject to implementation.

In De Visschere et al. (2012), trained external examiners evaluated the oral hygiene level of the participating residents. They measured dental plaque with the Silnes and Löe index (scale 0-3), denture plaque with the Augsburger and Elahi Methylene blue test (scale 0-4) and used the Winkel tongue plaque index (scale 0-12) to measure tongue plaque.

In Köpke et al. (2012), blinded investigators recorded the number of physical restraints on the participating wards three different times a day in unannounced observation sessions. In Van Gaal et al. (2011a,b), independent research assistants performed chart reviews, skin inspection and patient observation to measure the incidence of pressure ulcers, urinary tract infections and falls, as well as the amount of adequate care given to the nursing home residents at risk of those. In Ward et al. (2010), the nursing home staff performed chart reviews to measure the use of vitamin D supplements and hip protectors, the fall rates and the incidence of femoral neck fractures.

Because intervention delivery varied in the included studies, outcome measurement periods and frequencies varied as well. De Visschere et al. (2012) and Ward et al. (2010) measured at intervention end. Köpke et al. (2012) measured both mid-intervention and at intervention end. There was no post-intervention follow-up period in those three studies. Van Gaal et al. (2011a,b) only measured in the post-intervention follow-up period.

5.2 Risk of bias assessment

We judged De Visschere et al. (2012) and Köpke et al. (2012) to have an overall low, and Van Gaal et al. (2011a,b) and Ward et al. (2010) to have an overall high risk of bias. Table IV shows a short summary of the results of our judgements. Details on the risk of bias assessment are available in Appendix X.

5.2.1 Allocation sequence generation

Köpke et al. (2012) and Ward et al. (2010) used a computerised randomisation procedure to allocate the participants to either the intervention or control group. Ward et al. (2010) additionally used stratification to ensure that prognostic factors were evenly balanced across the groups. Consequently, we judged both studies to have a low risk of bias on that criterion.

De Visschere et al. (2012) and Van Gaal (2011a,b) performed stratified sampling without mentioning the use of a random component in the allocation sequence generation. Therefore,

we judged them to have an unclear risk of bias here.

5.2.2 Allocation concealment

All included studies performed allocation by institution or team and allocated all units at the start of the study. De Visschere et al. (2012) did not include participants after randomisation, which was the case in Köpke et al. (2012). However, the authors could not influence which nursing homes new residents were admitted to. For that reason, we judged the risk of selection bias in these two studies to be low.

Ward et al. (2010) did not state if all participants were allocated at the start of the study. Van Gaal et al. (2011a,b) included participants after randomisation without stating who allocated them. Because it is impossible to blind researchers or healthcare personnel when evaluating complex interventions (Hahn et al., 2005), the authors were aware of the allocation. That being the case, we judged both studies to have an unclear risk of selection bias.

5.2.3 Baseline outcome measurement

All included studies reported baseline outcome measurement prior to the start of the intervention. De Visschere et al. (2012) reported differences in baseline outcome variables. Baseline outcome measures were similar in Van Gaal et al. (2011a) and slightly different in Van Gaal (2011b). The authors of both studies adjusted statistically for baseline differences, so we judged the risk of bias in De Visschere et al. (2012) and Van Gaal et al. (2011a,b) to be low. Baseline outcome measures in Köpke et al. (2012) appeared to be similar, but no p-value was reported, ergo we judged the risk of bias to be unclear. Ward et al. (2010) reported baseline differences in mean use of vitamin D, while other baseline outcome measures were similar. Because there were no group differences in slopes pre-intervention and during intervention in the regression analyses of vitamin D use, and after consulting a statistician at Bergen University College about that topic, we were convinced that there was a low risk of bias.

5.2.4 Baseline characteristics

All included studies reported baseline characteristics. In De Visschere et al. (2012), Köpke et al. (2012) and Ward et al. (2010), baseline characteristics were similar for both groups. Van Gaal et al. (2011a,b) reported baseline differences in the number of physically impaired residents and rehabilitation residents without providing an explanation, but corrected

statistically for these differences. In conclusion, we judged all included studies to have a low risk of bias here.

5.2.5 Incomplete outcome data

All included studies encountered a loss to follow-up. The loss of individual residents was small in De Visschere et al. (2012) and Köpke et al. (2012), explained in the articles and no systematic differences between those who were lost and those who continued in the study were identified. No clusters were lost. In Ward et al. (2010), six facilities withdrew, but provided sufficient data to allow retention in the analyses and were analysed using intention to treat. As a result, we judged those studies to have a low risk of attrition bias.

In Van Gaal et al. (2011a,b), loss to follow-up was high and unevenly distributed between the groups. The authors explained the causes and used intention-to treat in the analysis. However, in an intention-to-treat analysis, the results of those who drop out are unknown and have to be stipulated ("imputation") (Hollis & Campbell, 1999). How much missing data one can correct for is debatable and ranges from 10% (Altman, 2009) over 15% (Hoffmann, Bennett & Del Mar, 2010, p. 30) to 20% (Bjørndal, Flottorp & Klovning, 2007, p. 82; DiCenso, Guyatt & Ciliska, 2005, p. 249). For that reason, and because of 20% drop-out in the intervention group and 31% in the control group, we judged this study to have a high risk of attrition bias.

Colón-Emeric et al. (2007) is the study which met the inclusion criteria, but was excluded after critical appraisal due to severe attrition bias. Colón-Emeric et al. (2007) encountered 64 - 89% non-compliance of the intervention nursing homes without having a convincing explanation for that. It also remained unclear if those nursing homes delivered sufficient data and if the authors performed an intention-to-treat analysis. On that ground and in consultation with the co-supervisor, we agreed that non-compliance this big must have eliminated baseline comparability, rendering the results of this study invalid. Consequently, we excluded the study.

5.2.6 Blinded outcome assessment

De Visschere et al (2012), Köpke et al. (2012) and Van Gaal et al. (2011a,b) assessed all outcome variables blindly, so we judged them to have a low risk of detection bias. In Ward et al. (2010), nursing home staff who were aware of the allocation collected the data. We therefore rated this study to have a high risk of detection bias.

5.2.7 Protection against contamination

We could not detect any contamination in De Visschere et al (2012) and Köpke et al. (2012), which we for that reason judged to have a low risk of contamination bias. In Van Gaal et al. (2011a,b), 10 wards from six nursing homes participated in the study. Thus, nursing homes with more than one participating ward must have hosted multiple wards from different groups, making contamination likely. In Ward et al. (2010), national fall prevention strategies targeting one of the main outcomes were promoted widely during the intervention period. Furthermore, the same physicians were responsible for vitamin D and calcium therapy in both groups and may, to an unknown degree, have introduced the intervention to the control group. Hence, we rated both studies to have a high risk of contamination bias.

Table IV – Risk of bias assessment

Study / **Criteria**	De Visschere et al., 2012	Köpke et al., 2012	Van Gaal et al., 2011a	Van Gaal et al., 2011b	Ward et al., 2010
Allocation sequence generation					
Allocation concealment					
Baseline outcome measurement					
Baseline characteristics					
Incomplete outcome data					
Blinded outcome assessment					
Protection against contamination					
Selective outcome reporting					
Other bias					
Overall risk of bias	Low	Low	High	High	High

Green = low risk of bias Yellow = unclear risk of bias Red = high risk of bias

5.2.8 Selective outcome reporting

All included studies reported all relevant outcomes from the methods section in the results section. For that reason, we judged them to have a low risk of reporting bias.

5.2.9 Other bias

The results in De Visschere et al. (2012), Köpke et al. (2012) and Van Gaal et al. (2011a,b)

were corrected for cluster, thus we judged the risk of bias on that criterion to be low. In Ward et al. (2010), all results but "residents with at minimum one femoral neck fracture" were cluster-corrected, which most probably was not. So we rated this study to have an unclear risk of bias here.

5.3 Analysis of the results

5.3.1 Theory on the effects of guideline intervention strategies

The theory I developed is available in Appendix XI. It shows how guideline implementation strategies can enhance guideline adherence and as a result improve professional practice and patient outcome. Guideline adherence depends on a plethora of different determinants. Education meetings and the distribution of educational materials are predominantly targeting predisposing determinants such as knowledge, attitude, skills and values (Forsetlund et al., 2009; Giguere et al., 2012). Other determinants to bring about change are staff availability, provision of resources and leadership involvement (Aarons et al., 2015). Audit and feedback (Ivers et al., 2012), educational outreach visits (O'Brien et al., 2007), reminders (Shojania et al., 2009) and local opinion leaders (Flodgren et al., 2011) are mostly targeting reinforcing determinants such as perceptions, beliefs and attitudes towards change, and may also facilitate awareness and performance.

Another important topic is the use of single versus multifaceted strategies, especially how many and what kind of strategies to combine (Squires et al., 2014). In addition, my theory is based on cognitive behavioural theory, because it can help to understand facilitators and barriers to implementation and their underlying mechanisms (Eccles et al., 2005). The theory of planned behaviour (Ajzen, 2003) can be used to predict and influence adherence to guidelines. The "stage of readiness to change model" (Prochaska & Velicer, 1997) emphasises the importance of motivation, skills, aptitude to change, experiences and the organisational culture when changing clinical practice. Roger's "diffusion of innovation" model (Valente & Rogers, 1995) is useful to determine which people to target at what stage of the implementation process.

Another background for my theory was my own experience that complexity is one of the biggest barriers when implementing guidelines. A guideline to be implemented must be easy to understand, readily available and user-friendly in order to self-promote its implementation.

5.3.2 Synthesis of the results

All included studies evaluated different outcomes, except fall rates in Van Gaal et al. (2011a) and Ward et al. (2010). Van Gaal et al. (2011a) evaluated the effect of a patient safety programme on the combined incidence of pressure ulcers, urinary tract infections and falls. The study also evaluated their individual incidence, but was not powered for that. There was no statistically significant effect on the incidence of fall rates, with a rate ratio of 0.63 in favour of the intervention group (95% CI: 0.35-1.16, $P > 0.05$). Ward et al. (2010) measured the effect of a project nurse on fall rates resulting in 0.023 fewer falls per 100 beds per month (95% CI: -0.14 to 0.09; $P = 0.686$).

Although the implementation strategies in both studies contained some common components, they significantly differed in how the various components were provided and by whom, indicating clinical heterogeneity. Furthermore, both studies have an overall high risk of bias. According to the Cochrane Collaboration, the results of studies with clinical heterogeneity or high risk of bias should not be combined in a meta-analysis (Deeks, Higgins & Altman, 2011, chap. 9.1.4). Consequently, I carried out a narrative synthesis.

5.3.3 Relationships within and between studies

All included studies used education meetings and educational material in their implementation strategies. The studies with statistically significant results on patient outcome additionally used a local consensus process and patient incentives (De Visschere et al., 2012) and audit and feedback (Van Gaal et al., 2011a). De Visschere et al. (2012) and Ward et al. (2010) also used clinical multidisciplinary teams, the former with statistically significant and the latter with non-significant results. The only study with statistically significant results on professional practice (Köpke et al., 2012) additionally used supportive material. Köpke et al. (2012), Van Gaal et al. (2011a,b) and Ward et al. (2010) compared their interventions with "care as usual". De Visschere et al. (2012) performed guideline dissemination in the control group.

5.3.4 Robustness of the synthesis

GRADE was used to evaluate the robustness of the results for every outcome. All included studies were cluster-RCTs and entered thus GRADE as high quality evidence.

Van Gaal et al. (2011a,b) and Ward et al. (2010) had a high risk of bias and I consequently downgraded for "risk of bias". The effect estimates in the included studies varied and no

outcome was evaluated more than once, making it impossible to rate consistency. After consulting a researcher from the Norwegian Knowledge Centre for the Health Services for clarification I decided not to downgrade for inconsistency, but to downgrade for "single studies" when rating imprecision.

To rate indirectness, I evaluated if the healthcare personnel and the participating residents in the included studies where comparable and the desired target groups for guideline implementation (Guyatt et al., 2011b). When judging imprecision, I downgraded for large confidence intervals, single studies, few events and a small sample size, because these are determinants for imprecise results (Guyatt et al., 2011c).

None of the included studies showed a large effect. Effective interventions did not consist of obviously more components or were performed more frequently compared with the ineffective interventions and across the included studies. Thus, I did not upgrade any of the studies.

Based on the individual ratings, the overall quality for each outcome was rated to be low (De Visschere et al. 2012; Köpke et al., 2012) or very low (Van Gaal et al., 2011a,b; Ward et al., 2010) (Appendix XII). This indicates that the effect estimates may or are likely to differ fundamentally from the true effect (Balshem et al., 2011). Therefore, I have limited to very little confidence in the effect estimates of the included studies. As a result, the quality of the documentation included in this systematic review is not robust enough to recommend or discourage the use of a particular guideline implementation strategy to improve guideline adherence in nursing homes.

6. DISCUSSION

The objective of this study was to summarise the effects of interventions to improve the implementation of guidelines in nursing homes. The guideline implementation strategies included in this review showed small to moderate or no effects on professional practice and patient outcome, and their results were inconsistent and varied. Two included studies have a high and two a low risk of bias. Based on the assessment of the robustness of the results using GRADE, there is limited to very little confidence in the results.

In this discussion section, the methodological strengths and weaknesses of this systematic review will be discussed first. Then, I will discuss the effect estimates of the included studies

and compare its results with other research in the field, with a special emphasis on different components of the interventions. Finally, I will consider the impact of the results on the field of practice and suggest some implications for further research.

6.1 Strengths and weaknesses of this systematic review

A strength of this systematic review is that all of its steps followed pre-defined criteria from the study protocol registered in advance in PROSPERO. The protocol made the whole review process transparent, and it enabled other researchers to peer review the planned review process and to give feedback. Furthermore, the protocol indicated the in-process work of this review and helped thus to avoid unnecessary duplication and publication bias.

Following the protocol, this systematic review evaluated both professional practice and patient outcome as a measure for guideline adherence. While a change in professional practice in accordance with guideline recommendations directly reflects guideline adherence, many factors that are extrinsic to guideline implementation can influence patient outcome. For example, evaluating conditions with a slow improvement rate may not lead to a measurable effect within common study periods, despite guideline adherence (Marshall et al., 2000). Additionally, the clinical competence, skills and experience of those applying guideline recommendations can have substantial impact on the effects on patient outcome (Mant, 2001). In conclusion, patient outcome may be inappropriate as a measure for guideline adherence, and its use as an outcome measure in this systematic review may thus be a weakness.

Another factor with influence on patient outcome is the effectiveness of the guideline itself. Therefore, only studies implementing evidence-based guidelines were included in this systematic review. Considering the potential inappropriateness of patient outcome as a measure for guideline adherence, altered inclusion criteria could have impacted on this systematic review. Including studies evaluating the effects of strategies to implement both evidence-based and non-evidence-based guidelines on professional practice, but not on patient outcome, would have resulted in considerably more studies being included. In turn, a bigger evidence-base would have underpinned the conclusions of this systematic review and its results would have been more generalisable (O'Connor, Green & Higgins, 2011, chap. 5.6).

6.1.1 Literature searches

A strength of this review is its comprehensive and sophisticate literature search. Most

systematic reviewers only search mean 3.2 (SD 1.6) databases, and they rarely perform reference screening and citation search (Beller et al., 2013). In this review, nine databases covering articles on the effects of healthcare interventions were searched, reference lists were screened and a citation search was performed. To reduce the impact of publication bias on this systematic review, I also searched for unpublished studies and grey literature. Furthermore, the included studies were screened on new search terms not present in the current search strategies. All search strategies were tested and adjusted prior to the final searches to establish high sensitivity while maintaining good specificity. Highly optimized search filters based on the results of a recent systematic review (Lee et al., 2012) and from the Cochrane EPOC review group were implemented.

On the downside, although a research librarian reviewed the final search strategies, the involvement of such expertise in all steps would have strengthened the literature search. Unfortunately, this was impossible due to a lack of resources. Moreover, excluding MEDLINE-indexed references from the search results in CINAHL, Embase and ISI Web of Science may have resulted in missing relevant studies.

Another shortcoming is the age of the literature searches. With a median age of eight months, 90% of the literature searches in systematic reviews are already outdated on publication (Beller et al., 2013). The literature searches in this review will be nearly one year old when submitting this extended introduction. However, they will be updated before submitting the article for publication.

6.1.2 Study selection

Two reviewers with a good common understanding of the inclusion and exclusion criteria independently performed all stages of the study selection. This reduced the risk of missing relevant studies due to misunderstandings or plain oversight and made the whole study selection process more effective and reliable (Higgins & Deeks, 2011, chap. 7.2.4).

However, while selecting studies for inclusion, sometimes it was a challenge to identify the underlying guideline of a study and its evidence base. The guideline may have been publicly available, but could not be found. Other guidelines claimed to be based on a literature review, but the searched databases were not stated and no search strategies were provided. This information could not be retrieved, though it may have existed elsewhere. Most of the authors did not respond on email requests. As a consequence, relevant studies may have been missed.

6.1.3 Risk of bias assessment

Two reviewers independently evaluated the risk of bias in the included studies, discussed the results and resolved discrepancies by consensus. As a novice to conducting systematic reviews, I had no experience in risk of bias assessment. Evaluating the risk of bias alone could have led to judgements different to those of an experienced reviewer (Higgins, Altman & Sterne, 2011, chap. 8.3.4). As a consequence, the collaboration with a second reviewer improved the quality of the risk of bias assessment.

To assess the risk of bias in the included studies, we used the EPOC risk of bias tool. The use of a standardised and transparent approach to risk of bias assessment makes the results of this systematic review more reliable and its conclusions more trustworthy.

6.1.4 Robustness of the results

A strength of this systematic review is the use of GRADE to evaluate the robustness of the results for every outcome, because it is a rigorous and transparent method making judgements about the quality of the evidence more reliable (Thornton et al., 2013). Furthermore, GRADE was used to calculate absolute effect estimates and to arrange the results in a "Summary of Findings" table (Guyatt et al., 2011a), making this information easy accessible to the reader.

On the other hand, two included studies (Van Gaal et al., 2011a,b; Ward et al., 2010) lacked data required to calculate a complete evidence profile, although the authors provided relative effect estimates. These results are therefore not as readily understandable and might confuse the reader. Furthermore, no outcome was evaluated more than once, making it impossible to pool the results in a meta-analysis which would have raised the impact of this systematic review.

Another shortcoming is that I worked out the evidence profiles alone. Although a second reviewer checked and discussed the results, GRADE is complex and exposes the user to substantial challenges. Thus, flaws affecting the GRADE profile may have been introduced, making the results of this systematic review less trustworthy.

6.2 Effects on professional practice and patient outcome

Only one included study showed a statistically significant result on professional practice (Köpke et al., 2012). A multifaceted guideline implementation strategy based on the theory of planned behaviour reduced the use of physical restraints by 21% compared with care as usual

(RR 0.79; 95% CI: 0.64-0.97) after three months, and by 22% (RR 0.78; 95% CI: 0.62-0.98) after six months. However, the wide confidence intervals indicate that these estimates are imprecise and suggest that the relative risk could be anywhere from 0.62 to 0.98. At best, the intervention could lead to a 38% reduction of physical restraints, while in the worst case a reduction of merely 2% is close to zero.

Two included studies showed statistically significant results on patient outcome (De Visschere et. Al, 2012; Van Gaal et al., 2011a). In De Visschere et al. (2012), a supervised implementation of an oral healthcare guideline could reduce denture plaque by mean 0.32 (95% CI: -0.52, -0.11) points on the "methylene blue denture plaque scale" (range 0-4), resulting in mean 8% plaque reduction (Augsburger & Elahi, 1982). Likewise, the estimate is imprecise and could be anywhere from 13% to 2.7%, indicating small to nearly zero improvement. Besides, the intervention could not significantly reduce dental or tongue plaque. In Van Gaal et al. (2011a), a patient safety program could reduce the combined incidence of pressure ulcers, urinary tract infections and falls by 33% per patient week (Rate ratio 0.67, 95% CI: 0.47-0.97). Also in this case the estimate is imprecise and could vary from more than halving the incidence to a nearly zero reduction.

While the wide confidence intervals in De Visschere et al. (2012) and Van Gaal et al. (2011a) were caused by small sample sizes, the sample size in Köpke et al. (2012) was big, and the wide confidence interval was caused by high intra-cluster correlation (ICC=0.029) reducing the effective sample size (Killip, 2004). Furthermore, the outcomes of the included studies varied and used different measures of effect that can not be adapted to each other. Hence, their results were not primarily comparable.

6.3 Comparison with other studies

To date, there is no systematic review on the effects of guideline implementation strategies in nursing homes which the results of this review could be compared with. However, there are systematic reviews on the effects on professional practice and patient outcome which cover guideline implementation strategies used in the studies included in this review.

Forsetlund et al. (2009) evaluated the effects of education meetings when used in multifaceted implementation strategies. Combined didactic and interactive education meetings were more effective than didactic meetings alone, and interactive meetings were generally less effective. Highly serious outcomes improved behaviour change, while highly complex interventions

impeded it. The overall effects were small and inconsistent (median 3-6%), and the authors reported no dose-response effect. Giguère et al. (2012) found an uncertain effectivity of printed education material as part of multifaceted implementation strategies. Ivers et al. (2012) found audit and feedback to have small and inconsistent effects (median 1.3-16%) when used alone or as the core part in multifaceted implementation strategies. Audit and feedback is expected to be more effective when used repeatedly, performed by colleagues or supervisors, given both spoken and written and when it has clear targets and an action plan (Ibid.).

The results of the included studies concur with these findings. De Visschere et al. (2012) used a didactic-interactive meeting, whereas the nature of the education meetings in the other included studies remained unclear (Köpke et al., 2012; Van Gaal et al., 2011a,b; Ward et al.; 2010). Furthermore, their outcomes were highly serious in contrast to the less serious outcomes in De Visschere et al. (2012). Additionally, Van Gaal et al. (2011a,b) used written and repeatedly performed audit and feedback.

Consequently, all of these components may have contributed to the statistically significant results in De Visschere et al. (2012), Köpke et al. (2012) and Van Gaal et al. (2011a). But as their results were small to moderate and varied, it was impossible to determine which components worked best. Even more, Ward et al. (2010) also used education meetings and addressed highly relevant outcomes, but could not show any statistically significant results. On that account, I could not detect any pattern that could have reliably linked the interventions to their outcomes.

Another widely discussed topic is the use and effectiveness of multifaceted implementation strategies. Grimshaw et al. (2004) reported small overall improvements (median 11%) for multifaceted strategies containing education meetings and educational materials. Prior et al. (2008) found positive but highly variable effects (median 0-60%) of multifaceted implementation strategies. Squires et al. (2014) found that the effect size is not positively associated with the number of components used in multifaceted strategies, which varied from five (Köpke et al. 2012; Van Gaal et al., 2011a,b; Ward et al., 2010) to six (De Visschere et al., 2012) in the included studies. There is also evidence that multifaceted strategies are especially effective in low-resource settings such as nursing homes (Shojania & Grimshaw, 2005; Rowe et al., 2005).

All included studies used multifaceted implementation strategies involving education meetings and educational materials, however with different results. While two studies showed statistically significant results (Köpke et al. 2012; Van Gaal et al., 2011a), De Visschere et al. (2012) were only successful with one of the three evaluated outcomes and the implementation strategy in Ward et al. (2010) was ineffective. It is especially remarkable that despite Van Gaal et al. (2011a) and Van Gaal et al. (2011b) being the same study evaluating the same implementation strategy on two different outcomes, only the results on patient outcome were statistically significant, but not on professional practice. The causal relationship between guideline adherence and patient outcome is therefore questionable, which in turn questions the validity of evaluating patient outcome as a measure for guideline adherence. In conclusion, there is no pattern which might have explained the differences in effectiveness of the multifaceted implementation strategies evaluated in this systematic review.

6.4 Practical impact of the results

Although the evaluated implementation strategies were mainly based on components with documented effectiveness in other healthcare settings, the results of this systematic review are too weak in order to inform practice. But this does not necessarily mean that the evaluated implementation strategies are not effective.

Guideline implementation depends on a lot of different factors, which I made visible in my hypothesis (Appendix XI). A comprehensive understanding of how all these factors affect the outcomes is crucial in order to succeed (Craig et al., 2008). For instance, environmental factors can have tremendous impact on how an implementation strategy works (Rowe et al, 2005). A strategy that works in one setting may thus not work in another. For that reason, it is highly recommended to prospectively identify barriers to change and to subsequently tailor the implementation strategy to address these barriers (Oxman et al., 1995; Hakkennes & Dodd, 2008; Baker et al., 2010). However, none of the included studies prospectively identified barriers to change. Targeting these barriers may have strengthened the implementation strategies, with more explicit results as a consequence.

Another critical factor when implementing guidelines is time. Nursing homes are generally understaffed (Hefner, 2002; Harrington, 2005), suffer from low retention rates of registered nurses, have high personal turnover and recruit primarily healthcare workers with low vocational training (Harrington & Swan, 2003; Donoghue, 2010). This makes them slow to

adopt new innovations in a world where knowledge translation can take years to accomplish (Titler, 2008; Morris, Wooding & Grant, 2011).

On that ground, the six months intervention period in De Visschere et al. (2012) and Köpke et al. (2012) without any post-intervention follow-up seems rather short. For that reason, longer intervention periods together with post-intervention follow up may have contributed to bigger effect estimates. With intervention periods of 17 months with 9 months post-intervention follow-up in Van Gaal et al. (2011a,b) and 14 months in Ward et al. (2010), it is less obvious if the results would have profited from a prolonged intervention period. Considering the multitude of factors influencing guideline adherence and the increased expenses for longer studies, the sweet spot is rather unpredictable and individually different.

Complexity of the intervention itself is another factor with impact on guideline adherence (Craig et al., 2008). Composed of "several interacting components" and targeting the behaviour of a broad range of healthcare professions, guideline implementation strategies qualify as complex interventions (Ibid.). That being the case, both one single component, multiple components in concert or the combination of all components in a guideline implementation strategy can have impact on guideline adherence (Medical Research Council, 2008). Consequently, it can be difficult to determine why an intervention is working or to identify the components that were effective.

A promising, yet rarely used approach to gain insight into the underlying processes of complex interventions is the use of qualitative research alongside RCTs (Lewin, Glenton & Oxman, 2009). Qualitative research can be useful in all stages of an RCT, for example in tailoring an intervention to overcome barriers to change, in understanding processes that brought about change, in investigating why a strategy worked or why effects were varying (Ibid.). Of the included studies, only Köpke et al. (2012) performed a qualitative process evaluation during the intervention period to explore barriers and facilitators to implementation. However, the new insights were not incorporated into the ongoing guideline implementation process, which may have facilitated guideline adherence and hence strengthened the results.

As shown, guideline implementation strategies may not achieve their full potential due to a lack of understanding of the mechanism linked to behaviour change. Michie et al. (2005) used psychological and social behavioural theory to explore barriers and facilitators to guideline

implementation and identified twelve domains of behaviour change (Table 2). Hakkennes & Dodd (2008) found that educational interventions were the most frequently used strategies in guideline implementation, which is also true for the studies included in this review. However, educational interventions cover only one of the twelve domains of Michie et al. (2005) (knowledge), which indicates large idle potential in the use of theory when conducting guideline implementation strategies. Köpke et al. (2012) was the only included study that used theory to target the attitudes, subjective norms and perceived behavioural control of the healthcare personnel. As a result, the whole implementation strategy covered six of the domains of Michie et al. (2005), which might be an explanation for the achieved significant results despite the short intervention period.

Table 2

Theoretical domains to explain behaviour change		
1. Knowledge	5. Beliefs about consequences	9. Social influences
2. Skills	6. Motivation and goals	10. Emotion
3. Social/professional role and identity	7. Memory, attention and decision processes	11. Behavioural regulation
4. Beliefs about capabilities	8. Environmental context and resources	12. Nature of the behaviours

(Michie et al., 2005)

6.5 Summarising discussion

This is the first systematic review evaluating the effects of guideline implementation strategies in nursing homes. The effects of the guideline implementation strategies included in this systematic review are small to moderate, variable and concur with the body of evidence from other healthcare settings. On that basis and as discussed, it is not possible to recommend or discourage the use of a particular guideline implementation strategy.

Guideline implementation is complex and depends on a myriad of different factors. This review emphasises the importance of prospectively identifying barriers to change and tailoring the implementation strategy to address these barriers. The use of theory appears to be promising when conducting and evaluating an intervention. Future research should consider the use of qualitative research alongside RCTs evaluating professional practice rather than patient outcome and running long enough to make change possible.

7. CONCLUSIONS

There are few studies which can inform practice in nursing homes on how to successfully implement clinical practice guidelines. More implementation research is needed to ensure

high quality of care in nursing homes.

In this systematic review, I used a transparent and thorough methodology to find and critically appraise the available body of evidence and to synthesise its results. This systematic review found small to moderate effects of guideline implementation strategies in nursing homes. The overall quality of the included evidence is low or very low. Future research is very likely to change the confidence in the effect estimates. I discussed the complexity of guideline implementation and the challenges and opportunities it encompasses. Based on the results and findings of this systematic review, I also gave recommendations to the field of practice and suggested implications for future research.

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Appendix I – Study protocol

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PROSPERO International prospective register of systematic reviews

Interventions to improve the uptake of guidelines in nursing homes: a systematic review

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Review question(s)

What are the effects of interventions to improve the implementation of guidelines in nursing homes?

Searches

We will search the electronic databases CINAHL, EMBASE, MEDLINE, SveMed+ and ISI Web of Science, as well as the Database of Abstracts of Reviews of Effects (DARE) and the Health Technology Assessment Database (HTA). Within the Cochrane Library, we will search the Database of Systematic Reviews (CDSR) and the Cochrane Central Register of Controlled Trials (CENTRAL). We will also search ClinicalTrials, OpenGrey and PROSPERO to identify unpublished studies. In addition, we will browse systematic reviews published by the Cochrane EPOC review group relevant for studies conducted in nursing homes. We will also perform a citation search in ISI Web of Science based on the included studies and examine their reference lists for possibly relevant studies.

We will not apply any restrictions on language or publication period during the searches. The search strategy for MEDLINE (Ovid) is available in the accompanying PDF document. We will adapt it to other databases using the appropriate search terms as applicable and with the guidance of a research librarian. To address a possible indexation problem of knowledge translation articles in older adults, we will screen all included studies for additional relevant search terms not present in the current search strategy. Then, we will re-run the literature search with the new search terms applied and match up the results against the present search results. We will screen any new articles for inclusion.

Types of study to be included

We will include randomized controlled trials, non-randomized controlled trials and controlled before-after studies. We will also include interrupted-time-series studies if they have a clear defined entry point and at least three data points before and after the intervention. Although the preliminary search did not reveal any previously published systematic review, we will include systematic reviews of high methodological quality which provide a "risk of bias" assessment for all of the included studies.

Condition or domain being studied

Quality of care in nursing homes has been an ongoing major concern for governments, caregivers and clients themselves. Clinical practice guidelines provide health care personnel with recommendations based on the best research evidence available, have the potential to improve professional practice and patient outcomes and can counteract unwarranted variation in health care delivery. However, its translation into daily care routines is generally poor, if it actually happens. Research on guideline implementation strategies has mostly been conducted in either a primary care setting other than nursing homes or in a specialist care, hospital care or outpatient setting. These differ from a nursing home setting both in the characteristics of the population, the skill mix, the staffing, available resources and the working environment. While the proportion of older people worldwide is rapidly rising and expenditure for their care is growing, there is an increasing need for evidence-based knowledge on how to get guidelines successfully integrated into the daily care routines in nursing homes.

Participants/ population

Any study in which the participants are health care professionals working in a nursing home. Nursing home is defined

as a long-term institution for the aged providing 24-hour nursing care. These are nursing homes (UK terminology), skilled-nursing facilities (US terminology) and aged-care facilities providing high-level care (Australian terminology). Studies conducted in institutions with obviously lower level of care provided as for example residential homes, assisted living facilities and aged-care facilities providing low-level care will be excluded, as well as studies conducted in any home care, specialist care, hospital care, outpatient or primary care setting other than nursing homes.

Intervention(s), exposure(s)

Any implementation strategy directed at health care professionals working in nursing homes and aimed at promoting the use of guidelines, both as a single or multifaceted intervention. According to the taxonomy of the Cochrane Effective Practice and Organisation of Care (EPOC) group these could be professional, organizational, financial and regulatory interventions, as for example education, workshops, reminders, audit and feedback, provider incentives, team reorganization or regulation by law. Studies which do not clearly describe the implementation strategy will be excluded. It is the very nature of evidence-based practice to get research evidence into daily practice. Therefore, the guidelines to be implemented have to be based on a review of the literature, their recommendations have to be tied to the findings of the literature search and they have to be publicly available. We will exclude studies which are not explicit about the guideline the implementation strategy is trying to promote.

Comparator(s)/ control

Care as usual, as well as any implementation strategy directed at health care professionals working in nursing homes and aimed at promoting the use of guidelines, both as a single or multifaceted intervention.

Outcome(s)

Primary outcomes

We will include studies if they report objective measures of professional practice or patient outcomes. Professional practice could for example be a change in daily care routines in accordance with recommendations from guidelines or a reduction in inappropriate treatment. Patient outcomes could be physical health (for example mortality or fall rates), psychological health (for example psychological well-being) or psychosocial health (for example quality of life).

Secondary outcomes

These are subjective measures of outcomes as for example a change in knowledge, attitudes or the residents satisfaction. Studies which only report secondary outcomes will be excluded.

Data extraction, (selection and coding)

Two reviewers will examine the title and abstract of all references for potentially relevant studies and classify them into three groups: "excluded", "unclear" and "possibly relevant". We will pre-test inter-rater agreement by calculating a weighted Kappa statistic based on the classification of the first 200 references. If agreement is low (Kappa lower than 0.61), we will assess the cause and if necessary adjust the inclusion-/exclusion criteria before we proceed. Then, only those studies classified by both reviewers as "excluded" will be excluded. Any disagreement will be resolved by consensus. We will then retrieve the full text version of the remaining studies and missing information from the authors. If full text or missing information is not obtainable, we will exclude the study. Two reviewers will then screen the remaining full text articles for inclusion and sort them into three groups: "excluded", "unclear" or "included". Any disagreement will be resolved by consensus. If additional information on studies classified as "unclear" is not obtainable from the authors, they will be excluded. We will present all articles excluded in this stage of the selection process and from which the reader might have expected to find in this review in an "Excluded studies" table together with the reason for the exclusion. We will create a PRISMA flow chart to visualize the study selection process.Two reviewers will independently extract data from the included studies using a customized EPOC data abstraction form. Any disagreement will be resolved by consensus. We will extract data including the full reference, objectives, target population, description of the intervention and control intervention, outcome measures, design, length of post-intervention follow-up period and the results of a study.

Risk of bias (quality) assessment

Two reviewers will independently assess the risk of bias of the included studies. Any disagreement will be resolved by consensus. We will use the EPOC "risk of bias" tool to assess the risk of bias of all included primary studies. It contains nine standard quality criteria for randomized controlled trials, non-randomised controlled trials and

controlled before-after studies, and seven quality criteria for interrupted-time-series studies. We will evaluate each criterion as either "high", "unclear" or "low" risk of bias. To assess the risk of bias of included systematic reviews, we will use the AMSTAR measurement tool for assessment of systematic reviews.

Strategy for data synthesis
Depending on the type of data presented in the included studies, we will present the results as a single effect size for each type of outcome and comparison in every included study. We will report relative risk and risk difference for dichotomous data and mean difference for continuous data, both with a 95% confidence interval. If two or more of the included studies are similar in both the participants, the interventions and their outcomes, we will perform a Chi-squared test and calculate an I-squared value to identify and measure statistical heterogeneity. If possible, we will pool the results in a meta-analysis using either a fixed-effects or a random-effects model, as appropriate. If a meta-analysis is not possible, we will carry out a narrative synthesis using the Centre for Reviews and Disseminations framework for narrative data synthesis. We will apply the "Grading of Recommendation, Assessment, Development and Evaluation" (GRADE) approach by using the software GRADEpro. Our confidence in the results for every outcome will be evaluated as either "high", "moderate", "low" or "very low".

Analysis of subgroups or subsets
None planned.

Dissemination plans
The target audience for the review is policy makers, nursing home providers, health care professionals and implementation science researchers. Therefore, the finished review article will be tried to get published in an open access journal as for example "BMC Health Services Research" or "Implementation Science".

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29 May 2015

Funding sources/sponsors
None

Conflicts of interest

None known

Language
English

Country
Norway

Subject index terms status
Subject indexing assigned by CRD

Subject index terms
Guidelines as Topic; Humans; Nursing Homes

Any other information
This systematic review will be the masters thesis of one of the authors (Heinz Diehl).

Reference and/or URL for protocol
http://www.crd.york.ac.uk/PROSPEROFILES/7664_PROTOCOL_20140702.pdf

Stage of review
Ongoing

Date of registration in PROSPERO
04 August 2014

Date of publication of this revision
04 August 2014

Stage of review at time of this submission	Started	Completed
Preliminary searches	Yes	Yes
Piloting of the study selection process	Yes	Yes
Formal screening of search results against eligibility criteria	Yes	No
Data extraction	No	No
Risk of bias (quality) assessment	No	No
Data analysis	No	No

Appendix II – Search strategies

Search strategy: CINAHL (EBSCOhost)
Timespan: 1984 – May 2014
Search date: 21.05.2014
Hits: 214

S1	(MH "Nursing Homes+")
S2	TI (nursing W0 (home# or facilit*")) or AB (nursing W0 (home# or facilit*"))
S3	TI (intermediate or long-term or longterm) W0 ("care facilit*") or AB (intermediate or long-term or longterm) W0 ("care facilit*")
S4	TI (("aged care" or "skilled nursing") W0 facilit*) or AB (("aged care" or "skilled nursing") W0 facilit*)
S5	TI ("home# for the aged" or "home# for the elderly") or AB ("home# for the aged" or "home# for the elderly")
S6	S1 OR S2 OR S3 OR S4 OR S5
S7	(MH "Practice Guidelines")
S8	(MH "Guideline Adherence")
S9	(MH "Professional Compliance")
S10	TI ((guideline# or protocol) N2 (implementation or dissemination or uptake or diffusion or adherence or compliance)) or AB ((guideline# or protocol) N2 (implementation or dissemination or uptake or diffusion or adherence or compliance))
S11	(MH "Professional Practice, Evidence-Based+")
S12	TI ("evidence based") W0 (practice or nursing or medicine) or AB ("evidence based") W0 (practice or nursing or medicine)
S13	TI (evidence N2 uptake) or AB (evidence N2 uptake)
S14	(MH "Selective Dissemination of Information")
S15	TI (information or "best practice" or guideline# or research) N2 (dissemination or utili?ation) or AB (information or "best practice" or guideline# or research) N2 (dissemination or utili?ation)
S16	TI "effective dissemination#" or AB "effective dissemination#"
S17	TI (applied W0 (dissemination or "health research")) or AB (applied W0 (dissemination or "health research"))
S18	(MH "Diffusion of Innovation")
S19	TI (innovation N2 (adaptation or adoption or diffusion)) or AB (innovation N2 (adaptation or adoption or diffusion))
S20	TI "best practice#" or AB "best practice#"
S21	TI "capacity building" or AB "capacity building"
S22	TI (change N2 implementation#) or AB (change N2 implementation#)

S23	TI ((changing W0 (provider or physician or doctor)) W0 behavio#r) or AB ((changing W0 (provider or physician or doctor)) W0 behavio#r)
S24	TI "collaborative development" or AB "collaborative development"
S25	TI (complex W0 (intervention# or science# or study or studies)) or AB (complex W0 (intervention# or science# or study or studies))
S26	TI ((continuing W0 (medical or nursing or dental)) W0 education#) or AB ((continuing W0 (medical or nursing or dental)) W0 education#)
S27	TI "crossing the quality chasm" or AB "crossing the quality chasm"
S28	TI ((effectiveness or evaluation) W0 research*) or AB ((effectiveness or evaluation) W0 research*)
S29	TI (gap N2 (analysis or evidence or practice)) or AB (gap N2 (analysis or evidence or practice))
S30	TI (audit N2 feedback) or AB (audit N2 feedback)
S31	TI ((getting W0 (knowledge or research)) W0 "into practice") or AB ((getting W0 (knowledge or research)) W0 "into practice")
S32	TI "GRIP" or AB "GRIP"
S33	TI "know-do" or AB "know-do"
S34	TI (knowledge N2 (adoption or brokering or communication or cycle# or developement or application or diffusion or dissemination or exchange or management or mobili?ation or synthesis or transfer or transformation or translation or uptake or utili?ation)) or AB (knowledge N2 (adoption or brokering or communication or cycle# or developement or application or diffusion or dissemination or exchange or management or mobili?ation or synthesis or transfer or transformation or translation or uptake or utili?ation))
S35	TI "knowledge to action" or AB "knowledge to action"
S36	TI "KSTE" or AB "KSTE"
S37	TI ("linkage and exchange") or AB ("linkage and exchange")
S38	TI "opinion leader#" or AB "opinion leader#"
S39	TI (patient W0 (education or safety)) or AB (patient W0 (education or safety))
S40	TI "populari?ation of research" or AB "populari?ation of research"
S41	TI "professional behavio#r change" or AB "professional behavio#r change"
S42	TI (quality W0 (assurance or improv*)) or AB (quality W0 (assurance or improv*))
S43	TI (research N2 (capacity or implementation or mediation or transfer or translation or utili?ation)) or AB (research N2 (capacity or implementation or mediation or transfer or translation or utili?ation))
S44	TI ("research into" W0 (action or practice)) or AB ("research into" W0 (action or practice))
S45	TI "science communication" or AB "science communication"
S46	TI (quality N2 improvement) or AB (quality N2 improvement)
S47	TI ((technology or technologies) N2 transfer) or AB ((technology or technologies) N2 transfer)
S48	TI ((translat* or turning) W0 research) or AB ((translat* or turning) W0 research)

S49	TI "TRIP" or AB "TRIP"
S50	TI "translational science" or AB "translational science"
S51	TI (third W0 (mission or wave)) or AB (third W0 (mission or wave))
S52	S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36 OR S37 OR S38 OR S39 OR S40 OR S41 OR S42 OR S43 OR S44 OR S45 OR S46 OR S47 OR S48 OR S49 OR S50 OR S51
S53	S6 AND S52
S54	PT clinical trial
S55	PT research
S56	(MH "Randomized Controlled Trials")
S57	(MH "Clinical Trials")
S58	(MH "Intervention Trials")
S59	(MH "Nonrandomized Trials")
S60	(MH "Experimental Studies")
S61	(MH "Pretest-Posttest Design+")
S62	(MH "Quasi-Experimental Studies+")
S63	(MH "Multicenter Studies")
S64	(MH "Health Services Research")
S65	TI (randomis* or randomiz* or random* W0 allocat*) OR AB (randomis* or randomiz* or random* W0 allocat*)
S66	TI ((intervention* or controlled or control W0 group* or compare or compared or before N5 after or pre N5 post or pretest or "pre test" or posttest or "post test" or quasiexperiment* or quasi W0 experiment* or evaluat* or effect or impact or "time series" or time W0 point* or repeated W0 measur*)) OR AB ((intervention* or controlled or control W0 group* or compare or compared or before N5 after or pre N5 post or pretest or "pre test" or posttest or "post test" or quasiexperiment* or quasi W0 experiment* or evaluat* or effect or impact or "time series" or time W0 point* or repeated W0 measur*))
S67	TX meta-analysis
S68	PT review
S69	PT systematic review
S70	S54 OR S55 OR S56 OR S57 OR S58 OR S59 OR S60 OR S61 OR S62 OR S63 OR S64 OR S65 OR S66 OR S67 OR S68 OR S69
S71	S53 AND S70 Limiters - Exclude MEDLINE records

Search strategy: ClinicalTrials
Timespan: All years
Search date: 21.05.2014
Hits: 28

(nursing home OR intermediate care facility OR long term care facility OR skilled nursing facility OR home for the aged) AND (guideline (implementation OR dissemination OR uptake OR diffusion OR adherence OR translation))

Search strategy: Cochrane Database of Systematic Reviews (CDSR), Cochrane Central Register of Controlled Trials (CENTRAL)
Timespan: All years
Search date: 21.05.2014
Hits: 209

#1 MeSH descriptor: [Nursing Homes] explode all trees
#2 (nursing next (home? or facilit*)):ti,ab,kw
#3 ((intermediate or long-term or longterm) next "care facilit*"):ti,ab,kw
#4 ((aged-care or "aged care" or skilled-nursing or "skilled nursing") next facilit*):ti,ab,kw
#5 MeSH descriptor: [Homes for the Aged] explode all trees
#6 ("home? for the aged" or "home? for the elderly"):ti,ab,kw
#7 #1 or #2 or #3 or #4 or #5 or #6
#8 MeSH descriptor: [Guideline] explode all trees
#9 MeSH descriptor: [Guidelines as Topic] explode all trees
#10 MeSH descriptor: [Guideline Adherence] explode all trees
#11 (guideline near/2 (implementation or dissemination or uptake or diffusion or adherence)):ti,ab,kw
#12 MeSH descriptor: [Evidence-Based Practice] explode all trees
#13 MeSH descriptor: [Evidence-Based Nursing] explode all trees
#14 MeSH descriptor: [Evidence-Based Medicine] explode all trees
#15 (("evidence based" or "evidence based") next (nursing or medicine or practice)):ti,ab,kw
#16 (evidence near/2 uptake):ti,ab,kw
#17 MeSH descriptor: [Information Dissemination] explode all trees
#18 ((information or "best practice" or guideline? or research) near/2 (dissemination or utili?ation)):ti,ab,kw

#19 "effective dissemination":ti,ab,kw

#20 (applied next (dissemination or "health research")):ti,ab,kw

#21 MeSH descriptor: [Diffusion of Innovation] explode all trees

#22 (innovation near/2 (adaptation or adoption or diffusion)):ti,ab,kw

#23 "best practice?":ti,ab,kw

#24 "capacity building":ti,ab,kw

#25 (change near/2 implementation?):ti,ab,kw

#26 (changing next ((provider or physician or doctor) next behavio?r))

#27 "collaborative development":ti,ab,kw

#28 (complex next (intervention? or science? or study or studies)):ti,ab,kw

#29 (continuing next ((medical or nursing or dental) next education*)):ti,ab,kw

#30 "crossing the quality chasm":ti,ab,kw

#31 ((effectiveness or evaluation) next research*):ti,ab,kw

#32 (gap near/2 (analysis or evidence or practice)):ti,ab,kw

#33 (audit near/2 feedback):ti,ab,kw

#34 (getting next (knowledge or research) next "into practice"):ti,ab,kw

#35 GRIP:ti,ab,kw

#36 know-do:ti,ab,kw

#37 (Knowledge near/2 (adoption or brokering or communication or cycle? or developement or application or diffusion or dissemination or exchange or management or mobili?ation or synthesis or transfer or transformation or translation or uptake or utili?ation)):ti,ab,kw

#38 "knowledge to action":ti,ab,kw

#39 KSTE:ti,ab,kw

#40 "linkage and exchange":ti,ab,kw

#41 "opinion leader?":ti,ab,kw

#42 (patient next (education or safety)):ti,ab,kw

#43 "populari?ation of research":ti,ab,kw

#44 "professional behavio?r change":ti,ab,kw

#45 (quality near/2 (assurance or improv*)):ti,ab,kw

#46 (research near/2 (capacity or implementation or mediation or transfer or translation or utili?ation)):ti,ab,kw

#47 "research into (action or practice)":ti,ab,kw

#48 "science communication":ti,ab,kw

#49 (quality near/2 improvement?):ti,ab,kw

#50 ((technology or technologies) near/2 transfer):ti,ab,kw

#51 ((translat* or turning) next research):ti,ab,kw

#52 TRIP:ti,ab,kw

#53 "translational science":ti,ab,kw

#54 (third next (mission or wave)):ti,ab,kw

#55 #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30 or #31 or #32 or #33 or #34 or #35 or #36 or #37 or #38 or #39 or #40 or #41 or #42 or #43 or #44 or #45 or #46 or #47 or #48 or #49 or #50 or #51 or #52 or #53 or #54

#56 #7 and #55

Search strategy: Database of Abstracts of Reviews of Effects (DARE), Health Assessment Database (HTA)
Timespan: All years
Search date: 21.05.2014
Hits: 15

1. MeSH DESCRIPTOR Nursing Homes EXPLODE ALL TREES
2. (“intermediate care” OR “long term care”): TI IN DARE, HTA
3. (“aged care facilit*” OR “skilled nursing facilit*”): TI IN DARE, HTA
4. MeSH DESCRIPTOR Homes for the Aged EXPLODE ALL TREES
5. (“home* for the aged” OR “home* for the elderly”): TI IN DARE, HTA
6. #1 OR #2 OR #3 OR #4 OR #5
7. MeSH DESCRIPTOR Guideline EXPLODE ALL TREES
8. MeSH DESCRIPTOR Guidelines as Topic EXPLODE ALL TREES
9. MeSH DESCRIPTOR Guideline Adherence EXPLODE ALL TREES
10. (implementation OR dissemination OR uptake OR diffusion OR adherence OR translation): TI IN DARE, HTA
11. MeSH DESCRIPTOR Evidence-Based Practice EXPLODE ALL TREES
12. MeSH DESCRIPTOR Evidence-Based Nursing EXPLODE ALL TREES
13. MeSH DESCRIPTOR Evidence-Based Medicine EXPLODE ALL TREES
14. (“evidence based”): TI IN DARE, HTA
15. MeSH DESCRIPTOR Information Dissemination EXPLODE ALL TREES
16. MeSH DESCRIPTOR Diffusion of Innovation EXPLODE ALL TREES
17. #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16
18. #6 AND #17

Search strategy: Embase (Ovid)
Timespan: 1974 – May 2014
Search date: 21.05.2014
Hits: 311

1. exp nursing home/
2. (nursing adj (home? or facilit*)).tw.
3. ((intermediate or long-term or longterm) adj care facilit*).tw.
4. ((aged-care or skilled-nursing) adj facilit*).tw.
5. exp home for the aged/
6. (home? for the aged or home? for the elderly).tw.
7. 1 or 2 or 3 or 4 or 5 or 6
8. exp practice guideline/
9. exp protocol compliance/
10. ((guideline? or protocol) adj2 (implementation or dissemination or uptake or diffusion or adherence or compliance)).tw.
11. exp evidence based practice/
12. exp evidence based medicine/
13. (evidence-based adj (nursing or medicine or practice)).tw.
14. (evidence adj2 uptake).tw.
15. exp information dissemination/
16. ((information or "best practice" or guideline? or research) adj2 (dissemination or utili? ation)).tw.
17. "effective dissemination?".tw.
18. (applied adj (dissemination or health research)).tw.
19. (innovation adj2 (adaptation or adoption or diffusion)).tw.
20. "best practice?".tw.
21. "capacity building".tw.
22. (change adj2 implementation?).tw.
23. (changing adj ((provider or physician or doctor) adj behavio?r)).tw.
24. "collaborative development".tw.
25. (complex adj (intervention? or science? or study or studies)).tw.
26. (continuing adj ((medical or nursing or dental) adj education*)).tw.
27. "crossing the quality chasm".tw.
28. ((effectiveness or evaluation) adj research*).tw.

29. (gap adj2 (analysis or evidence or practice)).tw.
30. (audit adj2 feedback).tw.
31. (getting adj (knowledge or research) adj into practice).tw.
32. GRIP.tw.
33. know-do.tw.
34. (Knowledge adj2 (adoption or brokering or communication or cycle? or developement or application or diffusion or dissemination or exchange or management or mobili?ation or synthesis or transfer or transformation or translation or uptake or utili?ation)).tw.
35. "knowledge to action".tw.
36. KSTE.tw.
37. "linkage and exchange".tw.
38. "opinion leader?".tw.
39. (patient adj (education or safety)).tw.
40. "populari?ation of research".tw.
41. "professional behavio?r change".tw.
42. (quality adj2 (assurance or improv*)).tw.
43. (research adj2 (capacity or implementation or mediation or transfer or translation or utili?ation)).tw.
44. "research into (action or practice)".tw.
45. "science communication".tw.
46. (quality adj2 improvement?).tw.
47. ((technology or technologies) adj2 transfer).tw.
48. ((translat* or turning) adj research).tw.
49. TRIP.tw.
50. "translational science".tw.
51. (third adj (mission or wave)).tw.
52. 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51
53. 7 and 52
54. Randomized Controlled Trial/
55. Controlled Clinical Trial/
56. Quasi Experimental Study/
57. Pretest Posttest Control Group Design/

58. Time Series Analysis/
59. Experimental Design/
60. Multicenter Study/
61. (randomis* or randomiz* or randomly or random allocat*).ti,ab.
62. groups.ab.
63. (trial or multicentre or multicenter or multi centre or multi center).ti.
64. (intervention* or controlled or control group or compare or compared or (before adj5 after) or (pre adj5 post) or pretest or pre test or posttest or post test or quasiexperiment* or quasi experiment* or evaluat* or effect or impact or time series or time point? or repeated measur*).ti,ab.
65. or/54-64
66. Nonhuman/
67. 65 not 66
68. meta-analy:.mp.
69. search:.tw.
70. review.pt.
71. or/68-70
72. 67 or 71
73. 53 and 72
74. limit 73 to exclude medline journals

Search strategy: ISI Web of Science
Timespan: All years
Search date: 21.05.2014
Hits: 355

#1 **TOPIC:** ("nursing home" or "nursing homes" or "nursing facilit*")

#2 **TOPIC:** ("intermediate care facilit*" or "long-term care facilit*" or "longterm care facilit*")

#3 **TOPIC:** ("aged-care facilit*" or "skilled-nursing facilit*")

#4 **TOPIC:** ("home for the aged" or "homes for the aged")

#5 **TOPIC:** ("home for the elderly" or "homes for the elderly")

#6 #1 OR #2 OR #3 OR #4 OR #5

#7 **TOPIC:** (guideline$)

#8 **TOPIC:** ("evidence-based practice" or "evidence-based nursing" or "evidence-based medicine")

#9 **TOPIC:** (evidence NEAR/2 uptake)

#10 **TOPIC:** ((information or "best practice" or guideline$ or research) NEAR/2 (dissemination or utili?ation))

#11 **TOPIC:** ("effective dissemination")

#12 **TOPIC:** ("applied dissemination" or "applied health research")

#13 **TOPIC:** (innovation NEAR/2 (adaptation or adoption or diffusion))

#14 **TOPIC:** ("best practice" or "best practices")

#15 **TOPIC:** ("capacity building")

#16 **TOPIC:** (change NEAR/2 implementation)

#17 **TOPIC:** ("changing provider behavior" or "changing physician behavior" or "changing doctor behavior")

#18 **TOPIC:** ("changing provider behaviour" or "changing physician behaviour" or "changing doctor behaviour")

#19 **TOPIC:** ("collaborative development")

#20 **TOPIC:** ("complex intervention" or "complex interventions" or "complex science" or "complex sciences" or "complex study" or "complex studies")

#21 **TOPIC:** ("continuing medical education" or "continuing nursing education" or "continuing dental education")

#22 **TOPIC:** ("crossing the quality chasm")

#23 **TOPIC:** ("effectiveness research" or "evaluation research")

#24 **TOPIC:** (gap NEAR/2 (analysis or evidence or practice))

#25 **TOPIC:** (audit NEAR/2 feedback)

#26 **TOPIC:** ("getting knowledge into practice" or "getting research into practice")

#27 **TOPIC:** (GRIP)

#28 **TOPIC:** ("know-do")

#29 **TOPIC:** (knowledge NEAR/2 (adoption or brokering or communication or cycle$ or developement or application or diffusion or dissemination or exchange or management or mobili?ation or synthesis or transfer or transformation or translation or uptake or utili?ation))

#30 **TOPIC:** ("knowledge to action")

#31 **TOPIC:** (KSTE)

#32 **TOPIC:** ("linkage and exchange")

#33 **TOPIC:** ("opinion leader" or "opinion leaders")

#34 **TOPIC:** ("patient education" or "patient safety")

#35 **TOPIC:** ("populari?ation of research")

#36 **TOPIC:** ("professional behavior change" or "professional behaviour change")

#37 **TOPIC:** (quality NEAR/2 (assurance or improv*))

#38 **TOPIC:** (research NEAR/2 (capacity or implementation or mediation or transfer or translation or utili?ation))

#39 **TOPIC:** ("research into action" or "research into practice")

#40 **TOPIC:** ("science communication")

#41 **TOPIC:** (quality NEAR/2 improvement)

#42 **TOPIC:** ((technology or technologies) NEAR/2 transfer)

#43 **TOPIC:** ("translat* research" or "turning research")

#44 **TOPIC:** (TRIP)

#45 **TOPIC:** ("translational science")

#46 **TOPIC:** ("third mission" or "third wave")

#47 #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 OR #35 OR #36 OR #37 OR #38 OR #39 OR #40 OR #41 OR #42 OR #43 OR #44 OR #45 OR #46

#48 #6 AND #47

#49 **TOPIC:** ((random* or “control* trial*” or intervention* or experiment* or “time series” or “pre test” or pretest or “post test” or posttest or impact* or chang* or evaluat* or effect* or comparat*))

#50 **TOPIC:** (review)

#51 **TOPIC:** ("meta-analysis")

#52 **TOPIC:** (search)

#53 #50 OR #51 OR #52

#54 #49 OR #53

#55 #48 AND #54 Refined by: [excluding] Databases=(MEDLINE)

Search strategy: MEDLINE ® In-Process & Other Non-Indexed Citations and Ovid MEDLINE ®
Timespan: 1946 – May 2014
Search date: 21.05.2014
Hits: 1781

1. exp Nursing Homes/
2. (nursing adj (home? or facilit*)).tw.
3. ((intermediate or long-term or longterm) adj care facilit*).tw.
4. ((aged-care or skilled-nursing) adj facilit*).tw.
5. exp Homes for the Aged/
6. (home? for the aged or home? for the elderly).tw.
7. or/1-6
8. exp Guideline/
9. exp Guidelines as Topic/
10. exp Guideline Adherence/
11. ((guideline? or protocol) adj2 (implementation or dissemination or uptake or diffusion or adherence or compliance)).tw.
12. exp Evidence-Based Practice/
13. exp Evidence-Based Nursing/
14. exp Evidence-based Medicine/
15. (evidence-based adj (nursing or medicine or practice)).tw.
16. (evidence adj2 uptake).tw.
17. exp Information Dissemination/
18. ((information or "best practice" or guideline? or research) adj2 (dissemination or utili? ation)).tw.
19. "effective dissemination?".tw.
20. (applied adj (dissemination or health research)).tw.
21. exp Diffusion of Innovation/
22. (innovation adj2 (adaptation or adoption or diffusion)).tw.
23. "best practice?".tw.
24. "capacity building".tw.
25. (change adj2 implementation?).tw.
26. (changing adj ((provider or physician or doctor) adj behavio?r)).tw.
27. "collaborative development".tw.

28. (complex adj (intervention? or science? or study or studies)).tw.
29. (continuing adj ((medical or nursing or dental) adj education*)).tw.
30. "crossing the quality chasm".tw.
31. ((effectiveness or evaluation) adj research*).tw.
32. (gap adj2 (analysis or evidence or practice)).tw.
33. (audit adj2 feedback).tw.
34. (getting adj (knowledge or research) adj into practice).tw.
35. GRIP.tw.
36. know-do.tw.
37. (Knowledge adj2 (adoption or brokering or communication or cycle? or developement or application or diffusion or dissemination or exchange or management or mobili?ation or synthesis or transfer or transformation or translation or uptake or utili?ation)).tw.
38. "knowledge to action".tw.
39. KSTE.tw.
40. "linkage and exchange".tw.
41. "opinion leader?".tw.
42. (patient adj (education or safety)).tw.
43. "populari?ation of research".tw.
44. "professional behavio?r change".tw.
45. (quality adj2 (assurance or improv*)).tw.
46. (research adj2 (capacity or implementation or mediation or transfer or translation or utili?ation)).tw.
47. "research into (action or practice)".tw.
48. "science communication".tw.
49. (quality adj2 improvement?).tw.
50. ((technology or technologies) adj2 transfer).tw.
51. ((translat* or turning) adj research).tw.
52. TRIP.tw.
53. "translational science".tw.
54. (third adj (mission or wave)).tw.
55. or/8-54
56. 7 and 55
57. randomized controlled trial.pt.
58. controlled clinical trial.pt.

59. multicenter study.pt.
60. (randomis* or randomiz* or randomly allocat* or random allocat*).ti,ab.
61. groups.ab.
62. (trial or multicenter or multi center or multicentre or multi centre).ti.
63. (intervention* or controlled or control group or compare or compared or (before adj5 after) or (pre adj5 post) or pretest or pre test or posttest or post test or quasiexperiment* or quasi experiment* or evaluat* or effect or impact or time series or time point? or repeated measur*).ti,ab.
64. or/57-63
65. exp Animals/
66. Humans/
67. 65 not (65 and 66)
68. 64 not 67
69. review.ab.
70. review.pt.
71. meta-analysis.ab.
72. meta-analysis.pt.
73. meta-analysis.ti.
74. or/69-73
75. letter.pt.
76. comment.pt.
77. editorial.pt.
78. or/75-77
79. 74 not 78
80. 68 or 79
81. 56 and 80

Search strategy: OpenGrey
Timespan: All years
Search date: 21.05.2014
Hits: 5

(nursing home OR intermediate care facility OR long term care facility OR skilled nursing facility OR home for the aged) AND (implementation OR dissemination OR uptake OR diffusion OR adherence OR translation)

Search strategy: PROSPERO
Timespan: All years
Search date: 21.05.2014
Hits: 10

nursing home OR intermediate care facility OR long term care facility OR skilled nursing facility OR home for the aged

Search strategy: SveMed+
Timespan: All years
Search date: 21.05.2014
Hits: 46

1	exp:"nursing homes"
2	"nursing home" OR "nursing facility"
3	"intermediate care facility" OR "long term care facility
4	"aged care facility" OR "skilled nursing facility"
5	exp:"homes for the aged"
6	"home for the aged" OR "home for the elderly"
7	#1 OR #2 OR #3 OR #4 OR #5 OR #6
8	exp:"Guidelines as Topic"
9	exp:"Guideline Adherence"
10	implementation OR dissemination OR uptake OR diffusion OR adherence OR translation
11	exp:"Evidence-Based Practice"
12	exp:"Evidence-Based Nursing"
13	exp:"Evidence-Based Medicine"
14	"evidence based"
15	exp:"Information Dissemination"
16	exp:"Diffusion of Innovation"
17	#8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16
18	#7 AND #17

Appendix III – Kappa statistics

```
R version 3.1.2 (2014-10-31) -- "Pumpkin Helmet"
Copyright (C) 2014 The R Foundation for Statistical Computing
Platform: x86_64-redhat-linux-gnu (64-bit)

[Workspace loaded from ~/.RData]

> library(irr)
Loading required package: lpSolve
> categ <- c("Excluded", "Unclear", "Possibly relevant")
> lvls  <- factor(categ, levels=categ)
> Heinz   <- rep(lvls, c(185,13,2))
> Birgitte   <- rep(rep(lvls, nlevels(lvls)), c(179,6,0, 2,11,0, 0,0,2))
> cTab  <- table(Heinz, Birgitte)
> addmargins(cTab)
                   Birgitte
Heinz               Excluded Unclear Possibly relevant Sum
  Excluded               179       6                 0 185
  Unclear                  2      11                 0  13
  Possibly relevant        0       0                 2   2
  Sum                    181      17                 2 200
> kappa2(cbind(Heinz, Birgitte), weight="squared")
 Cohen's Kappa for 2 Raters (Weights: squared)

 Subjects = 200
   Raters = 2
    Kappa = 0.811

        z = 11.5
  p-value = 0
```

Appendix IV – Data abstraction form

DATA ABSTRACTION FORM

Data collection

Name of reviewer: **Date:** **Study ID:** **Study reference:**

Objective(s):

Scope: The effect(s) of a professional, organisational, financial or regulatory intervention(s) to implement guidelines in nursing homes is evaluated.	☐

1. INCLUSION CRITERIA

1.1 Study design

Cluster-randomised controlled trial	☐
Randomised controlled trial	☐
Controlled before-after design	☐
Interrupted-time-series design	☐
Clearly defined entry point in time when the intervention occurred	☐
At least three data points before and three after the intervention	☐

1.2 Participants

Healthcare personnel working in a nursing home	☐

1.3 Intervention(s)

Professional ☐	**Organisational** ☐	**Financial** ☐	**Regulatory** ☐
Intervention clearly stated ☐			
Based upon implementation of clinical practice guideline(s) ☐			
Clinical practice guideline(s) Based on a review of the literature ☐ Recommendations tied to the identified evidence ☐ Publicly available ☐			

1.4 Control intervention(s)

Professional ☐	**Organisational** ☐	**Financial** ☐	**Regulatory** ☐
Care as usual ☐			
Other (specify):			

1.5 Outcome(s)

The objective measurement of performance / provider behaviour or health / patient outcomes ☐
Relevant and interpretable data presented or obtainable ☐

2. INTERVENTIONS

2.1 Type of intervention (state all interventions for each comparison / study group)

2.2 Control(s)

3. TYPE OF TARGETED BEHAVIOUR (state more than one where appropriate)

4. PARTICIPANTS

4.1 Characteristics of participating providers

Profession:
Level of vocational training:

4.2 Characteristics of participating residents

4.2.1 Other resident characteristics

Age:
Gender:
Ethnicity:
Other (specify):

4.2.2 Number of residents included in the study

Episodes of care:
Residents:
Providers:
Communities or regions:

5. SETTING

Location of care:
Country:
Proportion of eligible providers or allocation units:

6. METHODS

Unit of allocation:
Unit of analysis:
Power calculation:

7. PROSPECTIVE IDENTIFICATION OF BARRIERS TO CHANGE

8. INTERVENTION

8.1 Characteristics of the intervention

Evidence base of recommendation:			
Purpose of recommendations:			
Single intervention	☐	**Multifaceted intervention**	☐

8.2 Timing

Frequency / number of intervention events:
Duration of intervention:

9. OUTCOMES

9.1 Description of the main outcome measure(s)

Health professional outcomes / process measures:
Patient outcomes:

9.2 Length of time

Length of time during which outcomes were measured after initiation of the intervention:
Length of post-intervention follow-up:

9.3 Identify a possible ceiling effect

Identified by investigator	☐
Identified by reviewer	☐

10. RESULTS (use extra page if necessary)

10.1.1 For (cluster-)randomised controlled trials

10.1.2 For controlled before-after studies

10.1.3 For interrupted-time-series studies

Appendix V – Statistical calculations

1. Köpke et al. (2012)

1.1 Residents with physical restraints after three months

```
R version 3.1.2 (2014-10-31) -- "Pumpkin Helmet"
Copyright (C) 2014 The R Foundation for Statistical Computing
Platform: x86_64-redhat-linux-gnu (64-bit)

[Workspace loaded from ~/.RData]

> library (Epi)

Attaching package: 'Epi'

The following object is masked from 'package:base':

    merge.data.frame

> M[1] <- (1872+1792)/(18+18)
> ICC[2] <- 0.029
> DE[3] <- (1+(M-1)*ICC)
> events_intervention <- round(447/DE)
> pop_intervention <- round(1872/DE)
> events_control <- round(546/DE)
> pop_control <- round(1792/DE)
> dat <- matrix(c((pop_control-events_control),events_control,
(pop_intervention-events_intervention),events_intervention), nrow = 2,
byrow = TRUE)
> twoby2(dat[c(2,1),c(2,1)])
2 by 2 table analysis:
------------------------------------------------------
Outcome   : Col 1
Comparing : Row 1 vs. Row 2

      Col 1 Col 2    P(Col 1) 95% conf. interval
Row 1   114   363      0.2390    0.2028   0.2793
Row 2   139   318      0.3042    0.2637   0.3479

                                  95% conf. interval
            Relative Risk:  0.7858    0.6358   0.9712
        Sample Odds Ratio:  0.7185    0.5377   0.9600
Conditional MLE Odds Ratio:  0.7187    0.5318   0.9700
    Probability difference: -0.0652   -0.1218  -0.0081

            Exact P-value: 0.0272
        Asymptotic P-value: 0.0254
```

1 Average cluster size
2 Intra-cluster correlation coefficient
3 Design effect

1.2 Residents with physical restraints after six months

```
R version 3.1.2 (2014-10-31) -- "Pumpkin Helmet"
Copyright (C) 2014 The R Foundation for Statistical Computing
Platform: x86_64-redhat-linux-gnu (64-bit)

[Workspace loaded from ~/.RData]

> library (Epi)

Attaching package: ‘Epi’

The following object is masked from ‘package:base’:

    merge.data.frame

> M <- (1868+1802)/(18+18)
> ICC <- 0.029
> DE <- (1+(M-1)*ICC)
> events_intervention <- round(423/DE)
> pop_intervention <- round(1868/DE)
> events_control <- round(525/DE)
> pop_control <- round(1802/DE)
> dat <- matrix(c((pop_control-events_control),events_control,
(pop_intervention-events_intervention),events_intervention), nrow = 2,
byrow = TRUE)
> twoby2(dat[c(2,1),c(2,1)])
2 by 2 table analysis:
------------------------------------------------------
Outcome   : Col 1
Comparing : Row 1 vs. Row 2

      Col 1 Col 2    P(Col 1) 95% conf. interval
Row 1   108   368      0.2269    0.1915   0.2667
Row 2   134   325      0.2919    0.2521   0.3352

                                  95% conf. interval
            Relative Risk:  0.7772    0.6246   0.9671
         Sample Odds Ratio:  0.7118    0.5304   0.9552
Conditional MLE Odds Ratio:  0.7121    0.5244   0.9653
    Probability difference: -0.0650   -0.1209  -0.0089

             Exact P-value: 0.0251
        Asymptotic P-value: 0.0235
```

2. Van Gaal et al. (2011b)

2.1 Adequate care given to nursing home residents at risk for pressure ulcers

```
R version 3.1.2 (2014-10-31) -- "Pumpkin Helmet"
Copyright (C) 2014 The R Foundation for Statistical Computing
Platform: x86_64-redhat-linux-gnu (64-bit)

[Workspace loaded from ~/.RData]

> library(Epi)

Attaching package: 'Epi'

The following object is masked from 'package:base':

  merge.data.frame

> M <- (196+196)/(5+5)
> ICC <- 0.01
> DE <- (1+(M-1)*ICC)
> events_intervention <- round((196*0.19)/DE)
> noevents_intervention <- round(196*0.81/DE)
> events_control <- round(196*0.13/DE)
> noevents_control <- round(196*0.87/DE)
> dat <- matrix(c((noevents_control-events_control),events_control,
(noevents_intervention-events_intervention),events_intervention), nrow = 2,
byrow = TRUE)
> twoby2(dat[c(2,1),c(2,1)])
2 by 2 table analysis:
------------------------------------------------------
Outcome   : Col 1
Comparing : Row 1 vs. Row 2

      Col 1 Col 2    P(Col 1) 95% conf. interval
Row 1    27    88      0.2348    0.1662   0.3208
Row 2    18   105      0.1463    0.0942   0.2204

                                  95% conf. interval
            Relative Risk: 1.6043    0.9354   2.7517
         Sample Odds Ratio: 1.7898    0.9248   3.4637
Conditional MLE Odds Ratio: 1.7853    0.8815   3.6886
    Probability difference: 0.0884   -0.0115   0.1882

             Exact P-value: 0.098
        Asymptotic P-value: 0.084
```

2.2 Adequate care given to nursing home residents at risk for urinary tract infections

```
R version 3.1.2 (2014-10-31) -- "Pumpkin Helmet"
Copyright (C) 2014 The R Foundation for Statistical Computing
Platform: x86_64-redhat-linux-gnu (64-bit)

[Workspace loaded from ~/.RData]

> library(Epi)

Attaching package: 'Epi'

The following object is masked from 'package:base':

    merge.data.frame

> M <- (196+196)/(5+5)
> ICC <- 0.01
> DE <- (1+(M-1)*ICC)
> events_intervention <- round((196*0.43)/DE)
> noevents_intervention <- round(196*0.57/DE)
> events_control <- round(196*0.41/DE)
> noevents_control <- round(196*0.59/DE)
> dat <- matrix(c((noevents_control-events_control),events_control,
(noevents_intervention-events_intervention),events_intervention), nrow = 2,
byrow = TRUE)
> twoby2(dat[c(2,1),c(2,1)])
2 by 2 table analysis:
------------------------------------------------------
Outcome   : Col 1
Comparing : Row 1 vs. Row 2

      Col 1 Col 2    P(Col 1) 95% conf. interval
Row 1    61    20      0.7531    0.6480   0.8348
Row 2    58    26      0.6905    0.5841   0.7799

                                  95% conf. interval
            Relative Risk: 1.0907    0.9021   1.3187
        Sample Odds Ratio: 1.3672    0.6893   2.7119
Conditional MLE Odds Ratio: 1.3646    0.6529   2.8843
    Probability difference: 0.0626   -0.0740   0.1955

              Exact P-value: 0.3905
    Asymptotic P-value: 0.3707
```

3. Ward et al. (2010)

3.1 Residents with at minimum one femoral neck fracture

```
R version 3.1.2 (2014-10-31) -- "Pumpkin Helmet"
Copyright (C) 2014 The R Foundation for Statistical Computing
Platform: x86_64-redhat-linux-gnu (64-bit)

[Workspace loaded from ~/.RData]

> library (Epi)

Attaching package: 'Epi'

The following object is masked from 'package:base':

    merge.data.frame

> M <- (2802+2589)/(46+42)
> ICC <- 0.0247
> DE <- (1+(M-1)*ICC)
> events_intervention <- round(109/DE)
> pop_intervention <- round(2802/DE)
> events_control <- round(106/DE)
> pop_control <- round(2589/DE)
> dat <- matrix(c((pop_control-events_control),events_control,
(pop_intervention-events_intervention),events_intervention), nrow = 2,
byrow = TRUE)
> twoby2(dat[c(2,1),c(2,1)])
2 by 2 table analysis:
------------------------------------------------------
Outcome   : Col 1
Comparing : Row 1 vs. Row 2

      Col 1 Col 2    P(Col 1) 95% conf. interval
Row 1    44  1082      0.0391    0.0292   0.0521
Row 2    43   997      0.0413    0.0308   0.0553

                                  95% conf. interval
            Relative Risk:  0.9451    0.6261   1.4266
        Sample Odds Ratio:  0.9429    0.6140   1.4480
Conditional MLE Odds Ratio:  0.9429    0.5994   1.4841
    Probability difference: -0.0023   -0.0193   0.0144

            Exact P-value: 0.827
        Asymptotic P-value: 0.7881
```

Appendix VI - Table of excluded studies

Study	Reason for exclusion
(Abel et al., 2005) Quality improvement in nursing homes in Texas: results from a pressure ulcer prevention project.	Pre-post design with too few data points.
(Baier et al., 2004) Ameliorating pain in nursing homes: a collaborative quality-improvement project.	Pre-post design with too few data points.
(Baker, Gottschalk & Bianco, 2007) Step by step: integrating evidence-based fall-risk management into senior centers.	Not guideline implementation.
(Baldwin et al., 2010) Cluster randomised controlled trial of an infection control education and training intervention programme focusing on meticillin-resistant Staphylococcus aureus in nursing homes for older people.	Not guideline implementation.
(Beeckman et al., 2013) A multi-faceted tailored strategy to implement an electronic clinical decision support system for pressure ulcer prevention in nursing homes: a two-armed randomized controlled trial.	Self-developed computerized decision support system (PrevPlan), guidelines used not stated.
(Blinkhorn et al., 2011) An intervention to improve the oral health of residents in an aged care facility led by nurses.	Not guideline implementation.
(Byrne, 2005) Impact of prospective computerized clinical decision support information and targeted assistance on nursing home resident outcomes.	Doctoral dissertation.
(Chami et al., 2012) A short-term, multicomponent infection control program in nursing homes: a cluster randomized controlled trial.	Guideline based on a Delphi consensus survey. No review of the literature.
(Collins et al., 2004) An evaluation of a "best practices" musculoskeletal injury prevention program in nursing homes.	Not guideline implementation.
(Colon-Emeric et al., 2006) Translating evidence-based falls prevention into clinical practice.	Not guideline implementation.
(Colon-Emeric et al., 2007) Randomized trial to improve fracture prevention in nursing home residents.	Excluded after critical appraisal due to severe attrition bias.
(Colon-Emeric et al., 2009) Development and pilot testing of computerized order entry algorithms for geriatric problems in nursing homes.	Pre-post design with too few data points.
(Colon-Emeric et al., 2013) CONNECT for better fall prevention in nursing homes: results from a pilot intervention study.	Not guideline implementation.
(Crotty et al., 2004) An outreach intervention to implement evidence based practice in residential care: a randomized controlled trial [ISRCTN67855475].	Intervention only partially guideline based, guideline not available. Both high-level (nursing homes) and low-level care (hostels), no separate outcomes reported.
(Davidsson et al., 2011) A multidisciplinary approach to improve drug therapy in nursing homes.	Pre-post design with with too few data points.

Study	Reason for exclusion
(Dharmarajan et al., 2012) Prevention of venous thromboembolism in long term care: results of a multicenter educational intervention using clinical practice guidelines: part 2 of 2 (an AMDA Foundation project).	Intervention not described.
(Ersek et al., 2012) Addressing methodological challenges in implementing the nursing home pain management algorithm randomized controlled trial.	Missing outcome data.
(Fagan et al., 2012) Antibiotic prescribing in nursing homes in an area with low prevalence of antibiotic resistance: compliance with national guidelines.	Not an experimental design.
(Falls Committee Staff, Middlesex Terrace Nursing Home, Delaware, Ontario, 2012) Employing Best Practice Guidelines in the prevention of falls.	Not an experimental design.
(Field et al., 2009) Computerized clinical decision support during medication ordering for long-term care residents with renal insufficiency.	Not guideline implementation.
(Godkin & Onyskiw, 1999) A systematic overview of interventions to reduce physical restraint use in long-term care settings.	Not guideline implementation.
(Gokula, Gaspar & Siram, 2013) Implementation of an Evidence Based Protocol to Reduce Use of Indwelling Urinary Catheters in the Long Term Care Environment... Long Term Care Medicine 2013 Conference.	Poster abstract.
(Gopal Rao et al., 2009) Effectiveness of short-term, enhanced, infection control support in improving compliance with infection control guidelines and practice in nursing homes: a cluster randomized trial.	Guidelines used not stated and not in reference list.
(Gotoh et al., 2005) Effectiveness of the introduction of a guideline for urinary management in the elderly at nursing homes.	Article unable to be retrieved.
(Haines, 2009) Can the safety culture of residential aged care facilities be impacted upon by an action-research strategy to implement best practice guidelines for prevention of falls?	Conference abstract of a survey.
(Halm et al., 2004) Limited Impact of a Multicenter Intervention To Improve the Quality and Efficiency of Pneumonia Care.	Not a nursing home setting.
(Hanson et al., 2005) A quality improvement intervention to increase palliative care in nursing homes.	Not guideline implementation.
(Harvey, Kitson & Munn, 2012) Promoting continence in nursing homes in four European countries: the use of PACES as a mechanism for improving the uptake of evidence-based recommendations.	Not an experimental design.
(Haut et al., 2010) Effectiveness of a guideline clipped intervention for the reduction of physical restraints in nursing homes – cluster-randomized controlled study.	Conference abstract.

Study	Reason for exclusion
(Heid-Grubman, 2005) Best practices. Management decisions and their impact on resident behaviors.	Not an experimental design.
(Ho et al., 2011) Hand hygiene promotion in long-term care facilities (LTCF) - A cluster randomized controlled trial.	Conference abstract.
(Ho et al., 2012) Effectiveness of multifaceted hand hygiene interventions in long-term care facilities in Hong Kong: a cluster-randomized controlled trial.	Not guideline implementation.
(Horey, Street & Sands, 2012) Acceptability and feasibility of end-of-life care pathways in Australian residential aged care facilities	Not an experimental design.
(Hutt et al., 2008) Associations among nurse and certified nursing assistant hours per resident per day and adherence to guidelines for treating nursing home-acquired pneumonia.	Not an experimental design.
(Hutt et al., 2006) A multifaceted intervention to implement guidelines improved treatment of nursing home-acquired pneumonia in a state veterans home.	Guideline not based on a review of the literature.
(Hutt et al., 2011) A multifaceted intervention to implement guidelines did not affect hospitalization rates for nursing home-acquired pneumonia.	Guideline not based on a review of the literature.
(James, Alemi & Zepeda, 2013) Effectiveness and Implementation of Evidence-Based Practices in Residential Care Settings.	Not a nursing home setting (residential care for childs).
(Jones et al., 2004) Translation research in long-term care: improving pain management in nursing homes.	Participants healthcare personnel, family and residents. No separate analysis.
(Keay et al., 2003) Nursing home physician educational intervention improves end-of-life outcomes.	Not guideline implementation.
(Kennedy et al., 2012) An interdisciplinary knowledge translation intervention in long-term care: study protocol for the vitamin D and osteoporosis study (ViDOS) pilot cluster randomized controlled trial.	Study protocol.
(Kennelly et al., 2011) Sustained benefits of a community dietetics intervention designed to improve oral nutritional supplement prescribing practices.	Not a nursing home setting.
(Kheirbek et al., 2004) The effect of a quality improvement initiative to promote advance care planning in the nursing home.	Conference abstract.
(Kim, Burkard & Howell, 2012) Effective geriatric pain education program for nursing home staffs: evidence-based practice.	Conference abstract.
(Kwong et al., 2011) A pressure ulcer prevention programme specially designed for nursing homes: does it work?	Pre-post design with too few data points.
(Lapane et al., 2008) Effectiveness of a clinical informatics tool to promote patient safety during the medication monitoring stage in nursing homes.	Conference abstract.

Study	Reason for exclusion
(Loganathan et al., 2010) P26 Interventions to improve prescribing quality in care homes: a systematic review.	Not guideline implementation.
(Lynn et al., 2007) Collaborative clinical quality improvement for pressure ulcers in nursing homes.	Pre-post design with too few data points.
(McGilton et al., 2009) A systematic review of the effectiveness of communication interventions for health care providers caring for patients in residential care settings.	Not guideline implementation.
(McMurdo, Millar & Daly, 2000) A randomized controlled trial of fall prevention strategies in old peoples' homes.	Not guideline implementation.
(Meyer et al., 2003) Effect on hip fractures of increased use of hip protectors in nursing homes: cluster randomised controlled trial.	Not guideline implementation.
(Monette et al., 2012) Effect of an Interdisciplinary Educational Program on Antipsychotic Prescribing Among Residents With Dementia in Two Long-Term Care Centers.	Pre-post design with too few data points.
(Murphy et al., 2005) Development and evaluation of a best practice initiative to improve nursing home quality in management of depression.	Conference abstract.
(Naughton et al., 2001) Antibiotic use, hospital admissions, and mortality before and after implementing guidelines for nursing home-acquired pneumonia.	Guideline based on experience and community practice. No review of the literature.
(Neyens et al., 2011) Effectiveness and implementation aspects of interventions for preventing falls in elderly people in long-term care facilities: a systematic review of RCTs.	Not guideline implementation.
(Nicolle, 2014) Antimicrobial stewardship in long term care facilities: What is effective?	Non-systematic review.
(Niederhauser et al., 2012) Comprehensive programs for preventing pressure ulcers: a review of the literature.	Not guideline implementation.
(O'Brien et al., 2007) Educational outreach visits: effects on professional practice and health care outcomes.	Not guideline implementation.
(O'Halloran, 2004) A cluster randomised controlled trial to evaluate a policy of making hip protectors available to residents of nursing homes.	Not guideline implementation.
(Olsho et al., 2014) Evaluation of AHRQ's on-time pressure ulcer prevention program: a facilitator-assisted clinical decision support intervention for nursing homes.	Not guideline implementation.
(Proctor et al., 1999) Behavioural management in nursing and residential homes: a randomised controlled trial.	Not guideline implementation.
(Rahman et al., 2012) Distance coursework and coaching to improve nursing home incontinence care: lessons learned.	Not guideline implementation.

Study	Reason for exclusion
(Rantz et al., 2001) Randomized clinical trial of a quality improvement intervention in nursing homes.	Not guideline implementation.
(Rantz et al., 2012) Randomized Multilevel Intervention to Improve Outcomes of Residents in Nursing Homes in Need of Improvement.	Not guideline implementation.
(Rapp et al., 2013) Agitation in nursing home residents with dementia (VIDEANT trial): effects of a cluster-randomized, controlled, guideline implementation trial.	Consensus guideline, not evidence-based..
(Resnick, Quinn & Baxter, 2004) Testing the feasibility of implementation of clinical practice guidelines in long-term care facilities.	Pre-post design with too few data points.
(Richter et al., 2012) Psychosocial interventions for reducing antipsychotic medication in care home residents (Review).	Not guideline implementation.
(Rosen at al., 2006) Ability, incentives, and management feedback: organizational change to reduce pressure ulcers in a nursing home	Pre-post design with too few data points.
(Santos, 2007) Promoting best practices in long-term care homes.	Not an experimental design.
(Scherer et al., 2006) Promoting evidence-based best practices for hip fracture prevention in residential aged care.	Not guideline implementation.
(Schmidt et al., 1998) The impact of regular multidisciplinary team interventions on psychotropic prescribing in Swedish nursing homes.	Not explicitely guideline-based. Guideline unable to be retrieved, not publically available.
(Schweon et al., 2013) Effectiveness of a comprehensive hand hygiene program for reduction of infection rates in a long-term care facility.	Pre-post design with too few data points.
(Shanley, 2003) Falls and injury reduction in residential aged care: translating research into practice.	Non-systematic review.
(Sie, Thorstad & Andersen, 2008) Infection control and hand hygiene in nursing homes in Oslo.	Not an experimental design.
(Steeman et al., 2006) Implementation of discharge management for geriatric patients at risk of readmission or institutionalization.	Pre-post design with too few data points.
(Sung, Chang & Abbey, 2006) An implementation programme to improve nursing home staff's knowledge of and adherence to an individualized music protocol.	Not guideline implementation.
(Teresi et al., 2013) Comparative effectiveness of implementing evidence-based education and best practices in nursing homes: effects on falls, quality-of-life and societal costs.	Not guideline implementation.
(Testad et al., 2005) The effect of staff training on agitation and use of restraint in nursing home residents with dementia: a single-blind, randomized controlled trial.	Intervention only partially guideline-based. Guideline not stated and not in reference list.

Study	Reason for exclusion
(Thompson et al., 2005) Skin care protocols for pressure ulcers and incontinence in long-term care: a quasi-experimental study.	Not guideline implementation.
(Tideiksaar, 2007) Preventing fractures with hip protectors.	Not an experimental design.
(Tjia et al., 2014) Dissemination of Evidence-Based Antipsychotic Prescribing Guidelines to Nursing Homes: A Cluster Randomized Trial.	Conference abstract.
(Tse, 2011) Effectiveness of an integrated pain management program on older persons and staff in nursing homes.	Not guideline implementation.
(Valle, Chinellato & Milani, 2001) Impact of a guideline-based management on outcomes of very old persons with heart failure living in nursing homes.	Not an experimental design.
(Vasse et al., 2010) A systematic review of communication strategies for people with dementia in residential and nursing homes.	Not guideline implementation.
(Verkaik et al., 2011) The effects of introducing a nursing guideline on depression in psychogeriatric nursing home residents with dementia.	Guideline not based on a review of the literature, not based on current evidence.
(Verrue et al., 2009) Pharmacists' interventions for optimization of medication use in nursing homes : a systematic review.	Not guideline implementation.
(Vlaeyen et al., 2013) Characteristics and effectiveness of fall prevention programs in nursing homes: A systematic review and meta-analysis of randomized controlled trials.	Not guideline implementation.
(Wanlass, Robinson & French, 1991) Converting research into practice – A study of physical restraints in a nursing-home.	Conference abstract.
(Watson-Wolfe et al., 2014) Application of the Antipsychotic Use in Dementia Assessment audit tool to facilitate appropriate antipsychotic use in long term care residents with dementia.	Pre-post design with too few data points.
(Weening-Verbree et al., 2012) Oral health care in older people in long term care facilities: A systematic review of implementation strategies.	Not guideline implementation.
(Westbury et al., 2010) An effective approach to decrease antipsychotic and benzodiazepine use in nursing homes: the RedUSe project.	Guidelines not based on a review of the literature, not based on current evidence.
(Wikby, Ek & Christensson, 2009) Implementation of a nutritional programme in elderly people admitted to resident homes.	Not guideline implementation.
(Xakellis et al., 2001) Translating pressure ulcer guidelines into practice: it's harder than it sounds.	Pre-post design with too few data points.
(Yeung, Tam & Wong, 2011) Clustered randomized controlled trial of a hand hygiene intervention involving pocket-sized containers of alcohol-based hand rub for the control of infections in long-term care facilities.	Not guideline implementation.

Study	Reason for exclusion
(Zabarsky, Sethi & Donskey, 2008) Sustained reduction in inappropriate treatment of asymptomatic bacteriuria in a long-term care facility through an educational intervention.	Pre-post design with too few data points.
(Zarowitz et al., 2006) The application of evidence-based principles of care in older persons (issue 3): management of diabetes mellitus.	Not an experimental design.
(Zimmerman et al., 2010) Adherence to hip protectors and implications for U.S. long-term care settings.	Not an experimental design.
(Zimmerman et al., 2014) Successfully reducing antibiotic prescribing in nursing homes.	Guideline not evidence-based, no review of the literature.

Appendix VII – References of excluded studies

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Appendix VIII – Characteristics of included studies

Study, nationality and design	Participating providers (Level of training)	Participating residents (Clusters, number)	Outcome (relevant for this systematic review)	Outcome measurement	Outcome measurement frequency/period	Length of post-intervention follow-up
DeVisschere et al. (2012), Belgium. Cluster-randomised controlled trial.	Nurses, nurse aids. Level of training not stated.	12 nursing homes (N = 297). Nursing home residents, mean age 84 years, high degree of physical disability and cognitive impairment.	Patient outcome:oral hygiene level of the participating residents: dental plaque, denture plaque, tongue plaque (primary outcomes).	Dental plaque: Silnes and Löe plaque index. Denture plaque: Augsburger and Elahi Methylene-blue test. Tongue plaque: Winkel tongue coating index. Tests carried out by trained external examiners.	Measured once after the 6 months intervention period.	-
Köpke et al. (2012), Germany. Cluster-randomised controlled trial.	Nurses with three years of vocational training, certified nurse assistants with 1 year vocational training, untrained nurse assistants.	36 nursing homes (N = 3670). Nursing home residents, mean age 85.5 years, high degree of physical disability and cognitive impairment.	Professional practice: the number of residents with physical restraints after 6 months (primary outcome). Restraint use at 3 months (secondary outcome).	Unannounced observation by blinded investigators on three different occasions during one day.	Measured after 3 and 6 months during the 6 months intervention period.	-
Van Gaal (2011a/b), Netherlands. Cluster-randomised controlled trial.	Nurses. Level of training not stated.	10 wards from 6 nursing homes (N = 392). Nursing home residents, mean age 78 years, half of them physically impaired. No cognitive impairment.	Patient outcome (Part I): Incidence of adverse events: pressure ulcer, urinary tract infections and falls (primary outcome). Professional practice (Part II): adequate care given to nursing home residents at risk of adverse events (secondary outcome).	Primary outcome: chart review and inspection of patient's skin by independent research assistants. Secondary outcome: chart review and patient observation by independent research assistants.	Primary outcomes: measured weekly during post-intervention follow up. Secondary outcomes: measured weekly during post-intervention follow-up. Three additional observational visits on every ward. No measurement during the 14 months intervention period.	9 months.
Ward et al. (2010), Australia. Cluster-randomised controlled trial.	Nursing home staff including physicians. Level of training not stated.	88 nursing homes (N = 5391). Nursing home residents, mean age 85.5 years, about 70% able to stand or walk with or without assistance, 21% received dementia-specific care.	Professional practice: use of vitamin D supplements, use of hip protectors (primary outcomes). Patient outcome: change in fall rates, residents with a fractured neck of femur (primary outcomes).	Chart review by nursing home staff.	Monthly during the 17 months intervention period.	-

Appendix IX – Detailed description of interventions

Study	Objective(s) / Intervention	Target population	Comparator	KT activities	Facilitators and barriers	Frequency and duration
DeVisschere et al. (2012)	A supervised implementation of an oral healthcare guideline to improve the oral hygiene level of nursing home residents. Organizational: Conduction of one oral healthcare team per ward consisting of two oral healthcare organizers, a physician and either an occupational or speech therapist. Professional: 1.5 hours presentation of the guideline, the oral healthcare protocol and the study to the director of nursing. 2 hours theoretical and 1 hour practical education for the members of the oral healthcare team covering the guideline.1.5 hours training session for all ward nurses and nurse aids. Regularly bedside support of the oral healthcare organizers to ensure the delivery of the oral healthcare protocol and adherence to the guideline recommendations. Free oral healthcare products for all residents. Six-weekly meetings of the investigator, the project supervisor and the oral healthcare organizers to ensure implementation and to discuss problems.	Healthcare personnel, nursing home management.	Guideline dissemination[1]	Multifaceted: Clinical multidisciplinary teams, local consensus process, distribution of educational materials, education meetings, patient incentives.	Not prospectively identified.	Once in the beginning of the 6 months intervention period. Bedside-support and team meetings frequently over the 6 months intervention period.
Köpke et al. (2012)	A multifaceted guideline implementation based on the theory of planned behaviour to reduce physical restraint use. Professional: 90 min. information session for intervention nursing homes to sensitize nurses about the matter of physical restraints and the message of the guideline by addressing their attitudes and experiences. Provision of a short version of the guideline. Distribution of posters, pens, mugs and notepads with the intervention's logo. Flyers and brochures for relatives. Workshop for cluster-nurses on their role in the implementation process and in-depth information on avoiding physical restraints. A poster in the nursing homes foyer showing the contact nurses of the residents.	Healthcare personnel	Care as usual. Standard information provided: three brochures about the use of physical restraints and how to avoid them. A short presentation on physical restraints.	Multifaceted: Distribution of educational materials, education meetings, provision of promotional material.	Not prospectively identified.	Once in the beginning of the 6 months intervention period.

1 Not stated in the article. Information obtained via email from the corresponding author Luc De Visschere.

Study	Objective(s) / Intervention	Target population	Comparison	KT activities	Facilitators and barriers	Frequency and duration
Van Gaal et al. (2011a/b)	Implementation of the patient safety programme"SAFE or SORRY?" to reduce the incidence of pressure ulcers, urinary tract infections and falls and to improve preventive care for residents at risk of those. Professional: 1.5 hours small-scale education meetings on the wards for all nurses on the causes of pressure ulcers, urinary tract infections and falls, their prevention and on assessment of patients at risk. Two 30 min. case discussions on every ward on these topics. Distribution of a CD-ROM containing educational material and a knowledge test. Three separate information leaflets on the prevention of pressure ulcers, urinary tract infections and falls provided to residents at risk. Chart feedback on process and outcome indicators for the three adverse events using a computerized registration system.	Healthcare personnel.	Care as usual.	Multifaceted: Distribution of educational materials, education meetings, audit and feedback.	Not prospectively identified.	Once in the beginning of the 14 months intervention period. Chart feedback frequently over the 14 months intervention period.
Ward et al. (2010)	Employment of a project nurse to encourage the adoption of best-practice falls prevention strategies. Organizational: Employment of a project nurse to encourage the facilities in using guideline-based strategies in fall risk and mobility assessment, the use of hip protectors, vitamin D supplementation, continence management, exercise programs, the use of appropriate footwear, medication review and post-fall management review. Professional: Provision of information on the prevention of falls and fall injuries to the intervention nursing homes. An initial training session followed by three-monthly network meetings. Development of a resource set to promote fall prevention guidelines. Workshop on running exercise programs for the healthcare personnel of the intervention facilities.	Healthcare personnel.	Care as usual.	Multifaceted: Clinical multidisciplinary teams, distribution of educational materials, education meetings.	Not prospectively identified.	Once in the beginning of the 17 months intervention period. Three-monthly network meetings over the 17 months intervention period.

Appendix X – Risk of bias assessment

Study: Colon-Emeric et al., 2007 **Design:** Cluster-randomised controlled trial		
Domain	**Evaluation**	**Comments**
Was the allocation sequence adequately generated?	Low risk	Quote:"*The nursing homes were randomized within each state... using a random number generator."*
Was the allocation adequately concealed?	Low risk	Allocation by institution, performed on start of the study.
Were baseline outcome measurements similar?	High risk	Described in Table 2. Significantly higher prescription rate of vitamin D in the intervention group. Analysis not corrected. Prescription rates of Calcium and vitamin D ~ 70% in both groups. Ceiling effect.
Were baseline characteristics similar?	Low risk	Quote: "*Intervention residents were more likely to be African American, younger, and used tobacco; and less likely to have previous fracture or dysphagia."* Quote: "*..adjusting for baseline factors that were imbalanced, including bed size, age, race, sex, previous fracture, insurance status, ambulatory status, gastrointestinal reflux, breast and endometrial cancer, dysphagia, and tobacco use.* Comment: imbalance at baseline statistically corrected for.
Were incomplete outcome data adequately addressed?	High risk[1]	Quote: "*Participation in the intervention activities was low.."* Comment: 64-89% non-compliance in the intervention group (Table 3). Intention-to-treat not sufficient to correct for non-compliance this big. Groups no longer comparable. Quote: "*All randomized facilities were analysed regardless of their participation in the study.*" Not stated if all nursing homes delivered data or if and how many were lost to-follow-up. Unclear if the authors performed intention-to-treat analysis.
Was knowledge of the allocated interventions adequately prevented during the study?	Low risk	Quote: "*Trained data collectors, blinded to intervention status, abstracted data from the medical record before and after the intervention.*"

1 Study excluded because of severe attrition bias.

Domain	Evaluation	Comments
Was the study adequately protected against contamination?	Low risk	Quote: "*Cluster-randomized, single-blind, controlled trial of a multi-modal quality improvement intervention.*" Unlikely that the control group received the intervention.
Was the study free from selective outcome reporting?	Low risk	All outcomes from the methods section reported in Table 2.
Was the study free from other risks of bias?	Low risk	Quote: "*Analysis was at the facility-level and Generalized Estimating Equation modelling was used to account for clustering.*
Overall risk of bias: Study excluded		

Study: De Visschere et al. (2012) **Design:** Cluster-randomised controlled trial		
Domain	**Judgement**	**Support for judgement**
Was the allocation sequence adequately generated?	Unclear	Stratified cluster sampling with random allocation. No random component mentioned.
Was the allocation adequately concealed?	Low risk	Quote: "*A random sample of 12 nursing homes was randomly allocated to the intervention or the control group."* Comment: Allocation by institution and performed at the start of the study.
Were baseline outcome measurements similar?	Low risk	Quote: *"Baseline plaque levels similar in both groups. The outcome variables, tongue plaque, dental plaque and denture plaque were skewed both at baseline (T0) and at 6-month follow-up (T1). These differences have been adjusted for the corresponding baseline value of the variable as a covariate and the random effect of the institution."*
Were baseline characteristics similar?	Low risk	No significant difference in age, care-dependency, MMSE[2], co-morbidity, dental status and oral hygiene status. P = 0.05 for gender.
Were incomplete outcome data adequately addressed?	Low risk	Quote: *"No other differences were found between residents who completed the study and those who did not, indicating no evidence for a loss to follow-up effect."* Comment: All wards of the respective nursing homes involved.
Was knowledge of the allocated interventions adequately prevented during the study?	Low risk	Quote: *"The primary outcome variable was the oral hygiene level of the participating residents."* Quote: *"The examiners were masked."*
Was the study adequately protected against contamination?	Low risk	Allocation by institution. Unlikely that the control group received the intervention.
Was the study free from selective outcome reporting?	Low risk	All outcome measures are reported (tongue plaque, dental plaque, denture plaque).
Was the study free from other risks of bias?	Low risk	Accounted for clustering in the power calculation and data analysis.
Overall risk of bias: Low		

2 Mini-mental state examination.

Study: Köpke et al., 2012 **Design:** Cluster-randomised controlled trial		
Domain	**Judgement**	**Support for judgement**
Was the allocation sequence adequately generated?	Low risk	Quote: *"Computer-generated randomization lists were used for allocation of clusters in blocks of 4, 6, and 8 nursing homes."*
Was the allocation adequately concealed?	Low risk	Quote: *"Cluster randomized controlled trial. Allocation of clusters was performed by an external person not involved in the study."* Comment: Allocation blinded and by institution. All units allocated at the start of the study. Newly admitted residents were included after randomisation into the group the respective nursing home was assigned to and uninfluenced by the investigators. Therefore low risk of selection bias.
Were baseline outcome measurements similar?	Unclear risk	Residents with physical restraints / restraint use: Table 2. Psychotropic medicine prescriptions: Table 4. Falls and fall-related fractures: Table 1 (Characteristics!). Most probably no important differences. However, p-values are missing.
Were baseline characteristics similar?	Low risk	Stated in Table 1, similar.
Were incomplete outcome data adequately addressed?	Low risk	Quote: *"Analyses were by intention to treat; no participants or clusters changed groups and no cluster dropped out during follow-up."* Comment: However, there was drop-out of individual participants, which was distributed similar between both groups. All drop-outs due to death or movement.
Was knowledge of the allocated interventions adequately prevented during the study?	Low risk	Quote: "*Statistical analyses were conducted after the end of follow-up by the statistician (B.H.), who was unaware of group allocation of clusters."* Quote: *"Data on prevalence of physical restraint use at the 3- and 6-month follow-ups were assessed similarly to baseline by external investigators blinded to cluster group allocation."* Comment: Data collection and analysis performed by blinded investigators.

Domain	Judgement	Support for judgement
Was the study adequately protected against contamination?	Low risk	Quote: *"Cluster randomized controlled trial."* Comment: Allocation by institution. Unlikely that the control group received the intervention.
Was the study free from selective outcome reporting?	Low risk	Results for all outcomes reported (Table 2, 3 and 4).
Was the study free from other risks of bias?	Low risk	Accounted for clustering in sample size calculation and in the data analysis.
Overall risk of bias: Low		

Study: Van Gaal et al., 2011a **Design:** Cluster-randomised controlled trial (PART-I)		
Domain	**Judgement**	**Support for judgement**
Was the allocation sequence adequately generated?	Unclear risk	Quote:*"The randomisation of the wards was stratified for institute and type of ward and each ward was considered as a cluster. The ten hospital wards and ten nursing home wards were assigned to an intervention or usual care group."* Comment: No random component mentioned.
Was the allocation adequately concealed?	Unclear risk	Quote: "*The ten hospital wards and ten nursing home wards were assigned to an intervention or usual care group."* Comment: Unit of allocation by team. Quote: *"Nursing home patients were asked to participate at the start of the data collection periods, or within two weeks after admission."* Quote: *"Although we included the majority of the patients admitted, it is possible that this caused some minor selection bias."* Comment: Participants allocated after randomisation. Not stated who allocated them. Staff and researchers were aware of the allocation.
Were baseline outcome measurements similar?	Low risk	Quote: "*After the randomisation, baseline data were collected during three months at all wards, followed by the implementation of the patient safety programme in the intervention group."* Comment: Baseline outcomes measured prior to the intervention. Quote: *"Results (are) rate ratio from a Poisson regression model using ward as random factor the offset was the duration of observation and institution patients at risk for an AE[3] at the first visit and the incidence of AEs from each ward at baseline."* Comment: Baseline outcome measures similar, Table 4. Adjusted for baseline differences in the analysis.

3 Adverse events (pressure ulcers, urinary tract infections, falls)

Domain	Judgement	Support for judgement
Were baseline characteristics similar?	Low risk	Quote: *"Table 3 presents the characteristics of the patients included in the intervention and usual care group at baseline and at follow-up."* Comment: Nearly half as much physically impaired residents and twice as much rehabilitation residents in the intervention group. Table 1: more wards with physically impaired residents in the intervention group, and more rehabilitation wards in the control group. Number of residents at risk for adverse events and falls similar. Quote: "*...analysed using a random effects Poisson regression analysis, including the following covariates: ward (random effect), institution and the baseline results of the ward."* Comment: Corrected for baseline imbalance in the data analysis.
Were incomplete outcome data adequately addressed?	High risk	Quote: *"Analyses were performed by intention to treat."* Comment: loss to follow-up 20% in the intervention and 31% in the control group (refused with cause unknown, discharged or died). Analysed by intention to treat.
Was knowledge of the allocated interventions adequately prevented during the study?	Low risk	Quote: *"To ensure the validity of the results, all data were collected by independent research assistants who were trained in reading patient files..."* Quote: *"Trained independent research assistants collected the data in: (1) a weekly visit, and (2) by three additional observations on every ward."* Comment: Investigators collecting data were unaware of allocation.
Was the study adequately protected against contamination?	High risk	Quote: *"Cluster randomized controlled trial .."* Comment: Allocation by institution. Quote (design): *"The randomisation of the wards was stratified for centre and type of ward (Figure 1).."* Comment: 6 nursing homes with a total of 10 wards participated. Impossible that the nursing home(s) with more than one participating ward only hosted wards within the same group. Contamination likely.

Domain	Judgement	Support for judgement
Was the study free from selective outcome reporting?	Low risk	All relevant outcomes in the methods section are reported in the results section.
Was the study free from other risks of bias?	Low risk	Quote (design): *"As randomisation was on ward level, a ward was considered to be a cluster. To account for these clusters an intra class correlation coefficient of 0.01 was used in the calculation."* Comments: results corrected for clustering.
Overall risk of bias: High		

Study: Van Gaal et al., 2011b **Design:** Cluster-randomized controlled trial (PART-II)[4]		
Domain	**Judgement**	**Support for judgement**
Was the allocation sequence adequately generated?	Unclear	Quote: *"As described in Part I, ten wards from four hospitals and ten wards from six nursing homes were stratified for institute and ward type and then randomised to intervention or usual care group."* Comment: No random component mentioned.
Was the allocation adequately concealed?	Unclear	Quote: "*As described in Part I, ten wards from four hospitals and ten wards from six nursing homes were stratified for institute and ward type and then randomised to intervention or usual care group."* Comment: Unit of allocation by team. Quote: *"Nursing home patients were asked to participate at the start of the data collection periods, or within two weeks after admission."* Comment: Participants allocated after randomisation. Not stated who allocated them. Staff and investigators were aware of the allocation.
Were baseline outcome measurements similar?	Low risk	Quote (Part I): "*After the randomisation, baseline data were collected during three months at all wards, followed by the implementation of the patient safety programme in the intervention group."* Comment: Baseline outcomes measured prior to the intervention. Quote: *"The results of this study were clustered to ward level, so we used random effects analyses with ward as random factor. Group, institution and the baseline results of the ward were fixed covariates."* Comment: Baseline outcome measures slightly different for all of the three main outcome measures, Table 3. Adjusted for in the analysis.

4*"The design and setting of the cluster randomised trial, which was conducted between September 2006 and November 2008, has been described in Part I."* (Van Gaal et al., 2011b).

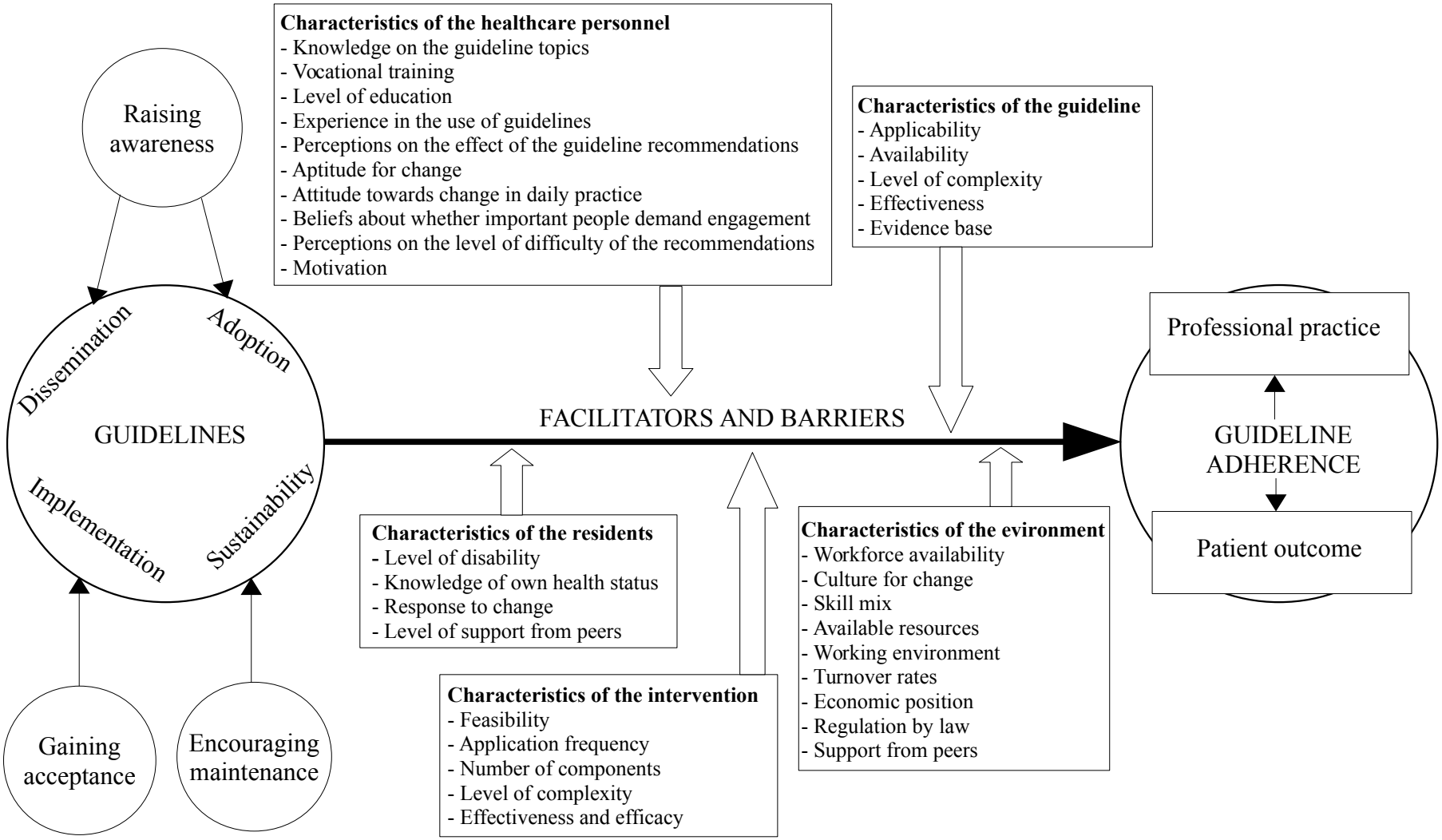
Domain	Judgement	Support for judgement
Were baseline characteristics similar?	Low risk	Quote: *"The characteristics of the patients included in the intervention and the usual care group at baseline and follow-up have been described in Part I of this study".* Quote (Part I): *"Table 3 presents the characteristics of the patients included in the intervention and usual care group at baseline and at follow-up."* Comment: Nearly half as much physically impaired residents and twice as much rehabilitation residents in the intervention group. Number of residents at risk for adverse events similar. Quote: *"The results of this study were clustered to ward level, so we used random effects analyses with ward as random factor. Group, institution and the baseline results of the ward were fixed covariates."* Comment: Corrected for baseline imbalance in the data analysis.
Were incomplete outcome data adequately addressed?	High risk	Quote (Part I): *"Analyses were performed by intention to treat."* Comment: loss to follow-up 20% in the intervention and 31% in the control group (refused, discharged or died). Analysis by intention to treat insufficient.
Was knowledge of the allocated interventions adequately prevented during the study?	Low risk	Quote: *Trained independent research assistants collected the data in: (1) a weekly visit, and (2) by three additional observations on every ward."* Comment: Investigators collecting data were unaware of allocation.
Was the study adequately protected against contamination?	High risk	Quote: *"Cluster randomized controlled trial .."* Comment: Allocation by institution. Quote (design): *"The randomisation of the wards was stratified for centre and type of ward (Figure 1).."* Comment: 6 nursing homes with a total of 10 wards participated. Mathematically impossible that the nursing home(s) hosting more than one participating ward only hosted wards within the same group. Contamination likely.
Was the study free from selective outcome reporting?	Low risk	All relevant outcomes in the methods section reported in the results section.

Domain	Judgement	Support for judgement
Was the study free from other risks of bias?	Low risk	Quote (design): *"As randomisation was on ward level, a ward was considered to be a cluster. To account for these clusters an intra class correlation coefficient of 0.01 was used in the calculation."* Comment: results corrected for clustering.
Overall risk of bias: High risk		

Study: Ward et al., 2010 **Design:** Cluster-randomized controlled trial		
Domain	**Judgement**	**Support for judgement**
Was the allocation sequence adequately generated?	Low risk	Quote: *"Consenting facilities were.. randomly allocated within strata into intervention or control groups by the statistician (R E G) using the procedure "surveyselect" in SAS statistical software."*
Was the allocation adequately concealed?	Unclear risk	Quote: *"We undertook a cluster randomised controlled trial."* Comment: Allocation by institution. Not stated if participants were allocated at the start of the study or who allocated them. Staff and researchers were aware of the allocation.
Were baseline outcome measurements similar?	Low risk	Quote: *"Mean use of vitamin D at baseline was 12.7 supplements per 100 beds (95% CI, 7.4 to 18.1) in the control group and was 6.7 per 100 beds (95% CI, 1.2 to 10.9) lower in the intervention group. However, there were no differences in slopes, for either the first or second stage..with respect to study group."* Comment: No differences between study groups. Therefore unlikely that the results are biased. Baseline outcome measurements similar for the use of hip protectors and fall rates.
Were baseline characteristics similar?	Low risk	Quote: *"Box 1 shows that randomisation produced reasonably similar characteristics for residents in the control and intervention groups. Consenting facilities were stratified."*
Were incomplete outcome data adequately addressed?	Low risk	Quote: *"Overall, six facilities withdrew from the project during the intervention. All withdrawing facilities provided sufficient data to allow retention in analyses. All facilities were analysed according to random allocation (intention to treat)."*

Domain	Judgement	Support for judgement
Was knowledge of the allocated interventions adequately prevented during the study?	High risk	Quote: *"The main outcomes of interest were change in use of vitamin D supplements and hip protectors, and change in the rate of fall events."* Comment: Monthly data collection/reporting on falls, vitamin D supplements and the use of hip protectors by the nursing home staff (self-reporting), who were aware of the allocation of the intervention. *Quote: "Failure to produce monthly data was followed up by the project nurse."* Comment: The project nurse was aware of the allocation.
Was the study adequately protected against contamination?	High risk	Quote: *"There was also a possibility of contamination between the intervention and control groups with regard to the introduction of the strategies. This almost certainly happened, because falls prevention was promoted widely by NSW Health to aged care facilities during this period. In addition, doctors responsible for prescription of calcium and vitamin D supplements visited both the intervention and control facilities."* Comment: The physicians could also have introduced (parts of) the intervention to the control group.
Was the study free from selective outcome reporting?	Low risk	All outcomes from the methods section reported in the results section.
Was the study free from other risks of bias?	Unclear risk	Results cluster-corrected, but most probably not for main outcome "Residents with at minimum one femoral neck fracture".
Overall risk of bias: High		

Appendix XI - Hypothesis on the effect of guideline implementation strategies in nursing homes



Appendix XII – Summary of findings tables

Supervision by an oral health care team compared to guideline dissemination for the implementation of an oral health care guideline

Patient or population: Healthcare personnel
Setting: Nursing homes in Belgium
Intervention: Supervision by an oral health care team
Comparison: Guideline dissemination

Outcomes	**Anticipated absolute effects*** (95% CI)		Relative effect (95% CI)	№ of participants (Studies)	Quality of the evidence (GRADE)	Comments
	Risk with guideline dissemination	**Risk with supervision by an oral health care team**				
Tongue plaque level Assessed with: Oral examination by external investigators. Scale from: 0 to 12 Follow up: 6 months	The mean tongue plaque level in the control group was **3.66** plaque index score points.	The mean tongue plaque level in the intervention group was 0.07 lower (0.91 lower to 0.77 higher)	Not estimable.	12 nursing homes, 278 residents (1 Cluster-RCT)	⨁⨁◯◯ LOW [1,2]	P = 0.87 Results corrected for cluster and baseline differences.
Dental plaque level. Assessed with: Oral examination by external investigators. Scale from: 0 to 3 Follow up: 6 months	The mean dental plaque level. in the control group was **1.77** plaque index score points.	The mean dental plaque level. in the intervention group was 0.15 lower (0.45 lower to 0.14 higher)	Not estimable.	12 nursing homes, 97 residents (1 Cluster-RCT)	⨁⨁◯◯ LOW [1,2]	P = 0.32 Results corrected for cluster and baseline differences.
Denture plaque level. Assessed with: Oral examination by external investigators. Scale from: 0 to 4 Follow up: 6 months	The mean denture plaque level. in the control group was **2.37** plaque index score points.	The mean denture plaque level. in the intervention group was 0.32 lower (0.52 lower to 0.11 lower)	Not estimable.	12 nursing homes, 194 residents (1 Cluster-RCT)	⨁⨁◯◯ LOW [1,2]	P = 0.02 Results corrected for cluster and baseline differences.

1. Only one single study with few events
2. Small sample size

A multifaceted theory-based educational intervention compared to standard information for the implementation of best practices to reduce physical restraints

Patient or population: Healthcare personnel
Setting: Nursing homes in Germany
Intervention: A multifaceted theory-based educational intervention
Comparison: Usual care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (Studies)	Quality of the evidence (GRADE)	Comments
	Risk with standard information	Risk with a multifaceted theory-based educational intervention				
Residents with physical restraints. Assessed with: direct observation by external investigators. Follow up: 3 months	**Study population** 305 per 1000	**241 per 1000 (195 to 196)**	**RR 0.79** (0.64 to 0.97)	36 nursing homes, 3670 residents (1 Cluster-RCT)	⨁⨁◯◯ LOW [1,2]	P=0.025 Results corrected for cluster.
Residents with physical restraints. Assessed with: direct observation by external investigators Follow up: 6 months	**Study population** 291 per 1000	**227 per 1000 (181 to 283)**	**RR 0.78** (0.63 to 0.97)	36 nursing homes, 3664 residents (1 Cluster-RCT)	⨁⨁◯◯ LOW [1,2]	P=0.024 Results corrected for cluster.

1. Only one single study
2. Wide confidence interval

The patient safety programme "SAFE OR SORRY?" compared to usual care for the implementation of pressure ulcer, urinary tract infection and falls best practice guidelines

Patient or population: Healthcare personnel
Setting: Nursing homes in Netherland
Intervention: The patient safety programme "SAFE OR SORRY?"
Comparison: Usual care

Outcomes	**Anticipated absolute effects*** (95% CI)		Relative effect (95% CI)	№ of participants (Studies)	Quality of the evidence (GRADE)	Comments
	Risk with usual care	**Risk with the patient safety programme "SAFE OR SORRY?"**				
Incidence of adverse events (pressure ulcer, urinary tract infections and falls). Assessed with: chart review and skin inspection by independent research assistants. Follow up: 9 months	**Study population** Mean 0.07 events/patient week	**Mean 0.07 events/patient week**	**Rate ratio 0.67** (0.47 to 0.97)	10 wards from 6 nursing homes, 392 residents (1 Cluster-RCT)	⨁◯◯◯ VERY LOW [1 2 3 4]	P<0.05 Intervention group 174/2754, control group 272/3045 adverse events/patient weeks. Results corrected for cluster.
Adequate care given to patients at risk for pressure ulcers Assessed with: chart review and patient observation by independent research assistants. Follow up: 9 months	**Study population** 128 per 1000	**204 per 1000 (120 to 351)**	**RR 1.60** (0.94 to 2.75)	10 wards from 6 nursing homes, 392 residents (1 Cluster-RCT)	⨁◯◯◯ VERY LOW [1 2 3 4]	P=0.084 Results corrected for cluster.
Adequate care given to patients at risk for urinary tract infections. Assessed with: chart review and patient observation by independent research assistants. Follow up: 9 months	**Study population** 408 per 1000	**445 per 1000 (367 to 539)**	**RR 1.09** (0.90 to 1.32)	10 wards from 6 nursing homes, 392 residents (1 Cluster-RCT)	⨁◯◯◯ VERY LOW [1 2 4]	P=0.37 Results corrected for cluster.
Adequate care given to patients at risk for falls. Assessed with: chart review and patient observation by independent research assistants. Follow up: 9 months	**Study population** Not estimable	Not estimable	Not estimable	10 wards from 6 nursing homes, 392 residents (1 Cluster-RCT)	⨁◯◯◯ VERY LOW [1 2 3 4]	1% or fewer events in both intervention and control groups. Percentages too low for statistical analysis.

1. Participants allocated after randomisation, unclear risk of selection bias. Intervention and control wards within the same nursing home, high risk of contamination bias.
2. Only one single study with few events.
3. Wide confidence interval.
4. Small sample size.

The employment of a project nurse compared to usual care for the implementation of falls best practice strategies

Patient or population: Healthcare personnel
Setting: Nursing homes in Australia
Intervention: The employment of a project nurse
Comparison: Usual care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (Studies)	Quality of the evidence (GRADE)	Comments
	Risk with usual care	**Risk with the employment of a project nurse**				
Residents with at minimum one femoral neck fracture Assessed with: Monthly chart review by the nursing home staff. Follow up: 17 months	**Study population** 41 per 1000	**39 per 1000 (26 to 59)**	**RR 0.95** (0.63 to 1.43)	88 nursing homes, 5391 residents (1 Cluster-RCT)	⨁◯◯◯ VERY LOW [1][2][3]	P=0.79 Results corrected for cluster.
The use of vitamin D supplements Assessed with: Monthly chart review by the nursing home staff. Follow up: 17 months	**Study population** Not estimable	Not estimable	Not estimable	88 nursing homes, 5391 residents (1 Cluster-RCT)	⨁◯◯◯ VERY LOW [1][2][3]	Increase in the use of vitamin D supplements with mean slope of 2.0 supplements per 100 beds per month (P < 0.001) averaged over both groups. No difference between intervention and control group (P = 0.092). No confidence interval supplied. Results corrected for cluster.
The use of hip protectors Assessed with: Monthly chart review by the nursing home staff. Follow up: 17 months	**Study population** Not estimable	Not estimable	Not estimable	88 nursing homes, 5391 residents (1 Cluster-RCT)	⨁◯◯◯ VERY LOW [1][2][3]	Small increase in the use of hip protectors in both groups: 0.29 per 100 beds per month (95% CI, 0.17 to 0.41; P < 0.001). No difference between intervention and control group (P > 0.05). Results corrected for cluster.

1. Contamination between intervention and control group, high risk of contamination bias. Unclear allocation concealment, possibility of selection bias. Self-reporting, high risk of detection bias.
2. Only one single study with few events.
3. Large confidence interval.

Implementing guidelines in nursing homes: a systematic review.

Article draft for BMC Implementation Science

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ABSTRACT

Background

Research on guideline implementation strategies has mostly been conducted in settings which differ significantly from a nursing home setting and is therefore hardly transferable. The objective of this study was to systematically review the effects of interventions to improve the implementation of guidelines in nursing homes.

Methods

A systematic literature search was conducted in the Cochrane Library, CINAHL, Embase, MEDLINE, DARE, HTA, CENTRAL, SveMed+ and ISI Web of Science in May 2014. Reference screening and a citation search were performed. Studies were eligible if they evaluated any type of guideline implementation strategy in a nursing home setting. Eligible study designs were systematic reviews, randomised controlled trials, non-randomised controlled trials, controlled before-after studies and interrupted-time-series studies. The EPOC risk of bias tool was used to evaluate the risk of bias in the included studies. The overall quality of the evidence was rated using GRADE.

Results

Four cluster-randomised controlled trials met the inclusion criteria, evaluating a total of four different multifaceted implementation strategies. One study reported a small statistically significant effect on professional practice, and two studies demonstrated small to moderate statistically significant effects on patient outcome. The overall quality of the documentation for all comparisons was low or very low using GRADE.

Conclusions

Little is known about how to increase guideline adherence in nursing homes, and the evidence to support or discourage particular interventions is inconclusive. More implementation research is needed to ensure high quality of care in nursing homes.

Keywords: Nursing homes; Guideline adherence; Knowledge translation; Systematic review.

Background

With the global ageing comes a rapid increase in the number of people in need of long-term care [1]. As a result, the use and societal expense of nursing home care will grow at a dramatic pace [2]. The most complex care needs are often found in the frail nursing home population, attributed to high levels of disability and the presence of multiple chronic diseases [3]. This demographic challenge is closely interlinked to the concern of the quality of care in nursing homes and a shortage of implementing high quality evidence into daily care [4,5].

Clinical practice guidelines (guidelines) provide healthcare personnel with decision support based on the best evidence available in order to improve quality of care and to reduce unwarranted variation in healthcare delivery [6,7]. Although guideline dissemination is the first step in moving from recommendations to implementation, it is rarely sufficient. An effective implementation strategy is crucial to ensure guideline adherence in daily practice [8].

Various international reviews evaluated the effects of guideline implementation strategies on professional practice and patient outcome [9-18]. In addition, a large scoping review examined the extent of knowledge translation studies in older adults [19]. Most studies in these reviews were, however, conducted in acute care, outpatient and primary care settings other than nursing homes. These settings differ from nursing homes in several important factors like the skill-mix, the environment, the case mix and the availability of human and financial resources [19,20]. Such factors are shown to play an important role in the translation of evidence into practice [21,22], thus implementation strategies from other settings will hardly be transferable to the nursing home setting.

This highlights the need for knowledge about evidence-informed implementation strategies on successful uptake of guidelines in nursing homes. Nursing home providers could benefit from

improved understanding on how to increase guideline adherence. In turn, society could benefit from reduced healthcare costs. And most important, improved quality of care and reduced unwarranted variation in healthcare delivery could result in a better life for the "oldest old". The aim of this study was, therefore, to conduct a systematic review to evaluate the effects of guideline implementation strategies on professional practice and patient outcome in nursing homes.

Methods

A study protocol describing the details of this review was developed in advance and is available in PROSPERO [23].

Eligibility criteria

We considered studies for inclusion if they involved healthcare personnel working in a nursing home providing high-level care, evaluated any type of guideline implementation strategy, compared with any other type of guideline implementation strategy or care as usual. The primary outcomes of interest were objective measures of professional practice or patient outcome. Secondary outcomes were subjective outcome measures as for example a change in knowledge, attitudes or the residents satisfaction. Studies only reporting secondary outcomes were excluded. Study designs to be included were systematic reviews, randomised controlled trials, non-randomised controlled trials, controlled before-after studies and interrupted-time-series studies with at least three measure points before and after the intervention and a clearly defined entry point.

The guidelines subject to implementation were required to be based on a review of the literature, their recommendations had to be tied to the findings of the literature search and they had to be publicly available [24]. To facilitate replicability and proper data synthesis, the intervention had to be clearly described.

Information sources and search

From their inception until May 2014, we searched the electronic databases CINAHL, Embase, MEDLINE, SveMed+, ISI Web of Science, the Database of Abstracts of Reviews of Effects (DARE), the Health Technology Assessment Database (HTA), the Cochrane Database of Systematic Reviews (CDSR) and the Cochrane Central Register of Controlled Trials (CENTRAL). Additionally, we searched the grey literature in ClinicalTrials, OpenGrey and PROSPERO, hand searched the references of the included studies, performed a citation search based on the included studies and browsed systematic reviews published by the Cochrane Effective Practice and Organisation of Care (EPOC) review group. No language or document format restrictions were imposed. Furthermore, we screened the included studies on search terms not present in our search strategy to overcome a potential indexing flaw in knowledge translation studies [19]. We used keywords and subject headings where appropriate based on the nursing home setting and the intervention when developing the search strategy. The complete search strategy is available in Additional File 1.

Study selection and quality assessment

Two authors (HD, BG) independently reviewed titles and abstracts, retrieved possibly relevant articles in full-text and assessed them for inclusion in line with the eligibility criteria. A weighted kappa of the screening results of the first 200 references was calculated to test inter-rater agreement [25]. We resolved disagreement by discussion and consensus. Two reviewers (HD, BG) independently assessed the risk of bias in the included studies using the EPOC risk of bias tool [26]. We resolved disagreement by discussion and consensus or by consulting a third reviewer (HL).

Data abstraction

One author (HD) extracted information from the included studies using a customised EPOC

data abstraction form [26] (Additional file 2). A second author (BG) checked the results. We resolved any disagreement by discussion and consensus. When additional information was needed, we contacted the study authors by email. We extracted the following information from each included study: full reference, study objectives, participating healthcare personnel and residents, characteristics of the intervention and control intervention, outcome measures, study design and the results.

Data synthesis

Due to heterogeneity in interventions and outcomes of the included studies, a meta-analysis was not possible. Instead, we performed a narrative synthesis of the results and summarised the effectiveness in the categories *professional practice* and *patient outcome.* When possible, we recalculated effect estimates using the statistical software R [27]. We calculated risk ratio (95% CI) for dichotomous data and mean difference (95% CI) for continuous data. The effect estimates were corrected for clustering. We used the "Grading of Recommendations, Assessment, Development and Evaluation" (GRADE) approach to rate the overall quality of the evidence for each outcome as high, moderate, low or very low [28].

Results

Study selection

The literature search yielded 3321 individual articles. Inter-rater agreement based on the screening results of the first 200 references was strong ($\kappa = 0.81$). We retrieved 101 articles in full-text, and five met the inclusion criteria. One article was excluded after risk of bias assessment [29], and we finally included four trials [30-34]. One study was reported in two complementary articles [32,33]. Figure 1 shows the selection process. A table of excluded studies from which the reader might have expected to find in this review together with a rationale for exclusion is provided in Additional file 3. No new search terms were identified.

Figure 1 – Search and study retrieval process

Study characteristics

The four included cluster-randomised controlled trials used different multifaceted implementation strategies based on education meetings and the distribution of educational material. None of the included studies reported on the secondary outcomes of this review. A total of 9750 residents from 142 nursing homes with a mean age of 83 years participated. Study length ranged from 6 to 23 months. The characteristics of the included studies are summarised in Table 1. Table 2 shows a detailed description of the interventions. Additional files 4 and 5 provide a summary of findings.

Table 1 – Characteristics of included studies

Table 2 – Detailed description of interventions

Risk of bias and overall quality

Using GRADE, the overall quality of the evidence for all outcomes was rated low or very low. We downgraded two studies due to a high risk of bias [32-34]. In addition, imprecision led to a downgrade in all included studies. Details on our risk of bias and GRADE assessment are available in the Additional files 4,5,6. Table 3 provides a short overview over the risk of bias in the included studies.

Table 3 – Risk of bias in included studies

Effects on professional practice

Three studies evaluated the effects of guideline implementation strategies on professional practice [31,33,34]. A total of 9453 residents with mean age of 83 years from 130 nursing homes participated in the studies.

Köpke and colleagues [31] examined the impact of a guideline implementation strategy based

on the theory of planned behaviour on physical restraints use in nursing home residents. The intervention consisted of an information session, the provision of a short version of the guideline, a workshop, the distribution of promotional material and posters. Among the intervention sites, there was a statistically significant lower use of physical restraints (RR 0.78; 95% CI: 0.63-0.97; P=0.024) (Additional file 4: Table S1).

Van Gaal and colleagues [33] tested the effect of the patient safety programme "SAFE OR SORRY?" on the amount of adequate preventive care for residents at risk of pressure ulcers, urinary tract infections or falls. "SAFE OR SORRY?" consisted of a multifaceted guideline implementation strategy to implement three guidelines at once. The intervention included education meetings, distribution of educational material, case discussions and chart feedback. The risk ratio between the intervention and control group showed an increase in adequate care to prevent pressure ulcers and urinary tract infections, but the results were statistically non-significant. There were too few events on the prevention of falls for a statistical analysis (Additional file 4: Table S2).

Ward and colleagues [34] evaluated the effect of employing a project nurse to facilitate the implementation of best-practice fall prevention on the use of vitamin D plus calcium supplements and hip protectors. The intervention is composed of an initial training session, network meetings, a resource set to promote fall prevention guidelines and a workshop. No differences were measured for both outcomes (Additional file 4: Table S3).

The overall quality of the documentation for the results in the category *professional practice* was rated low [31] and very low [33,34] (Additional file 4: Tables S1-S3).

Effects on patient outcome

Three studies evaluated the effects of guideline implementation strategies on patient outcome [30,32,34]. A total of 6080 residents with mean age of 82.5 years from 106 nursing homes

participated in the studies.

De Visschere and colleagues [30] tested the effect of a supervised implementation of an oral healthcare guideline on the oral hygiene level of the participating residents. The intervention involved an oral healthcare team, guideline presentation, interactive education, training sessions, bedside support, network meetings and the provision of free oral healthcare products. Mean difference between the intervention and control group was a statistically non-significant reduction of tongue and dental plaque. The intervention nursing homes encountered a statistically significant reduction in denture plaque (MD -0.32; 95% CI: -0.52, -0.11; P=0.02) (Additional file 5: Table S4).

Van Gaal and colleagues [32] tested the effect of the patient safety programme "SAFE OR SORRY?" on the incidence of pressure ulcers, urinary tract infections and falls. The study is described previously. There was a statistically significant reduction of adverse events per patient week in favour of the intervention nursing homes (Rate ratio 0.67: 95% CI: 0.47-0.97; $P < 0.05$) (Additional file 5: Table S5).

Ward and colleagues [34] evaluated the effect of employing a project nurse to facilitate the implementation of best-practice fall prevention on the rate of residents with at minimum one femoral neck fracture. The study is described previously. A statistically non-significant reduction in residents with at minimum one femoral neck fracture was measured in favour of the intervention group (Additional file 5: Table S6).

The overall quality of the documentation for the results in the category *patient outcome* was rated low [30] and very low [32,34] (Additional file 4: Tables S4-S6).

Discussion

This is the first systematic review to evaluate the effectiveness of guideline implementation

strategies in nursing homes. This review includes four studies evaluating different multifaceted implementation strategies. No outcome was evaluated more than once, and different measures of effect were used. Thus, the results were not primarily comparable. The effects on professional practice and patient outcome were small to moderate and variable. The overall quality of the evidence was low or very low for each outcome, and our confidence in the results is therefore weak.

Interventions to increase adherence to guidelines in nursing homes

Köpke and colleagues [31] showed that theory-based guideline implementation can improve professional practice. However, despite the big sample size in this study, the effect estimate is imprecise and could vary from 38% to nearly zero improvement. The imprecision can be explained by high intra-cluster correlation (ICC=0.029) reducing the effective sample size. A multifaceted guideline implementation strategy to implement three guidelines at once and the employment of a project nurse to facilitate guideline adherence were not effective on professional practice [33,34]. The lack of effect may be due to contamination bias, which was present in both studies. In the first study [33], participating nursing homes hosted wards from both the intervention- and control group. In the second study [34], practice strategies targeting the primary study outcome were promoted nationwide during the intervention period, which may have influenced professional practice in the control group. In addition, general practitioners responsible for calcium and vitamin D prescription visited both intervention and control nursing homes.

De Visschere and colleagues [30] found a supervised guideline implementation to be effective on patient outcome. Yet, only one of three evaluated outcomes improved. The authors argue that sparse outcome-related events and the healthcare personnels antipathy to one of the guideline recommendations could be responsible for the insufficient effectiveness. Van Gaal

and colleagues [32] showed that a multifaceted guideline implementation strategy to implement three guidelines at once can improve patient outcome. The effect estimates are imprecise in both studies, with borderline significance on the lower end of the confidence interval caused by small sample sizes. The employment of a project nurse to facilitate guideline adherence was ineffective on patient outcome, most likely due to contamination bias as explained previously [34].

Comparison with existing literature

Several EPOC reviews [35-37] evaluated guideline implementation strategies and have demonstrated that education meetings, printed educational materials and audit and feedback can improve professional practice and patient outcome. The overall effects were small and inconsistent with a median improvement of 16% or less. This review included studies with results that conform to the existing literature. Education meetings and printed educational materials were a part of the implementation strategies of all included studies, and audit and feedback was used in one study. But as the results were small to moderate and varied both within and across the included studies, it was impossible to determine which components were effective and to what degree.

The use and effectiveness of multifaceted implementation strategies is another often debated issue. All included studies used multifaceted implementation strategies. Their effects were small to moderate and variable, which concurs with evidence from multiple systematic reviews reporting on the topic [9,11,38]. Notably in this context is that the multifaceted implementation strategy in one of the included studies only improved patient outcome [32], but not professional practice [33]. The causal relationship between guideline adherence and patient outcome is thus debatable. Many factors common in nursing homes as for example slowly improving conditions and varying regularity, skills and experience guideline

recommendations are applied with can have impact on patient outcome as a measure for guideline adherence [39,40]. Professional practice directly depicts the extent of activities in concordance with recommendations from guidelines and may ergo be better suited to measure guideline adherence in nursing homes.

Limitations

The first and main limitation of this systematic review is the overall quality of the included evidence, which limits any conclusion. Second, only four studies were included, and every comparison was only evaluated once. We could therefore not identify any pattern that could have reliably linked the interventions to their outcomes. Third, clinical heterogeneity between the included studies impeded meta-analysis. The narrative approach we used is merely a coarse estimate of effect. Fourth, we applied a limiter excluding MEDLINE-indexed articles from the search results in some of the databases. We also excluded some possibly relevant articles because we were unable to determine the evidence base of the guidelines to be implemented. As a consequence, we may have missed relevant studies. Finally, we used the EPOC taxonomy of interventions to classify intervention components. Despite its widespread use, there is no general consensus on the use of this method to categorize intervention components in nursing homes.

Implications for practice and future research

The impact on the field of practice of this systematic review is limited by sparse and low quality evidence. But this does not implicitly mean that the evaluated implementation strategies are ineffective. In fact, more high quality nursing home implementation studies are needed to establish a larger and more reliable evidence base. The multitude of quality improvement studies evaluating the impact of guidelines on patient outcome clearly shows the high interest in effective and reliable evidence in nursing homes. However, in order to

improve patient outcome, guidelines must be implemented first. Thus, future studies evaluating interventions to improve guideline adherence should have a greater emphasis on outcomes that directly reflect change in guideline use, rather than evaluating patient outcome as a measure for guideline adherence.

There is also unused potential in the design of implementation strategies. Although highly recommended [10,41,42], none of the included studies identified and addressed barriers to change when tailoring their interventions. Moreover, not knowing the particular barriers to change precludes proper identification of the factors that rendered an implementation strategy ineffective. And finally, yet rarely used, the use of theory may be another promising approach to change behaviour towards guideline use [43,44]. It may also be an explanation for the successful guideline implementation in one of the included studies, despite its short study period [31].

Conclusions

There are few studies which can inform practice in nursing homes on how to successfully implement guidelines. We identified four different multifaceted interventions targeting four different outcomes. The effects of the guideline implementation strategies included in this review are small to moderate, variable and concur with the body of evidence from other healthcare settings. The overall quality of the evidence was low or very low for all comparisons in this review. On that basis, it is not possible to recommend or discourage the use of a particular guideline implementation strategy. Rather, these findings illustrate an evidence gap. More implementation research is needed to ensure high quality of care in nursing homes.

Care providers in nursing homes and researchers should carefully identify and address barriers to change when designing their implementation strategies. Authors of future studies

are encouraged to focus on outcomes that directly reflect guideline adherence. The use of theory when implementing guidelines should be studied further.

Competing interests

The authors declare that they have no competing interests.

Author's Contributions

HD = Heinz Diehl, Bergen University College

BG = Birgitte Graverholt, Bergen University College

HL = Hans Lund, Bergen University College, University of Southern Denmark

[This section has to be revised before submitting for publication.]

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Figure 1 – Search and study retrieval process

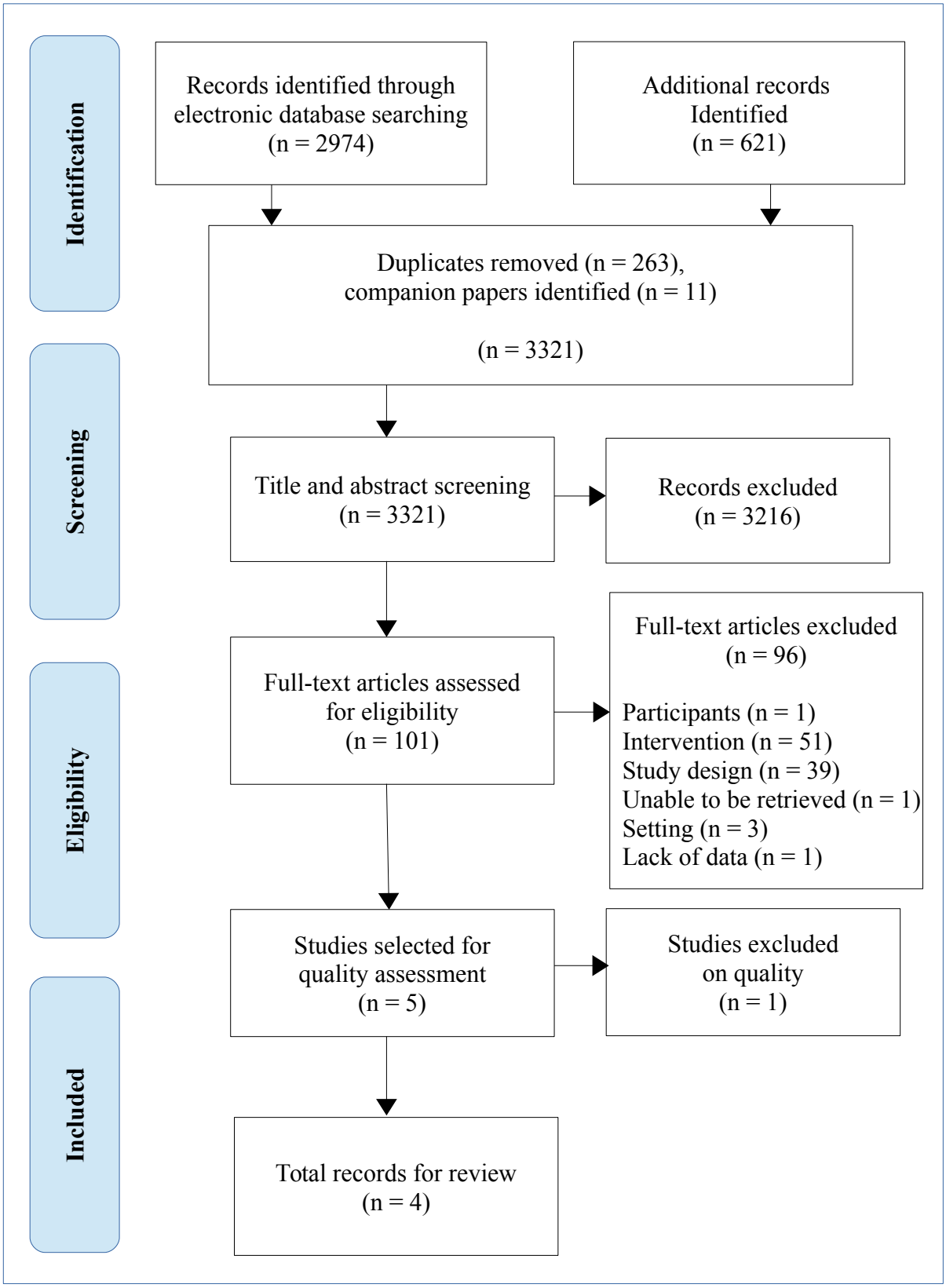

Table 1 – Characteristics of included studies

Study, nationality and design	Participating providers (Level of training)	Participating residents (Clusters, number)	Outcome (relevant for this systematic review)	Outcome measurement	Outcome measurement frequency/period	Length of post-intervention follow-up
DeVisschere et al. (2012), Belgium. Cluster-randomised controlled trial.	Nurses, nurse aids. Level of training not stated.	12 nursing homes (N = 297). Nursing home residents, mean age 84 years, high degree of physical disability and cognitive impairment.	Patient outcome:oral hygiene level of the participating residents: dental plaque, denture plaque, tongue plaque (primary outcomes).	Dental plaque: Silnes and Löe plaque index. Denture plaque: Augsburger and Elahi Methylene-blue test. Tongue plaque: Winkel tongue coating index. Tests carried out by trained external examiners.	Measured once after the 6 months intervention period.	-
Köpke et al. (2012), Germany. Cluster-randomised controlled trial.	Nurses with three years of vocational training, certified nurse assistants with 1 year vocational training, untrained nurse assistants.	36 nursing homes (N = 3670). Nursing home residents, mean age 85.5 years, high degree of physical disability and cognitive impairment.	Professional practice: the number of residents with physical restraints after 6 months (primary outcome). Restraint use at 3 months (secondary outcome).	Unannounced observation by blinded investigators on three different occasions during one day.	Measured after 3 and 6 months during the 6 months intervention period.	-
Van Gaal (2011a/b), Netherlands. Cluster-randomised controlled trial.	Nurses. Level of training not stated.	10 wards from 6 nursing homes (N = 392). Nursing home residents, mean age 78 years, half of them physically impaired. No cognitive impairment.	Patient outcome (Part I): Incidence of adverse events: pressure ulcer, urinary tract infections and falls (primary outcome). Professional practice (Part II): adequate care given to nursing home residents at risk of adverse events (secondary outcome).	Primary outcome: chart review and inspection of patient's skin by independent research assistants. Secondary outcome: chart review and patient observation by independent research assistants.	Primary outcomes: measured weekly during post-intervention follow up. Secondary outcomes: measured weekly during post-intervention follow-up. Three additional observational visits on every ward. No measurement during the 14 months intervention period.	9 months.
Ward et al. (2010), Australia. Cluster-randomised controlled trial.	Nursing home staff including physicians. Level of training not stated.	88 nursing homes (N = 5391). Nursing home residents, mean age 85.5 years, about 70% able to stand or walk with or without assistance, 21% received dementia-specific care.	Professional practice: use of vitamin D supplements, use of hip protectors (primary outcomes). Patient outcome: change in fall rates, residents with a fractured neck of femur (primary outcomes).	Chart review by nursing home staff.	Monthly during the 17 months intervention period.	-

Table 2 – Detailed description of interventions

Study	Objective(s) / Intervention	Target population	Comparator	KT activities	Facilitators and barriers	Frequency and duration
DeVisschere et al. (2012)	A supervised implementation of an oral healthcare guideline to improve the oral hygiene level of nursing home residents. Organizational: Conduction of one oral healthcare team per ward consisting of two oral healthcare organizers, a physician and either an occupational or speech therapist. Professional: 1.5 hours presentation of the guideline, the oral healthcare protocol and the study to the director of nursing. 2 hours theoretical and 1 hour practical education for the members of the oral healthcare team covering the guideline.1.5 hours training session for all ward nurses and nurse aids. Regularly bedside support of the oral healthcare organizers to ensure the delivery of the oral healthcare protocol and adherence to the guideline recommendations. Free oral healthcare products for all residents. Six-weekly meetings of the investigator, the project supervisor and the oral healthcare organizers to ensure implementation and to discuss problems.	Healthcare personnel, nursing home management.	Guideline dissemination[1]	Multifaceted: Clinical multidisciplinary teams, local consensus process, distribution of educational materials, education meetings, patient incentives.	Not prospectively identified.	Once in the beginning of the 6 months intervention period. Bedside-support and team meetings frequently over the 6 months intervention period.
Köpke et al. (2012)	A multifaceted guideline implementation based on the theory of planned behaviour to reduce physical restraint use. Professional: 90 min. information session for intervention nursing homes to sensitize nurses about the matter of physical restraints and the message of the guideline by addressing their attitudes and experiences. Provision of a short version of the guideline. Distribution of posters, pens, mugs and notepads with the intervention's logo. Flyers and brochures for relatives. Workshop for cluster-nurses on their role in the implementation process and in-depth information on avoiding physical restraints. A poster in the nursing homes foyer showing the contact nurses of the residents.	Healthcare personnel	Care as usual. Standard information provided: three brochures about the use of physical restraints and how to avoid them. A short presentation on physical restraints.	Multifaceted: Distribution of educational materials, education meetings, provision of promotional material.	Not prospectively identified.	Once in the beginning of the 6 months intervention period.

1 Not stated in the article. Information obtained via email from the corresponding author Luc De Visschere.

Study	Objective(s) / Intervention	Target population	Comparison	KT activities	Facilitators and barriers	Frequency and duration
Van Gaal et al. (2011a/b)	Implementation of the patient safety programme"SAFE or SORRY?" to reduce the incidence of pressure ulcers, urinary tract infections and falls and to improve preventive care for residents at risk of those. Professional: 1.5 hours small-scale education meetings on the wards for all nurses on the causes of pressure ulcers, urinary tract infections and falls, their prevention and on assessment of patients at risk. Two 30 min. case discussions on every ward on these topics. Distribution of a CD-ROM containing educational material and a knowledge test. Three separate information leaflets on the prevention of pressure ulcers, urinary tract infections and falls provided to residents at risk. Chart feedback on process and outcome indicators for the three adverse events using a computerized registration system.	Healthcare personnel.	Care as usual.	Multifaceted: Distribution of educational materials, education meetings, audit and feedback.	Not prospectively identified.	Once in the beginning of the 14 months intervention period. Chart feedback frequently over the 14 months intervention period.
Ward et al. (2010)	Employment of a project nurse to encourage the adoption of best-practice falls prevention strategies. Organizational: Employment of a project nurse to encourage the facilities in using guideline-based strategies in fall risk and mobility assessment, the use of hip protectors, vitamin D supplementation, continence management, exercise programs, the use of appropriate footwear, medication review and post-fall management review. Professional: Provision of information on the prevention of falls and fall injuries to the intervention nursing homes. An initial training session followed by three-monthly network meetings. Development of a resource set to promote fall prevention guidelines. Workshop on running exercise programs for the healthcare personnel of the intervention facilities.	Healthcare personnel.	Care as usual.	Multifaceted: Clinical multidisciplinary teams, distribution of educational materials, education meetings.	Not prospectively identified.	Once in the beginning of the 17 months intervention period. Three-monthly network meetings over the 17 months intervention period.

Table 3 – Risk of bias in included studies

First author / **Criteria**	De Visschere [30]	Köpke [31]	Van Gaal [32]	Van Gaal [33]	Ward [34]
Allocation sequence generation					
Allocation concealment					
Baseline outcome measurement					
Baseline characteristics					
Incomplete outcome data					
Blinded outcome assessment					
Protection against contamination					
Selective outcome reporting					
Other bias					
Overall risk of bias	Low	Low	High	High	High

Green = low risk of bias **Yellow = unclear risk of bias** **Red = high risk of bias**

Additional file 1 – Search strategy

Search strategy: CINAHL (EBSCOhost)
Timespan: 1984 – May 2014
Search date: 21.05.2014
Hits: 214

S1	(MH "Nursing Homes+")
S2	TI (nursing W0 (home# or facilit*")) or AB (nursing W0 (home# or facilit*"))
S3	TI (intermediate or long-term or longterm) W0 ("care facilit*") or AB (intermediate or long-term or longterm) W0 ("care facilit*")
S4	TI (("aged care" or "skilled nursing") W0 facilit*) or AB (("aged care" or "skilled nursing") W0 facilit*)
S5	TI ("home# for the aged" or "home# for the elderly") or AB ("home# for the aged" or "home# for the elderly")
S6	S1 OR S2 OR S3 OR S4 OR S5
S7	(MH "Practice Guidelines")
S8	(MH "Guideline Adherence")
S9	(MH "Professional Compliance")
S10	TI ((guideline# or protocol) N2 (implementation or dissemination or uptake or diffusion or adherence or compliance)) or AB ((guideline# or protocol) N2 (implementation or dissemination or uptake or diffusion or adherence or compliance))
S11	(MH "Professional Practice, Evidence-Based+")
S12	TI ("evidence based") W0 (practice or nursing or medicine) or AB ("evidence based") W0 (practice or nursing or medicine)
S13	TI (evidence N2 uptake) or AB (evidence N2 uptake)
S14	(MH "Selective Dissemination of Information")
S15	TI (information or "best practice" or guideline# or research) N2 (dissemination or utili?ation) or AB (information or "best practice" or guideline# or research) N2 (dissemination or utili?ation)
S16	TI "effective dissemination#" or AB "effective dissemination#"
S17	TI (applied W0 (dissemination or "health research")) or AB (applied W0 (dissemination or "health research"))
S18	(MH "Diffusion of Innovation")
S19	TI (innovation N2 (adaptation or adoption or diffusion)) or AB (innovation N2 (adaptation or adoption or diffusion))
S20	TI "best practice#" or AB "best practice#"
S21	TI "capacity building" or AB "capacity building"
S22	TI (change N2 implementation#) or AB (change N2 implementation#)

S23	TI ((changing W0 (provider or physician or doctor)) W0 behavio#r) or AB ((changing W0 (provider or physician or doctor)) W0 behavio#r)
S24	TI "collaborative development" or AB "collaborative development"
S25	TI (complex W0 (intervention# or science# or study or studies)) or AB (complex W0 (intervention# or science# or study or studies))
S26	TI ((continuing W0 (medical or nursing or dental)) W0 education#) or AB ((continuing W0 (medical or nursing or dental)) W0 education#)
S27	TI "crossing the quality chasm" or AB "crossing the quality chasm"
S28	TI ((effectiveness or evaluation) W0 research*) or AB ((effectiveness or evaluation) W0 research*)
S29	TI (gap N2 (analysis or evidence or practice)) or AB (gap N2 (analysis or evidence or practice))
S30	TI (audit N2 feedback) or AB (audit N2 feedback)
S31	TI ((getting W0 (knowledge or research)) W0 "into practice") or AB ((getting W0 (knowledge or research)) W0 "into practice")
S32	TI "GRIP" or AB "GRIP"
S33	TI "know-do" or AB "know-do"
S34	TI (knowledge N2 (adoption or brokering or communication or cycle# or developement or application or diffusion or dissemination or exchange or management or mobili?ation or synthesis or transfer or transformation or translation or uptake or utili?ation)) or AB (knowledge N2 (adoption or brokering or communication or cycle# or developement or application or diffusion or dissemination or exchange or management or mobili?ation or synthesis or transfer or transformation or translation or uptake or utili?ation))
S35	TI "knowledge to action" or AB "knowledge to action"
S36	TI "KSTE" or AB "KSTE"
S37	TI ("linkage and exchange") or AB ("linkage and exchange")
S38	TI "opinion leader#" or AB "opinion leader#"
S39	TI (patient W0 (education or safety)) or AB (patient W0 (education or safety))
S40	TI "populari?ation of research" or AB "populari?ation of research"
S41	TI "professional behavio#r change" or AB "professional behavio#r change"
S42	TI (quality W0 (assurance or improv*)) or AB (quality W0 (assurance or improv*))
S43	TI (research N2 (capacity or implementation or mediation or transfer or translation or utili?ation)) or AB (research N2 (capacity or implementation or mediation or transfer or translation or utili?ation))
S44	TI ("research into" W0 (action or practice)) or AB ("research into" W0 (action or practice))
S45	TI "science communication" or AB "science communication"
S46	TI (quality N2 improvement) or AB (quality N2 improvement)
S47	TI ((technology or technologies) N2 transfer) or AB ((technology or technologies) N2 transfer)
S48	TI ((translat* or turning) W0 research) or AB ((translat* or turning) W0 research)

S49	TI "TRIP" or AB "TRIP"
S50	TI "translational science" or AB "translational science"
S51	TI (third W0 (mission or wave)) or AB (third W0 (mission or wave))
S52	S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36 OR S37 OR S38 OR S39 OR S40 OR S41 OR S42 OR S43 OR S44 OR S45 OR S46 OR S47 OR S48 OR S49 OR S50 OR S51
S53	S6 AND S52
S54	PT clinical trial
S55	PT research
S56	(MH "Randomized Controlled Trials")
S57	(MH "Clinical Trials")
S58	(MH "Intervention Trials")
S59	(MH "Nonrandomized Trials")
S60	(MH "Experimental Studies")
S61	(MH "Pretest-Posttest Design+")
S62	(MH "Quasi-Experimental Studies+")
S63	(MH "Multicenter Studies")
S64	(MH "Health Services Research")
S65	TI (randomis* or randomiz* or random* W0 allocat*) OR AB (randomis* or randomiz* or random* W0 allocat*)
S66	TI ((intervention* or controlled or control W0 group* or compare or compared or before N5 after or pre N5 post or pretest or "pre test" or posttest or "post test" or quasiexperiment* or quasi W0 experiment* or evaluat* or effect or impact or "time series" or time W0 point* or repeated W0 measur*)) OR AB ((intervention* or controlled or control W0 group* or compare or compared or before N5 after or pre N5 post or pretest or "pre test" or posttest or "post test" or quasiexperiment* or quasi W0 experiment* or evaluat* or effect or impact or "time series" or time W0 point* or repeated W0 measur*))
S67	TX meta-analysis
S68	PT review
S69	PT systematic review
S70	S54 OR S55 OR S56 OR S57 OR S58 OR S59 OR S60 OR S61 OR S62 OR S63 OR S64 OR S65 OR S66 OR S67 OR S68 OR S69
S71	S53 AND S70 Limiters - Exclude MEDLINE records

Search strategy: ClinicalTrials
Timespan: All years
Search date: 21.05.2014
Hits: 28

(nursing home OR intermediate care facility OR long term care facility OR skilled nursing facility OR home for the aged) AND (guideline (implementation OR dissemination OR uptake OR diffusion OR adherence OR translation))

Search strategy: Cochrane Database of Systematic Reviews (CDSR), Cochrane Central Register of Controlled Trials (CENTRAL)
Timespan: All years
Search date: 21.05.2014
Hits: 209

#1 MeSH descriptor: [Nursing Homes] explode all trees
#2 (nursing next (home? or facilit*)):ti,ab,kw
#3 ((intermediate or long-term or longterm) next "care facilit*"):ti,ab,kw
#4 ((aged-care or "aged care" or skilled-nursing or "skilled nursing") next facilit*):ti,ab,kw
#5 MeSH descriptor: [Homes for the Aged] explode all trees
#6 ("home? for the aged" or "home? for the elderly"):ti,ab,kw
#7 #1 or #2 or #3 or #4 or #5 or #6
#8 MeSH descriptor: [Guideline] explode all trees
#9 MeSH descriptor: [Guidelines as Topic] explode all trees
#10 MeSH descriptor: [Guideline Adherence] explode all trees
#11 (guideline near/2 (implementation or dissemination or uptake or diffusion or adherence)):ti,ab,kw
#12 MeSH descriptor: [Evidence-Based Practice] explode all trees
#13 MeSH descriptor: [Evidence-Based Nursing] explode all trees
#14 MeSH descriptor: [Evidence-Based Medicine] explode all trees
#15 (("evidence based" or "evidence based") next (nursing or medicine or practice)):ti,ab,kw
#16 (evidence near/2 uptake):ti,ab,kw
#17 MeSH descriptor: [Information Dissemination] explode all trees
#18 ((information or "best practice" or guideline? or research) near/2 (dissemination or utili?ation)):ti,ab,kw

#19 "effective dissemination":ti,ab,kw

#20 (applied next (dissemination or "health research")):ti,ab,kw

#21 MeSH descriptor: [Diffusion of Innovation] explode all trees

#22 (innovation near/2 (adaptation or adoption or diffusion)):ti,ab,kw

#23 "best practice?":ti,ab,kw

#24 "capacity building":ti,ab,kw

#25 (change near/2 implementation?):ti,ab,kw

#26 (changing next ((provider or physician or doctor) next behavio?r))

#27 "collaborative development":ti,ab,kw

#28 (complex next (intervention? or science? or study or studies)):ti,ab,kw

#29 (continuing next ((medical or nursing or dental) next education*)):ti,ab,kw

#30 "crossing the quality chasm":ti,ab,kw

#31 ((effectiveness or evaluation) next research*):ti,ab,kw

#32 (gap near/2 (analysis or evidence or practice)):ti,ab,kw

#33 (audit near/2 feedback):ti,ab,kw

#34 (getting next (knowledge or research) next "into practice"):ti,ab,kw

#35 GRIP:ti,ab,kw

#36 know-do:ti,ab,kw

#37 (Knowledge near/2 (adoption or brokering or communication or cycle? or developement or application or diffusion or dissemination or exchange or management or mobili?ation or synthesis or transfer or transformation or translation or uptake or utili?ation)):ti,ab,kw

#38 "knowledge to action":ti,ab,kw

#39 KSTE:ti,ab,kw

#40 "linkage and exchange":ti,ab,kw

#41 "opinion leader?":ti,ab,kw

#42 (patient next (education or safety)):ti,ab,kw

#43 "populari?ation of research":ti,ab,kw

#44 "professional behavio?r change":ti,ab,kw

#45 (quality near/2 (assurance or improv*)):ti,ab,kw

#46 (research near/2 (capacity or implementation or mediation or transfer or translation or utili?ation)):ti,ab,kw

#47 "research into (action or practice)":ti,ab,kw

#48 "science communication":ti,ab,kw

#49 (quality near/2 improvement?):ti,ab,kw

#50 ((technology or technologies) near/2 transfer):ti,ab,kw

#51 ((translat* or turning) next research):ti,ab,kw

#52 TRIP:ti,ab,kw

#53 "translational science":ti,ab,kw

#54 (third next (mission or wave)):ti,ab,kw

#55 #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30 or #31 or #32 or #33 or #34 or #35 or #36 or #37 or #38 or #39 or #40 or #41 or #42 or #43 or #44 or #45 or #46 or #47 or #48 or #49 or #50 or #51 or #52 or #53 or #54

#56 #7 and #55

Search strategy: Database of Abstracts of Reviews of Effects (DARE), Health Assessment Database (HTA)
Timespan: All years
Search date: 21.05.2014
Hits: 15

1. MeSH DESCRIPTOR Nursing Homes EXPLODE ALL TREES
2. (“intermediate care” OR “long term care”): TI IN DARE, HTA
3. (“aged care facilit*” OR “skilled nursing facilit*”): TI IN DARE, HTA
4. MeSH DESCRIPTOR Homes for the Aged EXPLODE ALL TREES
5. (“home* for the aged” OR “home* for the elderly”): TI IN DARE, HTA
6. #1 OR #2 OR #3 OR #4 OR #5
7. MeSH DESCRIPTOR Guideline EXPLODE ALL TREES
8. MeSH DESCRIPTOR Guidelines as Topic EXPLODE ALL TREES
9. MeSH DESCRIPTOR Guideline Adherence EXPLODE ALL TREES
10. (implementation OR dissemination OR uptake OR diffusion OR adherence OR translation): TI IN DARE, HTA
11. MeSH DESCRIPTOR Evidence-Based Practice EXPLODE ALL TREES
12. MeSH DESCRIPTOR Evidence-Based Nursing EXPLODE ALL TREES
13. MeSH DESCRIPTOR Evidence-Based Medicine EXPLODE ALL TREES
14. (“evidence based”): TI IN DARE, HTA
15. MeSH DESCRIPTOR Information Dissemination EXPLODE ALL TREES
16. MeSH DESCRIPTOR Diffusion of Innovation EXPLODE ALL TREES
17. #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16
18. #6 AND #17

Search strategy: Embase (Ovid)
Timespan: 1974 – May 2014
Search date: 21.05.2014
Hits: 311

1. exp nursing home/
2. (nursing adj (home? or facilit*)).tw.
3. ((intermediate or long-term or longterm) adj care facilit*).tw.
4. ((aged-care or skilled-nursing) adj facilit*).tw.
5. exp home for the aged/
6. (home? for the aged or home? for the elderly).tw.
7. 1 or 2 or 3 or 4 or 5 or 6
8. exp practice guideline/
9. exp protocol compliance/
10. ((guideline? or protocol) adj2 (implementation or dissemination or uptake or diffusion or adherence or compliance)).tw.
11. exp evidence based practice/
12. exp evidence based medicine/
13. (evidence-based adj (nursing or medicine or practice)).tw.
14. (evidence adj2 uptake).tw.
15. exp information dissemination/
16. ((information or "best practice" or guideline? or research) adj2 (dissemination or utili? ation)).tw.
17. "effective dissemination?".tw.
18. (applied adj (dissemination or health research)).tw.
19. (innovation adj2 (adaptation or adoption or diffusion)).tw.
20. "best practice?".tw.
21. "capacity building".tw.
22. (change adj2 implementation?).tw.
23. (changing adj ((provider or physician or doctor) adj behavio?r)).tw.
24. "collaborative development".tw.
25. (complex adj (intervention? or science? or study or studies)).tw.
26. (continuing adj ((medical or nursing or dental) adj education*)).tw.
27. "crossing the quality chasm".tw.
28. ((effectiveness or evaluation) adj research*).tw.

29. (gap adj2 (analysis or evidence or practice)).tw.
30. (audit adj2 feedback).tw.
31. (getting adj (knowledge or research) adj into practice).tw.
32. GRIP.tw.
33. know-do.tw.
34. (Knowledge adj2 (adoption or brokering or communication or cycle? or developement or application or diffusion or dissemination or exchange or management or mobili?ation or synthesis or transfer or transformation or translation or uptake or utili?ation)).tw.
35. "knowledge to action".tw.
36. KSTE.tw.
37. "linkage and exchange".tw.
38. "opinion leader?".tw.
39. (patient adj (education or safety)).tw.
40. "populari?ation of research".tw.
41. "professional behavio?r change".tw.
42. (quality adj2 (assurance or improv*)).tw.
43. (research adj2 (capacity or implementation or mediation or transfer or translation or utili?ation)).tw.
44. "research into (action or practice)".tw.
45. "science communication".tw.
46. (quality adj2 improvement?).tw.
47. ((technology or technologies) adj2 transfer).tw.
48. ((translat* or turning) adj research).tw.
49. TRIP.tw.
50. "translational science".tw.
51. (third adj (mission or wave)).tw.
52. 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51
53. 7 and 52
54. Randomized Controlled Trial/
55. Controlled Clinical Trial/
56. Quasi Experimental Study/
57. Pretest Posttest Control Group Design/

58. Time Series Analysis/
59. Experimental Design/
60. Multicenter Study/
61. (randomis* or randomiz* or randomly or random allocat*).ti,ab.
62. groups.ab.
63. (trial or multicentre or multicenter or multi centre or multi center).ti.
64. (intervention* or controlled or control group or compare or compared or (before adj5 after) or (pre adj5 post) or pretest or pre test or posttest or post test or quasiexperiment* or quasi experiment* or evaluat* or effect or impact or time series or time point? or repeated measur*).ti,ab.
65. or/54-64
66. Nonhuman/
67. 65 not 66
68. meta-analy:.mp.
69. search:.tw.
70. review.pt.
71. or/68-70
72. 67 or 71
73. 53 and 72
74. limit 73 to exclude medline journals

Search strategy: ISI Web of Science
Timespan: All years
Search date: 21.05.2014
Hits: 355

#1 **TOPIC:** ("nursing home" or "nursing homes" or "nursing facilit*")

#2 **TOPIC:** ("intermediate care facilit*" or "long-term care facilit*" or "longterm care facilit*")

#3 **TOPIC:** ("aged-care facilit*" or "skilled-nursing facilit*")

#4 **TOPIC:** ("home for the aged" or "homes for the aged")

#5 **TOPIC:** ("home for the elderly" or "homes for the elderly")

#6 #1 OR #2 OR #3 OR #4 OR #5

#7 **TOPIC:** (guideline$)

#8 **TOPIC:** ("evidence-based practice" or "evidence-based nursing" or "evidence-based medicine")

#9 **TOPIC:** (evidence NEAR/2 uptake)

#10 **TOPIC:** ((information or "best practice" or guideline$ or research) NEAR/2 (dissemination or utili?ation))

#11 **TOPIC:** ("effective dissemination")

#12 **TOPIC:** ("applied dissemination" or "applied health research")

#13 **TOPIC:** (innovation NEAR/2 (adaptation or adoption or diffusion))

#14 **TOPIC:** ("best practice" or "best practices")

#15 **TOPIC:** ("capacity building")

#16 **TOPIC:** (change NEAR/2 implementation)

#17 **TOPIC:** ("changing provider behavior" or "changing physician behavior" or "changing doctor behavior")

#18 **TOPIC:** ("changing provider behaviour" or "changing physician behaviour" or "changing doctor behaviour")

#19 **TOPIC:** ("collaborative development")

#20 **TOPIC:** ("complex intervention" or "complex interventions" or "complex science" or "complex sciences" or "complex study" or "complex studies")

#21 **TOPIC:** ("continuing medical education" or "continuing nursing education" or "continuing dental education")

#22 **TOPIC:** ("crossing the quality chasm")

#23 **TOPIC:** ("effectiveness research" or "evaluation research")

#24 **TOPIC:** (gap NEAR/2 (analysis or evidence or practice))

#25 **TOPIC:** (audit NEAR/2 feedback)

#26 **TOPIC:** ("getting knowledge into practice" or "getting research into practice")

#27 **TOPIC:** (GRIP)

#28 **TOPIC:** ("know-do")

#29 **TOPIC:** (knowledge NEAR/2 (adoption or brokering or communication or cycle$ or developement or application or diffusion or dissemination or exchange or management or mobili?ation or synthesis or transfer or transformation or translation or uptake or utili?ation))

#30 **TOPIC:** ("knowledge to action")

#31 **TOPIC:** (KSTE)

#32 **TOPIC:** ("linkage and exchange")

#33 **TOPIC:** ("opinion leader" or "opinion leaders")

#34 **TOPIC:** ("patient education" or "patient safety")

#35 **TOPIC:** ("populari?ation of research")

#36 **TOPIC:** ("professional behavior change" or "professional behaviour change")

#37 **TOPIC:** (quality NEAR/2 (assurance or improv*))

#38 **TOPIC:** (research NEAR/2 (capacity or implementation or mediation or transfer or translation or utili?ation))

#39 **TOPIC:** ("research into action" or "research into practice")

#40 **TOPIC:** ("science communication")

#41 **TOPIC:** (quality NEAR/2 improvement)

#42 **TOPIC:** ((technology or technologies) NEAR/2 transfer)

#43 **TOPIC:** ("translat* research" or "turning research")

#44 **TOPIC:** (TRIP)

#45 **TOPIC:** ("translational science")

#46 **TOPIC:** ("third mission" or "third wave")

#47 #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 OR #35 OR #36 OR #37 OR #38 OR #39 OR #40 OR #41 OR #42 OR #43 OR #44 OR #45 OR #46

#48 #6 AND #47

#49 **TOPIC:** ((random* or “control* trial*” or intervention* or experiment* or “time series” or “pre test” or pretest or “post test” or posttest or impact* or chang* or evaluat* or effect* or comparat*))

#50 **TOPIC:** (review)

#51 **TOPIC:** ("meta-analysis")

#52 **TOPIC:** (search)

#53 #50 OR #51 OR #52

#54 #49 OR #53

#55 #48 AND #54 Refined by: [excluding] Databases=(MEDLINE)

Search strategy: MEDLINE ® In-Process & Other Non-Indexed Citations and Ovid MEDLINE ®
Timespan: 1946 – May 2014
Search date: 21.05.2014
Hits: 1781

1. exp Nursing Homes/
2. (nursing adj (home? or facilit*)).tw.
3. ((intermediate or long-term or longterm) adj care facilit*).tw.
4. ((aged-care or skilled-nursing) adj facilit*).tw.
5. exp Homes for the Aged/
6. (home? for the aged or home? for the elderly).tw.
7. or/1-6
8. exp Guideline/
9. exp Guidelines as Topic/
10. exp Guideline Adherence/
11. ((guideline? or protocol) adj2 (implementation or dissemination or uptake or diffusion or adherence or compliance)).tw.
12. exp Evidence-Based Practice/
13. exp Evidence-Based Nursing/
14. exp Evidence-based Medicine/
15. (evidence-based adj (nursing or medicine or practice)).tw.
16. (evidence adj2 uptake).tw.
17. exp Information Dissemination/
18. ((information or "best practice" or guideline? or research) adj2 (dissemination or utili? ation)).tw.
19. "effective dissemination?".tw.
20. (applied adj (dissemination or health research)).tw.
21. exp Diffusion of Innovation/
22. (innovation adj2 (adaptation or adoption or diffusion)).tw.
23. "best practice?".tw.
24. "capacity building".tw.
25. (change adj2 implementation?).tw.
26. (changing adj ((provider or physician or doctor) adj behavio?r)).tw.
27. "collaborative development".tw.

28. (complex adj (intervention? or science? or study or studies)).tw.
29. (continuing adj ((medical or nursing or dental) adj education*)).tw.
30. "crossing the quality chasm".tw.
31. ((effectiveness or evaluation) adj research*).tw.
32. (gap adj2 (analysis or evidence or practice)).tw.
33. (audit adj2 feedback).tw.
34. (getting adj (knowledge or research) adj into practice).tw.
35. GRIP.tw.
36. know-do.tw.
37. (Knowledge adj2 (adoption or brokering or communication or cycle? or developement or application or diffusion or dissemination or exchange or management or mobili?ation or synthesis or transfer or transformation or translation or uptake or utili?ation)).tw.
38. "knowledge to action".tw.
39. KSTE.tw.
40. "linkage and exchange".tw.
41. "opinion leader?".tw.
42. (patient adj (education or safety)).tw.
43. "populari?ation of research".tw.
44. "professional behavio?r change".tw.
45. (quality adj2 (assurance or improv*)).tw.
46. (research adj2 (capacity or implementation or mediation or transfer or translation or utili?ation)).tw.
47. "research into (action or practice)".tw.
48. "science communication".tw.
49. (quality adj2 improvement?).tw.
50. ((technology or technologies) adj2 transfer).tw.
51. ((translat* or turning) adj research).tw.
52. TRIP.tw.
53. "translational science".tw.
54. (third adj (mission or wave)).tw.
55. or/8-54
56. 7 and 55
57. randomized controlled trial.pt.
58. controlled clinical trial.pt.

59. multicenter study.pt.
60. (randomis* or randomiz* or randomly allocat* or random allocat*).ti,ab.
61. groups.ab.
62. (trial or multicenter or multi center or multicentre or multi centre).ti.
63. (intervention* or controlled or control group or compare or compared or (before adj5 after) or (pre adj5 post) or pretest or pre test or posttest or post test or quasiexperiment* or quasi experiment* or evaluat* or effect or impact or time series or time point? or repeated measur*).ti,ab.
64. or/57-63
65. exp Animals/
66. Humans/
67. 65 not (65 and 66)
68. 64 not 67
69. review.ab.
70. review.pt.
71. meta-analysis.ab.
72. meta-analysis.pt.
73. meta-analysis.ti.
74. or/69-73
75. letter.pt.
76. comment.pt.
77. editorial.pt.
78. or/75-77
79. 74 not 78
80. 68 or 79
81. 56 and 80

Search strategy: OpenGrey
Timespan: All years
Search date: 21.05.2014
Hits: 5

(nursing home OR intermediate care facility OR long term care facility OR skilled nursing facility OR home for the aged) AND (implementation OR dissemination OR uptake OR diffusion OR adherence OR translation)

Search strategy: PROSPERO
Timespan: All years
Search date: 21.05.2014
Hits: 10

nursing home OR intermediate care facility OR long term care facility OR skilled nursing facility OR home for the aged

Search strategy: SveMed+
Timespan: All years
Search date: 21.05.2014
Hits: 46

1	exp:"nursing homes"
2	"nursing home" OR "nursing facility"
3	"intermediate care facility" OR "long term care facility
4	"aged care facility" OR "skilled nursing facility"
5	exp:"homes for the aged"
6	"home for the aged" OR "home for the elderly"
7	#1 OR #2 OR #3 OR #4 OR #5 OR #6
8	exp:"Guidelines as Topic"
9	exp:"Guideline Adherence"
10	implementation OR dissemination OR uptake OR diffusion OR adherence OR translation
11	exp:"Evidence-Based Practice"
12	exp:"Evidence-Based Nursing"
13	exp:"Evidence-Based Medicine"
14	"evidence based"
15	exp:"Information Dissemination"
16	exp:"Diffusion of Innovation"
17	#8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16
18	#7 AND #17

Additional file 2 – Data abstraction form

DATA ABSTRACTION FORM

Data collection

Name of reviewer: **Date:** **Study ID:** **Study reference:**

Objective(s):

Scope: The effect(s) of a professional, organisational, financial or regulatory intervention(s) to implement guidelines in nursing homes is evaluated.	☐

1. INCLUSION CRITERIA

1.1 Study design

Cluster-randomised controlled trial	☐
Randomised controlled trial	☐
Controlled before-after design	☐
Interrupted-time-series design	☐
Clearly defined entry point in time when the intervention occurred	☐
At least three data points before and three after the intervention	☐

1.2 Participants

Healthcare personnel working in a nursing home	☐

1.3 Intervention(s)

Professional ☐	**Organisational** ☐	**Financial** ☐	**Regulatory** ☐
Intervention clearly stated ☐			
Based upon implementation of clinical practice guideline(s) ☐			
Clinical practice guideline(s) Based on a review of the literature ☐ Recommendations tied to the identified evidence ☐ Publicly available ☐			

1.4 Control intervention(s)

Professional ☐	**Organisational** ☐	**Financial** ☐	**Regulatory** ☐
Care as usual ☐			
Other (specify):			

1.5 Outcome(s)

The objective measurement of performance / provider behaviour or health / patient outcomes ☐
Relevant and interpretable data presented or obtainable ☐

2. INTERVENTIONS

2.1 Type of intervention (state all interventions for each comparison / study group)

2.2 Control(s)

3. TYPE OF TARGETED BEHAVIOUR (state more than one where appropriate)

4. PARTICIPANTS

4.1 Characteristics of participating providers

Profession:
Level of vocational training:

4.2 Characteristics of participating residents

4.2.1 Other resident characteristics

Age:
Gender:
Ethnicity:
Other (specify):

4.2.2 Number of residents included in the study

Episodes of care:
Residents:
Providers:
Communities or regions:

5. SETTING

Location of care:
Country:
Proportion of eligible providers or allocation units:

6. METHODS

Unit of allocation:
Unit of analysis:
Power calculation:

7. PROSPECTIVE IDENTIFICATION OF BARRIERS TO CHANGE

8. INTERVENTION

8.1 Characteristics of the intervention

Evidence base of recommendation:			
Purpose of recommendations:			
Single intervention	☐	**Multifaceted intervention**	☐

8.2 Timing

Frequency / number of intervention events:
Duration of intervention:

9. OUTCOMES

9.1 Description of the main outcome measure(s)

Health professional outcomes / process measures:
Patient outcomes:

9.2 Length of time

Length of time during which outcomes were measured after initiation of the intervention:
Length of post-intervention follow-up:

9.3 Identify a possible ceiling effect

Identified by investigator	☐
Identified by reviewer	☐

10. RESULTS (use extra page if necessary)

10.1.1 For (cluster-)randomised controlled trials

10.1.2 For controlled before-after studies

10.1.3 For interrupted-time-series studies

Additional file 3 - Table of excluded studies

Study reference	Reason for exclusion
Beeckman D, Clays E, Van Hecke A, Vanderwee K, Schoonhoven L, Verhaeghe S: **A multi-faceted tailored strategy to implement an electronic clinical decision support system for pressure ulcer prevention in nursing homes: a two-armed randomized controlled trial.** *Int J Nurs Stud* 2013, **50**:475–86.	Self-developed computerised decision support system (PrevPlan), guidelines used not stated.
Chami K, Gavazzi G, Bar-Hen A, Carrat F, de Wazieres B, Lejeune B, Armand N, Rainfray M, Hajjar J, Piette F, Tondeur MR: **A short-term, multicomponent infection control program in nursing homes: a cluster randomized controlled trial.** *J Am Med Dir Assoc* 2012, **13**:569.e9–17.	Guideline based on a Delphi consensus survey. No review of the literature.
Colón-Emeric CS, Lyles KW, House P, Levine DA, Schenck AP, Allison J, Gorospe J, Fermazin M, Oliver K, Curtis JR, others: **Randomized trial to improve fracture prevention in nursing home residents**. *Am J Med* 2007, **120**:886–892.	Excluded after risk of bias assessment due to severe attrition bias.
Crotty M, Whitehead C, Rowett D, Halbert J, Weller D, Finucane P, Esterman A: **An outreach intervention to implement evidence based practice in residential care: a randomized controlled trial [ISRCTN67855475].** *BMC Health Serv Res* 2004, **4**:6.	Intervention only partially guideline based, guideline not available. Both high-level (nursing homes) and low-level care (hostels), no separate outcomes reported.
Dharmarajan TS, Nanda A, Agarwal B, Agnihotri P, Doxsie GL, Gokula M, Javaheri A, Kanagala M, Lebelt AS, Madireddy P, Mahapatra S, Murakonda P, Muthavarapu SRR, Patel M, Patterson C, Soch K, Troncales A, Yaokim K, Kroft R, Norkus EP: **Prevention of venous thromboembolism in long term care: results of a multicenter educational intervention using clinical practice guidelines: part 2 of 2 (an AMDA Foundation project).** *J Am Med Dir Assoc* 2012, **13**:303–7.	Intervention not described.
Ersek M, Polissar N, Pen AD, Jablonski A, Herr K, Neradilek MB: **Addressing methodological challenges in implementing the nursing home pain management algorithm randomized controlled trial.** *Clin Trials Lond Engl* 2012, **9**:634–44.	Missing outcome data.
Gopal Rao G, Jeanes A, Russell H, Wilson D, Atere-Roberts E, O'Sullivan D, Donaldson N: **Effectiveness of short-term, enhanced, infection control support in improving compliance with infection control guidelines and practice in nursing homes: a cluster randomized trial.** *Epidemiol Infect* 2009, **137**:1465–71.	Guidelines used not stated and not in reference list.
Gotoh M, Yoshikawa Y, Ono Y, Ohshima S: **Effectiveness of the introduction of a guideline for urinary management in the elderly at nursing homes**. *J Urol* 2005, **173**:4–4.	Article unable to be retrieved.
Hutt E, Ruscin JM, Corbett K, Radcliff TA, Kramer AM, Williams EM, Liebrecht D, Klenke W, Hartmann S: **A multifaceted intervention to implement guidelines improved treatment of nursing home-acquired pneumonia in a state veterans home.** *J Am Geriatr Soc* 2006, **54**:1694–700.	Guideline not based on a review of the literature.

Study reference	Reason for exclusion
Hutt E, Ruscin JM, Linnebur SA, Fish DN, Oman KS, Fink RM, Radcliff TA, Van Dorsten B, Liebrecht D, Fish R, McNulty MC: **A multifaceted intervention to implement guidelines did not affect hospitalization rates for nursing home-acquired pneumonia.** *J Am Med Dir Assoc* 2011, **12**:499–507.	Guideline not based on a review of the literature.
Jones K, Fink R, Vojir C, Pepper G, Hutt E, Clark L, Scott J, Martinez R, Vincent D, Mellis B: **Translation research in long-term care: improving pain management in nursing homes.** *Worldviews Evid Based Nurs* 2004, **1**:S13–20.	Participants healthcare personnel, family and residents. No separate analysis.
Naughton BJ, Mylotte JM, Ramadan F, Karuza J, Priore RL: **Antibiotic use, hospital admissions, and mortality before and after implementing guidelines for nursing home-acquired pneumonia.** *J Am Geriatr Soc* 2001, **49**:1020–4.	Guideline based on experience and community practice. No review of the literature.
Rapp MA, Mell T, Majic T, Treusch Y, Nordheim J, Niemann-Mirmehdi M, Gutzmann H, Heinz A: **Agitation in nursing home residents with dementia (VIDEANT trial): effects of a cluster-randomized, controlled, guideline implementation trial.** *J Am Med Dir Assoc* 2013, **14**:690–5.	Consensus guideline, not evidence-based.
Schmidt I, Claesson CB, Westerholm B, Nilsson LG, Svarstad BL: **The impact of regular multidisciplinary team interventions on psychotropic prescribing in Swedish nursing homes**. *J Am Geriatr Soc* 1998, **46**:77–82.	Not explicitely guideline-based. Guideline unable to be retrieved, not publically available.
Testad I, Aasland AM, Aarsland D: **The effect of staff training on the use of restraint in dementia: a single-blind randomised controlled trial.** *Int J Geriatr Psychiatry* 2005, **20**:587–90.	Intervention only partially guideline-based. Guideline not stated and not in reference list.
Verkaik R, Francke AL, van Meijel B, Spreeuwenberg PMM, Ribbe MW, Bensing JM: **The effects of a nursing guideline on depression in psychogeriatric nursing home residents with dementia.** *Int J Geriatr Psychiatry* 2011, **26**:723–32.	Guideline not based on a review of the literature, not based on current evidence.
Westbury J, Jackson S, Gee P, Peterson G: **An effective approach to decrease antipsychotic and benzodiazepine use in nursing homes: the RedUSe project.** *Int Psychogeriatr IPA* 2010, **22**:26–36.	Guidelines not based on a review of the literature, not based on current evidence.
Zimmerman S, Sloane PD, Bertrand R, Olsho LEW, Beeber A, Kistler C, Hadden L, Edwards A, Weber DJ, Mitchell CM: **Successfully reducing antibiotic prescribing in nursing homes.** *J Am Geriatr Soc* 2014, **62**:907–12.	Guideline not evidence-based, no review of the literature.

Additional file 4 – Summary of findings tables (professional practice)

Table S1

A multifaceted theory-based educational intervention compared to standard information for the implementation of best practices to reduce physical restraints

Patient or population: Healthcare personnel
Setting: Nursing homes in Germany
Intervention: A multifaceted theory-based educational intervention
Comparison: Usual care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (Studies)	Quality of the evidence (GRADE)	Comments
	Risk with standard information	Risk with a multifaceted theory-based educational intervention				
Residents with physical restraints. Assessed with: direct observation by external investigators. Follow up: 3 months	**Study population** 305 per 1000	**241 per 1000 (195 to 196)**	**RR 0.79** (0.64 to 0.97)	36 nursing homes, 3670 residents (1 Cluster-RCT)	⨁⨁◯◯ LOW [1,2]	P=0.025 Results corrected for cluster.
Residents with physical restraints. Assessed with: direct observation by external investigators Follow up: 6 months	**Study population** 291 per 1000	**227 per 1000 (181 to 283)**	**RR 0.78** (0.63 to 0.97)	36 nursing homes, 3664 residents (1 Cluster-RCT)	⨁⨁◯◯ LOW [1,2]	P=0.024 Results corrected for cluster.

1. Only one single study
2. Wide confidence interval

Table S2

The patient safety programme "SAFE OR SORRY?" compared to usual care for the implementation of pressure ulcer, urinary tract infection and falls best practice guidelines

Patient or population: Healthcare personnel
Setting: Nursing homes in Netherland
Intervention: The patient safety programme "SAFE OR SORRY?"
Comparison: Usual care

Outcomes	**Anticipated absolute effects*** (95% CI)		Relative effect (95% CI)	№ of participants (Studies)	Quality of the evidence (GRADE)	Comments
	Risk with usual care	**Risk with the patient safety programme "SAFE OR SORRY?"**				
Adequate care given to patients at risk for pressure ulcers Assessed with: chart review and patient observation by independent research assistants. Follow up: 9 months	**Study population** 128 per 1000	**204 per 1000 (120 to 351)**	**RR 1.60** (0.94 to 2.75)	10 wards from 6 nursing homes, 392 residents (1 Cluster-RCT)	⨁◯◯◯ VERY LOW [1][2][3][4]	P=0.084 Results corrected for cluster.
Adequate care given to patients at risk for urinary tract infections. Assessed with: chart review and patient observation by independent research assistants. Follow up: 9 months	**Study population** 408 per 1000	**445 per 1000 (367 to 539)**	**RR 1.09** (0.90 to 1.32)	10 wards from 6 nursing homes, 392 residents (1 Cluster-RCT)	⨁◯◯◯ VERY LOW [1][2][4]	P=0.37 Results corrected for cluster.
Adequate care given to patients at risk for falls. Assessed with: chart review and patient observation by independent research assistants. Follow up: 9 months	**Study population** Not estimable	Not estimable	Not estimable	10 wards from 6 nursing homes, 392 residents (1 Cluster-RCT)	⨁◯◯◯ VERY LOW [1][2][3][4]	1% or fewer events in both intervention and control groups. Percentages too low for statistical analysis.

1. Participants allocated after randomization, unclear risk of selection bias. Intervention and control wards within the same nursing home, high risk of contamination bias.
2. Only one single study with few events.
3. Wide confidence interval.
4. Small sample size.

Table S3

The employment of a project nurse compared to usual care for the implementation of falls best practice strategies

Patient or population: Healthcare personnel
Setting: Nursing homes in Australia
Intervention: The employment of a project nurse
Comparison: Usual care

Outcomes	**Anticipated absolute effects*** (95% CI)		Relative effect (95% CI)	№ of participants (Studies)	Quality of the evidence (GRADE)	Comments
	Risk with usual care	**Risk with the employment of a project nurse**				
The use of vitamin D supplements Assessed with: Monthly chart review by the nursing home staff. Follow up: 17 months	**Study population**		Not estimable	88 nursing homes, 5391 residents (1 Cluster-RCT)	⨁◯◯◯ VERY LOW [1][2][3]	Increase in the use of vitamin D supplements with mean slope of 2.0 supplements per 100 beds per month (P < 0.001) averaged over both groups. No difference between intervention and control group (P = 0.092). No confidence interval supplied. Results corrected for cluster.
	Not estimable	Not estimable				
The use of hip protectors Assessed with: Monthly chart review by the nursing home staff. Follow up: 17 months	**Study population**		Not estimable	88 nursing homes, 5391 residents (1 Cluster-RCT)	⨁◯◯◯ VERY LOW [1][2][3]	Small increase in the use of hip protectors in both groups: 0.29 per 100 beds per month (95% CI, 0.17 to 0.41; P < 0.001). No difference between intervention and control group (P > 0.05). Results corrected for cluster.
	Not estimable	Not estimable				

1. Contamination between intervention and control group, high risk of contamination bias. Unclear allocation concealment, possibility of selection bias. Self-reporting, high risk of detection bias.
2. Only one single study with few events.
3. Large confidence interval.

Additional file 5 – Summary of findings tables (patient outcome)

Table S4

Supervision by an oral health care team compared to guideline dissemination for the implementation of an oral health care guideline

Patient or population: Healthcare personnel
Setting: Nursing homes in Belgium
Intervention: Supervision by an oral health care team
Comparison: Guideline dissemination

Outcomes	**Anticipated absolute effects*** (95% CI)		Relative effect (95% CI)	№ of participants (Studies)	Quality of the evidence (GRADE)	Comments
	Risk with guideline dissemination	**Risk with supervision by an oral health care team**				
Tongue plaque level Assessed with: Oral examination by external investigators. Scale from: 0 to 12 Follow up: 6 months	The mean tongue plaque level in the control group was **3.66** plaque index score points.	The mean tongue plaque level in the intervention group was 0.07 lower (0.91 lower to 0.77 higher)	Not estimable.	12 nursing homes, 278 residents (1 Cluster-RCT)	⨁⨁◯◯ LOW [1,2]	P = 0.87 Results corrected for cluster and baseline differences.
Dental plaque level. Assessed with: Oral examination by external investigators. Scale from: 0 to 3 Follow up: 6 months	The mean dental plaque level. in the control group was **1.77** plaque index score points.	The mean dental plaque level. in the intervention group was 0.15 lower (0.45 lower to 0.14 higher)	Not estimable.	12 nursing homes, 97 residents (1 Cluster-RCT)	⨁⨁◯◯ LOW [1,2]	P = 0.32 Results corrected for cluster and baseline differences.
Denture plaque level. Assessed with: Oral examination by external investigators. Scale from: 0 to 4 Follow up: 6 months	The mean denture plaque level. in the control group was **2.37** plaque index score points.	The mean denture plaque level. in the intervention group was 0.32 lower (0.52 lower to 0.11 lower)	Not estimable.	12 nursing homes, 194 residents (1 Cluster-RCT)	⨁⨁◯◯ LOW [1,2]	P = 0.02 Results corrected for cluster and baseline differences.

1. Only one single study with few events
2. Small sample size

Table S5

The patient safety programme "SAFE OR SORRY?" compared to usual care for the implementation of pressure ulcer, urinary tract infection and falls best practice guidelines

Patient or population: Healthcare personnel
Setting: Nursing homes in Netherland
Intervention: The patient safety programme "SAFE OR SORRY?"
Comparison: Usual care

Outcomes	**Anticipated absolute effects*** (95% CI)		Relative effect (95% CI)	№ of participants (Studies)	Quality of the evidence (GRADE)	Comments
	Risk with usual care	**Risk with the patient safety programme "SAFE OR SORRY?"**				
Incidence of adverse events (pressure ulcer, urinary tract infections and falls). Assessed with: chart review and skin inspection by independent research assistants. Follow up: 9 months	**Study population**		**Rate ratio 0.67** (0.47 to 0.97)	10 wards from 6 nursing homes, 392 residents (1 Cluster-RCT)	⨁◯◯◯ VERY LOW [1][2][3][4]	P<0.05 Intervention group 174/2754, control group 272/3045 adverse events/patient weeks. Results corrected for cluster.
	Mean 0.07 events/patient week	**Mean 0.07 events/patient week**				

1. Participants allocated after randomization, unclear risk of selection bias. Intervention and control wards within the same nursing home, high risk of contamination bias.
2. Only one single study with few events.
3. Wide confidence interval.
4. Small sample size.

Table S6

The employment of a project nurse compared to usual care for the implementation of falls best practice strategies

Patient or population: Healthcare personnel
Setting: Nursing homes in Australia
Intervention: The employment of a project nurse
Comparison: Usual care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (Studies)	Quality of the evidence (GRADE)	Comments
	Risk with usual care	**Risk with the employment of a project nurse**				
Residents with at minimum one femoral neck fracture Assessed with: Monthly chart review by the nursing home staff. Follow up: 17 months	**Study population** 41 per 1000	**39 per 1000 (26 to 59)**	**RR 0.95** (0.63 to 1.43)	88 nursing homes, 5391 residents (1 Cluster-RCT)	⨁◯◯◯ VERY LOW [1][2][3]	P=0.79 Results corrected for cluster.

1. Contamination between intervention and control group, high risk of contamination bias. Unclear allocation concealment, possibility of selection bias. Self-reporting, high risk of detection bias.
2. Only one single study with few events.
3. Large confidence interval.

Additional file 6 – Risk of bias assessment

Study: Colon-Emeric et al., 2007 **Design:** Cluster-randomised controlled trial		
Domain	**Evaluation**	**Comments**
Was the allocation sequence adequately generated?	Low risk	Quote:"*The nursing homes were randomized within each state... using a random number generator."*
Was the allocation adequately concealed?	Low risk	Allocation by institution, performed on start of the study.
Were baseline outcome measurements similar?	High risk	Described in Table 2. Significantly higher prescription rate of vitamin D in the intervention group. Analysis not corrected. Prescription rates of Calcium and vitamin D ~ 70% in both groups. Ceiling effect.
Were baseline characteristics similar?	Low risk	Quote: "*Intervention residents were more likely to be African American, younger, and used tobacco; and less likely to have previous fracture or dysphagia."* Quote: "*..adjusting for baseline factors that were imbalanced, including bed size, age, race, sex, previous fracture, insurance status, ambulatory status, gastrointestinal reflux, breast and endometrial cancer, dysphagia, and tobacco use.* Comment: imbalance at baseline statistically corrected for.
Were incomplete outcome data adequately addressed?	High risk[1]	Quote: "*Participation in the intervention activities was low.."* Comment: 64-89% non-compliance in the intervention group (Table 3). Intention-to-treat not sufficient to correct for non-compliance this big. Groups no longer comparable. Quote: "*All randomized facilities were analysed regardless of their participation in the study.*" Not stated if all nursing homes delivered data or if and how many were lost to-follow-up. Unclear if the authors performed intention-to-treat analysis.
Was knowledge of the allocated interventions adequately prevented during the study?	Low risk	Quote: "*Trained data collectors, blinded to intervention status, abstracted data from the medical record before and after the intervention.*"

1 Study excluded because of severe attrition bias.

Domain	Evaluation	Comments
Was the study adequately protected against contamination?	Low risk	Quote: "*Cluster-randomized, single-blind, controlled trial of a multi-modal quality improvement intervention.*" Unlikely that the control group received the intervention.
Was the study free from selective outcome reporting?	Low risk	All outcomes from the methods section reported in Table 2.
Was the study free from other risks of bias?	Low risk	Quote: "*Analysis was at the facility-level and Generalized Estimating Equation modelling was used to account for clustering.*
Overall risk of bias: Study excluded		

Study: De Visschere et al. (2012) **Design:** Cluster-randomised controlled trial		
Domain	**Judgement**	**Support for judgement**
Was the allocation sequence adequately generated?	Unclear	Stratified cluster sampling with random allocation. No random component mentioned.
Was the allocation adequately concealed?	Low risk	Quote: "*A random sample of 12 nursing homes was randomly allocated to the intervention or the control group."* Comment: Allocation by institution and performed at the start of the study.
Were baseline outcome measurements similar?	Low risk	Quote: *"Baseline plaque levels similar in both groups. The outcome variables, tongue plaque, dental plaque and denture plaque were skewed both at baseline (T0) and at 6-month follow-up (T1). These differences have been adjusted for the corresponding baseline value of the variable as a covariate and the random effect of the institution."*
Were baseline characteristics similar?	Low risk	No significant difference in age, care-dependency, MMSE[2], co-morbidity, dental status and oral hygiene status. P = 0.05 for gender.
Were incomplete outcome data adequately addressed?	Low risk	Quote: *"No other differences were found between residents who completed the study and those who did not, indicating no evidence for a loss to follow-up effect."* Comment: All wards of the respective nursing homes involved.
Was knowledge of the allocated interventions adequately prevented during the study?	Low risk	Quote: *"The primary outcome variable was the oral hygiene level of the participating residents."* Quote: *"The examiners were masked."*
Was the study adequately protected against contamination?	Low risk	Allocation by institution. Unlikely that the control group received the intervention.
Was the study free from selective outcome reporting?	Low risk	All outcome measures are reported (tongue plaque, dental plaque, denture plaque).
Was the study free from other risks of bias?	Low risk	Accounted for clustering in the power calculation and data analysis.
Overall risk of bias: Low		

2 Mini-mental state examination.

Study: Köpke et al., 2012 **Design:** Cluster-randomised controlled trial		
Domain	**Judgement**	**Support for judgement**
Was the allocation sequence adequately generated?	Low risk	Quote: *"Computer-generated randomization lists were used for allocation of clusters in blocks of 4, 6, and 8 nursing homes."*
Was the allocation adequately concealed?	Low risk	Quote: *"Cluster randomized controlled trial. Allocation of clusters was performed by an external person not involved in the study."* Comment: Allocation blinded and by institution. All units allocated at the start of the study. Newly admitted residents were included after randomisation into the group the respective nursing home was assigned to and uninfluenced by the investigators. Therefore low risk of selection bias.
Were baseline outcome measurements similar?	Unclear risk	Residents with physical restraints / restraint use: Table 2. Psychotropic medicine prescriptions: Table 4. Falls and fall-related fractures: Table 1 (Characteristics!). Most probably no important differences. However, p-values are missing.
Were baseline characteristics similar?	Low risk	Stated in Table 1, similar.
Were incomplete outcome data adequately addressed?	Low risk	Quote: *"Analyses were by intention to treat; no participants or clusters changed groups and no cluster dropped out during follow-up."* Comment: However, there was drop-out of individual participants, which was distributed similar between both groups. All drop-outs due to death or movement.
Was knowledge of the allocated interventions adequately prevented during the study?	Low risk	Quote: "*Statistical analyses were conducted after the end of follow-up by the statistician (B.H.), who was unaware of group allocation of clusters."* Quote: *"Data on prevalence of physical restraint use at the 3- and 6-month follow-ups were assessed similarly to baseline by external investigators blinded to cluster group allocation."* Comment: Data collection and analysis performed by blinded investigators.

Domain	Judgement	Support for judgement
Was the study adequately protected against contamination?	Low risk	Quote: *"Cluster randomized controlled trial."* Comment: Allocation by institution. Unlikely that the control group received the intervention.
Was the study free from selective outcome reporting?	Low risk	Results for all outcomes reported (Table 2, 3 and 4).
Was the study free from other risks of bias?	Low risk	Accounted for clustering in sample size calculation and in the data analysis.
Overall risk of bias: Low		

Study: Van Gaal et al., 2011a **Design:** Cluster-randomised controlled trial (PART-I)		
Domain	**Judgement**	**Support for judgement**
Was the allocation sequence adequately generated?	Unclear risk	Quote:*"The randomisation of the wards was stratified for institute and type of ward and each ward was considered as a cluster. The ten hospital wards and ten nursing home wards were assigned to an intervention or usual care group."* Comment: No random component mentioned.
Was the allocation adequately concealed?	Unclear risk	Quote: "*The ten hospital wards and ten nursing home wards were assigned to an intervention or usual care group."* Comment: Unit of allocation by team. Quote: *"Nursing home patients were asked to participate at the start of the data collection periods, or within two weeks after admission."* Quote: *"Although we included the majority of the patients admitted, it is possible that this caused some minor selection bias."* Comment: Participants allocated after randomisation. Not stated who allocated them. Staff and researchers were aware of the allocation.
Were baseline outcome measurements similar?	Low risk	Quote: "*After the randomisation, baseline data were collected during three months at all wards, followed by the implementation of the patient safety programme in the intervention group."* Comment: Baseline outcomes measured prior to the intervention. Quote: *"Results (are) rate ratio from a Poisson regression model using ward as random factor the offset was the duration of observation and institution patients at risk for an AE[3] at the first visit and the incidence of AEs from each ward at baseline."* Comment: Baseline outcome measures similar, Table 4. Adjusted for baseline differences in the analysis.

3 Adverse events (pressure ulcers, urinary tract infections, falls)

Domain	Judgement	Support for judgement
Were baseline characteristics similar?	Low risk	Quote: *"Table 3 presents the characteristics of the patients included in the intervention and usual care group at baseline and at follow-up."* Comment: Nearly half as much physically impaired residents and twice as much rehabilitation residents in the intervention group. Table 1: more wards with physically impaired residents in the intervention group, and more rehabilitation wards in the control group. Number of residents at risk for adverse events and falls similar. Quote: "*...analysed using a random effects Poisson regression analysis, including the following covariates: ward (random effect), institution and the baseline results of the ward."* Comment: Corrected for baseline imbalance in the data analysis.
Were incomplete outcome data adequately addressed?	High risk	Quote: *"Analyses were performed by intention to treat."* Comment: loss to follow-up 20% in the intervention and 31% in the control group (refused with cause unknown, discharged or died). Analysed by intention to treat.
Was knowledge of the allocated interventions adequately prevented during the study?	Low risk	Quote: *"To ensure the validity of the results, all data were collected by independent research assistants who were trained in reading patient files..."* Quote: *"Trained independent research assistants collected the data in: (1) a weekly visit, and (2) by three additional observations on every ward."* Comment: Investigators collecting data were unaware of allocation.
Was the study adequately protected against contamination?	High risk	Quote: *"Cluster randomized controlled trial .."* Comment: Allocation by institution. Quote (design): *"The randomisation of the wards was stratified for centre and type of ward (Figure 1).."* Comment: 6 nursing homes with a total of 10 wards participated. Impossible that the nursing home(s) with more than one participating ward only hosted wards within the same group. Contamination likely.

Domain	Judgement	Support for judgement
Was the study free from selective outcome reporting?	Low risk	All relevant outcomes in the methods section are reported in the results section.
Was the study free from other risks of bias?	Low risk	Quote (design): *"As randomisation was on ward level, a ward was considered to be a cluster. To account for these clusters an intra class correlation coefficient of 0.01 was used in the calculation."* Comments: results corrected for clustering.
Overall risk of bias: High		

Study: Van Gaal et al., 2011b **Design:** Cluster-randomized controlled trial (PART-II)[4]		
Domain	**Judgement**	**Support for judgement**
Was the allocation sequence adequately generated?	Unclear	Quote: *"As described in Part I, ten wards from four hospitals and ten wards from six nursing homes were stratified for institute and ward type and then randomised to intervention or usual care group."* Comment: No random component mentioned.
Was the allocation adequately concealed?	Unclear	Quote: "*As described in Part I, ten wards from four hospitals and ten wards from six nursing homes were stratified for institute and ward type and then randomised to intervention or usual care group."* Comment: Unit of allocation by team. Quote: *"Nursing home patients were asked to participate at the start of the data collection periods, or within two weeks after admission."* Comment: Participants allocated after randomisation. Not stated who allocated them. Staff and investigators were aware of the allocation.
Were baseline outcome measurements similar?	Low risk	Quote (Part I): "*After the randomisation, baseline data were collected during three months at all wards, followed by the implementation of the patient safety programme in the intervention group."* Comment: Baseline outcomes measured prior to the intervention. Quote: *"The results of this study were clustered to ward level, so we used random effects analyses with ward as random factor. Group, institution and the baseline results of the ward were fixed covariates."* Comment: Baseline outcome measures slightly different for all of the three main outcome measures, Table 3. Adjusted for in the analysis.

4*"The design and setting of the cluster randomised trial, which was conducted between September 2006 and November 2008, has been described in Part I."* (Van Gaal et al., 2011b).

Domain	Judgement	Support for judgement
Were baseline characteristics similar?	Low risk	Quote: *"The characteristics of the patients included in the intervention and the usual care group at baseline and follow-up have been described in Part I of this study".* Quote (Part I): *"Table 3 presents the characteristics of the patients included in the intervention and usual care group at baseline and at follow-up."* Comment: Nearly half as much physically impaired residents and twice as much rehabilitation residents in the intervention group. Number of residents at risk for adverse events similar. Quote: *"The results of this study were clustered to ward level, so we used random effects analyses with ward as random factor. Group, institution and the baseline results of the ward were fixed covariates."* Comment: Corrected for baseline imbalance in the data analysis.
Were incomplete outcome data adequately addressed?	High risk	Quote (Part I): *"Analyses were performed by intention to treat."* Comment: loss to follow-up 20% in the intervention and 31% in the control group (refused, discharged or died). Analysis by intention to treat insufficient.
Was knowledge of the allocated interventions adequately prevented during the study?	Low risk	Quote: *Trained independent research assistants collected the data in: (1) a weekly visit, and (2) by three additional observations on every ward."* Comment: Investigators collecting data were unaware of allocation.
Was the study adequately protected against contamination?	High risk	Quote: *"Cluster randomized controlled trial .."* Comment: Allocation by institution. Quote (design): *"The randomisation of the wards was stratified for centre and type of ward (Figure 1).."* Comment: 6 nursing homes with a total of 10 wards participated. Mathematically impossible that the nursing home(s) hosting more than one participating ward only hosted wards within the same group. Contamination likely.
Was the study free from selective outcome reporting?	Low risk	All relevant outcomes in the methods section reported in the results section.

Domain	Judgement	Support for judgement
Was the study free from other risks of bias?	Low risk	Quote (design): *"As randomisation was on ward level, a ward was considered to be a cluster. To account for these clusters an intra class correlation coefficient of 0.01 was used in the calculation."* Comment: results corrected for clustering.
Overall risk of bias: High risk		

Study: Ward et al., 2010 **Design:** Cluster-randomized controlled trial		
Domain	**Judgement**	**Support for judgement**
Was the allocation sequence adequately generated?	Low risk	Quote: *"Consenting facilities were.. randomly allocated within strata into intervention or control groups by the statistician (R E G) using the procedure "surveyselect" in SAS statistical software."*
Was the allocation adequately concealed?	Unclear risk	Quote: *"We undertook a cluster randomised controlled trial."* Comment: Allocation by institution. Not stated if participants were allocated at the start of the study or who allocated them. Staff and researchers were aware of the allocation.
Were baseline outcome measurements similar?	Low risk	Quote: *"Mean use of vitamin D at baseline was 12.7 supplements per 100 beds (95% CI, 7.4 to 18.1) in the control group and was 6.7 per 100 beds (95% CI, 1.2 to 10.9) lower in the intervention group. However, there were no differences in slopes, for either the first or second stage..with respect to study group."* Comment: No differences between study groups. Therefore unlikely that the results are biased. Baseline outcome measurements similar for the use of hip protectors and fall rates.
Were baseline characteristics similar?	Low risk	Quote: *"Box 1 shows that randomisation produced reasonably similar characteristics for residents in the control and intervention groups. Consenting facilities were stratified."*
Were incomplete outcome data adequately addressed?	Low risk	Quote: *"Overall, six facilities withdrew from the project during the intervention. All withdrawing facilities provided sufficient data to allow retention in analyses. All facilities were analysed according to random allocation (intention to treat)."*

Domain	Judgement	Support for judgement
Was knowledge of the allocated interventions adequately prevented during the study?	High risk	Quote: *"The main outcomes of interest were change in use of vitamin D supplements and hip protectors, and change in the rate of fall events."* Comment: Monthly data collection/reporting on falls, vitamin D supplements and the use of hip protectors by the nursing home staff (self-reporting), who were aware of the allocation of the intervention. *Quote: "Failure to produce monthly data was followed up by the project nurse."* Comment: The project nurse was aware of the allocation.
Was the study adequately protected against contamination?	High risk	Quote: *"There was also a possibility of contamination between the intervention and control groups with regard to the introduction of the strategies. This almost certainly happened, because falls prevention was promoted widely by NSW Health to aged care facilities during this period. In addition, doctors responsible for prescription of calcium and vitamin D supplements visited both the intervention and control facilities."* Comment: The physicians could also have introduced (parts of) the intervention to the control group.
Was the study free from selective outcome reporting?	Low risk	All outcomes from the methods section reported in the results section.
Was the study free from other risks of bias?	Unclear risk	Results cluster-corrected, but most probably not for main outcome "Residents with at minimum one femoral neck fracture".
Overall risk of bias: High		