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Sustainability of professionals' adherence to clinical practice guidelines in medical care: a systematic review

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ABSTRACT

Objectives To evaluate the sustainability of professionals' adherence to guideline recommendations in medical practice more than one year following the cessation of active implementation.

Design Systematic review

Data sources Searches were conducted till June 2014 in MEDLINE, CINAHL, EMBASE, Cochrane Central Register of Controlled Trials (CENTRAL) and the Guidelines International Network (GIN) library. A snowball strategy, in which reference sections of other reviews and of included papers were searched, was used to identify additional papers.

Eligibility criteria Studies needed to be focused on sustainability and on professionals' adherence to clinical practice guidelines in medical care. Studies had to include at least two measurements: one before (PRE) or immediately after implementation (EARLY POST) and one measurement longer than one year after active implementation (LATE POST).

Results The search retrieved 3950 items, of which thirteen studies met the inclusion criteria, involving seventeen sustainability evaluations. The mean timeframe between the end of active implementation and the sustainability evaluation was 2.7 years [min 1.5 – max 7.0]. The studies were heterogeneous with respect to their methodology. Sustainability was considered to be successful if performance in terms of professionals' adherence was fully maintained in the late post-implementation phase. Long-term sustainability of professionals' adherence was reported in 41% of the evaluations (7 out of 17), adherence was not sustained in five evaluations, four evaluations showed mixed sustainability results and in one evaluation it was unclear whether the professional adherence was sustained.

Conclusions Professionals' adherence to a clinical practice guideline in medical care decreased after more than one year after implementation in about half of the cases. Due to the limited number of studies, the absence of a uniform definition, the high risk of bias, and the mixed results, no firm conclusion about the sustainability of professionals' adherence to guideline recommendations in medical practice can be drawn.

Key words: sustainability, clinical practice guidelines, medical care, quality improvement, implementation, adherence

Article summary

Strengths and limitations of this study

- This is the first systematic review of the literature that has considered professionals' adherence to clinical practice guidelines more than one year after active implementation. This review shows that in half of the sustainability studies professionals fully sustained in their adherence to a clinical practice guideline.
- This review showed that sustainability research is a relatively new and underexplored field in health care.
- Sustainability research is not well indexed in electronic databases, and text word searches are prone to high recall and low specificity. However, it is likely that the use of a broad variety of search terms that covered sustainability, has downsized the number of relevant studies missed and is a strength of the review.
- The number of studies and the methodological quality of the studies focusing on the sustainability of professionals' adherence are limited. This makes it difficult to draw firm conclusions.

INTRODUCTION

More than ever, improving healthcare performance is necessary due to limited budgets, increased demand and the continuous development of innovations. Quality of care can be improved by decreasing unwarranted practice variation between professionals. One way to reduce practice variation is by transferring evidence-based knowledge into daily practice. To facilitate the translation of the most recent evidence into practice, guidelines are developed and implemented. Following the Institute of Medicine (IOM), clinical practice 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 benefit and harms of alternative care options*" (1). Guidelines contain practical evidence based advice for professionals and patients and aim to improve the quality of care (2). In general, uptake of guidelines does not happen spontaneously and often an active implementation approach is required (3). Moreover, once a guideline is successfully implemented in practice, it may be difficult to sustain the quality improvements over a longer period of time. People tend to fall back into old routines (4) which may impact long-term adherence to a guideline.

The road towards sustainability of health care innovations into practice is suggested to be a dynamic process (5) and sustainable adherence may not be self-evident without continued efforts. Sustainable change of professionals' behaviour has the potential to result in more optimal health care delivery and efficiency. Not sustaining quality improvements can result in nihilistic attitudes towards future innovation. In recent years, sustainability has gained attention in healthcare. Unfortunately, the concept of sustainability is still underdeveloped (6, 7). Some existing reviews studied sustainability from a wide health care perspective, including studies varying from medical care to public health. Results showed that determinants of sustainability varied widely between healthcare areas (8, 9) and suggest that partial sustainability of health care innovations is more common than full sustainability (10).

In this systematic review, the scope of sustainability research will be narrowed to professionals' adherence to clinical practice guidelines in medical care. The aim of the current review was to evaluate the level of sustained professionals' adherence to guideline recommendations in medical practice more than one year following the cessation of the implementation project.

METHODS

Eligibility criteria

Studies needed to be focused on sustainability and on clinical practice guidelines. Sustainability was described as "*Sustainability of change exists when a newly implemented innovation continues to deliver the benefits achieved over a longer period of time, certainly does not return to the usual processes and becomes 'the way things are done around here'* (11)*, even after the implementation project is no longer actively carried out, until a better innovation comes along*" (12). Studies had to include at least two measurements: one before (PRE) or immediately after implementation (EARLY POST) and one measurement longer than one year after active implementation (LATE POST). All

activities to facilitate the adherence to clinical practice guidelines were labelled as part of the implementation project. Studies needed to be focused on professionals' adherence to a clinical practice guideline. Studies only using self-reported adherence were excluded to reduce the chance of social desirability bias and an overestimation of results (13). Lastly, studies had to focus on medical care. Participants had to be healthcare professionals who deliver direct patient care. There were no restrictions on study design of the research articles.

Search methods for identification of studies

Electronic searches

We searched MEDLINE (OvidSP) (1946- February 2014), CINAHL (EBSCO Host) (1982- February 2014), EMBASE (OvidSP) (February 2014), Cochrane Central Register of Controlled Trials (CENTRAL) and the Guidelines International Network (GIN) library for studies. The electronic search strategy was designed to focus on sustainability of guideline recommendations. Free text terms and MeSH terms regarding sustainability, quality improvement, impact and guideline recommendations were used. An information expert checked the developed search strategies (supplementary file 1). Before final analyses, update searches were performed to identify possible additional studies (June 26, 2014).

Searching other resources

A snowball strategy was performed, in which the reference sections of reviews (6-10, 14) and research papers on sustainability (15, 16) were searched. Also, databases such as PubMed and the Web of Knowledge Science Citation Index were used to locate publications and publications citing the original references. The process was repeated for any new relevant publication found.

Data collection and analysis

Selection of studies

All records were merged into a bibliographic database and screened independently by two reviewers (SA, JdG) based on title and abstract. Full text screening was performed by two reviewers (SA, JdG). Disagreement on selection was resolved in consensus meetings with a third reviewer (TvW). Reasons for exclusion were documented during the full text screening. If more clarification or details of a study were needed, an author was contacted. Authors of conference abstracts were emailed and were asked to send the research protocol. Duplicate papers were identified and all papers published on one study were used for retrieving information.

Data extraction and management

Data of the methodology and results were independently extracted by two reviewers (SA, JdG), guided by a predefined data extraction form. Effective Practice and Organisation of Care (EPOC) Data Collection Checklist (17) items (e.g. location of care, type of targeted behaviour, implementation interventions) were integrated in the data extraction form. The data extraction form was developed by the authors and was pilot tested. The following study characteristics were recorded: study design, publication year, whether the study was executed in a single centre or in multiple centres, type of targeted behaviour, location of care, the name of the clinical practice guideline, clinical specialty, the implementation activities used and whether or not the implementation strategy was externally guided. An externally guided implementation strategy is a strategy which is lead and supported by an external expert organisation. With respect to the methodology of the sustainability evaluation the following data were extracted: the timeframe between the end of the implementation strategy and the sustainability evaluation, the applied definition of sustainability, the data collection method, whether the evaluation was performed on patient, hospital or multiple hospital level and whether the sustainability evaluation was performed on single or multiple centre level. With respect to the outcome measures of the studies, data on the professionals' adherence rates before, early after implementation and longer than one year after implementation, and the authors' comments with respect to the sustainability of professionals' adherence were extracted. Adherence was presented in terms of proportion of patients receiving treatment according to the clinical practice guideline recommendations. If sustainability of professionals' adherence to a clinical practice guideline was evaluated at multiple post-implementation moments, the latest evaluation was selected as LATE POST measurement. The authors (SA and JdG) checked if updates of the clinical practice guidelines had become available in the post-implementation phase (e.g. between the EARLY POST and the LATE POST measurement), which may explain reduced professionals' adherence. Disagreement on data extraction was resolved in consensus meetings with a third reviewer (TvW).

Assessment of risk of bias in included studies

Risk of bias assessment was independently conducted by two authors using the Downs and Black checklist for randomized and non-randomized studies (18). This is a checklist which can be used for checking the risk of bias of original research articles of various study designs. Results were interpreted under consideration of risk of bias. The assessments were also used for recommendations for further research by identifying elements of studies that can be improved in future studies. The checklist was adapted to the research question. Risk of bias of the studies was presented on reporting, external validity, internal validity (bias and confounding), power and overall level.

Analysis

The analysis was narrative. This included a summary of the methodological characteristics of the sustainability evaluations, and the level of sustained professionals' adherence compared to results achieved immediately after implementation. Sustainability was considered to be successful if performance in terms of professionals' adherence was fully maintained in the late post-implementation

phase. A sensitivity analysis was performed by applying a 90% instead of 100% adherence criterion of sustainability.

RESULTS

Description of studies

For this review, 3950 items were retrieved and screened based on title and abstract, and 174 studies were assessed based on full text reading. Figure 1 shows the study selection process as recommended by the PRISMA statement (19) (supplementary file 2). Thirteen studies met the inclusion criteria for this review, describing seventeen sustainability evaluations (20-32). Table 1 presents the characteristics of the included studies. Two publications were published before and eleven after 2000 (21, 31). In five studies the targeted behaviour was prescribing (22, 23, 26, 28, 31), in four studies procedures (27, 29, 30, 32), in three studies general management of a problem (20, 24, 25) and in one study (21) general management of a problem and prescribing. The location of care was inpatient in six studies (21, 26, 27, 30, 32), outpatient in three studies (22-24) and mixed in five studies (20, 25, 28, 29, 31).

The implementation strategy was described in twelve studies (supplementary file 3) (20-25, 27-37). According to the EPOC checklist classification, in one study (22), a single element implementation strategy was executed while in the other eleven studies a multi-faceted implementation strategy was executed. Implementation activities were professional targeted interventions (n=11) (20, 21, 23-25, 27, 28, 30-37), followed by organisational interventions (n=6) (20, 21, 24, 31-34, 36, 37) and financial interventions (n=1) (25). In five studies the implementation strategy was facilitated by external experts (20, 23-25, 29). In one study it was unclear whether the implementation strategy was externally supported (26).

Table 1. Characteristics of the included studies

Study ID	Study design	Clinical practice guideline	Clinical specialty	Clinical practice guideline was updated in the post-implementation phase* (yes/no)	Time frame (years)
Ament (20) (2014) The Netherlands	case series	Guideline to facilitate short stay for breast cancer surgery (33)	Surgery	Between 2007-2012: No (38, 39)**	5
Benenson (21) (1999) UK	case series	Clinical pathway for pneumonia (40)	Various	Between 1995-1997: No (41, 42)	3
Cates (22)(2009) UK	case series	Guideline for antibiotic prescription for children with earache and inflamed eardrums who are not unduly ill (43)	General practice	Between 1998-2001: No (44)**	Centre 1: 3 Centre 2: 2
Enriquez-Puga (23) (2009) UK	RCT	(1) Antidepressant prescription guideline and (45) (2) Antibiotic prescription guideline (46) Control group: intervention groups were each other's control group	General practice	Guideline 1 between 2003-2004: yes (47) Guideline 2 between 2003-2004: No (46)	1.5
Forsner (24) (2010) Sweden	RCT	Clinical guideline (1) for depression (48) and (2) for suicidal behaviours (49) Control group: received the guideline but were not included in the intervention	Psychiatry	UTD	1.5
Higuchi (25) (2011) Canada	case series	(1) Adult Asthma Care Best Practice Guideline (50) and (2) Reducing Foot Complications for People with Diabetes Best Practice Guideline (51)	(1)Various (2)Various	Guideline 1 between 2002-2006: Yes (52) Guideline 2 between 2003-2006: Yes (53)	(1) 4 (2) 3
Kelly (26) (2000) Australia	case series	Guideline for nurse managed titrated narcotic analgesia (54)	Emergency medicine	UTD	2
Knops (27) (2010) The Netherlands	case series	(1) a fluid balance guideline for oncology patients (35) (2) a body temperature guideline for postoperative patients (55)	(1) Various (2) Surgery	Guideline 1 UTD (local guideline) Guideline 2 UTD (local guideline)	7
Loszadi (28) (2006) UK	case series	Guidelines for the prevention and management of corticosteroid induced osteoporosis (56)	Neurology	UTD	Unknown, > 2
Mclaws (29) (2009) Australia	case series	Guidelines on Hand Hygiene in Health Care (57)	Various	Between 2007-2008: No (57)	1.5
Stephan (30) (2006)	case series	Guideline for urine catheterization management for surgical procedures (58)	Orthopaedic / abdominal	UTD (local guideline)	1.5

Switzerland			surgery		
Wakefield (31) (1998) USA	case series	Guideline for the use of transdermal fentanyl for chronic pain (31)	Various	UTD	1.5
Williams (32) (2003) UK	case series	Guideline for the repair and follow-up of third degree tears (59)	Obstetrics and gynaecology	UTD (local guideline)	2
* The cpg was updated between the POST and LATE POST measurement (yes) or was not updated between the POST and LATE POST measurement (no) **Not updated with respect to the key recommendations of the guideline. The guideline was adopted in national guidelines in the post-implementation phase. UTD: unable to determine					

Characteristics of the sustainability evaluations

The mean timeframe between the end of the implementation strategy and the sustainability evaluation of twelve studies was 2.7 years [min 1.5 – max 7.0]. The actual timeframe of one evaluation was unclear, but was at least two years (28). Two studies referred to a definition of sustainability (20, 25). Eight studies used a retrospective data collection method (21-27, 31), two studies used a prospective data collection method (29, 30) and three studies used both a prospective and a retrospective data collection method (20, 28, 32). Nine papers reported the level of sustained adherence of a single clinical practice guideline (20-22, 26, 28-32), while four reported the late post-implementation adherence of two clinical practice guidelines (23-25, 27). Seven studies had a single centre design (21, 26-28, 30-32) and six studies evaluated sustainability in multiple centres (20, 22-25, 29). Three out of six multiple centre studies evaluated the sustainability on multiple centre level (20, 24, 29). Two out of six multiple centre studies evaluated the sustainability of professionals' adherence of two guidelines which were implemented in one centre each (22, 25).

Sustainability of changed behaviour

The level of professionals' adherence was fully sustained in seven out of seventeen evaluations (table 2, supplementary file 4). The adherence was not fully sustained in five evaluations and four evaluations showed mixed sustainability results in the LATE POST measurement compared to the EARLY POST measurement. In one study, the EARLY POST measurement was not executed, while the authors reported sustained results (26). After decreasing the sustainability level of professionals' adherence to 90% or higher, nine out of seventeen evaluations showed sustained results, two evaluations showed no sustained results, four evaluations showed mixed results. In two evaluations it was unclear whether the professionals' adherence had been sustained at a level 90% or higher.

Five of the nine papers that reported about a single clinical practice guideline presented sustained professionals' adherence to clinical practice guidelines in the LATE POST measurement (20-22, 28, 32). One of these five papers evaluated the sustainability of a single clinical practice guideline in two centres (22). In both centres professionals' adherence had improved in the LATE POST measurement compared to the EARLY POST measurement. The four studies analysing the sustainability of two clinical practice guidelines showed mixed results. Two of these four studies (23, 27), presented the same level or improved adherence to one guideline and decreased adherence to the other guideline in the LATE POST measurement compared to the EARLY POST measurement. The other two of these four studies (24, 25) presented adherence results on guideline recommendation level and did not present overall adherence results on patient level. The adherence to the recommendations of the clinical practice guidelines showed decreased and improved levels in the LATE POST measurement compared to the EARLY POST measurement. In total, eight papers mentioned the term 'sustainability' in the conclusion (table 2) [20-26 30]. Five of these studies concluded to have sustained professionals' adherence in the late post-implementation phase [20-22 26 30], three out of eight studies described to have a 'mixed pattern', 'small desired' or 'almost' sustained professionals' adherence [23-25].

Table 2. Sustainability of professionals' adherence to clinical practice guidelines

Study ID	Authors' comments in terms of sustainability of adherence to the clinical practice guideline*	Sustained compared to early implementation results (100%) (yes/no)**	Sustained compared to early implementation results (90%) (yes/no)***
Ament (20)	"Adherence to the guideline recommendations was *sustained* in four early adopter hospitals"	yes	yes
Benenson (21)	"The observed pre pathway to post pathway differences were *sustained* over three years"	yes	yes
Cates (22)	(Centre 1 & 2) "our approach has brought about a *sustained* reduction in the use of antibiotics for children with acute otitis media, and after dissemination of our findings, similar results have been replicated at centre II using deferred prescribing of antibiotics for children who are not unduly ill"	yes	yes
Enriquez-Puga (23)	"There was a small change in the desired direction in the proportion of antidepressants prescribed according to guidelines that lasted for 24 months, although no change for antibiotics. A simple, group level educational outreach intervention, designed to take account of identified barriers to change, appears to have a small *sustained* effect on prescribing levels, but the effect is not consistent across different groups of drugs"	Guideline 1: no Guideline 2: yes	Guideline 1: no Guideline 2: yes
Forsner (24)	"This study suggested that the compliance to clinical guidelines, for treatment of depression and suicidal behaviour, was implemented and *sustained* over a two-year period after an active implementation"	Guideline 1: mixed Guideline 2: mixed	Guideline 1: mixed Guideline 2: mixed
Higuchi (25)	(1)" The chart audit revealed that eleven nursing care indicators related to the asthma guideline recommendations showed a mixed pattern of sustainability" (2) Not mentioned	Guideline 1: mixed Guideline 2: mixed	Guideline 1: mixed Guideline 2: mixed
Kelly (26)	"The study demonstrated a significant and *sustained* change in analgesia administration practices away from the intramuscular (IM) route in favour of the IV route."	na	na
Knops (27)	(1)Not mentioned (2)Not mentioned	Guideline 1: yes Guideline 2: no	Guideline 1: yes Guideline 2: no
Loszadi (28)	Not mentioned	yes	yes
Mclaws (29)	Not mentioned	no	yes
Stephan (30)	"One of the most important results of our intervention is its *sustained* impact. In particular, the frequency of catheter use decreased in the operating room not only immediately after guideline implementation, but also could be observed 2 years later."	no	yes
Wakefield (31)	Not mentioned	no	na
Williams (32)	Not mentioned	yes	yes

* Citations of the authors of reviewed papers about the sustainability of adherence to the clinical practice guideline
** The same level or improved professionals' adherence was achieved years after implementation compared to early post-implementation results (yes/no)
***At least 90% of professionals' adherence was achieved years after implementation, compared to early post-implementation results (yes/no)
na: not applicable as the early post-implementation results were not measured
mixed: The overall professionals' adherence was not presented, and both sustained and not sustained levels of professionals' adherence to clinical practice guideline recommendations were achieved in the late post-implementation phase compared to early post-implementation results.

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Risk of bias in included studies

All studies included in the present review had a high risk of bias, following the Downs and Black assessment tool (18) (table 3, supplementary file 5).

Table 3. Results of the risk of bias assessment

Study ID	Reporting	External validity	Internal validity - bias	Internal validity - confounding	Total
Ament (20)	Unclear	High	High	High	High
Benenson (21)	Unclear	High	High	High	High
Cates (22)	High	Unclear	High	High	High
Enriquez-Puga (23)	Unclear	High	High	High	High
Forsner (24)	Unclear	Low	High	High	High
Higuchi (25)	High	High	High	High	High
Kelly (26)	High	High	High	High	High
Knops (27)	High	Low	High	High	High
Loszadi (28)	Unclear	High	Unclear	High	High
Mclaws (29)	High	Low	Unclear	High	High
Stephan (30)	High	High	Unclear	High	High
Wakefield (31)	High	High	High	High	High
Williams (32)	High	High	Unclear	High	High
Total	**High**	**High**	**High**	**High**	**High**

DISCUSSION

This systematic review identified thirteen studies, including seventeen evaluations that investigated the sustainability of professionals' adherence to a clinical practice guideline more than one year after the implementation was finished. Of seventeen analyses that focused on the extent of sustained professionals' adherence to a clinical practice guideline, seven analyses revealed fully sustained results. After decreasing the sustainability level of professionals' adherence to 90% or higher, nine out of seventeen evaluations showed sustained results. The current review showed that the number of sustainability studies is scarce and that the studies are heterogeneous with respect to their methodology. Furthermore, almost no study analysed or reflected on the updates of the guideline in the post-implementation phase. The results of this review suggest that updates of the clinical practice guidelines may have led to a warranted decrease in the adherence to the original clinical practice guideline.

As was confirmed in another systematic review (10), the sustainability studies showed to have limited methodological rigor. Two out of thirteen studies used an experimental design. The lack of identified

studies in the current review suggests that most teams do not focus on the long-term performance effect of quality improvements (60). Due to the limited number of studies focusing on this subject, the heterogeneity in studies, suboptimal reporting by authors and the revealed methodological weaknesses, no strong conclusions can be drawn based on the presented sustainability results. As also shown in other research, most sustainability studies used a single-case study design by focusing on a single type of programme or performed the evaluation at a single centre level (61). The current review showed that in only two of the studies, a reference for the definition of sustainability was used. Other studies performed a sustainability evaluation without mentioning a definition. This shows the underdeveloped field of sustainability research. Also, a variety of timeframes to study the sustainability of professionals' adherence to clinical practice guidelines was revealed, varying from one and a half year to seven years following implementation.

Our review focused on the sustainability of implementation success in terms of professionals' adherence. Optimal adherence to a clinical practice guideline as determined during implementation is not always desired; for example, clinical experience and evidence may change. This systematic review included all research designs and seems to be the first review with respect to sustainability of professionals' adherence to clinical practice guidelines to date. Other reviews focused on healthcare from a broad perspective including multiple health care fields (10) or reviewed studies performed specifically in public health (6, 9). The sustainability of a health programme in public health may be influenced by other determinants than the sustainability of a clinical practice guideline in medical care. Also, the concept of the sustainability may differ between healthcare fields. For example, in public health sustainability of a health programme may be successfully sustained if health outcomes, e.g. changed lifestyle, are maintained and financial support is still available (6, 61). In medical care, the primary focus is on the quality and safety of care which is supposed to be captured in clinical practice guidelines. Due to the specific focus on clinical practice guidelines in the current review, mainly other studies were included compared to the existing sustainability reviews (6-10, 14).

Strengths and weaknesses

As yet, the term 'sustainability' is not consistently used for this area in the broader medical field, which presents a limitation to the electronic search strategy. The topic is not well indexed in electronic databases, and text word searches are prone to high recall and low specificity. However, it is likely that the use of a broad variety of search terms that covered sustainability, has downsized the number of relevant studies missed and is a strength of the review.

In this systematic review, sustainability was assessed as successful if performance in terms of professionals' adherence was fully maintained in the late post-implementation phase. Also, a sensitivity analysis was performed to analyse the sustainability at a level of 90% or higher. However, as mentioned before, a limitation of the review is the high risk of bias of all studies included. The majority of the studies used a retrospective data collection method. Nevertheless, results were interpreted under consideration of risk of bias, and the assessments were also used for

recommendations for further research by identifying elements of studies that can be improved in new studies. Also, the question is what the best method is for evaluating sustainability. For example, retrospective data may be desired to prevent a Hawthorne effect when studying routine practice.

The results of the current review show more studies with sustained professionals' adherence than might be expected without continuing efforts and support to promote the level of sustained adherence in the post-implementation phase. Possibly, studies with unfavourable results may not be published or unsuccessful implementation projects may not be evaluated, leading to an under-representation of the true amount of work carried out in the field (62, 63).

Implications for practice

The current review showed that the level of the sustainability of professionals' adherence to clinical practice guidelines varies on case study level and drops in more than half of the studies. Due to the lack of sustainability research we think that sustainability failure as presented in this study is an underestimation. Unfortunately, implementation projects are primarily focused on short-term actions and short-term effect (60). To guarantee a sustainable health care system, maintaining or improving the level of adherence to clinical practice guidelines achieved after implementation is necessary.

Future research

This review complements the existing sustainability research by focussing on sustained professionals' adherence in medical practice. The current review showed that not many studies reported data on the sustainability of professionals' adherence to clinical practice guidelines. Also, no strong conclusions can be drawn due to the high risk for bias and the heterogeneity of the studies. As shown in previous research, structural methods for sustainability evaluations are lacking (10, 64). More sustainability evaluation research and methodological guidance is needed to make future sustainability research more robust and generalizable and may be helpful in creating a general sustainability language.

CONCLUSION

This systematic review identified, reported and analysed studies that evaluated the level of sustainability of professionals' adherence to guideline recommendations in medical practice more than one year following the cessation of the implementation project. Seven out of seventeen evaluations showed sustained professionals' adherence on average 2.7 years after implementation. Due to the limited number and the lack of methodological quality of the identified studies, no firm conclusion about the sustainability of professionals' adherence to guideline recommendations in medical practice can be drawn. More sustainability evaluations, methodological sustainability studies and reviews are needed in order to develop a general framework for sustainability measurement and to facilitate uniform language and communication within the sustainability science.

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Ethical approval: Not required.

Transparency: SA (the manuscript's guarantor) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Data sharing statement: Unpublished study data, such as the search strategies for the other databases, are available upon request to the corresponding author.

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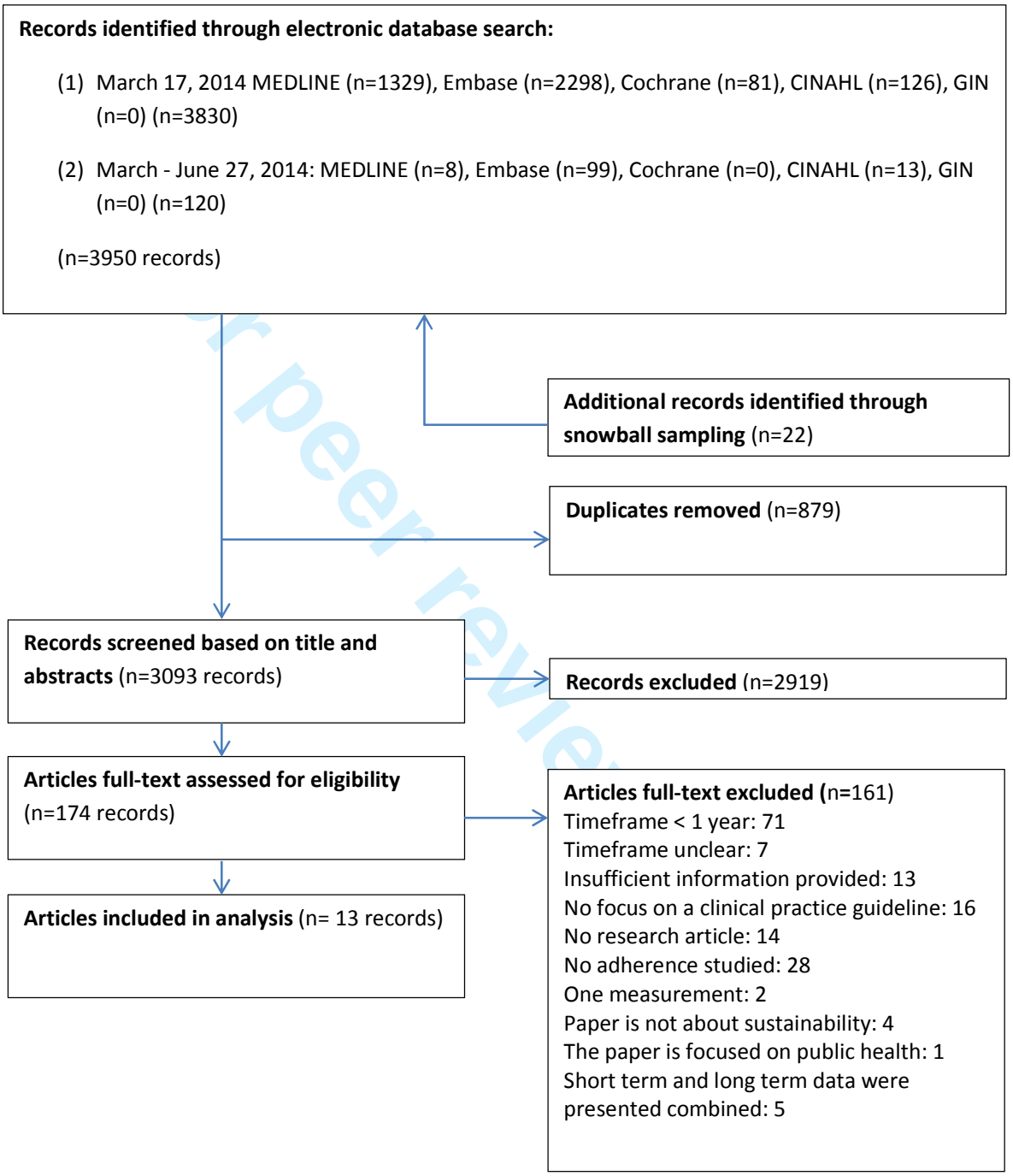
Figure Legends

Table 1	Characteristics of the studies included
Table 2	Sustainability of professionals' adherence to clinical practice guidelines
Table 3	Results of the risk of bias assessment
Figure 1	PRISMA Flow Diagram

Supplementary files

Supplementary file 1	Electronic search strategy for MEDLINE (OvidSP)
Supplementary file 2	Excluded articles based on full-text selection (n=161) (detailed table)
Supplementary file 3	Implementation strategies as described by the authors
Supplementary file 4	Sustainability of professionals' adherence to clinical practice guidelines (detailed table)
Supplementary file 5	Risk of bias using the Downs and Black checklist (detailed table)

Figure 1. PRISMA Flow Diagram



Supplementary file 1. Electronic search strategy for MEDLINE (OvidSP)

Database: Ovid MEDLINE <1946 to February Week 4 2014>
Date searched: 14.03.2014
Records found: 1329

Sustainability facet

1 (adoption adj2 (longitudinal or long term or longterm)).ti,ab,ot. (64)
2 ((continued or continuation) adj2 (adherence or compliance or effect or effects or effectiveness or impact$ or intervention$ or innovation$ or program$)).ti,ab,ot. (1823)
3 (de-adoption adj2 (chang$ or intervention$ or innovation$ or program$)).ti,ab,ot. (0)
4 (diffusion adj2 (longitudinal or long term or longterm)).ti,ab,ot. (188)
5 ((discontinued or discontinuance or discontinuation) adj2 (intervention$ or innovation$ or program$)).ti,ab,ot. (202)
6 ((dissemination or disseminated) adj2 (longitudinal or long term or longterm)).ti,ab,ot. (38)
7 (durability adj2 (adherence or benefit$ or chang$ or compliance or effect or effects or effectiveness or intervention$ or improvement$ or implement$ or impact$ or innovation$ or longitudinal or outcome$ or "over time" or process$ or program$ or post-implement$ or success$)).ti,ab,ot. (402)
8 (fidelity adj2 (adherence or adoption or chang$ or compliance or effect or effects or effectiveness or evaluat$ or impact$ or implement$ or improvement$ or intervention$ or innovation$ or long-term or longterm or longitudinal or "over time" or outcome$ or post-implementat$ or program$ or success$)).ti,ab,ot. (605)
9 (institutionali?ation adj2 (adherence or chang$ or compliance or effect or effects or effectiveness or improvement$ or impact$ or innovation$ or longitudinal or long-term or longterm or outcome$ or process$ or post-implement$)).ti,ab,ot. (235)
10 (longitudinal adj2 (adherence or assess$ or benefit$ or chang$ or compliance or effect or effects or effectiveness or examination$ or evaluat$ or impact$ or pattern? or program$ or success$)).ti,ab,ot. (9231)
11 ((maintenance or maintained) adj2 (adherence or chang$ or compliance or effect or effects or effectiveness or fail$ or intervention$ or improvement$ or implement$ or impact$ or innovation$ or long-term or longterm or longitudinal or outcome$ or "over time" or process$ or post-implement$)).ti,ab,ot. (11874)
12 (normali?ation adj2 (adherence or chang$ or compliance or effect or effects or effectiveness or improvement$ or impact$ or innovation$ or longitudinal or long-term or longterm or outcome$ or process$ or post-implement$)).ti,ab,ot. (1069)
13 (persistence adj2 (implement$ or innovation$ or program$ or long-term or longterm or "over time")).ti,ab,ot. (1551)
14 (routini$ adj2 (chang$ or improve$ or intervention$ or innovation$ or longitudinal or long-term or longterm or outcome$ or "over time" or program$ or post-implement$)).ti,ab,ot. (8)
15 (sustain$ adj2 (adherence or adoption or assess or benefit$ or chang$ or compliance or evaluat$ or effect or effects or effectiveness or fail$ or innovation$ or intervention$ or improvement$ or implement$ or impact$ or long-term or longterm or outcome$ or "over time" or program$ or post-implement$ or success$ or vitality)).ti,ab,ot. (15804)
16 sustainability.ti. (1367)
17 or/1-16 (43656)

Guidelines facet

18 guideline/ or practice guideline/ (24797)
19 guidelines as topic/ or practice guidelines as topic/ (108754)
20 Guideline Adherence/ (19958)
21 Health Planning Guidelines/ (3791)
22 (guideline$ or guide-line$).ti. (45298)
23 (practice adj3 parameter$).ti,ab. (1081)
24 clinical protocols/ (19624)

25 guidance.ti,ab. (53787)
26 care pathway*.ti,ab. (1337)
27 critical pathway/ (4502)
28 (clinical adj3 pathway$).ti,ab. (2907)
29 algorithms/ (168579)
30 consensus development conference.pt. (8886)
31 consensus development conference nih.pt. (725)
32 or/18-31 (396861)

33 17 and 32 (1378)

Animal-only study exclusion

34 exp animals/ not (exp animals/ and humans/) (3902375)

35 33 not 34 (1329)

Supplementary file 2. Excluded articles based on full-text selection

Paper	Exclusion reason
R. Adsit, D. Fraser, L. Redmond, S. Smith, and M. Fiore, 'Changing Clinical Practice, Helping People Quit: The Wisconsin Cessation Outreach Model', Wisconsin Medical Journal, 104 (2005), 32-36.	No adherence studied
B. Allegranzi, A. Gayet-Ageron, N. Damani, L. Bengaly, M. L. McLaws, M. L. Moro, Z. Memish, O. Urroz, H. Richet, J. Storr, L. Donaldson, and D. Pittet, 'Global Implementation of Who's Multimodal Strategy for Improvement of Hand Hygiene: A Quasi-Experimental Study', The Lancet	Timeframe < 1 year
J. C. Alonso, 'A Figo Project in Uruguay to Prevent Maternal Death Due to Unsafe Termination of Pregnancy', Journal of Perinatal Medicine, 41	Insufficient information provided
E. Alp, D. Haverkate, and A. Voss, 'Hand Hygiene among Laboratory Workers', Infection Control & Hospital Epidemiology, 27 (2006), 978-80.	Timeframe < 1 year
H. K. Amdany, and M. McMillan, 'Metronidazole Intravenous Formulation Use in in-Patients in Kapkatet District Hospital, Kenya: A Best Practice Implementation Project', JBI Database of Systematic Reviews and Implementation Reports, 12 (2014), 419-32.	Timeframe < 1 year
R. S. Bailie, D. Si, G. W. Robinson, S. J. Togni, and P. H. N. d'Abbs, 'A Multifaceted Health-Service Intervention in Remote Aboriginal Communities: 3-Year Follow-up of the Impact on Diabetes Care', Medical	Timeframe unclear
R. S. Bailie, S. J. Togni, D. Si, G. Robinson, and P. H. N. D'Abbs, 'Preventive Medical Care in Remote Aboriginal Communities in the Northern Territory: A Follow-up Study of the Impact of Clinical Guidelines, Computerised Recall and Reminder Systems, and Audit and Feedback',	Timeframe unclear
Anonymous, 'Report: Cpoe Adoption a Long-Term Process', Healthcare Benchmarks & Quality Improvement, 10 (2003), 105-7.	No research article
M. B. Goetz, T. Hoang, S. R. Henry, H. Knapp, H. D. Anaya, A. L. Gifford, and S. M. Asch, 'Evaluation of the Sustainability of an Intervention to Increase Hiv Testing', J Gen Intern Med, 24 (2009), 1275-80.	No focus on a clinical practice guideline
E. L. Mawdsley, S. Garcia-Houchins, and S. G. Weber, 'Back to Basics: Four Years of Sustained Improvement in Implementation of Contact Precautions at a University Hospital', Joint Commission journal on quality and patient safety / Joint Commission Resources, 36 (2010), 418-23.	No focus on a clinical practice guideline
R. S. Bailie, G. Robinson, S. N. Kondalsamy-Chennakesavan, S. Halpin, and Z. Wang, 'Investigating the Sustainability of Outcomes in a Chronic Disease Treatment Programme', Soc Sci Med, 63 (2006), 1661-70.	Timeframe < 1 year
F. E. Babl, D. Krieser, J. Belousoff, and T. Theophilos, 'Evaluation of a Paediatric Procedural Sedation Training and Credentialing Programme: Sustainability of Change', Emerg Med J, 27 (2010), 577-81.	Timeframe < 1 year
P. A. Bampton, J. J. Sandford, and G. P. Young, 'Achieving Long-Term Compliance with Colonoscopic Surveillance Guidelines for Patients at Increased Risk of Colorectal Cancer in Australia', International Journal of Clinical Practice, 61 (2007), 510-13.	Timeframe < 1 year
D. Berild, T. G. Abrahamsen, S. Andresen, E. Bjorlow, O. Haug, I. M. Kossenko, O. I. Kubar, M. Lelek, S. I. Mintchenko, M. F. Pyasetskaya, S. H. Ringertz, and G. A. Sysenko, 'A Controlled Intervention Study to Improve Antibiotic Use in a Russian Paediatric Hospital', International Journal of Antimicrobial Agents, 31 (2008), 478-83.	Timeframe < 1 year
M. T. Bigham, R. Amato, P. Bondurrant, J. Fridriksson, C. D. Krawczeski, J. Raake, S. Ryckman, S. Schwartz, J. Shaw, D. Wells, and R. J. Brilli, 'Ventilator-Associated Pneumonia in the Pediatric Intensive Care Unit: Characterizing the Problem and Implementing a Sustainable Solution',	Short term and long term data were presented combined
M. Fleuren, E. Dusseldorp, S. van den Bergh, H. Vlek, J. Wildschut, E. van den Akker, and D. Wijkel, 'Implementation of a Shared Care Guideline for Back Pain: Effect on Unnecessary Referrals', Int J Qual Health Care, 22	No focus on a clinical practice guideline

K. Blanchet, and P. James, 'Can International Health Programmes Be Sustained after the End of International Funding: The Case of Eye Care Interventions in Ghana', BMC Health Serv Res, 14 (2014), 77.	No focus on a clinical practice guideline
P. G. Teixeira, K. Inaba, J. Dubose, N. Melo, M. Bass, H. Belzberg, and D. Demetriades, 'Measurable Outcomes of Quality Improvement Using a Daily Quality Rounds Checklist: Two-Year Prospective Analysis of Sustainability in a Surgical Intensive Care Unit', The Journal of Trauma	No focus on a clinical practice guideline
L. Bowers, C. Berry-Caban, and R. Munson, 'Implementing Process Improvement Efforts to Increase Adherence with Diabetes Clinical Practice Guidelines in a Military Treatment Facility', Journal of the American	Insufficient information provided
C. C. Bowman, E. J. Sobo, S. M. Asch, and A. L. Gifford, 'Measuring Persistence of Implementation: Queri Series', Implement Sci, 3 (2008), 21.	No research article
C. Brand, F. Landgren, A. Hutchinson, C. Jones, L. MacGregor, and D. Campbell, 'Clinical Practice Guidelines: Barriers to Durability after Effective Early Implementation', Internal Medicine Journal, 35 (2005), 162-69.	One measurement
B. D. Brazzell, 'Improving High Hand-Hygiene Compliance and Reducing Healthcareassociated Infection in Eight Nursing Units', American Journal of Infection Control, 1) (2014), S25-S26.	Timeframe < 1 year
A. S. Brent, W. M. Rahman, L. L. Knarr, J. A. Harrison, K. L. Kearns, and D. S. Lindstrom, 'Reducing Cycle Times in Pediatric Emergency Medicine', Pediatric Emergency Care, 25 (2009), 307-11.	No adherence studied
D. L. Whitford, S. H. Roberts, and S. Griffin, 'Sustainability and Effectiveness of Comprehensive Diabetes Care to a District Population',	Timeframe unclear
B. L. Carter, 'Blood Pressure Control-Implementing a Team Approach', US Cardiology, 8 (2011), 108-13.	No research article
Ali A. Cheema, Annette M. Scott, Karen J. Shambaugh, Jacqueline N. Shaffer-Hartman, Ronald E. Dechert, Susan M. Hieber, John W. Gosbee, and Matthew F. Niedner, 'Rebound in Ventilator-Associated Pneumonia Rates During a Prevention Checklist Washout Period', BMJ Quality &	Short term and long term data were presented combined
Y. C. Chen, W. H. Sheng, J. T. Wang, S. C. Chang, H. C. Lin, K. L. Tien, L. Y. Hsu, and K. S. Tsai, 'Effectiveness and Limitations of Hand Hygiene Promotion on Decreasing Healthcare-Associated Infections', PLoS ONE	Timeframe < 1 year
L. L. Chlan, J. L. Guttormson, and K. Savik, 'Tailoring a Treatment Fidelity Framework for an Intensive Care Unit Clinical Trial', Nursing Research, 60	Timeframe < 1 year
B. Crawford, M. Skeath, and A. Whippy, 'Kaiser Permanente Northern California Sepsis Mortality Reduction Initiative', Critical Care, 16 (2012).	Timeframe < 1 year
J. D. Crews, E. Whaley, D. Syblik, and J. Starke, 'Sustained Improvement in Hand Hygiene at a Children's Hospital', Infection Control and Hospital Epidemiology, 34 (2013), 751-53.	Timeframe < 1 year
S. B. DeMauro, E. Douglas, K. Karp, B. Schmidt, J. Patel, A. Kronberger, R. Scarboro, and M. Posencheg, 'Improving Delivery Room Management for Very Preterm Infants', Pediatrics, 132 (2013), e1018-e25.	Short term and long term data were presented combined
S. Deuster, I. Roten, and S. Muehlebach, 'Implementation of Treatment Guidelines to Support Judicious Use of Antibiotic Therapy', Journal of Clinical Pharmacy and Therapeutics, 35 (2010), 71-78.	Timeframe < 1 year
M. A. Doyle, S. Brez, S. Sicoli, F. De Sousa, E. Keely, and J. C. Malcom, 'Using Standardized Insulin Orders to Improve Patient Safety in a Tertiary Care Centre', Canadian Journal of Diabetes, 38 (2014), 118-25.	Insufficient information provided
K. Ellingson, R. R. Muder, R. Jain, D. Kleinbaum, P. J. Feng, C. Cunningham, C. Squier, J. Lloyd, J. Edwards, V. Gebski, and J. Jernigan, 'Sustained Reduction in the Clinical Incidence of Methicillin-Resistant Staphylococcus Aureus Colonization or Infection Associated with a Multifaceted Infection Control Intervention', Infect Control Hosp Epidemiol,	No adherence studied
J. N. Epstein, J. M. Langberg, P. K. Lichtenstein, R. C. Kolb, and L. J. Stark, 'Sustained Improvement in Pediatricians' Adhd Practice Behaviors in the Context of a Community-Based Quality Improvement Initiative',	Timeframe < 1 year
K. J. Evans, J. Thompson, S. E. Spratt, L. F. Lien, and A. Vorderstrasse, 'The Implementation and Evaluation of an Evidence-Based Protocol to Treat Diabetic Ketoacidosis: A Quality Improvement Study', Adv Emerg	Timeframe < 1 year

M. Fakhry, G. B. Hanna, O. Anderson, A. Holmes, and D. Nathwani, 'Effectiveness of an Audible Reminder on Hand Hygiene Adherence', American Journal of Infection Control, 40 (2012), 320-23.	Timeframe < 1 year
M. G. Fakih, K. Jones, J. E. Rey, R. Takla, S. Szpunar, K. Brown, A. Boelstler, and L. Saravolatz, 'Peripheral Venous Catheter Care in the Emergency Department: Education and Feedback Lead to Marked Improvements', American Journal of Infection Control, 41 (2013), 531-6.	Timeframe < 1 year
M. Bunik, M. J. Federico, B. Beaty, M. Rannie, J. T. Olin, and A. Kempe, 'Quality Improvement for Asthma Care within a Hospital-Based Teaching Clinic', Academic Pediatrics, 11 (2011), 58-65.	Timeframe < 1 year
B. R. Ferrell, and R. Virani, 'Institutional Commitment to Improved Pain Management: Sustaining the Effort', Journal of Pharmaceutical Care in Pain and Symptom Control, 6 (1998), 43-55.	No adherence studied
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J. Melnikow, N. D. Kohatsu, and B. K. S. Chan, 'Put Prevention into Practice: A Controlled Evaluation', American Journal of Public Health, 90	Timeframe < 1 year
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P. J. Pronovost, C. A. Goeschel, E. Colantuoni, S. Watson, L. H. Lubomski, S. M. Berenholtz, D. A. Thompson, D. J. Sinopoli, S. Cosgrove, J. B. Sexton, J. A. Marsteller, R. C. Hyzy, R. Welsh, P. Posa, K. Schumacher, and D. Needham, 'Sustaining Reductions in Catheter Related Bloodstream Infections in Michigan Intensive Care Units:	No adherence studied
S. Provost, R. Pineault, P. Tousignant, M. Hamel, and R. B. Da Silva, 'Evaluation of the Implementation of an Integrated Primary Care Network for Prevention and Management of Cardiometabolic Risk in Montreal',	No research article
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A. P. Savant, L. J. Britton, K. Petren, S. A. McColley, and H. H. Gutierrez, 'Sustained Improvement in Nutritional Outcomes at Two Paediatric Cystic Fibrosis Centres after Quality Improvement Collaboratives', BMJ Quality	Timeframe < 1 year
S. Scheithauer, F. Eitner, H. Hafner, J. Floege, and S. W. Lemmen, 'Long-Term Sustainability of Hand Hygiene Improvements in the Hemodialysis Setting', Infection, 41 (2013), 675-80.	Timeframe < 1 year
L. H. Schwamm, G. C. Fonarow, M. J. Reeves, W. Pan, M. R. Frankel, E. E. Smith, G. Ellrodt, C. P. Cannon, L. Liang, E. Peterson, and K. A. LaBresh, 'Get with the Guidelines-Stroke Is Associated with Sustained Improvement in Care for Patients Hospitalized with Acute Stroke or Transient Ischemic Attack', Circulation, 119 (2009), 107-15.	No focus on a clinical practice guideline
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L. A. Shrier, S. A. Moszczenski, S. J. Emans, M. R. Laufer, and E. R. Woods, 'Three Years of a Clinical Practice Guideline for Uncomplicated Pelvic Inflammatory Disease in Adolescents', Journal of Adolescent	No adherence studied
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P. Sunaert, H. Bastiaens, F. Nobels, L. Feyen, G. Verbeke, E. Vermeire, J. De Maeseneer, S. Willems, and A. De Sutter, 'Effectiveness of the Introduction of a Chronic Care Model-Based Program for Type 2 Diabetes in Belgium', BMC Health Serv Res, 10 (2010), 207.	Timeframe unclear
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T. R. Talbot, J. G. Johnson, C. Fergus, J. H. Domenico, W. Schaffner, T. L. Daniels, G. Wilson, J. Slayton, N. Feistritzer, and G. B. Hickson, 'Sustained Improvement in Hand Hygiene Adherence: Utilizing Shared Accountability and Financial Incentives', Infection Control and Hospital	Timeframe < 1 year
D. R. Taylor, 'Sustained Success of Collaboratively Developed Ondansetron Guidelines', Australian Journal of Hospital Pharmacy, 25	Insufficient information provided
J. Tjia, C. Lemay, K. M. Mazor, B. A. Briesacher, T. S. Field, A. O. Kanaan, J. L. Donovan, L. R. Harrold, and J. H. Gurwitz, 'Dissemination of Evidence-Based Antipsychotic Prescribing Guidelines to Nursing Homes: A Cluster Randomized Trial', Journal of the American Geriatrics Society,	Timeframe < 1 year
A. Mukerji, J. Narciso, C. Moore, A. McGeer, E. Kelly, and V. Shah, 'An Observational Study of the Hand Hygiene Initiative: A Comparison of Preintervention and Postintervention Outcomes', BMJ Open, 3 (2013).	Timeframe < 1 year
R. Van Acker, I. De Bourdeaudhuij, K. De Cocker, L. M. Klesges, A. Willem, and G. Cardon, 'Sustainability of the Whole-Community Project '10,000 Steps': A Longitudinal Study', BMC Public Health, 12 (2012), 155.	No adherence studied
D. Pittet, S. Hugonnet, S. Harbarth, P. Mourouga, V. Sauvan, S. Touveneau, and T. V. Perneger, 'Effectiveness of a Hospital-Wide Programme to Improve Compliance with Hand Hygiene. Infection Control Programme.[Erratum Appears in Lancet 2000 Dec 23-	Timeframe < 1 year
B. W. Warner, K. A. Rich, H. Atherton, C. L. Andersen, and U. R. Kotagal, 'The Sustained Impact of an Evidenced-Based Clinical Pathway for Acute Appendicitis', Seminars in Pediatric Surgery, 11 (2002), 29-35.	No adherence studied
F. H. van Tiel, T. W. O. Elenbaas, B. M. A. M. Voskuilen, J. Herczeg, F. W. Verheggen, B. Mochtar, and E. E. Stobberingh, 'Plan-Do-Study-Act Cycles as an Instrument for Improvement of Compliance with Infection Control Measures in Care of Patients after Cardiothoracic Surgery',	Timeframe < 1 year
B. W. Trautner, N. J. Petersen, A. Gendrett, S. Hysong, J. E. Patterson, and A. D. Naik, 'An Audit/Feedback Intervention Reduces Inappropriate Screening and Treatment in Patients with Urinary Catheters', Journal of the American Geriatrics Society, 62 (2014), S125.	Timeframe < 1 year
A. L. Wentworth, C. H. Fox, L. S. Kahn, K. Glaser, and R. Cadzow, 'Two Years after a Quality Improvement Intervention for Chronic Kidney Disease Care in a Primary Care Office', American Journal of Medical	No adherence studied
M. Whitby, M. L. McLaws, K. Slater, E. Tong, and B. Johnson, 'Three Successful Interventions in Health Care Workers That Improve Compliance with Hand Hygiene: Is Sustained Replication Possible?', American Journal of Infection Control, 36 (2008), 349-55.	Timeframe < 1 year
S. Whitelaw, N. Graham, D. Black, J. Coburn, and L. Renwick, 'Developing Capacity and Achieving Sustainable Implementation in Healthy 'Settings': Insights from Nhs Health Scotland's Health Promoting Health Service Project', Health promotion international, 27 (2012), 127-37.	No research article
L. J. Weireter, Jr., J. N. Collins, R. C. Britt, S. F. Reed, T. J. Novosel, and L. D. Britt, 'Impact of a Monitored Program of Care on Incidence of Ventilator-Associated Pneumonia: Results of a Longterm Performance-Improvement Project', Journal of the American College of Surgeons, 208	Timeframe unclear
R. B. Womer, E. Tracy, W. Soo-Hoo, B. Bickert, S. DiTaranto, and J. H. Barnsteiner, 'Multidisciplinary Systems Approach to Chemotherapy Safety: Rebuilding Processes and Holding the Gains', Journal of Clinical	No adherence studied

D. M. Zerr, A. L. Allpress, J. Heath, R. Bornemann, and E. Bennett, 'Decreasing Hospital-Associated Rotavirus Infection: A Multidisciplinary Hand Hygiene Campaign in a Children's Hospital', Pediatric Infectious	Timeframe < 1 year
N. Zwar, J. Henderson, H. Britt, K. McGeechan, and G. Yeo, 'Influencing Antibiotic Prescribing by Prescriber Feedback and Management Guidelines: A 5-Year Follow-Up', in Family practice (2002), pp. 12-7.	No focus on a clinical practice guideline

Supplementary file 3. Implementation strategies as described by the authors

Implementation strategies as described by the authors

	professional interventions				
Author	**Distribution of educational materials**	**Educational meetings**	**Local consensus processes**	**Educational outreach visits**	**Local opinion leaders**
Ament [20, 33, 34]	•	•	•	•	•
Benenson [21]			•		
Cates [22]					
Enriquez-Puga [23], Antidepressant prescription guideline	•		•	•	
Enriquez-Puga [23], antibiotic prescription guideline	•		•	•	
Forsner [24], depression guideline	•	•	•	•	•
Forsner [24], suicidal behaviours guideline	•	•	•	•	•
Higuchi [25], Adult Asthma Care Best Practice Guideline	•	•		•	•
Higuchi [25], Reducing Foot Complications for People with Diabetes Best Practice Guideline	•	•		•	•
Kelly [26] *					
Knops [27, 35] fluid balance guideline for oncology patients *					
Knops [27, 35, 36] body temperature guideline for postoperative patients	•	•			
Loszadi [28]		•			
McLaws [29, 37]	•			•	•
Stephan [30]	•	•	•		
Wakefield [31]		•	•		
Williams [32]					

*no information about the implementation strategy provided

● item explicitly stated in one of the related articles of the study

Supplementary file 3. Implementation strategies as described by the authors

Author	**Patient mediated interventions**	**Audit and feedback**	**Reminders**	**Marketing**	**Mass media**	**Other**
Ament [20, 33, 34]		•				
Benenson [21]						
Cates [22]						
Enriquez-Puga [23], Antidepressant prescription guideline		•				
Enriquez-Puga [23], antibiotic prescription guideline		•				
Forsner [24], depression guideline		•				participation in local network
Forsner [24], suicidal behaviours guideline		•				participation in local network
Higuchi [25], Adult Asthma Care Best Practice Guideline		•			•	
Higuchi [25], Reducing Foot Complications for People with Diabetes Best Practice Guideline		•			•	
Kelly [26] *						
Knops [27, 35] fluid balance guideline for oncology patients *						
Knops [27, 35, 36] body temperature guideline for postoperative patients		•				
Loszadi [28]		•				
McLaws [29, 37]		•	•		•	
Stephan [30]		•	•		•	
Wakefield [31]			•			
Williams [32]		•				

*no information about the implementation strategy provided

● item explicitly stated in one of the related articles of the study

Supplementary file 3. Implementation strategies as described by the authors

	Financial interventions	Organisational interventions		
Author	**Other**	**Revision of professional roles**	**Clinical multidisciplinary team**	**Formal integration of services**
Ament [20, 33, 34]			•	•
Benenson [21]			•	•
Cates [22]				
Enriquez-Puga [23], Antidepressant prescription guideline				
Enriquez-Puga [23], antibiotic prescription guideline				
Forsner [24], depression guideline			•	
Forsner [24], suicidal behaviours guideline			•	
Higuchi [25], Adult Asthma Care Best Practice Guideline	Additional funding to replace nurses while they performed implementation activities			
Higuchi [25], Reducing Foot Complications for People with Diabetes Best Practice Guideline	Additional funding to replace nurses while they performed implementation activities			
Kelly [26] *				
Knops [27, 35] fluid balance guideline for oncology patients *				
Knops [27, 35, 36] body temperature guideline for postoperative patients				
Loszadi [28]				
McLaws [29, 37]				
Stephan [30]				
Wakefield [31]			•	
Williams [32]				

*no information about the implementation strategy provided

● item explicitly stated in one of the related articles of the study

Supplementary file 3. Implementation strategies as described by the authors

Author	Skill mix changes	Continuity of care	Changes in physical structure, facilities and equipment	Presence and organisation of quality monitoring mechanisms
Ament [20, 33, 34]		•		
Benenson [21]		•		
Cates [22]				
Enriquez-Puga [23], Antidepressant prescription guideline				
Enriquez-Puga [23], antibiotic prescription guideline				
Forsner [24], depression guideline				
Forsner [24], suicidal behaviours guideline				
Higuchi [25], Adult Asthma Care Best Practice Guideline				
Higuchi [25], Reducing Foot Complications for People with Diabetes Best Practice Guideline				
Kelly [26] *				
Knops [27, 35] fluid balance guideline for oncology patients *				
Knops [27, 35, 36] body temperature guideline for postoperative patients				
Loszadi [28]				
McLaws [29, 37]			•	•
Stephan [30]				
Wakefield [31]				
Williams [32]			•	

*no information about the implementation strategy provided

• item explicitly stated in one of the related articles of the study

Supplementary file 3. Implementation strategies as described by the authors

	Other
Author	
Ament [20, 33, 34]	
Benenson [21]	standard antibiotic order sheet
Cates [22]	Evidence-based patient handout
Enriquez-Puga [23], Antidepressant prescription guideline	
Enriquez-Puga [23], antibiotic prescription guideline	
Forsner [24], depression guideline	
Forsner [24], suicidal behaviours guideline	
Higuchi [25], Adult Asthma Care Best Practice Guideline	New documentation procedures
Higuchi [25], Reducing Foot Complications for People with Diabetes Best Practice Guideline	New documentation procedures
Kelly [26] *	
Knops [27, 35] fluid balance guideline for oncology patients *	
Knops [27, 35, 36] body temperature guideline for postoperative patients	
Loszadi [28]	
McLaws [29, 37]	
Stephan [30]	
Wakefield [31]	
Williams [32]	

*no information about the implementation strategy provided

● item explicitly stated in one of the related articles of the study

Supplementary file 4. Sustainability of professionals' adherence to clinical practice guidelines (detailed table)

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
Ament [20]	Proportion of patients treated following guideline recommendations:				5
	1a.Treatment is discussed in a preoperative multidisciplinary meeting*(n)	86% (n=139/161)	95% (154/163)	100% (n=156/156)	
	1b.The interval between referral and first visit to the breast unit is 5 working days or less*(n)	37% (n=16/44)	61% (45/75)	84% (n=109/130)	
	1c.The interval between diagnostic tests and informing patients about the results is 5 working days or less*(n)	62% (n=99/161)	64% (n=105/163)	90% (n=133/147)	
	1d.The interval between the decision to operate and surgery is 15 working days or less*(n)	89% (n= 144/161)	80% (n=131/163)	80% (n=128/160)	
	1e.The general practitioner is informed about the diagnosis, treatment plan and potential side-effects prior to surgery*(n)	73% (n=118/161)	76% (n=123/163)	98% (n=156/160)	
	1f.The breast nurse stays in contact with the patient after short stay (phone consultation)* (n)	7% (n=11/161)	12% (n=19/163)	15% (n=24/159)	
	Overall (excluding missing values) (original guideline comprises thirteen key recommendations)	59%	65%	78%	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
Benenson [21]	(1)Mean time to treatment (2) Initial treatment given at emergency department	(1)314.7 min (SD=199.0) (2)36/63 (58.1%)	(1)174.7 min (SD=113.1) (2)90/96 (93.8%)	(1)117.2 min (SD=98.8) (2)116/122 (96.7%)	3
Cates [22]	Annual number of prescriptions per 100 children < 5 years old (n)	Centre 1: n=139 Centre 2: n=122	Centre 1: n=95 Centre 2: n=67	Centre 1: n=76 Centre 2: n=61	Centre 1:3 Centre 2:2
Enriquez-Puga [23]	(1)Number of items antibiotics (co-amixiclav and quinolone) prescribed for each six-month study period per 1000 patients (2)Number of items antidepressants (lofepramine and fluoxetine) prescribed for each six-month study period per 1000 patients Notes: regression analysis adjusting for baseline	(1)Intervention group: 6.9 (1)Control group: 5.8 (2)Intervention group: 26.7 (2)Control group: 20.9	(1)Intervention group: 4.6 (1)Control group: 6.2 (2)Intervention group: 27.7 (2)Control group: 21.4	(1)Intervention group: 5.3 (1)Control group: 6.4 (2)Intervention group: 28.6 (2)Control group: 20.8	1.5
Forsner [24]	1 Proportion of patients treated following guideline recommendations for depression				1.5

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
	1a Accessibility/wait time	Intervention group: 77.9% (n=95/122) Control group: 59.0% (n=36/61)	Intervention group: 89.2% (n=107/120) Control group: 53.3% (n=32/60)	Intervention group: 90% (n=216/240) Control group: 51.7% (n=62/120)	
	1b Diagnostic assessment	Intervention group: 83.6% (n=102/122) Control group: 88.5% (n=54/61)	Intervention group: 97.5% (n=117/120) Control group: 90.0% (n=54/60)	Intervention group: 97.9% (n=235/240) Control group: 79.2% (n=95/120)	
	1c Diagnostic instrument	Intervention group: 12.3% (n=15/122) Control group: 1.6% (n=1/62)	Intervention group: 28.3% (n=34/120) Control group: 0% (n=0/60)	Intervention group: 44.2% (n=106/240) Control group: 0.8% (n=1/120)	
	1d Standardized rating scale	Intervention group: 64.8% (n=79/122) Control group: 44.3% (n=27/61)	Intervention group: 91.7% (n=110/120) Control group: 33.3% (n=20/60)	Intervention group: 94.2% (n=226/240) Control group: 36.7% (n=44/120)	
	1e Standardized rating scale during treatment	Intervention group: 50.0% (n=61/122) Control group: 24.6% (n=15/61)	Intervention group: 87.5% (n=105/120) Control group: 38.3% (n=23/60)	Intervention group: 88.3% (n=212/240) Control group: 33.3% (n=40/120)	
	1f Substance/drug abuse	Intervention group: 46.7% (n=57/122) Control group: 32.8% (n=20/61)	Intervention group: 87.5% (n=105/120) Control group: 53.2% (n=32/60)	Intervention group: 88.8% (n=213/240) Control group: 43.3% (n=52/120)	
	1g Treatment (care) plan	Intervention group: 59.8% (n=73/122) Control group: 42.6% (n=26/61)	Intervention group: 87.5% (n=105/120) Control group: 38.3% (n=23/60)	Intervention group: 91.3% (n=219/240) Control group: 27.5% (n=33/120)	
	1h Evaluation/outcome	Intervention group: 66.4% (n=81/122)	Intervention group: 95.8% (115/120)	Intervention group: 95.8% (n=230/240)	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
		Control group:	Control group:	Control group:	
		59.0% (n=36/61)	55.0% (n=33/60)	48.3 (n=58/120)	
	1i Continuity	Intervention group:	Intervention group:	Intervention group:	
		77.0% (n=94/122)	95.0% (n=114/120)	95.8% (n=230/240)	
		Control group:	Control group:	Control group:	
		78.7% (n=48/61)	61.7% (n=37/60)	68.3% (n=82/120)	
	1j Suicide assessment	Intervention group:	Intervention group:	Intervention group:	
		40.2% (n=49/122)	95.8% (n=115/120)	97.5% (n=234/240)	
		Control group:	Control group:	Control group:	
		45.9% (n=28/61)	35.0% (n=21/60)	30.0% (n=36/120)	
	1k Antidepressant medication	Intervention group:	Intervention group:	Intervention group:	
		54.1% (n=66/122)	90.8% (n=109/120)	92.5% (n=222/240)	
		Control group:	Control group:	Control group:	
		45.9% (n=28/61)	36.7% (n=22/60)	41.7% (n=50/120)	
	2 Proportion of patients treated following guideline recommendations for suicidal behaviour in % (n)				
	2a Accessibility/wait time	Intervention group:	Intervention group:	Intervention group:	
		15.7% (n=19/121)	14.2% (n=17/120)	59.2% (n=142/240)	
		Control group:	Control group:	Control group:	
		29.5% (n=18/61)	31.7% (n=19/60)	0% (n=0/120)	
	2b Diagnostic assessment	Intervention group:	Intervention group:	Intervention group:	
		49.6% (n=60/121)	73.3% (n=88/120)	91.7% (n=220/240)	
		Control group:	Control group:	Control group:	
		26.2% (n=16/61)	16.7% (n=10/60)	0% (n=0)	
	2c Diagnostic instrument	Intervention group:	Intervention group:	Intervention group:	
		0% (n=0/121)	7.5% (n=9/120)	7.5% (n=18)	
		Control group:	Control group:	Control group:	
		0% (n=0/61)	0% (n=0/60)	0% (n=0)	
	2d Standardized rating scale	Intervention group:	Intervention group:	Intervention group:	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
		41.3% (n=50/121)	67.5% (n=81/120)	78.3% (n=188)	
		Control group:	Control group:	Control group:	
		27.9% (n=17/61)	16.7% (n=10/60)	0.8% (n=1)	
	2e Standardized rating scale during treatment	Intervention group:	Intervention group:	Intervention group:	
		16.5% (n=20/121)	52.5% (n=63/120)	55.8% (n=134)	
		Control group:	Control group:	Control group:	
		16.4% (n=10/61)	10.0% (n=6/60)	5.0% (n=6)	
	2f Substance/drug abuse	Intervention group:	Intervention group:	Intervention group:	
		52.1% (n=63/121)	64.2% (n=77/120)	80.0% (n=192)	
		Control group:	Control group:	Control group:	
		55.7% (n=34/61)	56.7% (n=34/60)	29.2% (n=35)	
	2g Treatment (care) plan	Intervention group:	Intervention group:	Intervention group:	
		37.4% (n=68/182)	58.9% (n=106/120)	79.2% (n=190)	
		Control group:	Control group:	Control group:	
		44.3% (n=27/61)	41.7% (n=25/60)	0.8% (n=1)	
	2h Evaluation/outcome	Intervention group:	Intervention group:	Intervention group:	
		20.7% (n=25/121)	47.5% (n=57/120)	51.7% (n=124)	
		Control group:	Control group:	Control group:	
		19.7% (n=12/61)	8.3% (n=5/60)	0% (n=0)	
	2i Continuity	Intervention group:	Intervention group:	Intervention group:	
		86.0% (n=104/121)	81.7% (n=98/120)	91.3% (n=219)	
		Control group:	Control group:	Control group:	
		49.2% (n=30/61)	31.7% (n=19/60)	0% (n=0)	
	2j Suicide assessment	Intervention group:	Intervention group:	Intervention group:	
		55.4% (n=67/121)	93.3% (n=112/120)	97.1% (n=233)	
		Control group:	Control group:	Control group:	
		82.0% (n=50/61)	73.3% (n=44/60)	56.7% (n=68)	
	2k Specialist assessment	Intervention group:	Intervention group:	Intervention group:	
		50.4% (n=61/121)	85.4% (n=103/120)	91.7% (n=220)	
		Control group:	Control group:	Control group:	
		83.6% (n=51/61)	83.3% (n=50/60)	71.7% (n=86)	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
	2l Follow-up	Intervention group: 72.7% (n=88/121) Control group: 75.4% (n=46/61)	Intervention group: 88.3% (n=106/120) Control group: 65.0% (n=39/60)	Intervention group: 99.1% (n=221) Control group: 33.3% (n=45)	
	2m Evaluation assessment	Intervention group: 32.2% (n=39/121) Control group: 18.0% (n=11/61)	Intervention group: 64.2% (n=77/120) Control group: 13.3% (n=8/60)	Intervention group: 79.8% (n=180) Control group: 16.2% (n=13)	
Higuchi [25]	1 Proportion of patients receiving care according to asthma guideline recommendations	Not clear	(total n=10)	(total n=62)	Asthma: 4 Diabetes: 3
	1a Respiratory assessment done		n=10/10 100%	n=61/62 98.4%	
	Level of asthma control documented for :				
	1b medication in use		n=10/10 100%	n=61/62 98.4%	
	1c Use of B2 agonist		n=10/10 100%	n=52/62 84.4%	
	1d Experience of daytime symptoms		n=8/10 80.0%	n=32/62 51.7%	
	1e Experience of night time and/or awaking symptoms		n=8/10 80.0%	n=16/62 26.2%	
	1f Physical activity		n= unclear 77.8%	n=29/62 46.8%	
	1g Absence from school or work		n=7/10 70.0%	n=3/62 4.9%	
	1h Exacerbation		n=7/10 70.0%	n=47/62 76.2%	
	1i Individualised action plan developed for client's discharge		n=7/10 70.0%	n=2/62 3.2%	
	1j Baseline teaching information on asthma provided to patient by a nurse		n=6/10 60.0%	n=16/62 25.4%	
	1k Written information on asthma provided		n=6/10 60.0%	n=4/62 6.6%	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
	2 Proportion of patients receiving care according to diabetes foot care guideline recommendations (n=12)		(total n=50)	(total n=65)	
	2a Assessment for risk factors: foot ulceration/amputation		n=22/50 44.0%	n=64/65 98.5%	
	2b Assessment loss of protective sensation		n=5/50 10.0%	n=10/65 15.6%	
	2c Assessment Structural or biochemical abnormalities		n=3/50 6.0%	n=59/65 90.8%	
	2d Assessment evidence of impaired circulation		n=1/50 2.0%	n=34/65 52.3%	
	2e Assessment Deficit in self-care behaviour		n=14/50 28.0%	n=10/65 15.4%	
	2f Monofilament used to assess sensation in the feet		n=21/50 42.0%	n=41/65 63.1%	
	2g Risk classification for foot ulcer/amputation		n=37/50 73.7%	n=30/65 45.9%	
	Basic foot care education done on:				
	2h Client's risk factors		n=15/50 30.0%	n=53/62 81.5%	
	2i Daily self-inspection of feet		n=15/50 30.0%	n=53/62 81.5%	
	2j Proper nail and skin care		n=15/50 30.0%	n=54/62 83.1%	
	2k Injury prevention		n=15/50 30.0%	n=53/62 81.5%	
	2l When to seek help		n=15/50 30.0%	n=54/62 83.1%	
Kelly [26]	Proportion of patients receiving IM narcotic analgesia	76% (n=48/63)	NA	3% (n=2/65)	2
Knops [27]	(1)Proportion of patients receiving care according to fluid balance guideline recommendations	(1)NA	(1)NA	(1)100% (534/534)	7

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
	(2)Proportion of patients receiving care according to body temperature guideline recommendations	(2)NA	(2)91%	(2)50% (617/1226)	
Loszadi [28]	Proportion of patients receiving care according to guideline recommendations	61% (n=29/48)	79% (n=38/48)	92% (n=44/48)	unclear, >2
Mclaws [29]	(hand hygiene events observed / hand hygiene opportunities)x100 (%)	47% (3795/8057)	62% (NA)	58% (4041/6972)	1.5
Stephan [30]	Proportion of patients receiving care according to guideline recommendations	NA	82.2% (n=410/499)	80% (n=242/300)	1.5
Wakefield [31]	Proportion of patients receiving care according to guideline recommendations	Authors reported that the LATE POST compliance was lower compared to the EARLY POST measurement, but no further details were provided	NA	NS	1.5
Williams [32]	Proportion of patients treated according to guideline recommendations for the repair and follow-up of third degree tears				2
	A Senior SpR present	30% (n=13/44)	40% (n=20/50)	60% (n=18/30)	
	Theatre	70% (n=31/44)	82% (n=41/50)	97% (n=29/30)	
	GA/Regional	70% (n=31/44)	82% (n=41/50)	97% (n=29/30)	
	Prolene	64% (n=28/44)	76% (n=38/50)	93% (n=28/30)	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
	Overlap documented	30% (n=13/44)	54% (n=27/50)	67% (n=20/30)	

na: not applicable

Supplementary File 5: Risk of bias using the Downs and

	Author:	Ament [20]	Benenson [21]	Cates [22]	Enriquez [23]	Forsner [24]	Iliguchi [25]	Kelly [26]	Knops [27]	Lozsadi [28]
	Reporting	**comment**								
1	Is the hypothesis/aim/objective of the study clearly described?		yes	yes	no	yes	yes	yes	yes	yes
2	Are the main outcomes to be measured clearly described in the Introduction or Methods section?		yes	yes	yes	yes	yes	yes	yes	yes
3	Are the characteristics of the patients included in the study clearly described ?	*Patients' was replaced by 'professionals'*	yes	yes	yes	yes	yes	no	yes	yes
4	Are the interventions of interest clearly described?	*Intervention was replaced by guideline*	yes	yes	yes	yes	yes	yes	yes	yes
5	Are the distributions of principal confounders in each group of subjects to be compared clearly described?		yes	yes	no	yes	yes	no	no	yes
6	Are the main findings of the study clearly described?		yes	yes	yes	yes	yes	no	yes	yes
7	Does the study provide estimates of the random variability in the data for the main outcomes?		na	na	na	na	na	na	na	na
8	Have all important adverse events that may be a consequence of the intervention been reported?		na	na	na	na	na	na	na	na
9	Have the characteristics of patients lost to follow-up been described?	*Patients' was replaced by 'professionals'*	utd	utd	utd	utd	utd	utd	utd	utd
10	Have actual probability values been reported (e.g. 0.035 rather than <0.05) for the main outcomes except where the probability value is less than 0.001?		yes	yes	utd	yes	yes	yes	utd	utd

	Author:	Ament [20]	Benenson [21]	Cates [22]	Enriquez [23]	Forsner [24]	Higuchi [25]	Kelly [26]	Knops [27]	Lozsadi [28]
External validity										
11 Were the subjects asked to participate in the study representative of the entire population from which they were recruited?	*Subjects' was replaced by 'professionals'. In case of general guideline and a multicentre study: yes. In case of a centre specific guideline and one guideline: yes.*	yes	no	utd	yes	yes	no	no	yes	no
12 Were those subjects who were prepared to participate representative of the entire population from which they were recruited?	*Subjects' was replaced by 'professionals'*	yes	utd	utd	no	yes	no	utd	yes	utd
13 Were the staff, places, and facilities where the patients were treated, representative of the treatment the majority of patients receive?		no	yes	yes	yes	yes	yes	yes	yes	no
Internal validity - bias										
14 Was an attempt made to blind study subjects to the intervention they have received?	*Subjects' was replaced by 'professionals'*	na	na	na	na	na	na	na	na	na
15 Was an attempt made to blind those measuring the main outcomes of the intervention?		utd	utd	utd	utd	utd	utd	utd	utd	utd
16 If any of the results of the study were based on “data dredging”, was this made clear?		no	no	no	no	no	no	no	no	yes

		Author:	Ament [20]	Benenson [21]	Cates [22]	Enriquez [23]	Forsner [24]	Higuchi [25]	Kelly [26]	Knops [27]	Lozsadi [28]
17	In trials and cohort studies, do the analyses adjust for different lengths of follow-up of patients, or in case-control studies, is the time period between the intervention and outcome the same for cases and controls ?	*Patients' was replaced by 'professionals'*	na	na	na	yes	yes	na	na	na	na
18	Were the statistical tests used to assess the main outcomes appropriate?		yes	yes	no	yes	yes	yes	yes	no	utd
19	Was compliance with the intervention/s reliable?		na	na	na	na	na	na	na	na	na
20	Were the main outcome measures used accurate (valid and reliable)?		yes	yes	yes	yes	yes	yes	yes	yes	yes
	Internal validity - confounding (selection bias and power)										
21	Were the patients in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited from the same population?	*Patients' was replaced by 'professionals'*	na	na	na	yes	yes	na	na	na	na
22	Were study subjects in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited over the same period of time?	*Study subjects' was replaced by 'professionals'*	na	na	na	yes	yes	na	na	na	na
23	Were study subjects randomised to intervention groups?	*Subjects' was replaced by 'professionals'*	no	no	no	yes	yes	no	no	no	no

	Author:	Ament [20]	Benenson [21]	Cates [22]	Enriquez [23]	Forsner [24]	Iiguchi [25]	Kelly [26]	Knops [27]	Lozsadi [28]
24	Was the randomised intervention assignment concealed from both patients and health care staff until recruitment was complete and irrevocable?	no	no	no	no	no	no	no	no	no
25	Was there adequate adjustment for confounding in the analyses from which the main findings were drawn?	no	yes	no	yes	no	no	yes	no	no
26	Were losses of patients to follow-up taken into account?	utd	utd	utd	yes	utd	utd	utd	utd	utd
27	Did the study have sufficient power to detect a clinically important effect where the probability value for a difference being due to chance is less than 5%?	no	no	no	yes	no	yes	no	no	no

Patients was replaced by professionals

utd: Items were qualified as 'unable to determine' when information was not reported
na: not applicable

Supplementary File 5: Risk of bias using the Downs and

		Author:	McLaws [29]	Stephan [30]	Wakefield [31]	Williams [32]
	Reporting	**comment**				
1	Is the hypothesis/aim/objective of the study clearly described?		yes	yes	yes	yes
2	Are the main outcomes to be measured clearly described in the Introduction or Methods section?		yes	yes	no	yes
3	Are the characteristics of the patients included in the study clearly described ?	*Patients' was replaced by 'professionals'*	yes	no	no	no
4	Are the interventions of interest clearly described?	*Intervention was replaced by guideline*	yes	yes	yes	yes
5	Are the distributions of principal confounders in each group of subjects to be compared clearly described?		no	yes	no	yes
6	Are the main findings of the study clearly described?		yes	yes	yes	yes
7	Does the study provide estimates of the random variability in the data for the main outcomes?		na	na	na	na
8	Have all important adverse events that may be a consequence of the intervention been reported?		na	na	na	na
9	Have the characteristics of patients lost to follow-up been described?	*Patients' was replaced by 'professionals'*	utd	utd	utd	utd
10	Have actual probability values been reported (e.g. 0.035 rather than <0.05) for the main outcomes except where the probability value is less than 0.001?		yes	yes	yes	yes

	Author:	McLaws [29]	Stephan [30]	Wakefield [31]	Williams [32]
	External validity				
11	Were the subjects asked to participate in the study representative of the entire population from which they were recruited?	*Subjects' was replaced by 'professionals'. In case of general guideline and a multicentre study: yes. In case of a centre specific guideline and one guideline: yes.*	yes	no	no	yes
12	Were those subjects who were prepared to participate representative of the entire population from which they were recruited?	*Subjects' was replaced by 'professionals'*	yes	utd	utd	yes
13	Were the staff, places, and facilities where the patients were treated, representative of the treatment the majority of patients receive?		yes	no	no	no
	Internal validity - bias					
14	Was an attempt made to blind study subjects to the intervention they have received?	*Subjects' was replaced by 'professionals'*	na	na	na	na
15	Was an attempt made to blind those measuring the main outcomes of the intervention?		utd	utd	utd	utd
16	If any of the results of the study were based on “data dredging”, was this made clear?		yes	yes	no	yes

		Author:	McLaws [29]	Stephan [30]	Wakefield [31]	Williams [32]
17	In trials and cohort studies, do the analyses adjust for different lengths of follow-up of patients, or in case-control studies, is the time period between the intervention and outcome the same for cases and controls ?	*Patients' was replaced by 'professionals'*	na	na	na	na
18	Were the statistical tests used to assess the main outcomes appropriate?		yes	yes	yes	yes
19	Was compliance with the intervention/s reliable?		na	na	na	na
20	Were the main outcome measures used accurate (valid and reliable)?		yes	yes	yes	yes
	Internal validity - confounding (selection bias and power)					
21	Were the patients in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited from the same population?	*Patients' was replaced by 'professionals'*	na	na	na	na
22	Were study subjects in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited over the same period of time?	*Study subjects' was replaced by 'professionals'*	na	na	na	na
23	Were study subjects randomised to intervention groups?	*Subjects' was replaced by 'professionals'*	no	no	no	no

	Author:	McLaws [29]	Stephan [30]	Wakefield [31]	Williams [32]
24 Was the randomised intervention assignment concealed from both patients and health care staff until recruitment was complete and irrevocable?		no	no	no	no
25 Was there adequate adjustment for confounding in the analyses from which the main findings were drawn?		yes	yes	no	no
26 Were losses of patients to follow-up taken into account?	*Patients was replaced by professionals*	utd	utd	utd	utd
27 Did the study have sufficient power to detect a clinically important effect where the probability value for a difference being due to chance is less than 5%?		no	yes	no	no

utd: Items were qualified as 'unable to determine' when information was
na: not applicable

Supplementary file 6. PRISMA Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	na
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4,5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5, additional file 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4,5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	5,6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	5,6

Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	na
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	na
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	na
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	na
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7, table 1
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	12, table 3
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	10, table 2, additional file 4
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	na
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	12, table 3
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	10
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	12,13
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	13,14

Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	14
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	15

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Sustainability of professionals' adherence to clinical practice guidelines in medical care: a systematic review

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Sustainability of professionals' adherence to clinical practice guidelines in medical care: a systematic review

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ABSTRACT

Objectives To evaluate 1) the state of the art in sustainability research and 2) the outcomes of professionals' adherence to guideline recommendations in medical practice.

Design Systematic review

Data sources Searches were conducted till August 2015 in MEDLINE, CINAHL, EMBASE, Cochrane Central Register of Controlled Trials (CENTRAL) and the Guidelines International Network (GIN) library. A snowball strategy, in which reference sections of other reviews and of included papers were searched, was used to identify additional papers.

Eligibility criteria Studies needed to be focused on sustainability and on professionals' adherence to clinical practice guidelines in medical care. Studies had to include at least two measurements: one before (PRE) or immediately after implementation (EARLY POST) and one measurement longer than one year after active implementation (LATE POST).

Results The search retrieved 4219 items, of which fourteen studies met the inclusion criteria, involving eighteen sustainability evaluations. The mean timeframe between the end of active implementation and the sustainability evaluation was 2.6 years [min 1.5 – max 7.0]. The studies were heterogeneous with respect to their methodology. Sustainability was considered to be successful if performance in terms of professionals' adherence was fully maintained in the late post-implementation phase. Long-term sustainability of professionals' adherence was reported in seven out of eighteen evaluations, adherence was not sustained in six evaluations, four evaluations showed mixed sustainability results and in one evaluation it was unclear whether the professional adherence was sustained.

Conclusions 2) Professionals' adherence to a clinical practice guideline in medical care decreased after more than one year after implementation in about half of the cases. **1)** Due to the limited number of studies, the absence of a uniform definition, the high risk of bias, and the mixed results of studies, no firm conclusion about the sustainability of professionals' adherence to guidelines in medical practice can be drawn.

Key words: sustainability, clinical practice guidelines, medical care, quality improvement, implementation, adherence

Article summary

Strengths and limitations of this study

- This is the first systematic review of the literature that has considered professionals' adherence to clinical practice guidelines more than one year after active implementation. This review shows that in half of the sustainability studies professionals fully sustained in their adherence to a clinical practice guideline.
- This review showed that sustainability research is a relatively new and underexplored field in health care.
- Sustainability research is not well indexed in electronic databases, and text word searches are prone to high recall and low specificity. However, it is likely that the use of a broad variety of search terms that covered sustainability, has downsized the number of relevant studies missed and is a strength of the review.
- The number of studies and the methodological quality of the studies focusing on the sustainability of professionals' adherence are limited. This makes it difficult to draw firm conclusions.

INTRODUCTION

Quality of care can be improved by decreasing unwarranted practice variation between professionals. One way to reduce practice variation is by transferring evidence-based knowledge into daily practice.

To facilitate the translation of the most recent evidence into practice, guidelines are developed and implemented. Following the Institute of Medicine (IOM), clinical practice 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 benefit and harms of alternative care options*" (1). Guidelines contain practical evidence based advice for professionals and patients and aim to improve the quality of care (2). In general, uptake of guidelines does not happen spontaneously and often an active implementation approach is required (3). Moreover, once a guideline is successfully implemented in practice, it may be difficult to sustain the quality improvements over a longer period of time. People tend to fall back into old routines (4) which may impact long-term adherence to a guideline.

The road towards sustainability of health care innovations into practice is suggested to be a dynamic process (5) and sustainable adherence may not be self-evident without continued efforts. Sustainable change of professionals' behaviour has the potential to result in more optimal health care delivery and efficiency. Not sustaining quality improvements can result in nihilistic attitudes towards future innovation. In recent years, sustainability has gained attention in healthcare. Unfortunately, the concept of sustainability is still underdeveloped (6, 7). Some existing reviews studied sustainability from a wide health care perspective, including studies varying from medical care to public health. Results showed that determinants of sustainability varied widely between healthcare areas (8, 9) and suggest that partial sustainability of health care innovations is more common than full sustainability (10).

In this systematic review, the scope of sustainability research will be narrowed to professionals' adherence to clinical practice guidelines in medical care. The aim of the current review was to evaluate the state of the art in sustainability research and the level of sustained professionals' adherence to guideline recommendations in medical practice more than one year following the cessation of the implementation project.

METHODS

Eligibility criteria

Studies needed to be focused on sustainability and on clinical practice guidelines. Sustainability was described as "*Sustainability of change exists when a newly implemented innovation continues to deliver the benefits achieved over a longer period of time, certainly does not return to the usual processes and becomes 'the way things are done around here'* (11)*, even after the implementation project is no longer actively carried out, until a better innovation comes along*" (12). Studies had to include at least two measurements: one before (PRE) or immediately after implementation (EARLY POST) and one measurement longer than one year after active implementation (LATE POST). All activities to facilitate the adherence to clinical practice guidelines were labelled as part of the implementation project. Studies needed to be focused on professionals' adherence to a clinical practice guideline. Studies only using self-reported adherence were excluded to reduce the chance of

social desirability bias and an overestimation of results (13). Lastly, studies had to focus on medical care. Participants had to be healthcare professionals who deliver direct patient care. There were no restrictions on study design of the research articles.

Search methods for identification of studies

Electronic searches

We searched MEDLINE (OvidSP) (1946- February 2014), CINAHL (EBSCO Host) (1982- February 2014), EMBASE (OvidSP) (February 2014), Cochrane Central Register of Controlled Trials (CENTRAL) and the Guidelines International Network (GIN) library for studies. The electronic search strategy was designed to focus on sustainability of guideline recommendations. Free text terms and MeSH terms regarding sustainability, quality improvement, impact and guideline recommendations were used. An information expert checked the developed search strategies (supplementary file 1). Before final analyses, update searches were performed to identify possible additional studies (June 26, 2014 and August 4, 2015).

Searching other resources

A snowball strategy was performed, in which the reference sections of reviews (6-10, 14) (15) (16) and research papers on sustainability (17, 18) were searched. Also, databases such as PubMed and the Web of Knowledge Science Citation Index were used to locate publications and publications citing the original references. The process was repeated for any new relevant publication found.

Data collection and analysis

Selection of studies

All records were merged into a bibliographic database and screened independently by two reviewers (SA, JdG) based on title and abstract. Full text screening was performed by two reviewers (SA, JdG). Disagreement on selection was resolved in consensus meetings with a third reviewer (TvW). Reasons for exclusion were documented during the full text screening. If more clarification or details of a study were needed, an author was contacted. Authors of conference abstracts were emailed and were asked to send the research protocol. Duplicate papers were identified and all papers published on one study were used for retrieving information.

Data extraction and management

Data of the methodology and results were independently extracted by two reviewers (SA, JdG), guided by a predefined data extraction form. Effective Practice and Organisation of Care (EPOC) Data Collection Checklist (19) items (e.g. location of care, type of targeted behaviour, implementation interventions) were integrated in the data extraction form. The data extraction form was developed by

the authors and was pilot tested. The following study characteristics were recorded: study design, publication year, whether the study was executed in a single centre or in multiple centres, type of targeted behaviour, location of care, the name of the clinical practice guideline, clinical specialty, the implementation activities used and whether or not the implementation strategy was externally guided. An externally guided implementation strategy is a strategy which is lead and supported by an external expert organisation. With respect to the methodology of the sustainability evaluation the following data were extracted: the timeframe between the end of the implementation strategy and the sustainability evaluation, the applied definition of sustainability, the data collection method, whether the evaluation was performed on patient, hospital or multiple hospital level and whether the sustainability evaluation was performed on single or multiple centre level. With respect to the outcome measures of the studies, data on the professionals' adherence rates before, early after implementation and longer than one year after implementation, and the authors' comments with respect to the sustainability of professionals' adherence were extracted. Adherence was presented in terms of proportion of patients receiving treatment according to the clinical practice guideline recommendations. If sustainability of professionals' adherence to a clinical practice guideline was evaluated at multiple post-implementation moments, the latest evaluation was selected as LATE POST measurement. The authors (SA and JdG) checked if updates of the clinical practice guidelines had become available in the post-implementation phase (e.g. between the EARLY POST and the LATE POST measurement), which may explain reduced professionals' adherence. Disagreement on data extraction was resolved in consensus meetings with a third reviewer (TvW).

Assessment of risk of bias in included studies

Risk of bias assessment was independently conducted by two authors using the Downs and Black checklist for randomized and non-randomized studies (20). This is a checklist which can be used for checking the risk of bias of original research articles of various study designs. Results were interpreted under consideration of risk of bias. The assessments were also used for recommendations for further research by identifying elements of studies that can be improved in future studies. The checklist was adapted to the research question. Risk of bias of the studies was presented on reporting, external validity, internal validity (bias and confounding), power and overall level.

Analysis

The analysis was narrative. This included a summary of the methodological characteristics of the sustainability evaluations, descriptions of the level of sustainability as mentioned by the author, and the level of sustained professionals' adherence compared to results achieved immediately after implementation. Sustainability was considered to be successful if performance in terms of professionals' adherence was fully maintained in the late post-implementation phase. A sensitivity analysis was performed by applying a 90% instead of 100% adherence criterion of sustainability.

RESULTS

Description of studies

For this review, 4219 items were retrieved and screened based on title and abstract, and 185 studies were assessed based on full text reading. Figure 1 shows the study selection process as recommended by the PRISMA statement (21) (supplementary file 2). Fourteen studies met the inclusion criteria for this review, describing eighteen sustainability evaluations (22-35). Table 1 presents the characteristics of the included studies. Two publications were published before and twelve after 2000 (23, 33). In six studies the targeted behaviour was prescribing (24, 25, 28, 30, 33, 35), in four studies procedures (29, 31, 32, 34), in three studies general management of a problem (22, 26, 27) and in one study (23) general management of a problem and prescribing. The location of care was inpatient in five studies (23, 28, 29, 32, 34), outpatient in four studies (24-26, 35) and mixed in five studies (22, 27, 30, 31, 33).

The implementation strategy was described in thirteen studies (table 2) (22-27, 29-41). According to the EPOC checklist classification, in one study (24), a single element implementation strategy was executed while in the other twelve studies a multi-faceted implementation strategy was executed. Implementation activities were professional targeted interventions (n=12) {Ament, 2014 #20;de Kok, 2010 #33;Ament, 2014 #34;Benenson, 1999 #21;Enriquez-Puga, 2009 #23;Forsner, 2010 #24;Higuchi, 2011 #25;Knops, 2010 #27;Mank, 2003 #35;Knops, 2010 #27;Lozsadi, 2006 #28;Storm-Versloot, 2012 #36;Pantle, 2009 #37;Stephan, 2006 #30;Wakefield, 1998 #31;Williams, 2003 #32;Gerber, 2013 #67;Gerber, 2014 #69}, followed by organisational interventions (n=6) (22, 23, 26, 33, 34, 36, 37, 39, 40) and financial interventions (n=1) (27). In six studies the implementation strategy was facilitated by external experts (22, 25-27, 31, 35). In one study it was unclear whether the implementation strategy was externally supported (28).

Table 1. Characteristics of the included studies

Study ID	Study design	Clinical practice guideline	Clinical specialty	Clinical practice guideline was updated in the post-implementation phase* (yes/no)	Time frame (years)
Ament (22) (2014) The Netherlands	case series	Guideline to facilitate short stay for breast cancer surgery (36)	Surgery	Between 2007-2012: No (42, 43)**	5
Benenson (23) (1999) UK	case series	Clinical pathway for pneumonia (44)	Various	Between 1995-1997: No (45, 46)	3
Cates (24)(2009) UK	case series	Guideline for antibiotic prescription for children with earache and inflamed eardrums who are not unduly ill (47)	General practice	Between 1998-2001: No (48)**	Centre 1: 3 Centre 2: 2
Enriquez-Puga (25) (2009) UK	RCT	(1) Antidepressant prescription guideline and (49) (2) Antibiotic prescription guideline (50) Control group: intervention groups were each other's control group	General practice	Guideline 1 between 2003-2004: yes (51) Guideline 2 between 2003-2004: No (50)	1.5
Forsner (26) (2010) Sweden	RCT	Clinical guideline (1) for depression (52) and (2) for suicidal behaviours (48) Control group: received the guideline but were not included in the intervention	Psychiatry	UTD	1.5
Gerber (35) (2014) USA	case series	Outpatient antimicrobial stewardship intervention (53)	Pediatric primary care	Between 2011 - 2014: no (53)	1.5
Higuchi (27) (2011) Canada	case series	(1) Adult Asthma Care Best Practice Guideline (54) and (2) Reducing Foot Complications for People with Diabetes Best Practice Guideline (55)	(1)Various (2)Various	Guideline 1 between 2002-2006: Yes (56) Guideline 2 between 2003-2006: Yes (57)	(1) 4 (2) 3
Kelly (28) (2000) Australia	case series	Guideline for nurse managed titrated narcotic analgesia (58)	Emergency medicine	UTD	2
Knops (29) (2010) The Netherlands	case series	(1) a fluid balance guideline for oncology patients (38) (2) a body temperature guideline for postoperative patients (59)	(1) Various (2) Surgery	Guideline 1 UTD (local guideline) Guideline 2 UTD (local guideline)	7
Loszadi (30) (2006) UK	case series	Guidelines for the prevention and management of corticosteroid induced osteoporosis (60)	Neurology	UTD	Unknown, > 2
Mclaws (31) (2009) Australia	case series	Guidelines on Hand Hygiene in Health Care (61)	Various	Between 2007-2008: No (61)	1.5
Stephan (32)	case	Guideline for urine catheterization management for surgical	Orthopaedic /	UTD (local guideline)	1.5

(2006) Switzerland	series	procedures (62)	abdominal surgery		
Wakefield (33) (1998) USA	case series	Guideline for the use of transdermal fentanyl for chronic pain (33)	Various	UTD	1.5
Williams (34) (2003) UK	case series	Guideline for the repair and follow-up of third degree tears (63)	Obstetrics and gynaecology	UTD (local guideline)	2
* The cpg was updated between the POST and LATE POST measurement (yes) or was not updated between the POST and LATE POST measurement (no) **Not updated with respect to the key recommendations of the guideline. The guideline was adopted in national guidelines in the post-implementation phase. UTD: unable to determine					

Table 2 Implementation strategies as described by the authors

Author	Professional interventions					
	Distribution of educational materials	Educational meetings	Local consensus processes	Educational outreach visits	Local opinion leaders	Patient mediated interventions
Ament [22]	●	●	●	●	●	
Benenson [23]			●			
Cates [24]						
Enriquez-Puga [25], Antidepressant prescription guideline	●		●	●		
Enriquez-Puga [25], antibiotic prescription guideline	●		●	●		
Forsner [26], depression guideline	●	●	●	●	●	
Forsner [26], suicidal behaviours guideline	●	●	●	●	●	
Gerber [35]			●			
Higuchi [27], Adult Asthma Care Best Practice Guideline	●	●		●	●	
Higuchi [27], Reducing Foot Complications for People with Diabetes Best Practice Guideline	●	●		●	●	
Kelly [28] *						
Knops [29] fluid balance guideline for oncology patients *						
Knops [29] body temperature guideline for postoperative patients	●	●				
Loszadi [30]		●				
McLaws [31]	●			●	●	
Stephan [32]	●	●	●			
Wakefield [33]		●	●			
Williams [34]						

*no information about the implementation strategy provided

● item explicitly stated in one of the related articles of the study

Author	Professional interventions					Financial interventions
	Audit and feedback	Reminders	Marketing	Mass media	Other	Other
Ament [22]	•					
Benenson [23]						
Cates [24]						
Enriquez-Puga [25], Antidepressant prescription guideline	•		•			
Enriquez-Puga [25], antibiotic prescription guideline	•		•			
Forsner [26], depression guideline	•				participation in local network	
Forsner [26], suicidal behaviours guideline	•				participation in local network	
Gerber [35]	•					
Higuchi [27], Adult Asthma Care Best Practice Guideline	•			•		Additional funding to replace nurses while they performed implementation activities
Higuchi [27], Reducing Foot Complications for People with Diabetes Best Practice Guideline	•			•		Additional funding to replace nurses while they performed implementation activities
Kelly [28] *						
Knops [29] fluid balance guideline for oncology patients *						
Knops [29] body temperature guideline for postoperative patients	•		•			
Loszadi [30]	•					
McLaws [31]	•	•		•		
Stephan [32]	•	•		•		
Wakefield [33]		•				
Williams [34]	•					

*no information about the implementation strategy provided
• item explicitly stated in one of the related articles of the study

Author	Organisational interventions							Other
	Revision of professional roles	Clinical multidisciplinary team	Formal integration of services	Skill mix changes	Continuity of care	Changes in physical structure, facilities and equipment	Presence and organisation of quality monitoring	
Ament [22]		•	•		•			
Benenson [23]		•	•		•			Standard antibiotic order sheet
Cates [24]								Evidence-based patient handout
Enriquez-Puga [25], Antidepressant prescription guideline								
Enriquez-Puga [25], antibiotic prescription guideline								
Forsner [26], depression guideline		•						
Forsner [26], suicidal behaviours guideline		•						
Gerber [35]								
Higuchi [27], Adult Asthma Care Best Practice Guideline								New documentation procedures
Higuchi [27], Reducing Foot Complications for People with Diabetes Best Practice Guideline								New documentation procedures
Kelly [28] *								
Knops [29] fluid balance guideline for oncology patients *								
Knops [29] body temperature guideline for postoperative patients								
Loszadi [30]								
McLaws [31]						•	•	
Stephan [32]								
Wakefield [33]		•						
Williams [34]						•		

*no information about the implementation strategy provided

• item explicitly stated in one of the related articles of the study

Characteristics of the sustainability evaluations

The mean timeframe between the end of the implementation strategy and the sustainability evaluation of thirteen studies was 2.6 years [min 1.5 – max 7.0]. The actual timeframe of one evaluation was unclear, but was at least two years (30). Two studies referred to a definition of sustainability (22, 27). Eight studies used a retrospective data collection method (23-29, 33), three studies used a prospective data collection method (31, 32, 35) and three studies used both a prospective and a retrospective data collection method (22, 30, 34). Ten papers reported the level of sustained adherence of a single clinical practice guideline (22-24, 28, 30-35), while four reported the late post-implementation adherence of two clinical practice guidelines (25-27, 29). Seven studies had a single centre design (23, 28-30, 32-34) and seven studies evaluated sustainability in multiple centres (22, 24-27, 31, 35). Four out of six multiple centre studies evaluated the sustainability on multiple centre level (22, 26, 31, 35). Two out of six multiple centre studies evaluated the sustainability of professionals' adherence of two guidelines which were implemented in one centre each (24, 27).

Sustainability of changed behaviour

The level of professionals' adherence was fully sustained in seven out of eighteen evaluations (table 3, supplementary file 3). The adherence was not fully sustained in six evaluations and four evaluations showed mixed sustainability results in the LATE POST measurement compared to the EARLY POST measurement. In one study, the EARLY POST measurement was not executed, while the authors reported sustained results (28). After decreasing the sustainability level of professionals' adherence to 90% or higher, nine out of eighteen evaluations showed sustained results, three evaluations showed no sustained results, four evaluations showed mixed results. In two evaluations it was unclear whether the professionals' adherence had been sustained at a level 90% or higher.

Five of the ten papers that reported about a single clinical practice guideline presented sustained professionals' adherence to clinical practice guidelines in the LATE POST measurement (22-24, 30, 34). One of these five papers evaluated the sustainability of a single clinical practice guideline in two centres (24). In both centres professionals' adherence had improved in the LATE POST measurement compared to the EARLY POST measurement. The four studies analysing the sustainability of two clinical practice guidelines showed mixed results. Two of these four studies (25, 29), presented the same level or improved adherence to one guideline and decreased adherence to the other guideline in the LATE POST measurement compared to the EARLY POST measurement. The other two of these four studies (26, 27) presented adherence results on guideline recommendation level and did not present overall adherence results on patient level. The adherence to the recommendations of the clinical practice guidelines showed decreased and improved levels in the LATE POST measurement compared to the EARLY POST measurement. In total, eight papers mentioned the term 'sustainability' in the conclusion (table 3) (22-28, 32). Five of these studies concluded to have sustained professionals' adherence in the late post-implementation phase (22-24, 28, 32), three out of eight

studies described to have a ‘mixed pattern’, ‘small desired’ or ‘almost’ sustained professionals’ adherence (25-27).

Table 3. Sustainability of professionals' adherence to clinical practice guidelines

Study ID	Authors' comments in terms of sustainability of adherence to the clinical practice guideline*	Sustained compared to early implementation results (100%) (yes/no)**	Sustained compared to early implementation results (90%) (yes/no)***
Ament (22)	"Adherence to the guideline recommendations was *sustained* in four early adopter hospitals"	yes	yes
Benenson (23)	"The observed pre pathway to post pathway differences were *sustained* over three years"	yes	yes
Cates (24)	(Centre 1 & 2) "our approach has brought about a *sustained* reduction in the use of antibiotics for children with acute otitis media, and after dissemination of our findings, similar results have been replicated at centre II using deferred prescribing of antibiotics for children who are not unduly ill"	yes	yes
Enriquez-Puga (25)	"There was a small change in the desired direction in the proportion of antidepressants prescribed according to guidelines that lasted for 24 months, although no change for antibiotics. A simple, group level educational outreach intervention, designed to take account of identified barriers to change, appears to have a small *sustained* effect on prescribing levels, but the effect is not consistent across different groups of drugs"	Guideline 1: no Guideline 2: yes	Guideline 1: no Guideline 2: yes
Forsner (26)	"This study suggested that the compliance to clinical guidelines, for treatment of depression and suicidal behaviour, was implemented and *sustained* over a two-year period after an active implementation"	Guideline 1: mixed Guideline 2: mixed	Guideline 1: mixed Guideline 2: mixed
Gerber (35)	Not mentioned	no	no
Higuchi (27)	(1)" The chart audit revealed that eleven nursing care indicators related to the asthma guideline recommendations showed a mixed pattern of sustainability" (2) Not mentioned	Guideline 1: mixed Guideline 2: mixed	Guideline 1: mixed Guideline 2: mixed
Kelly (28)	"The study demonstrated a significant and *sustained* change in analgesia administration practices away from the intramuscular (IM) route in favour of the IV route."	na	na
Knops (29)	(1)Not mentioned (2)Not mentioned	Guideline 1: yes Guideline 2: no	Guideline 1: yes Guideline 2: no
Loszadi (30)	Not mentioned	yes	yes
Mclaws (31)	Not mentioned	no	yes
Stephan (32)	"One of the most important results of our intervention is its *sustained* impact. In particular, the frequency of catheter use decreased in the operating room not only immediately after guideline implementation, but also could be observed 2 years later."	no	yes
Wakefield (33)	Not mentioned	no	na
Williams (34)	Not mentioned	yes	yes

* Citations of the authors of reviewed papers about the sustainability of adherence to the clinical practice guideline
** The same level or improved professionals' adherence was achieved years after implementation compared to early post-implementation results (yes/no)
***At least 90% of professionals' adherence was achieved years after implementation, compared to early post-implementation results (yes/no)
na: not applicable as the early post-implementation results were not measured
mixed: The overall professionals' adherence was not presented, and both sustained and not sustained levels of professionals' adherence to clinical practice guideline recommendations were achieved in the late post-implementation phase compared to early post-implementation results.

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Risk of bias in included studies

All studies included in the present review had a high risk of bias, following the Downs and Black assessment tool (20) (table 4, supplementary file 4).

Table 4. Results of the risk of bias assessment

Study ID	Reporting	External validity	Internal validity - bias	Internal validity - confounding	Total
Ament (22)	Unclear	High	High	High	High
Benenson (23)	Unclear	High	High	High	High
Cates (24)	High	Unclear	High	High	High
Enriquez-Puga (25)	Unclear	High	High	Unclear	High
Forsner (26)	Unclear	Low	High	High	High
Gerber (35)	Low	Low	High	High	High
Higuchi (27)	High	High	High	High	High
Kelly (28)	High	High	High	High	High
Knops (29)	High	Low	High	High	High
Loszadi (30)	Unclear	High	Unclear	High	High
Mclaws (31)	High	Low	Unclear	High	High
Stephan (32)	High	High	Unclear	High	High
Wakefield (33)	High	High	High	High	High
Williams (34)	High	High	Unclear	High	High
Total	**High**	**High**	**High**	**High**	**High**

DISCUSSION

Our review focused on the level of sustainability of implementation success in terms of professionals' adherence. Also, this systematic review described the state of the art in sustainability research. This systematic review identified fourteen studies, including eighteen evaluations that investigated the sustainability of professionals' adherence to a clinical practice guideline more than one year after the implementation was finished. Of eighteen analyses that focused on the extent of sustained professionals' adherence to a clinical practice guideline, seven analyses revealed fully sustained results. After decreasing the sustainability level of professionals' adherence to 90% or higher, nine out of eighteen evaluations showed sustained results. The current review showed that the number of sustainability studies is scarce and that the studies are heterogeneous with respect to their methodology. Furthermore, almost no study analysed or reflected on the updates of the guideline in the post-implementation phase. The results of this review suggest that updates of the clinical practice guidelines may have led to a warranted decrease in the adherence to the original clinical practice guideline.

In this systematic review, information was presented about how to search for sustainability evaluations, how sustainability research is defined and about the type and the methodological quality of studies that report on sustainability. As was confirmed in another systematic review (10), the sustainability studies showed to have limited methodological rigor. Two out of fourteen studies used an experimental design. The lack of identified studies in the current review suggests that most teams do not focus on the long-term performance effect of quality improvements (64). Due to the limited number of studies focusing on this subject, the heterogeneity in studies, suboptimal reporting by authors and the revealed methodological weaknesses, no strong conclusions can be drawn based on the presented sustainability results. As also shown in other research, most sustainability studies used a single-case study design by focusing on a single type of programme or performed the evaluation at a single centre level (65). The current review showed that in only two of the studies, a reference for the definition of sustainability was used. Other studies performed a sustainability evaluation without mentioning a definition. This shows the underdeveloped field of sustainability research. Also, a variety of timeframes to study the sustainability of professionals' adherence to clinical practice guidelines was revealed, varying from one and a half year to seven years following implementation.

Optimal adherence to a clinical practice guideline as determined during implementation is not always desired; for example, clinical experience and evidence may change. This systematic review included all research designs and seems to be the first review with respect to sustainability of professionals' adherence to clinical practice guidelines to date. Other reviews focused on healthcare from a broad perspective including multiple health care fields (10) or reviewed studies performed specifically in public health (6, 9). The sustainability of a health programme in public health may be influenced by other determinants than the sustainability of a clinical practice guideline in medical care. Also, the concept of the sustainability may differ between healthcare fields. For example, in public health sustainability of a health programme may be successfully sustained if health outcomes, e.g. changed lifestyle, are maintained and financial support is still available (6, 65). In medical care, the primary focus is on the quality and safety of care which is supposed to be captured in clinical practice guidelines. Due to the specific focus on clinical practice guidelines in the current review, mainly other studies were included compared to the existing sustainability reviews (6-10, 14).

Strengths and weaknesses

As yet, the term 'sustainability' is not consistently used for this area in the broader medical field, which presents a limitation to the electronic search strategy. The topic is not well indexed in electronic databases, and text word searches are prone to high recall and low specificity. However, it is likely that the use of a broad variety of search terms that covered sustainability, has downsized the number of relevant studies missed and is a strength of the review.

In this systematic review, sustainability was assessed as successful if performance in terms of professionals' adherence was fully maintained in the late post-implementation phase. This definition of

sustainability may be too pragmatic as it could be undesirable to fully sustain the professionals' adherence in the late post-implementation phase. Therefore, a sensitivity analysis was performed to analyse the sustainability at a level of 90% or higher. However, as mentioned before, a limitation of the review is the high risk of bias of all studies included. The majority of the studies used a retrospective data collection method. Nevertheless, results were interpreted under consideration of risk of bias, and the assessments were also used for recommendations for further research by identifying elements of studies that can be improved in new studies. Also, the question is what the best method is for evaluating sustainability. For example, retrospective data may be desired to prevent a Hawthorne effect when studying routine practice.

The results of the current review show more studies with sustained professionals' adherence than might be expected without continuing efforts and support to promote the level of sustained adherence in the post-implementation phase. Possibly, studies with unfavourable results may not be published or unsuccessful implementation projects may not be evaluated, leading to an under-representation of the true amount of work carried out in the field (66, 67).

Sustainability of professionals' adherence may be influenced by the perceived quality of the guideline. However, we were not able to analyse the quality of the guidelines given the limited information in the manuscripts and the information on the Internet on the specific guidelines. More information about the quality of the guidelines in sustainability evaluations may be helpful to analyse the sustainability of the guideline. Also, the potential effect of the specific implementation strategies was not analysed as part of the systematic review. Professionals' adherence is an outcome measure used in implementation science and it captures the behaviour change as a result of implementation strategies. The type of implementation strategy may have had an effect on the sustainability of the implementation results. The studies included used various implementation strategies and implemented different clinical practices guidelines.

Implications for practice

The current review showed that the level of the sustainability of professionals' adherence to clinical practice guidelines varies on case study level and drops in more than half of the studies. Due to the lack of sustainability research we think that sustainability failure as presented in this study is an underestimation. Unfortunately, implementation projects are primarily focused on short-term actions and short-term effect (64).

Future research

This review complements the existing sustainability research by focussing on sustained professionals' adherence in medical practice. The current review showed that not many studies reported data on the sustainability of professionals' adherence to clinical practice guidelines. Also, no strong conclusions can be drawn due to the high risk for bias and the heterogeneity of the studies. As shown in previous

research, structural methods for sustainability evaluations are lacking (10, 68). Furthermore, future implementation and sustainability evaluations may include information about the quality of the clinical practice guideline, such as described in the AGREE instrument (69). More sustainability evaluation research and methodological guidance is needed to make future sustainability research more robust and generalizable and may be helpful in creating a general sustainability language.

CONCLUSION

This systematic review identified, reported and analysed studies that evaluated the level of sustainability of professionals' adherence to guideline recommendations in medical practice more than one year following the cessation of the implementation project. 2) Seven out of eighteen evaluations showed sustained professionals' adherence on average 2.6 years after implementation. 1) Due to the limited number and the lack of methodological quality of the identified studies, no firm conclusion about the sustainability of professionals' adherence to guideline recommendations in medical practice can be drawn. More sustainability evaluations, methodological sustainability studies and reviews are needed in order to develop a general framework for sustainability measurement and to facilitate uniform language and communication within the sustainability science.

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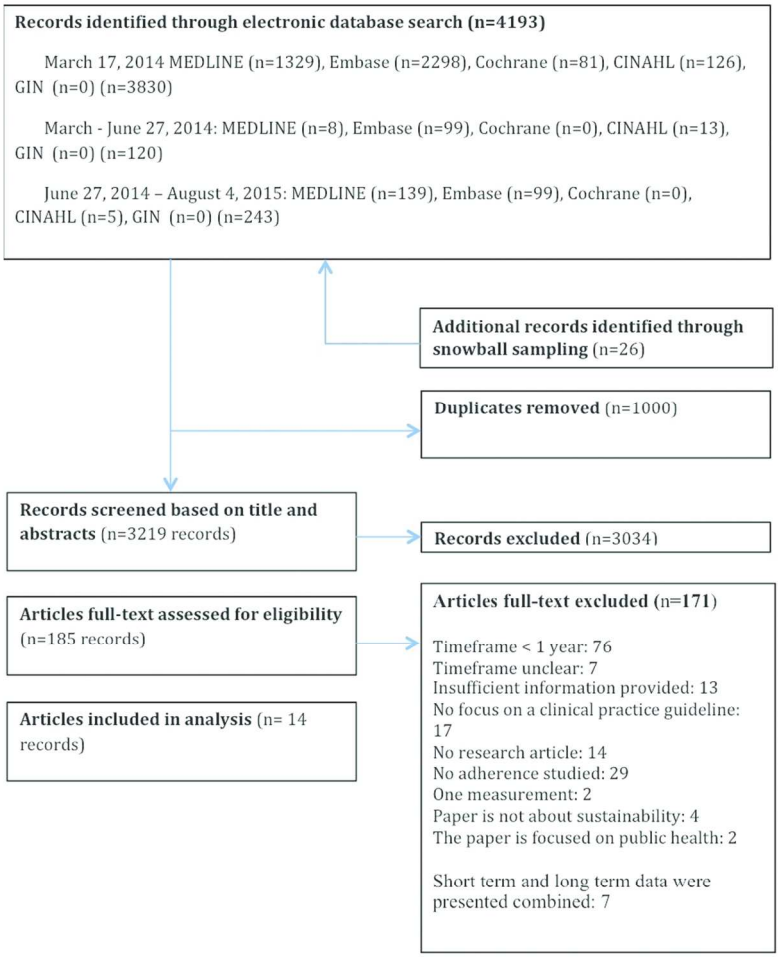
Figure Legends

Table 1	Characteristics of the studies included
Table 2	Implementation strategies as described by the authors
Table 3	Sustainability of professionals' adherence to clinical practice guidelines
Table 4	Results of the risk of bias assessment
Figure 1	PRISMA Flow Diagram

Supplementary files

Supplementary file 1	Electronic search strategy for MEDLINE (OvidSP)
Supplementary file 2	Excluded articles based on full-text selection (n=171) (detailed table)
Supplementary file 3	Sustainability of professionals' adherence to clinical practice guidelines (detailed table)
Supplementary file 4	Risk of bias using the Downs and Black checklist (detailed table)

Figure 1. PRISMA Flow Diagram



PRISMA Flow Diagram
91x127mm (300 x 300 DPI)

Supplementary file 1. Electronic search strategy for MEDLINE (OvidSP)

Database: Ovid MEDLINE <1946 to February Week 4 2014>
Date searched: 14.03.2014
Records found: 1329

Sustainability facet

1 (adoption adj2 (longitudinal or long term or longterm)).ti,ab,ot. (64)
2 ((continued or continuation) adj2 (adherence or compliance or effect or effects or effectiveness or impact$ or intervention$ or innovation$ or program$)).ti,ab,ot. (1823)
3 (de-adoption adj2 (chang$ or intervention$ or innovation$ or program$)).ti,ab,ot. (0)
4 (diffusion adj2 (longitudinal or long term or longterm)).ti,ab,ot. (188)
5 ((discontinued or discontinuance or discontinuation) adj2 (intervention$ or innovation$ or program$)).ti,ab,ot. (202)
6 ((dissemination or disseminated) adj2 (longitudinal or long term or longterm)).ti,ab,ot. (38)
7 (durability adj2 (adherence or benefit$ or chang$ or compliance or effect or effects or effectiveness or intervention$ or improvement$ or implement$ or impact$ or innovation$ or longitudinal or outcome$ or "over time" or process$ or program$ or post-implement$ or success$)).ti,ab,ot. (402)
8 (fidelity adj2 (adherence or adoption or chang$ or compliance or effect or effects or effectiveness or evaluat$ or impact$ or implement$ or improvement$ or intervention$ or innovation$ or long-term or longterm or longitudinal or "over time" or outcome$ or post-implementat$ or program$ or success$)).ti,ab,ot. (605)
9 (institutionali?ation adj2 (adherence or chang$ or compliance or effect or effects or effectiveness or improvement$ or impact$ or innovation$ or longitudinal or long-term or longterm or outcome$ or process$ or post-implement$)).ti,ab,ot. (235)
10 (longitudinal adj2 (adherence or assess$ or benefit$ or chang$ or compliance or effect or effects or effectiveness or examination$ or evaluat$ or impact$ or pattern? or program$ or success$)).ti,ab,ot. (9231)
11 ((maintenance or maintained) adj2 (adherence or chang$ or compliance or effect or effects or effectiveness or fail$ or intervention$ or improvement$ or implement$ or impact$ or innovation$ or long-term or longterm or longitudinal or outcome$ or "over time" or process$ or post-implement$)).ti,ab,ot. (11874)
12 (normali?ation adj2 (adherence or chang$ or compliance or effect or effects or effectiveness or improvement$ or impact$ or innovation$ or longitudinal or long-term or longterm or outcome$ or process$ or post-implement$)).ti,ab,ot. (1069)
13 (persistence adj2 (implement$ or innovation$ or program$ or long-term or longterm or "over time")).ti,ab,ot. (1551)
14 (routini$ adj2 (chang$ or improve$ or intervention$ or innovation$ or longitudinal or long-term or longterm or outcome$ or "over time" or program$ or post-implement$)).ti,ab,ot. (8)
15 (sustain$ adj2 (adherence or adoption or assess or benefit$ or chang$ or compliance or evaluat$ or effect or effects or effectiveness or fail$ or innovation$ or intervention$ or improvement$ or implement$ or impact$ or long-term or longterm or outcome$ or "over time" or program$ or post-implement$ or success$ or vitality)).ti,ab,ot. (15804)
16 sustainability.ti. (1367)
17 or/1-16 (43656)

Guidelines facet

18 guideline/ or practice guideline/ (24797)
19 guidelines as topic/ or practice guidelines as topic/ (108754)
20 Guideline Adherence/ (19958)
21 Health Planning Guidelines/ (3791)
22 (guideline$ or guide-line$).ti. (45298)
23 (practice adj3 parameter$).ti,ab. (1081)
24 clinical protocols/ (19624)

25 guidance.ti,ab. (53787)
26 care pathway*.ti,ab. (1337)
27 critical pathway/ (4502)
28 (clinical adj3 pathway$).ti,ab. (2907)
29 algorithms/ (168579)
30 consensus development conference.pt. (8886)
31 consensus development conference nih.pt. (725)
32 or/18-31 (396861)

33 17 and 32 (1378)

Animal-only study exclusion

34 exp animals/ not (exp animals/ and humans/) (3902375)

35 33 not 34 (1329)

Supplementary file 2. Excluded articles based on full-text selection (n=171)

Paper	Exclusion reason
R. Adsit, D. Fraser, L. Redmond, S. Smith, and M. Fiore, 'Changing Clinical Practice, Helping People Quit: The Wisconsin Cessation Outreach Model', Wisconsin Medical Journal, 104 (2005), 32-36.	No adherence studied
M.L. Affronti, S.M. Schneider, J.E. Herndon, S. Schlundt, H.S. Friedman, 'Adherence to antiemetic guidelines in patients with malignant glioma: a quality improvement project to translate evidence into practice', Supportive Care in Cancer 22(7) (2014): 1897-1905.	Timeframe < 1 year
B. Allegranzi, A. Gayet-Ageron, N. Damani, L. Bengaly, M. L. McLaws, M. L. Moro, Z. Memish, O. Urroz, H. Richet, J. Storr, L. Donaldson, and D. Pittet, 'Global Implementation of Who's Multimodal Strategy for Improvement of Hand Hygiene: A Quasi-Experimental Study', The Lancet Infectious Diseases, 13 (2013), 843-51.	Timeframe < 1 year
J. C. Alonso, 'A Figo Project in Uruguay to Prevent Maternal Death Due to Unsafe Termination of Pregnancy', Journal of Perinatal Medicine, 41 (2013).	Insufficient information provided
E. Alp, D. Haverkate, and A. Voss, 'Hand Hygiene among Laboratory Workers', Infection Control & Hospital Epidemiology, 27 (2006), 978-80.	Timeframe < 1 year
H. K. Amdany, and M. McMillan, 'Metronidazole Intravenous Formulation Use in in-Patients in Kapkatet District Hospital, Kenya: A Best Practice Implementation Project', JBI Database of Systematic Reviews and Implementation Reports, 12 (2014), 419-33.	Timeframe < 1 year
R. S. Bailie, D. Si, G. W. Robinson, S. J. Togni, and P. H. N. d'Abbs, 'A Multifaceted Health-Service Intervention in Remote Aboriginal Communities: 3-Year Follow-up of the Impact on Diabetes Care', Medical Journal of Australia, 181 (2004), 195-200.	Timeframe unclear

R. S. Bailie, S. J. Togni, D. Si, G. Robinson, and P. H. N. D'Abbs, 'Preventive Medical Care in Remote Aboriginal Communities in the Northern Territory: A Follow-up Study of the Impact of Clinical Guidelines, Computerised Recall and Reminder Systems, and Audit and Feedback', BMC Health Services Research, 3 (2003), 1-13.	Timeframe unclear
Anonymous, 'Report: Cpoe Adoption a Long-Term Process', Healthcare Benchmarks & Quality Improvement, 10 (2003), 1-5-7.	No research article
M. B. Goetz, T. Hoang, S. R. Henry, H. Knapp, H. D. Anaya, A. L. Gifford, and S. M. Asch, 'Evaluation of the Sustainability of an Intervention to Increase Hiv Testing', J Gen Intern Med, 24 (2009), 1275-80.	No focus on a clinical practice guideline
E. L. Mawdsley, S. Garcia-Houchins, and S. G. Weber, 'Back to Basics: Four Years of Sustained Improvement in Implementation of Contact Precautions at a University Hospital', Joint Commission journal on quality and patient safety / Joint Commission Resources, 36 (2010), 418-23.	No focus on a clinical practice guideline
R. S. Bailie, G. Robinson, S. N. Kondalsamy-Chennakesavan, S. Halpin, and Z. Wang, 'Investigating the Sustainability of Outcomes in a Chronic Disease Treatment Programme', Soc Sci Med, 63 (2006), 1661-70.	Timeframe < 1 year
F. E. Babl, D. Krieser, J. Belousoff, and T. Theophilos, 'Evaluation of a Paediatric Procedural Sedation Training and Credentialing Programme: Sustainability of Change', Emerg Med J, 27 (2010), 577-81.	Timeframe < 1 year
P. A. Bampton, J. J. Sandford, and G. P. Young, 'Achieving Long-Term Compliance with Colonoscopic Surveillance Guidelines for Patients at Increased Risk of Colorectal Cancer in Australia', International Journal of Clinical Practice, 61 (2007), 510-13.	Timeframe < 1 year
R.S. Bhatia, D.M. Dudzinski, C.E. Milford, M.H. Picard, R.B. Weiner "Educational intervention to reduce inappropriate transthoracic echocardiograms: the need for sustained intervention." Echocardiography 31(8) (2014): 916-923.	Timeframe < 1 year

D. Berild, T. G. Abrahamsen, S. Andresen, E. Bjorlow, O. Haug, I. M. Kossenko, O. I. Kubar, M. Lelek, S. I. Mintchenko, M. F. Pyasetskaya, S. H. Ringertz, and G. A. Sysenko, 'A Controlled Intervention Study to Improve Antibiotic Use in a Russian Paediatric Hospital', International Journal of Antimicrobial Agents, 31 (2008), 478-83.	Timeframe < 1 year
M. T. Bigham, R. Amato, P. Bondurrant, J. Fridriksson, C. D. Krawczeski, J. Raake, S. Ryckman, S. Schwartz, J. Shaw, D. Wells, and R. J. Brilli, 'Ventilator-Associated Pneumonia in the Pediatric Intensive Care Unit: Characterizing the Problem and Implementing a Sustainable Solution', Journal of Pediatrics, 154 (2009), 582-87.e2.	Short term and long term data were presented combined
M. Fleuren, E. Dusseldorp, S. van den Bergh, H. Vlek, J. Wildschut, E. van den Akker, and D. Wijkel, 'Implementation of a Shared Care Guideline for Back Pain: Effect on Unnecessary Referrals', Int J Qual Health Care, 22 (2010), 415-20.	No focus on a clinical practice guideline
K. Blanchet, and P. James, 'Can International Health Programmes Be Sustained after the End of International Funding? A Case of Eye Care Interventions in Ghana', BMC Health Serv Res, 14 (2014), 77.	No focus on a clinical practice guideline
P. G. Teixeira, K. Inaba, J. Dubose, N. Melo, M. Bass, H. Belzberg, and D. Demetriades, 'Measurable Outcomes of Quality Improvement Using a Daily Quality Rounds Checklist: Two-Year Prospective Analysis of Sustainability in a Surgical Intensive Care Unit', The Journal of Trauma and Acute Care Surgery, 75 (2013), 717-21.	No focus on a clinical practice guideline
L. Bowers, C. Berry-Caban, and R. Munson, 'Implementing Process Improvement Efforts to Increase Adherence with Diabetes Clinical Practice Guidelines in a Military Treatment Facility', Journal of the American Pharmacists Association, 52 (5) (2012), 631.	Insufficient information provided
C. C. Bowman, E. J. Sobo, S. M. Asch, and A. L. Gifford, 'Measuring Persistence of Implementation: Queri Series', Implement Sci, 3 (2008), 21.	No research article
C. Brand, F. Landgren, A. Hutchinson, C. Jones, L. MacGregor, and D. Campbell, 'Clinical Practice Guidelines: Barriers to Durability after Effective Early Implementation', Internal Medicine Journal, 35 (2005), 162-69.	One measurement

B. D. Brazzell, 'Improving High Hand-Hygiene Compliance and Reducing Healthcareassociated Infection in Eight Nursing Units', American Journal of Infection Control, 1) (2014), S25-S26.	Timeframe < 1 year
A. S. Brent, W. M. Rahman, L. L. Knarr, J. A. Harrison, K. L. Kearns, and D. S. Lindstrom, 'Reducing Cycle Times in Pediatric Emergency Medicine', Pediatric Emergency Care, 25 (2009), 307-11.	No adherence studied
D. L. Whitford, S. H. Roberts, and S. Griffin, 'Sustainability and Effectiveness of Comprehensive Diabetes Care to a Distinct Population', Diabet Med, 21 (2004), 1221-8.	Timeframe unclear
B. L. Carter, 'Blood Pressure Control-Implementing a Team Approach', US Cardiology, 8 (2011), 108-13.	No research article
Ali A. Cheema, Annette M. Scott, Karen J. Shambaugh, Jacqueline N. Shaffer-Hartman, Ronald E. Dechert, Susan M. Hiebert, John W. Gosbee, and Matthew F. Niedner, 'Rebound in Ventilator-Associated Pneumonia Rates During a Prevention Checklist Washout Period', BMJ Quality & Safety, 20 (2011), 811-17.	Short term and long term data were presented combined
Y. C. Chen, W. H. Sheng, J. T. Wang, S. C. Chang, H. C. Lin, K. L. Tien, L. Y. Hsu, and K. S. Tsai, 'Effectiveness and Limitations of Hand Hygiene Promotion on Decreasing Healthcare-Associated Infections', PLoS ONE [Electronic Resource], 6 (2011), e27163.	Timeframe < 1 year
L. L. Chlan, J. L. Guttormson, and K. Savik, 'Tailoring a Treatment Fidelity Framework for an Intensive Care Unit Clinical Trial', Nursing Research, 60 (2011), 348-53.	Timeframe < 1 year
B.R. Cooper, B.K. Bumbarger, J.E. Moore, "Sustaining Evidence-Based Prevention Programs: Correlates in a Large-Scale Dissemination Initiative." Prevention Science 16 (2015): 145-157.	The paper is focused on public health

B. Crawford, M. Skeath, and A. Whippy, 'Kaiser Permanente Northern California Sepsis Mortality Reduction Initiative', Critical Care, 16 (2012).	Timeframe < 1 year
J. D. Crews, E. Whaley, D. Syblik, and J. Starke, 'Sustained Improvement in Hand Hygiene at a Children's Hospital', Infection Control and Hospital Epidemiology, 34 (2013), 751-53.	Timeframe < 1 year
S. B. DeMauro, E. Douglas, K. Karp, B. Schmidt, J. Patel, A. Kronberger, R. Scarboro, and M. Posencheg, 'Improving Delivery Room Management for Very Preterm Infants', Pediatrics, 132 (2013), e1018-e25.	Short term and long term data were presented combined
S. Deuster, I. Roten, and S. Muehlebach, 'Implementation of Treatment Guidelines to Support Judicious Use of Antibiotic Therapy', Journal of Clinical Pharmacy and Therapeutics, 35 (2010), 71-78.	Timeframe < 1 year
M. A. Doyle, S. Brez, S. Sicoli, F. De Sousa, E. Keely, and J. C. Malcom, 'Using Standardized Insulin Orders to Improve Patient Safety in a Tertiary Care Centre', Canadian Journal of Diabetes, 38 (2014), 118-25.	Insufficient information provided
J.M. Edmunds, K.L. Read, V.A. Ringle, D.M. Brodman, P.C. Kendall, R.S. Beidas, "Sustaining clinician penetration, attitudes and knowledge in cognitive-behavioral therapy for youth anxiety." Implement Sci 9 (2014): 89.	No adherence studied
K. Ellingson, R. R. Muder, R. Jain, D. Kleinbaum, P. J. Feng, C. Cunningham, C. Squier, J. Lloyd, J. Edwards, V. Gebski, and J. Jernigan, 'Sustained Reduction in the Clinical Incidence of Methicillin-Resistant Staphylococcus Aureus Colonization or Infection Associated with a Multifaceted Infection Control Intervention', Infect Control Hosp Epidemiol, 32 (2011), 1-8.	No adherence studied
J. N. Epstein, J. M. Langberg, P. K. Lichtenstein, R. C. Kolb, and L. J. Stark, 'Sustained Improvement in Pediatricians' Adherence Practice Behaviors in the Context of a Community-Based Quality Improvement Initiative', Children's Health Care, 39 (2010), 296-311.	Timeframe < 1 year

K. J. Evans, J. Thompson, S. E. Spratt, L. F. Lien, and A. Vorderstrasse, 'The Implementation and Evaluation of an Evidence-Based Protocol to Treat Diabetic Ketoacidosis: A Quality Improvement Study', Adv Emerg Nurs J, 36 (2014), 189-98.	Timeframe < 1 year
M. Fakhry, G. B. Hanna, O. Anderson, A. Holmes, and D. Nathwani, 'Effectiveness of an Audible Reminder on Hand Hygiene Adherence', American Journal of Infection Control, 40 (2012), 320-23.	Timeframe < 1 year
M. G. Fakih, K. Jones, J. E. Rey, R. Takla, S. Szpunar, K. Brown, A. Boelstler, and L. Saravolatz, 'Peripheral Venous Catheter Care in the Emergency Department: Education and Feedback Lead to Marked Improvements', American Journal of Infection Control, 41 (2013), 531-6.	Timeframe < 1 year
M. Bunik, M. J. Federico, B. Beaty, M. Rannie, J. T. Olin, and A. Kempe, 'Quality Improvement for Asthma Care within a Hospital-Based Teaching Clinic', Academic Pediatrics, 11 (2011), 58-65.	Timeframe < 1 year
B. R. Ferrell, and R. Virani, 'Institutional Commitment to Improved Pain Management: Sustaining the Effort', Journal of Pharmaceutical Care in Pain and Symptom Control, 6 (1998), 43-55.	No adherence studied
G. T. Feyissa, J. S. Gomersall, and S. Robertson-Malt, 'Compliance to Hand Hygiene Practice among Nurses in Jimma University Specialized Hospital in Ethiopia: A Best Practice Implementation Project', JBI Database of Systematic Reviews and Implementation Reports, 12 (2014), 318-37.	Timeframe < 1 year
A. M. Finucane, B. Stevenson, R. Moyes, D. Oxenham, and S. A. Murray, 'Improving End-of-Life Care in Nursing Homes: Implementation and Evaluation of an Intervention to Sustain Quality of Care', Palliative Medicine, 27 (2013), 772-78.	Timeframe < 1 year
A. Fisher, 'How Nhs Trusts Are Tackling Healthcare-Associated Infections', Nursing management (Harrow, London, England : 1994), 16 (2010), 26-27.	No research article

E. J. Gallagher, and S. W. Trotzky, 'Sustained Effect of an Intervention to Limit Ordering of Emergency Department Lumbosacral Spine Films', Journal of Emergency Medicine, 16 (1998), 395-401.	No focus on a clinical practice guideline
G. C. Fonarow, M. J. Reeves, E. E. Smith, J. L. Saver, X. Zhao, D. W. Olson, A. F. Hernandez, E. D. Peterson, L. H. Schwamm, G. WTG-Stroke Steering Committee, and Investigators, 'Characteristics, Performance Measures, and in-Hospital Outcomes of the First One Million Stroke and Transient Ischemic Attack Admissions in Get with the Guidelines-Stroke', Circulation. Cardiovascular Quality and Outcomes, 3 (2010), 291-302.	No focus on a clinical practice guideline
D. Fonda, J. Cook, V. Sandler, and M. Bailey, 'Sustained Reduction in Serious Fall-Related Injuries in Older People in Hospital', Medical Journal of Australia, 184 (2006), 379-82.	No focus on a clinical practice guideline
S. P. Ford, M. K. Leick-Rude, K. A. Meinert, B. Anderson, M. B. Sheehan, B. M. Haney, S. R. Leeks, S. D. Simon, and A. Jackson, 'Overcoming Barriers to Oxygen Saturation Targeting', Pediatrics, 118 Suppl 2 (2006), S177-86.	No adherence studied
J. Fortney, M. Enderle, S. McDougall, J. Clothier, J. Otero, L. Altman, and G. Curran, 'Implementation Outcomes of Evidence-Based Quality Improvement for Depression in Va Community Based Outpatient Clinics', Implement Sci, 7 (2012), 30.	Timeframe < 1 year
J. B. Froehlich, D. Karavite, P. L. Russman, N. Erdem, C. Wise, G. Zelenock, T. Wakefield, J. Stanley, K. A. Eagle, Cardiology American College of, and Association American Heart, 'American College of Cardiology/American Heart Association Preoperative Assessment Guidelines Reduce Resource Utilization before Aortic Surgery', Journal of Vascular Surgery, 36 (2002), 758-63.	No adherence studied
L. Y. Fu, M. Weissman, R. McLaren, C. Thomas, J. Campbell, J. Mbafor, U. Doshi, and D. Cora-Bramble, 'Improving the Quality of Immunization Delivery to an at-Risk Population: A Comprehensive Approach', Pediatrics, 129 (2012), e496-e503.	Timeframe < 1 year
C. Fuller, S. Michie, J. Savage, J. McAteer, S. Besser, A. Charlett, A. Hayward, B. D. Cookson, B. S. Cooper, G. Duckworth, A. Jeanes, J. Roberts, L. Teare, and S. Stone, 'The Feedback Intervention Trial (Fit) - Improving Hand-Hygiene Compliance in Uk Healthcare Workers: A Stepped Wedge Cluster Randomised Controlled Trial', PLoS ONE, 7 (2012).	Timeframe < 1 year

P. W. Lee, A. J. Dietrich, T. E. Oxman, J. W. Williams, Jr., and S. L. Barry, 'Sustainable Impact of a Primary Care Depression Intervention', J Am Board Fam Med, 20 (2007), 427-33.	No focus on a clinical practice guideline
V. Ganju, 'Mental Health Quality and Accountability: The Role of Evidence-Based Practices and Performance Measurement', Administration & Policy in Mental Health, 33 (2006), 659-65.	No research article
M. Gazarian, and L. V. Graudins, 'Long-Term Reduction in Adverse Drug Events: An Evidence-Based Improvement Model', Pediatrics, 129 (2012), e1334-e42.	Timeframe < 1 year
K. M. Gendron, S. Y. Lai, G. S. Weinstein, A. A. Chalian, J. M. Husbands, P. F. Wolf, L. DiDonato, and R. S. Weber, 'Clinical Care Pathway for Head and Neck Cancer: A Valuable Tool for Decreasing Resource Utilization', Archives of Otolaryngology - Head and Neck Surgery, 128 (2002), 258-62.	No adherence studied
M. F. Gerdtz, R. Waite, T. Vassiliou, B. Garbutt, R. Prematunga, and E. Virtue, 'Evaluation of a Multifaceted Intervention on Documentation of Vital Signs at Triage: A before-and-after Study', EMA - Emergency Medicine Australasia, 25 (2013), 480-87.	Timeframe < 1 year
V. Gibbons, T. Esselink, and S. McHugh, 'Assessing Practice Relating to Fall Risk Management among Nurses in an Acute Ward Setting: A Best Practice Implementation Report', JBI Database of Systematic Reviews and Implementation Reports, 11 (2013), 277-85.	Insufficient information provided
F. Gillissen, S. M. C. Ament, J. M. C. Maessen, C. D. Dirksen, T. Van Der Weijden, and M. F. Von Meyenfeldt, 'Sustainability of an Enhanced Recovery Programme in Colonic Surgery in the Netherlands', European Journal of Cancer, 49 (2013), S533-S534.	Timeframe < 1 year
Edward M. Glaser, 'Durability of Innovations in Human Service Organizations: A Case-Study Analysis', Science Communication, 3 (1981), 167-85.	No focus on a clinical practice guideline

S. G. Anthony, L. M. Prevedello, M. M. Damiano, T. K. Gandhi, P. M. Doubilet, S. E. Seltzer, and R. Khorasani, 'Impact of a 4-Year Quality Improvement Initiative to Improve Communication of Critical Imaging Test Results', Radiology, 259 (2011), 802-07.	Timeframe < 1 year
L. Gonzalez, J. F. Elgart, H. Calvo, and J. J. Gagliardino, 'Changes in Quality of Care and Costs Induced by Implementation of a Diabetes Program in a Social Security Entity of Argentina', ClinicoEconomics and Outcomes Research, 5 (2013), 337-45.	No adherence studied
M. L. Grayson, P. L. Russo, M. Cruickshank, J. L. Bear, C. A. Gee, C. F. Hughes, P. D. R. Johnson, R. McCann, A. J. Mcmillan, B. G. Mitchell, C. E. Selvey, R. E. Smith, and I. J. Wilkinson, 'Outcomes from the First 2 Years of the Australian National Hand Hygiene Initiative', Medical Journal of Australia, 195 (2011), 615-19.	Timeframe < 1 year
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M. Whitby, M. L. McLaws, K. Slater, E. Tong, and B. Johnson, 'Three Successful Interventions in Health Care Workers That Improve Compliance with Hand Hygiene: Is Sustained Replication Possible?', American Journal of Infection Control, 36 (2008), 349-55.	Timeframe < 1 year
S. Whitelaw, N. Graham, D. Black, J. Coburn, and L. Renwick, 'Developing Capacity and Achieving Sustainable Implementation in Healthy 'Settings': Insights from Nhs Health Scotland's Health Promoting Health Service Project', Health promotion international, 27 (2012), 127-37.	No research article

L. J. Weireter, Jr., J. N. Collins, R. C. Britt, S. F. Reed, T. J. Novosel, and L. D. Britt, 'Impact of a Monitored Program of Care on Incidence of Ventilator-Associated Pneumonia: Results of a Longterm Performance-Improvement Project', Journal of the American College of Surgeons, 208 (2009), 700-4; discussion 04-5.	Timeframe unclear
R. B. Womer, E. Tracy, W. Soo-Hoo, B. Bickert, S. DiTaranto, and J. H. Barnsteiner, 'Multidisciplinary Systems Approach to Chemotherapy Safety: Rebuilding Processes and Holding the Gains', Journal of Clinical Oncology, 20 (2002), 4705-12.	No adherence studied
D. M. Zerr, A. L. Allpress, J. Heath, R. Bornemann, and E. Bennett, 'Decreasing Hospital-Associated Rotavirus Infection: A Multidisciplinary Hand Hygiene Campaign in a Children's Hospital', Pediatric Infectious Disease Journal, 24 (2005), 397-403.	Timeframe < 1 year
N. Zwar, J. Henderson, H. Britt, K. McGeechan, and G. Yeo, 'Influencing Antibiotic Prescribing by Prescriber Feedback and Management Guidelines: A 5-Year Follow-Up', in Family practice (2002), pp. 12-7.	No focus on a clinical practice guideline

Supplementary file 3. Sustainability of professionals' adherence to clinical practice guidelines (detailed table)

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
Ament [20]	Proportion of patients treated following guideline recommendations:				5
	1a.Treatment is discussed in a preoperative multidisciplinary meeting*(n)	86% (n=139/161)	95% (154/163)	100% (n=156/156)	
	1b.The interval between referral and first visit to the breast unit is 5 working days or less*(n)	37% (n=16/44)	61% (45/75)	84% (n=109/130)	
	1c.The interval between diagnostic tests and informing patients about the results is 5 working days or less*(n)	62% (n=99/161)	64% (n=105/163)	90% (n=133/147)	
	1d.The interval between the decision to operate and surgery is 15 working days or less*(n)	89% (n= 144/161)	80% (n=131/163)	80% (n=128/160)	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
	1e.The general practitioner is informed about the diagnosis, treatment plan and potential side-effects prior to surgery*(n)	73% (n=118/161)	76% (n=123/163)	98% (n=156/160)	
	1f.The breast nurse stays in contact with the patient after short stay (phone consultation)* (n)	7% (n=11/161)	12% (n=19/163)	15% (n=24/159)	
	Overall (excluding missing values) (original guideline comprises thirteen key recommendations)	59%	65%	78%	
Benenson [21]	(1)Mean time to treatment	(1)314.7 min (SD=199.0)	(1)174.7 min (SD=113.1)	(1)171.2 min (SD=98.8)	3
	(2) Initial treatment given at emergency department	(2)36/63 (58.1%)	(2)90/96 (93.8%)	(2)118/122 (96.7%)	
Cates [22]	Annual number of prescriptions per 100 children < 5 years old (n)	Centre 1: n=139	Centre 1: n=95	Centre 1: n=76	Centre 1:3

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
		Centre 2: n=122	Centre 2: n=67	Centre 2: n=61	Centre 2:2
Enriquez-Puga [23]	(1)Number of items antibiotics (co-amixiclav and quinolone) prescribed for each six-month study period per 1000 patients	(1)Intervention group: 6.9 (1)Control group: 5.8	(1)Intervention group: 4.6 (1)Control group: 6.2	(1)Intervention group: 5.8 (1)Control group: 6.4	1.5
	(2)Number of items antidepressants (lofepramine and fluoxetine) prescribed for each six-month study period per 1000 patients	(2)Intervention group: 26.7 (2)Control group: 20.9	(2)Intervention group: 27.7 (2)Control group: 21.4	(2)Intervention group: 28.6 (2)Control group: 20.8	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
	Notes: regression analysis adjusting for baseline				
Forsner [24]	1 Proportion of patients treated following guideline recommendations for depression				1.5
	1a Accessibility/wait time	Intervention group: 77.9% (n=95/122) Control group: 59.0% (n=36/61)	Intervention group: 89.2% (n=107/120) Control group: 53.3% (n=32/60)	Intervention group: 90% (n=216/240) Control group: 51.7% (n=62/120)	
	1b Diagnostic assessment	Intervention group: 83.6% (n=102/122) Control group: 88.5% (n=54/61)	Intervention group: 97.5% (n=117/120) Control group: 90.0% (n=54/60)	Intervention group: 97.9% (n=235/240) Control group: 79.2% (n=95/120)	
	1c Diagnostic instrument	Intervention group: 12.3% (n=15/122)	Intervention group: 28.3% (n=34/120)	Intervention group: 44.2% (n=106/240)	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
	1d Standardized rating scale	Control group: 1.6% (n=1/62) Intervention group: 64.8% (n=79/122)	Control group: 0% (n=0/60) Intervention group: 91.7% (n=110/120)	Control group: 0.8% (n=1/120) Intervention group: 94.2% (n=226/240)	
	1e Standardized rating scale during treatment	Control group: 44.3% (n=27/61) Intervention group: 50.0% (n=61/122)	Control group: 33.3% (n=20/60) Intervention group: 87.5% (n=105/120)	Control group: 36.7% (n=44/120) Intervention group: 88.3% (n=212/240)	
	1f Substance/drug abuse	Control group: 24.6% (n=15/61) Intervention group: 46.7% (n=57/122)	Control group: 38.3% (n=23/60) Intervention group: 87.5% (n=105/120)	Control group: 33.3% (n=40/120) Intervention group: 88.8% (n=213/240)	
	1g Treatment (care) plan	Control group: 32.8% (n=20/61) Intervention group:	Control group: 53.2% (n=32/60) Intervention group:	Control group: 43.3% (n=52/120) Intervention group:	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
		59.8% (n=73/122)	87.5% (n=105/120)	91.3% (n=219/240)	
		Control group:	Control group:	Control group:	
		42.6% (n=26/61)	38.3% (n=23/60)	27.5% (n=33/120)	
	1h Evaluation/outcome	Intervention group:	Intervention group:	Intervention group:	
		66.4% (n=81/122)	95.8% (115/120)	95.8% (n=230/240)	
		Control group:	Control group:	Control group:	
		59.0% (n=36/61)	55.0% (n=33/60)	48.3 (n=58/120)	
	1i Continuity	Intervention group:	Intervention group:	Intervention group:	
		77.0% (n=94/122)	95.0% (n=114/120)	95.8% (n=230/240)	
		Control group:	Control group:	Control group:	
		78.7% (n=48/61)	61.7% (n=37/60)	68.3% (n=82/120)	
	1j Suicide assessment	Intervention group:	Intervention group:	Intervention group:	
		40.2% (n=49/122)	95.8% (n=115/120)	97.5% (n=234/240)	
		Control group:	Control group:	Control group:	
		45.9% (n=28/61)	35.0% (n=21/60)	30.0% (n=36/120)	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
	1k Antidepressant medication	Intervention group: 54.1% (n=66/122) Control group: 45.9% (n=28/61)	Intervention group: 90.8% (n=109/120) Control group: 36.7% (n=22/60)	Intervention group: 92.5% (n=222/240) Control group: 41.7% (n=50/120)	
	2 Proportion of patients treated following guideline recommendations for suicidal behaviour in % (n)				
	2a Accessibility/wait time	Intervention group: 15.7% (n=19/121) Control group: 29.5% (n=18/61)	Intervention group: 14.2% (n=17/120) Control group: 31.7% (n=19/60)	Intervention group: 59.2% (n=142/240) Control group: 0% (n=0/120)	
	2b Diagnostic assessment	Intervention group: 49.6% (n=60/121) Control group:	Intervention group: 73.3% (n=88/120) Control group:	Intervention group: 91.7% (n=220/240) Control group:	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
		26.2% (n=16/61)	16.7% (n=10/60)	0% (n=0)	
	2c Diagnostic instrument	Intervention group:	Intervention group:	Intervention group:	
		0% (n=0/121)	7.5% (n=9/120)	7.5% (n=18)	
		Control group:	Control group:	Control group:	
		0% (n=0/61)	0% (n=0/60)	0% (n=0)	
	2d Standardized rating scale	Intervention group:	Intervention group:	Intervention group:	
		41.3% (n=50/121)	67.5% (n=81/120)	78.3% (n=188)	
		Control group:	Control group:	Control group:	
		27.9% (n=17/61)	16.7% (n=10/60)	0.8% (n=1)	
	2e Standardized rating scale during treatment	Intervention group:	Intervention group:	Intervention group:	
		16.5% (n=20/121)	52.5% (n=63/120)	55.8% (n=134)	
		Control group:	Control group:	Control group:	
		16.4% (n=10/61)	10.0% (n=6/60)	5.0% (n=6)	
	2f Substance/drug abuse	Intervention group:	Intervention group:	Intervention group:	
		52.1% (n=63/121)	64.2% (n=77/120)	80.0% (n=192)	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
	2g Treatment (care) plan	Control group: 55.7% (n=34/61) Intervention group: 37.4% (n=68/182)	Control group: 56.7% (n=34/60) Intervention group: 58.9% (n=106/120)	Control group: 29.2% (n=35) Intervention group: 79.2% (n=190)	
	2h Evaluation/outcome	Control group: 44.3% (n=27/61) Intervention group: 20.7% (n=25/121)	Control group: 41.7% (n=25/60) Intervention group: 47.5% (n=57/120)	Control group: 0.8% (n=1) Intervention group: 51.7% (n=124)	
	2i Continuity	Control group: 19.7% (n=12/61) Intervention group: 86.0% (n=104/121)	Control group: 8.3% (n=5/60) Intervention group: 81.7% (n=98/120)	Control group: 0% (n=0) Intervention group: 91.3% (n=219)	
	2j Suicide assessment	Control group: 49.2% (n=30/61) Intervention group:	Control group: 31.7% (n=19/60) Intervention group:	Control group: 0% (n=0) Intervention group:	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
		55.4% (n=67/121)	93.3% (n=112/120)	97.1% (n=233)	
		Control group:	Control group:	Control group:	
		82.0% (n=50/61)	73.3% (n=44/60)	56.7% (n=68)	
	2k Specialist assessment	Intervention group:	Intervention group:	Intervention group:	
		50.4% (n=61/121)	85.4% (n=103/120)	91.7% (n=220)	
		Control group:	Control group:	Control group:	
		83.6% (n=51/61)	83.3% (n=50/60)	71.7% (n=86)	
	2l Follow-up	Intervention group:	Intervention group:	Intervention group:	
		72.7% (n=88/121)	88.3% (n=106/120)	92.1% (n=221)	
		Control group:	Control group:	Control group:	
		75.4% (n=46/61)	65.0% (n=39/60)	37.5% (n=45)	
	2m Evaluation assessment	Intervention group:	Intervention group:	Intervention group:	
		32.2% (n=39/121)	64.2% (n=77/120)	75.0% (n=180)	
		Control group:	Control group:	Control group:	
		18.0% (n=11/61)	13.3% (n=8/60)	10.8% (n=13)	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
Gerber [35]	Proportion of patients receiving care according to guideline recommendations	n= 396.074 26,80%	n=253.516 14,30%	n=unclear 27,90%	1.5
Higuchi [25]	1 Proportion of patients receiving care according to asthma guideline recommendations	Not clear	(total n=10)	(total n=62)	Asthma: 4 Diabetes: 3
	1a Respiratory assessment done		n=10/10 100%	n=61/62 98.4%	
	Level of asthma control documented for :				
	1b medication in use		n=10/10 100%	n=61/62 98.4%	
	1c Use of B2 agonist		n=10/10 100%	n=52/62 84.4%	
	1d Experience of daytime symptoms		n=8/10 80.0%	n=32/62 51.7%	
	1e Experience of night time and/or awaking symptoms		n=8/10 80.0%	n=16/62 26.2%	
	1f Physical activity		n= unclear 77.8%	n=29/62 46.8%	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
	1g Absence from school or work		n=7/10 70.0%	n=3/62 4.9%	
	1h Exacerbation		n=7/10 70.0%	n=47/62 76.2%	
	1i Individualised action plan developed for client's discharge		n=7/10 70.0%	n=2/62 3.2%	
	1j Baseline teaching information on asthma provided to patient by a nurse		n=6/10 60.0%	n=16/62 25.4%	
	1k Written information on asthma provided		n=6/10 60.0%	n=4/62 6.6%	
	2 Proportion of patients receiving care according to diabetes foot care guideline		(total n=50)	(total n=65)	
	2a Assessment for risk factors: foot ulceration/amputation		n=22/50 44.0%	n=64/65 98.5%	
	2b Assessment loss of protective sensation		n=5/50 10.0%	n=10/65 15.6%	
	2c Assessment Structural or biochemical abnormalities		n=3/50 6.0%	n=59/65 90.8%	
	2d Assessment evidence of impaired circulation		n=1/50 2.0%	n=34/65 52.3%	
	2e Assessment Deficit in self-care behaviour		n=14/50 28.0%	n=10/65 15.4%	
	2f Monofilament used to assess sensation in the feet		n=21/50 42.0%	n=41/65 63.1%	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
	2g Risk classification for foot ulcer/amputation		n=37/50 73.7%	n=30/65 45.9%	
	Basic foot care education done on:				
	2h Client's risk factors		n=15/50 30.0%	n=53/62 81.5%	
	2i Daily self-inspection of feet		n=15/50 30.0%	n=53/62 81.5%	
	2j Proper nail and skin care		n=15/50 30.0%	n=54/62 83.1%	
	2k Injury prevention		n=15/50 30.0%	n=53/62 81.5%	
	2l When to seek help		n=15/50 30.0%	n=54/62 83.1%	
Kelly [26]	Proportion of patients receiving IM narcotic analgesia	76% (n=48/63)	NA	3% (n=2/65)	2
Knops [27]	(1)Proportion of patients receiving care according to fluid balance guideline recommendations	(1)NA	(1)NA	(1)100% (534/534)	7
	(2)Proportion of patients receiving care according to body temperature guideline recommendations	(2)NA	(2)91%	(2)50% (617/1226)	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
Loszadi [28]	Proportion of patients receiving care according to guideline recommendations	61% (n=29/48)	79% (n=38/48)	92% (n=44/48)	unclear, >2
Mclaws [29]	(hand hygiene events observed / hand hygiene opportunities)x100 (%)	47% (3795/8057)	62% (NA)	58% (4041/6972)	1.5
Stephan [30]	Proportion of patients receiving care according to guideline recommendations	NA	82.2% (n=410/499)	80.8% (n=242/300)	1.5
Wakefield [31]	Proportion of patients receiving care according to guideline recommendations	Authors reported that the LATE POST compliance was lower compared to the EARLY POST measurement, but no further details were provided	NA	NA	1.5
Williams [32]	Proportion of patients treated according to guideline recommendations for the repair and follow-up of third degree tears				2
	A Senior SpR present	30% (n=13/44)	40% (n=20/50)	60% (n=18/30)	
	Theatre	70% (n=31/44)	82% (n=41/50)	97% (n=29/30)	

Study ID	Primary outcome(s)	Adherence PRE measurement	Adherence EARLY POST measurement	Adherence LATE POST measurement	Time frame (years)
	GA/Regional	70% (n=31/44)	82% (n=41/50)	97% (n=29/30)	
	Prolene	64% (n=28/44)	76% (n=38/50)	93% (n=28/30)	
	Overlap documented	30% (n=13/44)	54% (n=27/50)	67% (n=20/30)	

na: not applicable

Supplementary File 4: Risk of bias using the Downs and Black

	Author:	Ament [20]	Benenson [21]	Cates [22]	Enriquez [23]	Forsner [24]	Gerber [35]	Higuchi [25]	Kelly [26]
	Reporting	**comment**							
1	Is the hypothesis/aim/objective of the study clearly described?		yes	yes	no	yes	yes	yes	yes
2	Are the main outcomes to be measured clearly described in the Introduction or Methods section?		yes	yes	yes	yes	yes	yes	yes
3	Are the characteristics of the patients included in the study clearly described ?	*Patients' was replaced by 'professionals'*	yes	yes	yes	yes	yes	yes	no
4	Are the interventions of interest clearly described?	*Intervention was replaced by guideline*	yes	yes	yes	yes	yes	yes	yes
5	Are the distributions of principal confounders in each group of subjects to be compared clearly described?		yes	yes	no	yes	yes	no	no
6	Are the main findings of the study clearly described?		yes	yes	yes	yes	yes	yes	no
7	Does the study provide estimates of the random variability in the data for the main outcomes?		na	na	na	na	na	na	na

		Author:	Ament [20]	Benenson [21]	Cates [22]	Enriquez [23]	Forsner [24]	Gerber [35]	Higuchi [25]	Kelly [26]
8	Have all important adverse events that may be a consequence of the intervention been reported?		na	na	na	na	na	na	na	na
9	Have the characteristics of patients lost to follow-up been described?	*Patients' was replaced by 'professionals'*	utd	utd	utd	utd	no	yes	utd	utd
10	Have actual probability values been reported (e.g. 0.035 rather than <0.05) for the main outcomes except where the probability value is less than 0.001?		yes	yes	utd	yes	yes	yes	no	yes
	External validity									
11	Were the subjects asked to participate in the study representative of the entire population from which they were recruited?	*Subjects' was replaced by 'professionals'. In case of general guideline and a multicentre study: yes. In case of a centre specific guideline and one guideline: yes.*	yes	no	utd	yes	yes	yes	no	no

	Author:	Ament [20]	Benenson [21]	Cates [22]	Enriquez [23]	Forsberg [24]	Gerber [35]	Higuchi [25]	Kelly [26]
12	Were those subjects who were prepared to participate representative of the entire population from which they were recruited?	*Subjects' was replaced by 'professionals'*	yes	utd	utd	no	yes	no	utd
13	Were the staff, places, and facilities where the patients were treated, representative of the treatment the majority of patients receive?		no	yes	yes	yes	yes	yes	yes
	Internal validity - bias								
14	Was an attempt made to blind study subjects to the intervention they have received?	*Subjects' was replaced by 'professionals'*	na	na	na	na	na	na	na
15	Was an attempt made to blind those measuring the main outcomes of the intervention?		utd	utd	utd	utd	no	utd	utd
16	If any of the results of the study were based on “data dredging”, was this made clear?		no	no	no	no	yes	no	no
17	In trials and cohort studies, do the analyses adjust for different lengths of follow-up of patients, or in case-control studies, is the time period between the intervention and outcome the same for cases and controls ?	*Patients' was replaced by 'professionals'*	na	na	na	yes	na	na	na

	Author:	Ament [20]	Benenson [21]	Cates [22]	Enriquez [23]	Forsner [24]	Gerber [35]	Higuchi [25]	Kelly [26]
18	Were the statistical tests used to assess the main outcomes appropriate?	yes	yes	no	yes	yes	yes	yes	yes
19	Was compliance with the intervention/s reliable?	na	na	na	na	na	na	na	na
20	Were the main outcome measures used accurate (valid and reliable)?	yes	yes	yes	yes	yes	yes	yes	yes
	Internal validity - confounding (selection bias and power)								
21	Were the patients in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited from the same population?	*Patients' was replaced by 'professionals'*	na	na	na	yes	na	na	na
22	Were study subjects in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited over the same period of time?	*Study subjects' was replaced by 'professionals'*	na	na	na	yes	na	na	na
23	Were study subjects randomised to intervention groups?	*Subjects' was replaced by 'professionals'*	no	no	no	yes	yes	no	no	no

	Author:	Ament [20]	Benenson [21]	Cates [22]	Enriquez [23]	Forsberg [24]	Gerber [35]	Higuchi [25]	Kelly [26]
24	Was the randomised intervention assignment concealed from both patients and health care staff until recruitment was complete and irrevocable?	na	na	na	utd	utd	na	na	na
25	Was there adequate adjustment for confounding in the analyses from which the main findings were drawn?	no	yes	no	yes	yes	yes	no	yes
26	Were losses of patients to follow-up taken into account?	*Patients was replaced by professionals*	utd	utd	utd	yes	utd	utd	utd
27	Did the study have sufficient power to detect a clinically important effect where the probability value for a difference being due to chance is less than 5%?	no	no	no	yes	no	yes	yes	no

utd: Items were qualified as 'unable to determine' when information was not reported
na: not applicable

Supplementary File 4: Risk of bias using the Downs and Black

		Author:	Knops [27]	Lozsadi [28]	McLaws [29]	Stephan [30]	Wakefield [31]	Williams [32]
	Reporting	**comment**						
1	Is the hypothesis/aim/objective of the study clearly described?		yes	yes	yes	yes	yes	yes
2	Are the main outcomes to be measured clearly described in the Introduction or Methods section?		yes	yes	yes	yes	no	yes
3	Are the characteristics of the patients included in the study clearly described ?	*Patients' was replaced by 'professionals'*	yes	yes	yes	no	no	no
4	Are the interventions of interest clearly described?	*Intervention was replaced by guideline*	yes	yes	yes	yes	yes	yes
5	Are the distributions of principal confounders in each group of subjects to be compared clearly described?		no	yes	no	yes	no	yes
6	Are the main findings of the study clearly described?		yes	yes	yes	yes	yes	yes
7	Does the study provide estimates of the random variability in the data for the main outcomes?		na	na	na	na	na	na

	Author:	Knops [27]	Lozsadi [28]	McLaws [29]	Stephan [30]	Wakefield [31]	Williams [32]
8 Have all important adverse events that may be a consequence of the intervention been reported?		na	na	na	na	na	na
9 Have the characteristics of patients lost to follow-up been described?	*Patients' was replaced by 'professionals'*	utd	utd	utd	utd	utd	utd
10 Have actual probability values been reported (e.g. 0.035 rather than <0.05) for the main outcomes except where the probability value is less than 0.001?		utd	utd	yes	yes	yes	yes
External validity							
11 Were the subjects asked to participate in the study representative of the entire population from which they were recruited?	*Subjects' was replaced by 'professionals'. In case of general guideline and a multicentre study: yes. In case of a centre specific guideline and one guideline: yes.*	yes	no	yes	no	no	yes

	Author:	Knops [27]	Lozsadi [28]	McLaws [29]	Stephan [30]	Wakefield [31]	Williams [32]
12 Were those subjects who were prepared to participate representative of the entire population from which they were recruited?	*Subjects' was replaced by 'professionals'*	yes	utd	yes	utd	utd	yes
13 Were the staff, places, and facilities where the patients were treated, representative of the treatment the majority of patients receive?		yes	no	yes	no	no	no
Internal validity - bias							
14 Was an attempt made to blind study subjects to the intervention they have received?	*Subjects' was replaced by 'professionals'*	na	na	na	na	na	na
15 Was an attempt made to blind those measuring the main outcomes of the intervention?		utd	utd	utd	utd	utd	utd
16 If any of the results of the study were based on “data dredging”, was this made clear?		no	yes	yes	yes	no	yes
17 In trials and cohort studies, do the analyses adjust for different lengths of follow-up of patients, or in case-control studies, is the time period between the intervention and outcome the same for cases and controls ?	*Patients' was replaced by 'professionals'*	na	na	na	na	na	na

	Author:	Knops [27]	Lozsadi [28]	McLaws [29]	Stephan [30]	Wakefield [31]	Williams [32]
18 Were the statistical tests used to assess the main outcomes appropriate?		no	utd	yes	yes	yes	yes
19 Was compliance with the intervention/s reliable?		na	na	na	na	na	na
20 Were the main outcome measures used accurate (valid and reliable)?		yes	yes	yes	yes	yes	yes
Internal validity - confounding (selection bias and power)							
21 Were the patients in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited from the same population?	*Patients' was replaced by 'professionals'*	na	na	na	na	na	na
22 Were study subjects in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited over the same period of time?	*Study subjects' was replaced by 'professionals'*	na	na	na	na	na	na
23 Were study subjects randomised to intervention groups?	*Subjects' was replaced by 'professionals'*	no	no	no	no	no	no

	Author:	Knops [27]	Lozsadi [28]	McLaws [29]	Stephan [30]	Wakefield [31]	Williams [32]
24 Was the randomised intervention assignment concealed from both patients and health care staff until recruitment was complete and irrevocable?		na	na	na	na	na	na
25 Was there adequate adjustment for confounding in the analyses from which the main findings were drawn?		no	no	yes	yes	no	no
26 Were losses of patients to follow-up taken into account?	*Patients was replaced by professionals*	utd	utd	utd	utd	utd	utd
27 Did the study have sufficient power to detect a clinically important effect where the probability value for a difference being due to chance is less than 5%?		no	no	no	yes	no	no

utd: Items were qualified as 'unable to determine' when information was not
na: not applicable

PRISMA Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	na
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4,5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5, additional file 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4,5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	5,6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	5,6

Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	na
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	na
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	na
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	na
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7, table 1
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	16, table 4
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	13, table 3, additional file 3
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	na
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	16, table 4
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	13
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	16,17
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	17,18

Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	19
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	19