Improving quality of care: a continuous process of (de-)implementation

Rietbergen, T.

IMPROVING QUALITY OF CARE

A continuous process of (de-)implementation

Tessa Rietbergen

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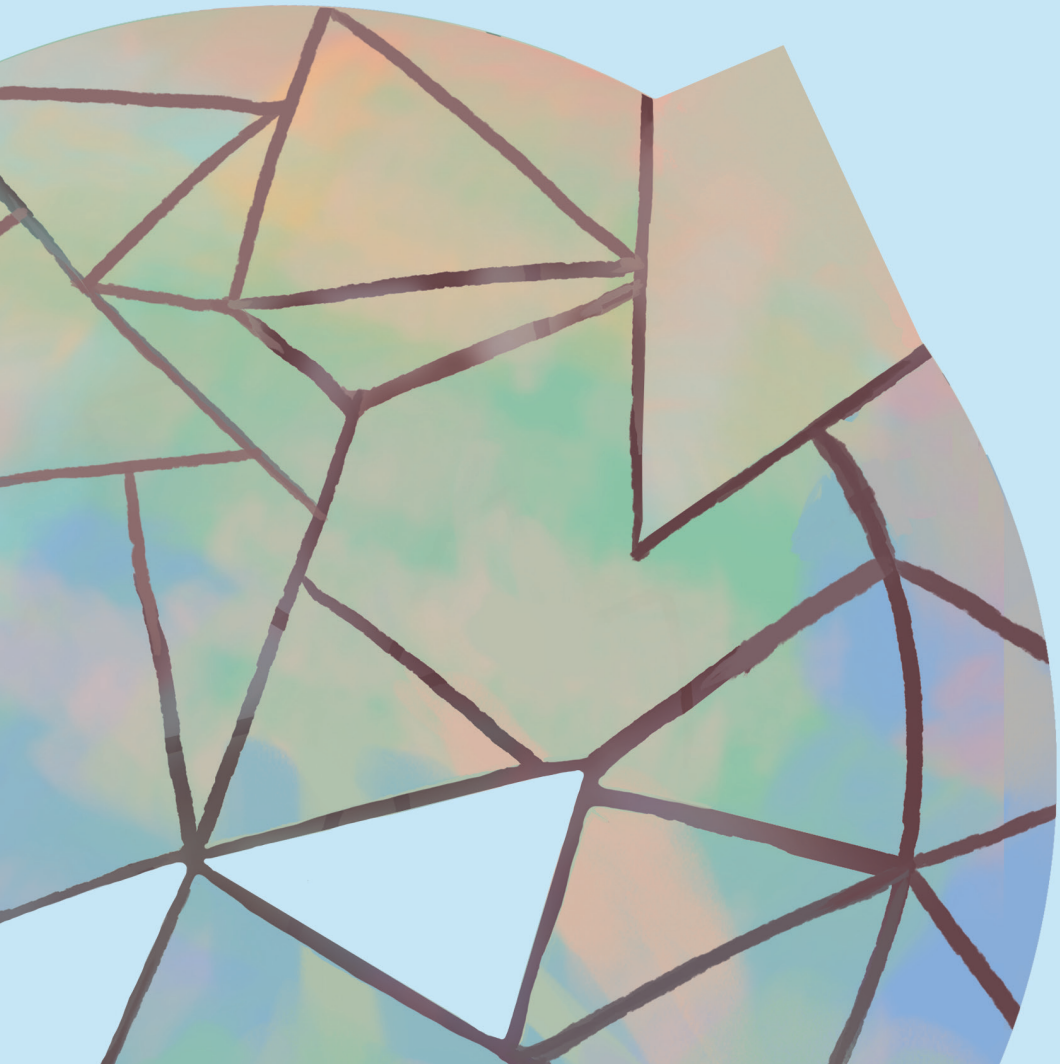

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General introduction

GENERAL INTRODUCTION

Implementation and de-implementation in healthcare

Both underuse as well as overuse of medical services is associated with poor outcomes in healthcare. Underuse includes the failure to use effective medical interventions, and exists worldwide with significant differences within and between countries[1]. Possible causes for failure to use effective medical interventions include clinicians' poor adherence to evidence and guidelines, and lack of access to medical services (e.g. hospitals, healthcare insurance, medical technology within hospitals)[1]. Overuse refers to providing low value medical services; i.e. services that are more likely to cause harm, waste resources or could lead to unnecessary healthcare costs (e.g. knee arthroscopy in degenerative knee disease or prolonged indwelling urinary catheter use)[2]. To improve quality of care and to create a sustainable healthcare system, it is essential to prevent underuse of effective medical care and to reduce the use of low value care by implementation and de-implementation initiatives. Implementation can be described as the planned process to introduce or to improve the use of medical interventions with the aim that those medical interventions are given a structural place within care practice[3]. In de-implementation, the use of low value medical interventions is reduced or stopped on a structural basis in a planned process[4]. For medical interventions with a lack of evidence more research to support or to reject is needed.

Processes in implementation and de-implementation

A distinction is commonly made between process-models for implementation and de-implementation. Examples of implementation process-models include the Implementation model of change of Grol and Wensing[5], Knowledge to action framework[6], and implementation mapping[7]. The de-adoption framework[8], de-implementation guide[9], and the Choosing Wisely de-implementation model[2] are examples of de-implementation process-models. These process-models for implementation and de-implementation include, however, more or less the same steps to accomplish change. These comparable steps are: (1) identify and prioritize relevant topics for implementation and/or de-implementation based on the existing evidence, (2) set goals, define target groups, and assess current practice, (3) define an (de-)implementation team to create more support and to divide responsibilities, (4) analyses of barriers and facilitators for (de-) implementation, (5 and 6) develop and execute a tailored (de-)implementation strategy, (7) evaluate the effects of the (de-)implementation strategy and (8)

sustain the results (see *figure 1*). Evaluation and sustainability of the results are not the final step of the (de-)implementation processes. Ideally, one is continuously assessing whether the use of medical interventions increases (implementation) or decreases (de-implementation), thus revising the (de-) implementation strategy in a continuous feedback loop based on findings and thus changes in the context of the (de-)implementation initiative.

Fig. 1 Key steps in (de-)implementation processes.

Determinants of successful implementation and de-implementation

Determinants (barriers and facilitators) play an important role in (de-)implementation and in the outcomes of the (de-)implementation processes[3,10,11]. An exploration

of the determinants is therefore needed enabling the development of a tailored (de-)implementation strategy that addresses these identified barriers and/or facilitators[10]. In the literature, many different determinant frameworks exist for the analysis of determinants for both implementation and de-implementation[12,13]. Frameworks for both implementation and de-implementation show comparable categories: a) the innovation/low value care, b) the individual professional, c) the patient, d) the social context, e) the organizational context, and f) the economic and political context[12].

Although frameworks for determinants of implementation of medical interventions and the de-implementation of low value care show similarities, there are also some important differences[14,15]. From a previous study there are signals that organizational factors play a more influential role in implementation; where motivational, economic and political factors are more associated with de-implementation[4]. Motivation of involved stakeholders to de-implement low value care may be negatively influenced by uncertainty and cognitive biases that play an important role in de-implementation[15]. Examples of uncertainties are fears for healthcare providers to miss a diagnosis, to dissatisfy patients or to be sued, the poor willingness of patients and the society to accept that there are always risks and uncertainties, and uncertainty of healthcare organizations and healthcare providers to sustain revenues[15]. These different forms of uncertainty could result in the use of more unnecessary diagnostic testing and treatments, driven by several cognitive biases[14]. Examples of these biases are the tendency to favor action over inaction (action bias) and to avoid experiencing regret by not performing a medical service (anticipated regret). Differences between determinants for implementation and de-implementation could lead to different (de-)implementation strategies.

Strategies for implementation and de-implementation

Strategies for both implementation and de-implementation may be more effective if they address the related determinants influencing the uptake of medical interventions or the reduction of low value care[10,14,16,17], targeting multiple levels and consisting of multiple components[14,18], and address multiple stakeholders[18]. Research shows that reducing low value care may require other approaches than for the implementation of medical interventions (19), because de-implementation and implementation show differences in determinants[4,10]. However, when we look at intervention level using the EPOC taxonomy of health systems interventions[20] frequently the same kind of interventions are used in implementation and de-implementation, including interactive education and clinical decision support[18,21]. Patey et al.[19] showed on the other hand that

the techniques used to change the behavior within these interventions differ between implementation and de-implementation strategies. In implementation "feedback on behavior" was more frequently identified; and in de-implementation "behavior substitution", "monitoring of behavior by others without feedback" and "restructuring social environment" were used[19]. Despite these differences in the frequency of use of certain behavior change techniques in implementation and de-implementation strategies, there is little evidence on which strategies are more effective for implementation and which for de-implementation[10,19]. Therefore, more research is needed to investigate which interventions are the most effective for (de-)implementation of medical services.

AIM AND OUTLINE THESIS

The aim of this thesis is to extend the knowledge on effective strategies for de-implementation of low value care and the implementation of underused medical services in orthopedic surgery as well as in nursing practice. The following research questions will be assessed:

1. What are effective de-implementation strategies for reducing low value care in orthopedic surgery as well as in nursing practice?
2. What are the differences and similarities between effective de-implementation and implementation strategies in nursing practice?

This will be evaluated based on two use cases: the use of MRI and knee arthroscopy for patients with degenerative knee disease (***Chapter 2-4***) and effective (de-)implementation strategies in nursing (***Chapter 5 and 6***).

Use of MRI and arthroscopy for degenerative knee disease

About 25% of patients 50 years and over experience degenerative knee complaints[22]. Patients aged 50 years and over with degenerative knee disease could suffer from complaints during walking, climbing stairs and squatting[23]. Some patients experience locking symptoms, which can be described as a limited range of motion of the knee due to lose bodies or meniscal tears. Meniscal tears in this age group occur mostly as part of a degenerative process and can be considered a feature of an early stage of osteoarthritis[24,25]. Clinical practice guidelines from professional orthopaedic associations[26-29] recommend to first prescribe weight-bearing radiographs including a fixed flexion view to examine the cartilage status of the knee, and non-surgical treatment modalities (pain medication, dietary advice and exercise therapy). After all, research has shown that there is no clinically relevant difference between a knee arthroscopy and

physical therapy for patients with degenerative knee disease, based on patient-specific outcomes (sports, walking, running, standing for a long time and rising from a chair)[30]. MRI and knee arthroscopy for this specific patient group is not directly recommended, because it provides limited benefit for the patient, requires resources and may even cause harm to the patient. Due to the poor association with symptoms, routine use of an MRI for diagnosis of degenerative knee disease is not recommended for this specific patient group[25,31-33]. Despite the existence of clinical practice guidelines and Choosing Wisely recommendations, still many patients receive an MRI and/or knee arthroscopy for degenerative knee disease[34-45].

Quality improvement in nursing

Nurses are, just like doctors, expected to provide evidence-based medical interventions to improve quality of healthcare. To facilitate evidence-based nursing practice, an increasing number of nursing guidelines are published and Choosing Wisely' lists of nursing procedures are recently created in several countries[1,4,11,12]. However, use of these guidelines and lists in daily practice is limited. To improve the uptake of guidelines and lists, (de-)implementation strategies are needed. Unfortunately, most studies assessing (de-)implementation strategies are directed towards to doctors[18,46], despite that many procedures (e.g. the use of restraints, wound care, and the use of intravenous and urinary catheters) are also routinely performed by nurses[47,48]. Therefore, it is important to investigate which strategies are effective to implement nursing guidelines and which de-implementation strategies are effective to reduce low value nursing care.

Outline of this thesis

This thesis aims to contribute to the knowledge on effective strategies for implementing and de-implementing medical services to improve quality of care for patients. In the first part of the thesis, the effectiveness of a tailored strategy to reduce the use of low value MRI and knee arthroscopies for patients aged 50 years and over with degenerative knee disease is described. In order to develop a tailored strategy, first the proportion of low value knee arthroscopies for this specific patient group in different types of hospitals was investigated in ***Chapter 2***. Based on this information about the use of low value knee arthroscopy and its indications, the (de-)implementation could be better tailored towards the needs of practice (*Figure 1, step 2*). In ***Chapter 3***, determinants influencing the de-implementation of low value MRI's and knee arthroscopies in patients with degenerative knee disease are explored (*Figure 1, step 4*). Insight in determinants for the decision to make an MRI as well as performing a knee arthroscopy are needed to develop

a tailored de-implementation strategy (*figure 1, step 5*). In ***Chapter 4***, the effect of this tailored de-implementation strategy is assessed in 13 hospitals (*Figure 1, step 6 and 7*).

In the second part of this thesis, it is investigated which strategies are effective for reducing low value nursing procedures ***(Chapter 5)*** as well as which strategies are effective for the implementation of nursing guidelines ***(Chapter 6)***.

Based on the results of the research in this thesis, the overall findings of the studies are described with regard to the overarching research questions of this thesis in ***Chapter 7.***

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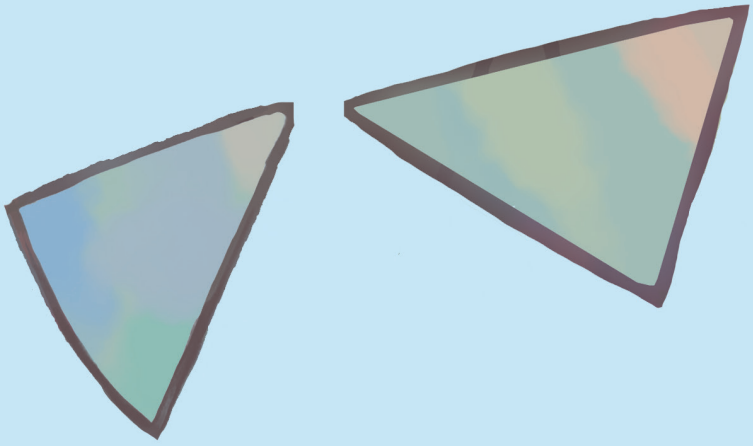

2

Performing a knee arthroscopy among patients with degenerative knee disease: one-third is potentially low value care

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ABSTRACT

Purpose

The purpose of this study was to assess in which proportion of patients with degenerative knee disease aged 50+ in whom a knee arthroscopy is performed, no valid surgical indication is reported in medical records, and to explore possible explanatory factors.

Methods

A retrospective study was conducted using administrative data from January – December 2016 in 13 orthopedic centers in the Netherlands. Medical records were selected from a random sample of 538 patients aged 50+ with degenerative knee disease in whom arthroscopy was performed, and reviewed on reported indications for the performed knee arthroscopy. Valid surgical indications were predefined based on clinical national guidelines and expert opinion (e.g. truly locked knee). A knee arthroscopy without a reported valid indication was considered potentially low value care. Multivariate logistic regression analysis was performed to assess whether age, diagnosis ("Arthrosis" versus "Meniscal lesion"), and type of care trajectory (initial or follow-up) were associated with performing a potentially low value knee arthroscopy.

Results

Of 26,991 patients with degenerative knee disease, 2556 (9.5%) underwent an arthroscopy in one of the participating orthopedic centers. Of 538 patients in whom an arthroscopy was performed, 65.1% had a valid indication reported in the medical record and 34.9% without a reported valid indication. From the patients without a valid indication, a joint patient-provider decision or patient request was reported as the main reason. Neither age [OR 1.013 (95% CI 0.984-1.043)], diagnosis [OR 0.998 (95% CI 0.886-1.124)] or type of care trajectory [OR 0.989 (95% CI 0.948-1.032)] were significantly associated with performing a potentially low value knee arthroscopy.

Conclusions

In a random sample of knee arthroscopies performed in 13 orthopedic centers in 2016, 65% had valid indications reported in the medical records but 35% were performed without a reported valid indication and, therefore, potentially low value care. Patient and/or surgeons' preference may play a large role in the decision to perform an arthroscopy without a valid indication. Therefore, interventions should be developed to increase adherence to clinical guidelines by surgeons that target invalid indications for a knee arthroscopy to improve care.

INTRODUCTION

Approximately 25% of people aged 50 years and over experience knee symptoms from degenerative knee disease[19]. Degenerative knee disease is typically the result of wear and tear of the cartilage of the knee joint. Patients with degenerative knee disease may suffer from pain and stiffness of the knee[14,22] and experience locking, clicking, or other mechanical symptoms[19].

Clinical guidelines[1,5,8,19] recommend non-surgical treatments (e.g. physical therapy, pain medication (acetaminophen, NSAIDs and opioids), and dietary advice (for weight loss)) for patients aged 50 years and over with degenerative knee disease. Arthroscopy is only warranted, in case of a truly locked knee due to an intra-articular mechanical blockage (when a patient is objectively unable to fully extend his/her knee)[19], or if pain is not reduced after non-surgical treatments[1,5,8]. These clinical guidelines are based on evidence showing that a knee arthroscopy for these patients has no benefit compared to non-surgical treatment[12,13,15,21]. Moreover, undergoing a knee arthroscopy can cause harm for patients and waste resources[12,18], and are, therefore, considered as low value care in Dutch Choosing Wisely recommendations and similarly by medical societies in other countries[2,6,9,23].

Despite the availability of guidelines and Choosing Wisely recommendations to treat degenerative knee disease primarily with non-surgical treatments, previous studies have shown that patients worldwide are not treated accordingly[11,16,20]. A recent study showed, for example that 70% of the patients did not receive physical therapy and 89% did not have regular pain medication (> 2 prescriptions within 6 months) prior to a knee arthroscopy[16]. On a global scale, arthroscopic knee surgery for degenerative knee disease is performed more than two million times each year[19]. However, previous research did not assess the surgical indications for patients undergoing a knee arthroscopy, and which proportion was valid or not, with the latter suggesting potentially low value care. Insight in the extent to which such low value knee arthroscopies are performed and what reasons are reported for them, is needed to develop tailored interventions to reduce them.

Therefore, the aim of this study is to assess which proportion of performed knee arthroscopies among patients aged 50 years and over is performed without a valid surgical indication being reported and thus potentially low value care, in 13 Dutch hospitals / private clinics as well as to explore factors associated with undergoing such a low value knee arthroscopy. Based on findings in other countries showing that patients frequently do not receive non-surgical

treatments before a knee arthroscopy, it is hypothesized that a considerable proportion of the performed knee arthroscopies do not have a valid indication.

MATERIALS AND METHODS

The Medical Ethical Committee (CME P16.190/NV/nv) of the Leiden University Medical Center waived the need for ethical approval under Dutch law for this retrospective study using administrative data and medical record review in 13 Dutch orthopedic centers (hospitals and private clinics). The data used were collected as part of the baseline measurement of the 'SMART (Step-down MRI's and ARThroscopies) study', an intervention study that aimed to reduce the use of low value MRI and arthroscopies for patients with degenerative knee disease.

Administrative data were collected and all patients aged 50 years and over with knee complaints (surgical Diagnosis Treatment Codes (DTC) 1801-1899), treated in 2016 in one of the 13 Dutch orthopedic centers, were selected. Collected data included: a unique anonymized patient ID, Diagnosis Treatment Code, type of care trajectory (initial or follow-up treatment), performed arthroscopy (yes/no), age at the start of the care trajectory. An initial care trajectory starts when a patient first visits a hospital for knee complaints. A follow-up trajectory can be opened after the initial trajectory when the patient still suffers from the same complaints. The maximum duration of an initial and follow-up trajectory is 120 days.

Each orthopedic center kept a data file which linked the unique anonymized patient IDs to the actual local patient numbers, which was not accessible for the researchers. Subsequently, the researchers randomly selected a sample of 50 patients who underwent a knee arthroscopy in each orthopedic center for retrospective chart review, and each orthopedic center looked up the patient charts matching the anonymized ID. All participating orthopedic centers gave permission and if required by hospital regulations, individual patients' permission was asked for reviewing their medical record. From the medical records, the surgical indications for knee arthroscopy (recorded on a date preceding the knee arthroscopy) were retrieved for each patient. Based on the Dutch knee arthroscopy guideline[1] and expert opinion from an orthopedic surgeon specialized in knee problems, an arthroscopy was coded as performed for a valid or invalid surgical indication (*Table 1*). An arthroscopy performed without a valid indication was considered as potentially low value care. The valid indications in the category "other symptoms" were all reviewed by an orthopedic surgeon specialized in knee problems (RD) and considered as being

potentially performed for a valid indication (based on the information reported in the medical record).

From the random sample of 650 patients with knee complaints aged 50+ who underwent a knee arthroscopy, only the medical records of patients with degenerative knee disease (surgical DTC 1801 "Arthrosis" and 1805 "Meniscal lesion") were included in the analyses (*n*=542, 83,5%). The patient selection for degenerative disease was based on surgical DTC codes 1801 and 1805 which are, according to expert opinions and a survey among Dutch orthopedic surgeons, the DTC codes used for these patients in daily practice. The minimal sample size (*n*=335) for the medical record review was calculated using a single population proportion formula; with the assumption of 0.5 without a valid indication, acceptable margin of error 0.05, a 95% confidence level, and a total population undergoing arthroscopy of 2556.

Table 1: Valid and invalid surgical indications for knee arthroscopy

Valid indications	Invalid indications
Anterior Cruciate Ligament (ACL) symptoms	Pseudo locking symptoms ('locking', 'clicking' or other mechanical symptoms without an objective extension limitation of the knee), reported in a medical record of a patient with words like 'pseudo-locking symptoms' and 'locking symptoms without a real blockage'.
A truly locked knee (an extension limitation of the knee due to an intra-articular blockage; e.g. a meniscal tear)	Arthroscopy performed as a result of a patient-provider decision (yes/no), defined as a decision that was made in consultation with the patient or on patient's request. Since the study is retrospective, this can only be determined if this information was written in the patient medical record.
Ineffective previous non-surgical treatment, defined as having at least physical therapy	All other cases without a valid or invalid indication reported.
Symptoms caused by a traumatic moment. A traumatic moment is defined as a sport injury, cycling accident or a fall	
Other symptoms (cyst, biopsy, synovitis, loose bodies, complications after arthroscopy, complications after knee replacement, complex lesion, bucket handle lesion, bone bruise, infection)	

Statistical analysis

Descriptive statistics were used to describe the characteristics of orthopedic centers, the proportion of all patients with degenerative knee disease treated in the 13 centers who underwent an arthroscopy, the proportion knee arthroscopies in the sample of medical records reviewed that were performed with and without a valid indication, and which specific indications were reported for the performed knee arthroscopies.

A multivariate logistic regression was performed to assess the extent to which age of the patient, diagnosis (arthrosis or meniscal lesion), and care trajectory (initial or follow-up) were associated with the decision to perform a knee arthroscopy without a valid indication reported. All analyses were performed using the software package SPSS (IBM SPSS, version 23). A *p*-value lower than 0.05 was considered statistically significant.

RESULTS

Background characteristics

As shown in *Table 2*, six of the 13 participating orthopedic centers were teaching hospitals (46.2%), 3 were general hospitals (23.1%), 2 were University Medical Centers (15.4%) and 2 were private clinics (15.4%). In 2016, 31,184 patients aged 50 years and older with knee complaints visited one of the participating orthopedic centers, of whom 26,991 (86.6%) had degenerative knee disease. The number of patients with knee complaints ranged from 371 to 4538 patients across centers (median 2126, IQR [1469-3451]). Both the minimum and maximum number of patients with knee complaints were from private clinics. The percentage of patients with degenerative knee disease ranged from 75.4% in a University Medical Center to 92.5% in a teaching hospital (median 86.9%, IQR [84.9%-87.4%]) (*Table 2*).

Table 2. Background characteristics per hospital (*n*=13)

Hospital number	Type of hospital	Total number of patients with knee complaints*	Number of patients with degenerative knee disease** (%)	Number of arthroscopies for degenerative knee disease** (%)	Number of medical patient records screened for degenerative knee disease***	Number of medical patient records for degenerative knee disease after exclusion***	Number of potentially low value arthroscopies for degenerative knee disease based on medical records (%)***	Number of potentially low value arthroscopies for degenerative knee disease** per hospital***
1	Teaching Hospital	3451	2968 (86.0%)	201 (6.8%)	42	42	10 (23.8%)	48 (23.8%)
2	Teaching Hospital	3297	2882 (87.4%)	370 (12.8%)	50	50	25 (50.0%)	185 (50.0%)
3	General Hospital	1469	1300 (88.5%)	87 (6.7%)	47	45	18 (40.0%)	35 (40.0%)
4	Teaching Hospital	3733	3256 (87.2%)	121 (3.7%)	41	41	12 (29.3%)	35 (29.3%)
5	Teaching Hospital	3768	3283 (87.1%)	286 (8.7%)	43	42	15 (35.7%)	102 (35.7%)
6	Private clinic	371	288 (77.6%)	73 (25.3%)	49	49	20 (40.8%)	30 (40.8%)
7	University Medical Center	461	322 (69.8%)	0 (0.0%)	-	-	-	-
8	Teaching Hospital	2126	1848 (86.9%)	245 (13.3%)	50	50	19 (38.0%)	93 (38.0%)
9	Teaching Hospital	2000	1849 (92.5%)	138 (7.5%)	41	41	10 (24.4%)	34 (24.4%)
10	Private clinic	4538	4010 (88.4%)	434 (10.8%)	47	47	13 (27.7%)	120 (27.7%)
11	General Hospital	2107	1780 (84.5%)	206 (11.6%)	50	50	14 (28.0%)	58 (28.0%)
12	General Hospital	2560	2222 (86.8%)	334 (15.0%)	44	44	28 (63.6%)	213 (63.6%%)
13	University Medical Center	1303	983 (75.4%)	61 (6.2%)	38	37	4 (10.8%)	7 (10.8%)
Total ****		31,184	26,991 (86.6%)	2556 (9.5%)	542	538	188 (34.9%)	893 (34.9%)

* All possible knee Diagnosis Treatment Codes (DTC) from 1801 till 1899
** Diagnosis Treatment Codes (DTC) 1801 and 1805
*** Diagnosis Treatment Codes (DTC) 1801 and 1805. There was an acceptable margin of error 0.05, with a 95% confidence level.
**** Total of all thirteen hospitals/private clinics.

Patients undergoing a knee arthroscopy

Overall, 2556 of the 26,991 (9.5%, range 0.0% to 25.3%) patients with degenerative knee disease underwent an arthroscopy in one of the participating orthopedic centers. One center did not perform any arthroscopy at all for patients with degenerative knee disease in 2016. From these 2556 patients, the medical records of 542 patients were reviewed on indications reported for the arthroscopy. Four patients were excluded because the medical records reported they underwent a (total) knee replacement rather than an arthroscopy. In 350 (65.1%) of the remaining 538 patients there was at least one valid surgical indication to perform the arthroscopy reported (in total 416 indications were reported). Ineffective previous non-surgical treatment (37.3%) and a truly locked knee (33.9%) were most frequently mentioned in the medical records as an indication to perform the arthroscopy (*Table 3*).

In 188 (34.9%) of the 538 patients there was no valid indication reported to perform a knee arthroscopy. The percentage of patients without a reported valid indication and therefore potentially low value care, ranged between 10.8% (in a University Medical Center) to 63.6% (in a general hospital) (*Table 2*). In 4.7% of these patients without a valid indication, pseudo locking symptoms were reported and patient-provider decisions (including on patient request) in 26.3% of patients (*Table 3*). Performing an arthroscopy without a valid indication was not associated with age [OR 1.013 (95% CI 0.984-1.043)], diagnosis [OR 0.998 (95% CI 0.886-1.124)] nor type of care trajectory [OR 0.989 (95% CI 0.948-1.032)].

Table 3. Valid and invalid indications to perform knee arthroscopy in degenerative knee disease.

Valid indications knee arthroscopy	Amount, n (%)	Invalid indications (low value) knee arthroscopy	Amount, n (%)
ACL symptoms	13 (3.1%)	Pseudo locking symptoms	9 (4.7%)
Locking symptoms	141 (33.9%)	Arthroscopy performed as a result of a patient-provider decision	50 (26.3%)
Failed previous non-surgical treatment	155 (37.3%)	All other cases without a valid or invalid indication reported	131 (68.9%)
Symptoms caused by traumatic moment	46 (11.1%)		
Other (cyst, biopsy, synovitis, loose bodies, complications after arthroscopy, complications after knee replacement, complex lesion, bucket handle lesion, bone bruise, infection)	61 (14.7%)		
Total	416	Total	190

DISCUSSION

This study shows that while for a considerable part (35%) of the knee arthroscopies performed in patients with degenerative knee disease no valid surgical indication was reported and could thus be considered potentially low value care, confirming our initial hypothesis, this also means that the majority (65%) was performed with a valid indication reported. Potentially low value knee arthroscopies were performed in all types of hospitals. A frequently reported reason (for 26% of the patients) was that it was a joint patient-provider decision or that the arthroscopy was performed on the patient's request. Age, diagnosis and type of care trajectory were not associated with patients undergoing a potentially low value knee arthroscopy.

Previous studies have shown that a considerable number of patients with degenerative knee disease received an arthroscopy without first performing non-surgical treatments as recommended by clinical practice guidelines[11,16,20]. Muheim et al.[16] for instance showed that 70% of the patients in their study did not receive physical therapy before they underwent a knee arthroscopy. However, it was unknown whether the indication to perform a knee arthroscopy in these patients was valid (e.g. a truly locked knee). The results of the current study thus add to the literature that in 65% of the patients with degenerative knee disease who undergo arthroscopy there is a valid indication. In addition, from the 35% of patients without a valid indication for their knee arthroscopy, our study showed that for 26% of these patients this was the result of a patient-provider decision. Although the Choosing Wisely campaign encourages physicians and patients to engage in conversations about unnecessary tests, treatments and procedures[3], it can be questioned whether low value treatments should be considered by orthopedic surgeons as result of a patient-provider decision. If we believe the harms and costs of arthroscopies outweigh any benefits and we are trying to reduce low value care, orthopedic surgeons should practice evidence-based decision making in which they clearly explain the evidence, listen to a patient's values and preferences, and not offer to perform an arthroscopy unless there is a valid surgical indication[7]. As already shown in a previous study of Rietbergen et al.[17], such evidence-based decision making may be hampered by orthopedic surgeons' beliefs in the added value of arthroscopies as well as positive experiences with knee arthroscopies among friends and family in the patient's environment.

Based on the results of the current study, 35% of the knee arthroscopies in these thirteen Dutch hospitals potentially do not add value for patients with degenerative knee disease, could possibly cause harm and waste resources. Data of Dutch

Hospital Data show that in 2016 12,374 knee arthroscopies (based on 61 hospitals but without any private clinics) were performed for degenerative knee disease[4]. Assuming that one third of these knee arthroscopies are potentially low value, this means that more than 1.6 million euros were spent on these knee arthroscopies in 2016[10]. Therefore, it remains important to advocate increased adherence to clinical guidelines by surgeons and to develop interventions that target invalid indications for a knee arthroscopy.

This study also has limitations. First, the hospitals participating in this study were likely a non-representative sample of Dutch hospitals and private clinics. They have participated voluntarily in the SMART study and agreed to the retrospective review of medical records, which may have resulted in selection bias e.g. because of interest in this issue, and could mean that these are conservative estimates if other hospitals would for instance have strong beliefs in the added value of arthroscopy. The second limitation is that the results are based on information written in medical records. It can only be assumed that all important information about indications for a knee arthroscopy were in fact reported. If documentation was incomplete, the frequency of potentially low value knee arthroscopies may have been overestimated if these were performed for valid surgical indications but not recorded. However, incomplete documentation could also have underestimated pseudo-locking symptoms and arthroscopies performed due to patient-provider decisions and thereby potentially low value knee arthroscopy, if these were not routinely reported which seems likely given that these are not valid indications for performing a knee arthroscopy according to clinical guidelines and corresponding literature. A third limitation is that we only examined the indication for which the knee arthroscopy was conducted based on the clinical guideline and corresponding literature. However, including clinical outcomes for patients after knee arthroscopies or whether patients have perceived the surgery to have had added value (e.g. reassured them) could have changed the results, both whether those considered as low value indeed did not add value for them but also whether the potentially high-value knee arthroscopy also resulted in e.g. better patient outcomes. However, that would be a different study rather than a limitation of the way this study is conducted, and since it is not included in the guidelines what would be considered sufficient improvement or not, including patients outcomes and their perspective may also introduce subjectivity and inter-rater variability in the assessment as well as hindsight bias.

CONCLUSIONS

In a random sample of patients with degenerative knee disease aged 50 years and over who underwent an arthroscopy, 65% had valid indications reported in the medical records but 35% were performed without a valid indication reported and, therefore, potentially low value care, inconsistent with clinical guidelines. Patient and/or surgeons' preference may play a large role in the decision to perform an arthroscopy without a valid indication. Therefore, interventions should be developed to increase adherence to clinical guidelines by surgeons that target invalid indications for a knee arthroscopy to improve care. Objective patient information should be provided to support and improve the patient-provider decision making process.

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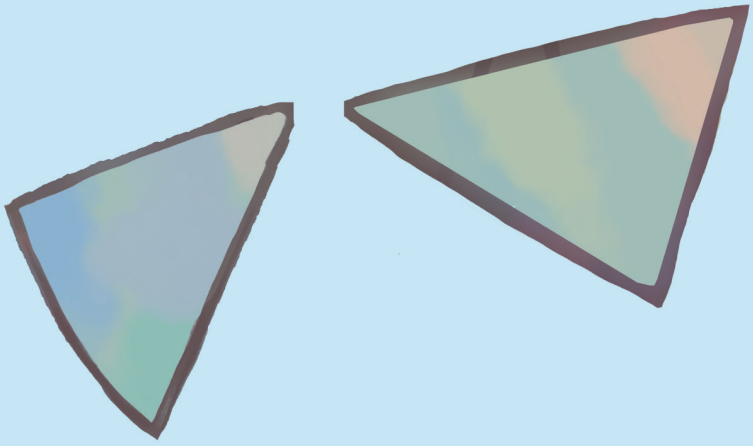

3

Preferences and beliefs of Dutch orthopaedic surgeons and patients reduce the implementation of “Choosing Wisely” recommendations in degenerative knee disease

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ABSTRACT

Purpose

The purpose of this study was to assess which factors were associated with the implementation of "Choosing Wisely" recommendations to refrain from routine MRI and arthroscopy use in degenerative knee disease.

Methods

Cross-sectional surveys were sent to 123 patients (response rate 95%) and 413 orthopaedic surgeons (response rate 62%) fulfilling the inclusion criteria. Univariate and multivariate logistic regression analyses were used to identify factors associated with implementation of "Choosing Wisely" recommendations.

Results

Factors reducing implementation of the MRI recommendation among patients included explanation of added value by an orthopaedic surgeon [OR 0.18 (95%CI 0.07-0.47)] and patient preference for MRI [OR 0.27 (95%CI 0.08-0.92)]. Factors reducing implementation among orthopaedic surgeons were higher valuation of own MRI experience than existing evidence [OR 0.41 (95%CI 0.19-0.88)] and higher estimated patients' knowledge to participate in shared-decision-making [OR 0.38 (95%CI 0.17-0.88)]. Factors reducing implementation of the arthroscopy recommendation among patients were orthopaedic surgeons' preferences for an arthroscopy [OR 0.03 (95%CI 0.00-0.22)] and positive experiences with arthroscopy of friends/family [OR 0.03 (95%CI 0.00-0.39)]. Factors reducing implementation among orthopaedic surgeons were higher valuation of own arthroscopy experience than existing evidence [OR 0.17 (95%CI 0.07-0.46)] and belief in the added value [OR 0.28 (95%CI 0.10-0.81)].

Conclusions

Implementation of "Choosing Wisely" recommendations in degenerative knee disease can be improved by strategies to change clinician beliefs about the added value of MRIs and arthroscopies, and by patient-directed strategies addressing patient preferences and underlying beliefs for added value of MRI and arthroscopies resulting from experiences of people in their environment.

INTRODUCTION

Approximately 25% of patients aged 50 years and over experience knee symptoms from degenerative knee disease[37,41]. These patients suffer from pain during walking, climbing stairs and squatting, and have functional loss[15,26]. In some cases, knee range of motion is limited due to a meniscal tear; also known as locking symptoms. These degenerative meniscal tears could be symptoms of early stage osteoarthritis[18,19].

For diagnosing patients with degenerative knee disease, clinical practice guidelines[2,4,7,8] and literature recommend weight bearing radiographs (fixed flexion view - Rosenberg view) to determine the presence and severity of degenerative knee disease and to exclude other causes of knee pain, such as osteonecrosis of the femoral condyle or tibial plateau[18,45]. Although MRI has high sensitivity and specificity in detecting meniscal tears in older patients [18,39], routine use of MRI is not recommended for diagnosis because of the poor correlation with patient symptoms[14,19,20,33]. Similarly, clinical practice guidelines do not recommend the use of arthroscopic surgery as there is no benefit shown of arthroscopic surgery over non-surgical treatments such as exercise therapy, analgesic medication and dietary advice[2,17,18,27,29-31,37,38,43,44]. If locking symptoms are present, or if pain is not reduced after non-surgical treatments, arthroscopy may be warranted. So, MRI and arthroscopic surgery without prior conservative management in degenerative knee disease can be considered as unnecessary or low value care as these provide no benefit for the patient, waste resources and may even cause harm to the patient[17,35].

Although practice guidelines and the underlying evidence do not recommend routine use of MRI and arthroscopy, many patients aged 50 years and over with degenerative knee disease receive an MRI and/or a knee arthroscopy[9,13,16,17,24,28,32,40]. Arthroscopic knee surgery is even the most common orthopaedic procedure in countries with available data and is, on a global scale, performed more than two million times each year[37].

In an effort to reduce the unnecessary use of MRIs and knee arthroscopies for patients with degenerative knee disease, medical societies in several countries have formulated "Choosing Wisely" recommendations regarding their use[1,3,6,10]. A recent study of Rosenberg et al.[34] showed that developing such recommendations does not necessarily eradicate low value care. To stimulate the implementation of the CW-recommendations, interventions should be adapted to the factors associated with implementation of specific CW-recommendations – in this case 'do not order an MRI for suspected degenerative meniscal tears'

and 'do not perform knee arthroscopy for patients with degenerative meniscal tears of degenerative knee disease without mechanical symptoms'[42]. Previous research has suggested that conducting knee arthroscopies is driven by clinician beliefs in the effectiveness[24,28], the need to meet patient expectations[12], perverse financial incentives for clinicians/hospitals[24,28], fragmented clinical decision pathways[24], and insurance coverage[32]. However, no study systematically studied factors influencing the implementation of these CW-recommendations on degenerative knee complaints in patients of 50 years and older.

Therefore, the aim of this study is to investigate which factors are associated with implementation of CW-recommendations among patients and orthopaedic surgeons in the Netherlands which aim to reduce the number of unnecessary MRIs and arthroscopies in patients aged 50 years and over with degenerative knee disease. Based on the previous research above, we hypothesize that orthopaedic surgeons' beliefs in the effectiveness of MRI and knee arthroscopy, the need to meet patient expectations, perverse financial incentives and insurance coverage all hamper the implementation of CW-recommendations.

MATERIALS AND METHODS

To investigate which factors are associated with implementation of CW-recommendations cross-sectional online surveys were performed among Dutch patients ≥ 50 years with degenerative knee disease and orthopaedic surgeons specialized in knee pathology (members of Dutch Knee Society) throughout the Netherlands. In the Netherlands, patients with (suspected) degenerative knee disease first visit a general practitioner before being referred to an orthopaedic surgeon.

A literature search and semi-structured interviews among Dutch patients with degenerative knee disease (n=3) and orthopaedic surgeons (n=3) were performed to identify potential factors influencing implementation of CW-recommendations regarding MRIs and arthroscopies in patients ≥ 50 years with degenerative knee disease. For the interviews, purposive sampling was applied to obtain contrasting views, thereby identifying a broad spectrum of potential factors. Patients ≥ 50 years with degenerative knee problems who did and did not have an MRI and/or arthroscopy, and orthopaedic surgeons who either do or do not perform an MRI and/or arthroscopy in these patients were selected. The interview questions were based on the framework of Grol and Wensing[23]. This framework distinguishes factors influencing implementation at the following six levels: a) innovation, b) individual professional, c) patient, d) social context, e) organisational context as well as the f) economic and political context.

The semi-structured interviews were audio-taped, fully transcribed and analysed using open-coding. The qualitative analysis was performed using the software program ATLAS.ti (version 7.5.16). A total of 55 factors were identified from the literature[21,22,25,36,46] for orthopaedic surgeons and patients. Besides, 4 factors were added based on the interviews among orthopaedic surgeons and patients. Overall, 59 factors were found, 26 for the patient and 33 for the orthopaedic surgeon.

Survey for patients

The survey included items about (1) background characteristics, (2) characteristics of the received care and (3) factors influencing implementation of the CW-recommendations regarding MRI and arthroscopy. The items of these first two categories are given in *Appendix 1*. The third part of the survey about factors influencing implementation of the CW-recommendations consisted of 26 items identified in the interviews and literature. Answers could be given on a 4-point Likert scale, ranging from "totally agree" (coded 1) till "totally disagree" (coded 4) and some questions could be answered with Yes/No. If the patient underwent an MRI or arthroscopy, additional questions followed, for example on waiting time.

Population

Patients were recruited via advertisements in newspapers and on websites of patient organisations. Assuming a baseline implementation rate of 15% in those with a certain barrier for implementation, sample size calculations showed that at least 120 patients would be needed to be able to detect a two-fold increase odds in those without the barrier with 80% power and 95% reliability. The developed survey was sent to a sample of patients with degenerative knee disease (n=138). Inclusion criteria were: age ≥ 50 years; degenerative knee disease; consultation with an orthopaedic surgeon for their degenerative knee disease. Patients on a waiting list for a Total Knee Arthroplasty (TKA) or who already received a TKA were excluded. Also, patients with an inability to understand written Dutch were excluded. If patients indicated that they preferred to fill in the survey on paper rather than online, they received a paper survey. Two reminders were sent in case of non-response, one after six and one twelve weeks after the initial invitation. Patients received a ten euro gift card as an incentive upon completion of the survey.

Survey for orthopaedic surgeons

The survey for orthopaedic surgeons included items regarding (1) background characteristics, (2) characteristics of care delivery and (3) factors influencing implementation of the CW-recommendations. The items of these first two categories are given in *Appendix 2*. The third part consisted of 33 items covering the factors influencing implementation of the CW-recommendations for orthopaedic surgeons. Answers could be given on a 4-point Likert scale, ranging from "totally agree" (coded 1) till "totally disagree" (coded 4).

Population

All Dutch orthopaedic surgeons specialized in knee pathology listed with an email address in the registry of the Dutch Orthopaedic Association (NOV) were invited by email to participate in the current study (*n*=422). Inclusion criterion was: treatment of patients ≥ 50 years with degenerative knee symptoms. This criterion was asked as first question of the survey. Non-responders received two reminders, one after 2 weeks and another 4 weeks after the initial invitation. The Medical Ethical Committee (CME P16.190/NV/nv) of the Leiden University Medical Center confirmed that ethical approval for this type of study is not required under Dutch law.

Statistical analysis

Data from all respondents who completed the survey and fulfilled the inclusion criteria were included in the analyses. Descriptive statistics were used to describe the background characteristics, the care received by the patients, and characteristics of the care delivery according to the orthopaedic surgeon. We dichotomized the factors influencing implementation into agree '1' (totally agree and agree) and disagree '0' (totally disagree and disagree), because of few observations in some categories of the original Likert scale. If patients had an MRI and/or an arthroscopy, we coded implemented CW-recommendation as 0 (No) and as 1 (Yes) otherwise.

For patients, univariate logistic regression analysis was first used to assess which background characteristics, received care and potential factor for implementation was associated with the implemented CW-recommendation, with MRI and Arthroscopy ('1' yes and '0' no) as the dependent variable. A similar analysis was conducted for orthopaedic surgeons, with self-reported implementation of the MRI/arthroscopy recommendations (yes/no) as dependent variable and background characteristics, care delivery characteristics and the factors influencing implementation of the CW-recommendations (agree/disagree) as independent variables.

In addition, for both patients and orthopaedic surgeons a multivariate logistic regression analysis was performed including those background characteristics, characteristics of the received care/ care delivery and the factors influencing the CW-recommendations with a p-value≤ 0.10 in univariate analyses. All analyses were performed using the software package SPSS (IBM SPSS, version 23).

RESULTS

Of the 138 recruited patients, 131 completed the survey (response rate 95%). Fifteen were excluded because they did not fulfil the inclusion criteria (*Appendix 3*). Of the 422 invited orthopaedic surgeons, 261 completed the survey (response rate 62%). Nine were excluded because they did not treat any patients ≥ 50 years with degenerative knee disease. *Table 1* shows that the majority of the patients were female (61%) receiving higher education (47%), with average age 63.2 years. The majority of patients had additional coverage in their insurance (85%). In the Netherlands, patients are obliged to have a basic insurance with or without an additional coverage. The basic insurance has a mandatory excess of 385 euro. Patients who completed the survey represented the target group well, compared to characteristics of Dutch orthopaedic patients[5]. Most of the orthopaedic surgeons who responded were male (90%), with average age of 47.2 years and 12.0 years of working experience (*Table 2*). This was a realistic representation of the orthopaedic work force in the Netherlands. The largest group worked in a general hospital (41%) in the middle region of the Netherlands (42%). Most of these orthopaedic surgeons saw more than 20 new patients per month (78%).

Table 1. Background characteristics of patients and received care from a patient perspective (*n*=116)

Background characteristics	
Age in years, mean (SD)	63.2 (7.9)
Female, n (%)	71 (61.2)
Region of residence, n (%)	
North	38 (32.8)
Middle	68 (58.6)
South	10 (8.6)
Education, n (%)	
Basic	8 (6.9)
Intermediate	53 (45.7)
High	55 (47.4)
Start of symptoms of degenerative knee disease, n (%)	
≤ 1 year ago	18 (15.4)
> 1 year ago	98 (84.5)
Diagnosis of locking symptoms by orthopaedic surgeon *******, n (%)	7 (12.5)
Pain before consult with orthopaedic surgeon (VAS), mean (SD)¥	7.1 (2.2)
Pain at this moment (VAS), mean (SD) ¥	4.7 (2.2)
Type of insurance, n (%)	
Basic only	17 (14.7)
Basic with additional coverage	99 (85.3)
Received care	
Patient visited …, n (%)	
General practitioner (GP)	103 (88.8)
Physical therapist	85 (73.3)
Dietician	10 (8.6)
Other primary care specialists	13 (11.2)
Patient received …, n (%)	
MRI scan	74 (63.8)
Arthroscopy	56 (48.3)
Time between start of knee complaints and the consultation with the general practitioner, n (%) *****	
≤ 6 weeks	47 (51.1)
> 6 weeks	45 (48.9)
Time between consultation with the general practitioner and orthopaedic surgeon, n (%) ******	
≤ 6 weeks	83 (80.6)
> 6 weeks	20 (19.4)
Waiting time MRI scan **, n (%)	
≤ 2 weeks	40 (66.7)
> 2 weeks	20 (33.3)
Waiting time arthroscopy *	
≤ 2 weeks	11 (23.9)
> 2 weeks	35 (76.1)
Implementation CW-recommendation regarding MRI/arthroscopy, n (yes), %	
MRI, n (%)	42 (36.2)
Arthroscopy, n (%)	58 (50.0)

n=116

*n=46 **n=60 ***n=72 ****n=52 *****n=92 ******n=103 *******n=56

¥ Pain measured on a visual analogue scale (VAS), 0 (no pain) - 10 (unbearable pain)

Table 2. Background characteristics orthopaedic surgeons, characteristics of care delivery and implementation of MRI/ arthroscopy clinical guidelines (*n*=252)

Background characteristics	
Age in years, (mean, SD)*	47.2 (8.5)
Female, n (%)	25 (9.9)
Years of work experience as orthopaedic surgeon, (mean, SD)	12.0 (8.0)
Work region, n (%)	
North	85 (33.7)
Middle	105 (41.7)
South	62 (24.6)
New patients ≥ 50 year with knee complaints seen per month, n (%)	
0-1	1 (0.4)
2-5	9 (3.6)
6-10	12 (4.8)
11-20	34 (13.5)
> 20	196 (77.8)
Number of MRI scans ordered per month, n (%)	
0-1	70 (27.8)
2-5	81 (32.1)
6-10	55 (21.8)
11-20	35 (13.9)
> 20	11 (4.4)
Number of arthroscopies carried out per month, mean (SD)	
0-1	107 (42.5)
2-5	97 (38.5)
6-10	37 (14.7)
11-20	9 (3.6)
> 20	2 (0.8)
Percentage of patients ≥ 50 year undergoing an arthroscopy because of locking symptoms, n (%)	
0-10 %	41 (16.3)
11-20 %	11 (4.4)
21-30 %	16 (6.3)
31-40 %	11 (4.4)
41-50 %	14 (5.6)
51-60 %	17 (6.7)
61-70 %	16 (6.3)
71-80 %	38 (15.1)
81-90 %	45 (17.9)
91-100 %	43 (17.1)

Characteristics of care delivery	
Centre has its own MRI scan, n (%)**	228 (90.5)
Waiting time for MRI scan, n (%)	
≤ 2 weeks	125 (51.0)
> 2 weeks	120 (49.0)
Waiting time for arthroscopy, n (%)***	
≤ 2 weeks	60 (24.5)
> 2 weeks	185 (75.5)
Implementation CW-recommendation regarding MRI/arthroscopy, n (yes), %	
MRI, n (%)	203 (80.6)
Arthroscopy, n (%)	208 (82.5)

n=252 *n=244 **n=245 ***n=227

Factors influencing the use of MRI and arthroscopy among patients

Table 3 shows that most patients agreed with the statements "Good contact with physical therapist helped me to persevere the physical therapy treatments" (90%), "Good guidance of the physical therapist helped me to persevere all physical therapy treatments" (90%), "I have an additional coverage" (85%), and "Physical activity was difficult because of pain" (84%).

Table 4 shows that undergoing an MRI was associated with five barriers and two background characteristics among patients. Undergoing a knee arthroscopy was associated with five barriers, three facilitators and one background characteristic. From these, the orthopaedic surgeon's explanation about the added value of an MRI (OR 0.18 (95% CI 0.07-0.47) and the preference of the patient for an MRI (OR 0.27 (95% CI 0.08-0.92) remained as independent factors associated with reduced implementation of the CW-recommendation regarding MRI, whereas a higher age (OR 1.07 (95% CI 1.01-1.14) was associated with higher implementation. For arthroscopy, the preference of the orthopaedic surgeon for arthroscopy (OR 0.03 (95% CI 0.00-0.22) and positive experiences of people in the patient's environment (OR 0.03 (95% CI 0.00-0.39) remained as independent factors association with reduced implementation of the CW-recommendation regarding arthroscopy.

Table 3. Presence factors influencing the implementation of CW-recommendation for MRI and/or arthroscopy reported by patients (*n*=116).

	Agree n (%)
Individual professional	
Orthopaedic surgeon asked which treatments the patient previously received for his/her knee complaints	89 (76.7)
Orthopaedic surgeon listened well to patient's wishes	89 (76.7)
Orthopaedic surgeon thought along with patient	86 (74.1)
Orthopaedic surgeon takes time to explain benefits and drawbacks of treatment options (medication, physical therapy, or arthroscopy)	81 (69.8)
Orthopaedic surgeon explained the added value of MRI	60 (51.7)
Orthopaedic surgeon explained benefits and drawbacks of an arthroscopy	60 (51.7)
Orthopaedic surgeon preferred an arthroscopy	47 (40.5)
Patient	
Physical activity was difficult because of pain	97 (83.6)
Patient searched for information before visiting the orthopaedic surgeon	73 (62.9)
Patient wanted an arthroscopy only if it was the last treatment option	55 (47.4)
Patient expected to receive an MRI scan before the consult with the orthopaedic surgeon	37 (31.9)
Patient expected to receive an arthroscopy prior to the consult with the orthopaedic surgeon	39 (33.6)
Patient preferred to receive an MRI scan during the consult with the orthopaedic surgeon	54 (46.6)
Patient preferred to receive an arthroscopy during the consult with the orthopaedic surgeon	52 (44.8)
Patient previously had negative experiences with physical therapy	15 (12.9)
In a situation in which different treatment options have approximately the same results:	
... patient prefers to decide about the treatment him/herself (active)	35 (30.2)
... patient prefers to decide about the treatment together with the orthopaedic surgeon (shared)	61 (52.6)
... patient prefers to let the orthopaedic surgeon decide about the treatment (passive)	20 (17.2)
In the situation of the consult of the patient with his/her orthopaedic surgeon:	
... patient decided about the treatment him/herself (active)	30 (25.9)
... patient decided about the treatment together with the orthopaedic surgeon (shared)	41 (35.3)
... patient let the orthopaedic surgeon decide about the treatment (passive)	45 (38.8)

Social context	
Good consultation between orthopaedic surgeon and physical therapist*	17 (29.3)
People in patient's environment recommended an MRI scan	33 (28.4)
People in patient's environment had good experiences with arthroscopy	48 (41.4)
People in patient's environment stimulated to keep on moving despite of pain	75 (64.7)
Organisational context	
Sufficient time for the orthopaedic surgeon to explain all treatment options (medication, physical therapy, or arthroscopy), including benefits and drawbacks	80 (69.0)
Good contact with physical therapist helped me carry on with non-surgical therapy**	64 (90.1)
Good guidance of the physical therapist helped me to uphold with the duration of the non-surgical therapy**	64 (90.1)
Economic and political context	
Additional payment for physical therapy not (fully) covered by insurance	99 (85.3)
Patient preferred an arthroscopy because physical therapy was not covered by insurance	4 (3.4)

*question answered by 58 of the 116 participants (*n*=58)
**question answered by 71 of the 116 participants (*n*=71)

Table 4. Influencing factors, background characteristics and received care reported by patients for implementation of CW-recommendations (*n*=116) (univariate and multivariate analyses).

	Univariate analyses		**Multivariate analyses**	
	Implementation CW MRI recommendation OR (95% CI)	**Implementation CW arthroscopy recommendation OR (95% CI)**	**Implementation CW MRI recommendation OR (95% CI)**	**Implementation CW arthroscopy recommendation OR (95% CI)**
Factors influencing the implementation of the CW recommendations				
Individual professional				
Orthopaedic surgeon asked which treatments the patient previously received for his/her knee complaints	1.18 (0.48-2.92) (+)	0.61 (0.26-1.47) (-)	x	x
Orthopaedic surgeon listened well to patient's wishes	0.95 (0.39-2.33) (-)	0.91 (0.38-2.15) (-)	x	x
Orthopaedic surgeon thought along with the patient	0.67 (0.29-1.56) (-)	1.00 (0.44-2.30)	x	x
Orthopaedic surgeon takes time to explain benefits and drawbacks of treatment options (medication, physical therapy, or arthroscopy)	x	0.92 (0.42-2.04) (-)	x	x
Orthopaedic surgeon explained the added value of an MRI	0.15 (0.06-0.36) (-)	x	**0.18 (0.07-0.47) (-)**	x
Orthopaedic surgeon explained benefits and drawbacks of an arthroscopy	x	0.30 (0.14-0.64) (-)	x	0.61 (0.09-3.94) (-)
Orthopaedic surgeon preferred an arthroscopy	x	0.02 (0.01-0.06) (-)	x	**0.03 (0.00-0.22) (-)**

Patient				
Patient expected to receive an MRI scan previous to the consult with the orthopaedic surgeon	0.45 (0.19-1.07) (-)	x	1.31 (0.35-4.90) (+)	x
Patient expected to receive an arthroscopy previous to the consult with the orthopaedic surgeon	x	0.30 (0.13-0.68) (-)	x	4.88 (0.36-65.71) (+)
Patient preferred to receive an MRI scan during the consult with the orthopaedic surgeon	0.21 (0.09-0.50) (-)	x	**0.27 (0.08-0.92) (-)**	x
Patient preferred to receive an arthroscopy during the consult with the orthopaedic surgeon	x	0.12 (0.05-0.27) (-)	x	0.24 (0.04-1.65) (-)
Physical activity was difficult because of pain	1.28 (0.45-3.66) (+)	0.88 (0.33-2.36) (-)	x	x
Patient searched for information previous to the visit to the orthopaedic surgeon	0.42 (0.19-0.93) (-)	1.25 (0.59-2.66) (+)	0.84 (0.31-2.28) (-)	x
Patient wanted an arthroscopy only if it was the last treatment option	x	0.81 (0.39-1.69) (-)	x	x
Patient previously had negative experiences with physical therapy	0.60 (0.18-2.03) (-)	1.17 (0.39-3.46) (+)	x	x
In a situation in which different treatment options have approximately the same results…:				
… patient prefers to decide about the treatment him/herself	0.60 (0.19-1.91) (-)	1.78 (0.58-5.43) (+)	x	x
… patient prefers to decide about the treatment together with the orthopaedic surgeon	0.97 (0.35-2.73) (-)	1.55 (0.56-4.32) (+)	x	x
… patient prefers to let the orthopaedic surgeon decide about the treatment	Reference category	Reference category	x	x
In the situation of the consult of the patient with his/her orthopaedic surgeon:				
… patient decided about the treatment him/herself	0.91 (0.34-2.40) (-)	1.97 (0.77 -5.08) (+)	x	x

... patient decided about the treatment together with the orthopaedic surgeon	1.16 (0.48-2.78) (+)	0.89 (0.38-2.09) (-)	x	x
... patient let the orthopaedic surgeon decide about the treatment	Reference category	Reference category	x	x
Social context				
Good consultation between orthopaedic surgeon and physical therapist*	x	0.80 (0.26-2.48) (-)	x	x
People in patients' environment recommended an MRI scan	0.37 (0.14-0.95) (-)	x	0.64 (0.19-2.12) (-)	x
People in patients' environment had good experiences with arthroscopy	x	0.13 (0.06-0.31) (-)	x	**0.03 (0.00-0.39) (-)**
People in patients' environment stimulated to keep on moving despite of pain	1.36 (0.61-3.04) (+)	1.99 (0.92-4.32) (+)	x	2.77 (0.24-31.44) (+)
Organisational context				
Sufficient time for the orthopaedic surgeon to explain all treatment options (medication, physical therapy or arthroscopy), including risks and benefits	x	1.18 (0.54-2.58) (+)	x	x
Good contact with physical therapist helped me carry on with non-surgical therapy** (-)	x	8.22 (0.94-72.33) (+)	x	7.69 (0.01-5090.47) (+)
Good guidance of the physical therapist helped me to uphold with the duration of the non-surgical therapy**	x	8.22 (0.94-72.33) (+)	x	5.95 (0.01-3504.06) (+)
Economic and political context				
Additional payment for physical therapy (fully) covered by insurance	0.78 (0.27-2.23) (-)	1.15 (0.41-3.22) (+)	x	x
Patient preferred an arthroscopy because physical therapy was not covered by insurance	1.80 (0.24-13.27) (+)	1.00 (0.14-7.35)	x	x

Background characteristics				
Age	1.09 (1.03-1.15)) (+)	0.98 (0.94-1.03) (-)	**1.07 (1.01-1.14) (+)**	x
Gender	0.90 (0.41-1.94) (-)	1.94 (0.91-4.13) (+)	x	2.28 (0.31-16.82) (+)
Province of residence				
North	0.66 (0.28-1.55) (-)	0.94 (0.43-2.09) (-)	x	x
Middle	Reference category	Reference category	x	x
South	1.61 (0.43-6.12) (+)	0.63 (0.16-2.43) (-)	x	x
Level of education				
Basic	2.32 (0.50-10.69) (+)	2.69 (0.50-14.51) (+)	3.45 (0.57-20.88) (+)	x
Intermediate	0.50 (0.22-1.13) (-)	0.69 (0.32-1.47) (-)	0.66 (0.25-1.77) (-)	x
High	Reference category	Reference category	Constant factor	x
Pain before consult with orthopaedic surgeon	0.97 (0.81-1.15) (-)	0.94 (0.80-1.12) (-)	x	x
Diagnosis of orthopaedic surgeon was a locked-knee***	2.63 (0.50-13.72) (+)	x	x	x
Received care				
Time between start of knee complaints and the consult with the general practitioner****	0.77 (0.32-1.84) (-)	0.91 (0.40-2.07) (-)	x	x
Time between consult with the general practitioner and consult with orthopaedic surgeon*****	0.81 (0.30-2.19) (-)	0.88 (0.33-2.35) (-)	x	x

OR (95% CI) = odds ratio (95% confidence interval)
(-) Barrier, OR <1
(+) Facilitator, OR >1

In bold: P-values ≤ 0.05

n=116
**n*=58, ***n*=71, ****n*=52, *****n*=92, ******n*=103

Factors influencing the use of MRI and arthroscopy among orthopaedic surgeons

Table 5 shows that most orthopaedic surgeons agreed with the statements "asking questions about the previous non-surgical treatments" (98%), the familiarity with the CW-recommendation for MRI (99%) and arthroscopy (98%) as influential factors for implementation.

Table 6 shows that implementation of the CW-recommendation regarding MRI was associated with four barriers and six facilitators among orthopaedic surgeons in univariate analysis. Implementation of the CW-recommendation regarding arthroscopy was associated with two barriers, five facilitators and three background characteristics. From these, agreement with the CW-recommendation regarding MRI (OR 12.10 (95% CI 3.51-41.64) remained as an independent factor associated with higher implementation of the CW-recommendation in multivariate analysis, whereas higher valuation of own experience than existing evidence (OR 0.41 (95% CI 0.19-0.88) and higher estimated patients' knowledge to participate in shared-decision-making (OR 0.38 (95% CI 0.17-0.88) were associated with reduced implementation. Knowledge of (OR 58.17 (95% CI 2.63-1287.24) and agreement with the CW-recommendations regarding arthroscopy (OR 37.45 (95% 5.39-260.24) as well as actively searching for newest evidence and guidelines (OR 3.28 (95% CI 1.19-9.08) were associated with higher implementation of the CW-recommendation regarding arthroscopy, whereas higher valuation of own experience than existing evidence (OR 0.17 (95% CI 0.07-0.46) and belief in the value of arthroscopy (OR 0.28 (95% CI 0.10-0.81) was associated with reduced implementation.

Table 5. Orthopaedic surgeons' agreement with factors influencing the implementation of the CW-recommendation regarding MRI and/or arthroscopy (*n*=252).

Level	Agree n (%)
Individual professional	
Orthopaedic surgeon asks about previously received non-surgical treatments (physical therapy, medication, nutritional advice when BMI> 25, and lifestyle advice)	248 (98.4)
Orthopaedic surgeon prescribes one or more non-surgical treatments (physical therapy, medication, nutritional advice when BMI> 25, and lifestyle advice) if patient did not receive all non-surgical treatment care yet (+)	240 (95.2)
Belief in effectivity of non-surgical treatment strategy (physical therapy, medication, nutritional advice when BMI> 25, and lifestyle advice) for knee complaints of patients ≥ 50 years	234 (92.9)
Fully familiar with the CW-recommendation for MRI	249 (98.8)
Agrees with the CW-recommendation for MRI	228 (90.5)
Higher valuation of own experience with MRI than of existing evidence	90 (35.7)
Belief in value of MRI over Fixed Flexion View	109 (43.3)
Fully familiar with the CW-recommendation for arthroscopy	248 (98.4)
Agrees with the CW-recommendation for arthroscopy	234 (92.9)
Higher valuation of own experience with arthroscopy than of existing evidence	73 (29.0)
Belief in value of arthroscopy for patients ≥ 50 years with knee complaints, without 'locked knee' complaints, despite possible complications and risks	50 (19.8)
Important to perform arthroscopy as soon as possible for patients ≥ 50 years with knee complaints, without 'locked knee' complaints	5 (2.0)
Actively searches for latest knowledge about evidence and guidelines for diagnosis/treatment of knee complaints	199 (79.0)
Orthopaedic surgeon wants to meet patients' expectations*	147 (59.5)
Orthopaedic surgeon is able to clarify to the patient whether an MRI scan is necessary, even if the patient has a contradictory opinion at first*	169 (68.4)
Orthopaedic surgeon is able to clarify to the patient whether an arthroscopy is necessary, even if the patient has a contradictory opinion at first*	188 (76.1)
Patient	
Orthopaedic surgeon notices that patients are well prepared for the consult by gaining of knowledge	67 (26.6)

Patients' level of knowledge is sufficient to make a shared decision about treatment	80 (31.7)
Patients ≥ 50 years with knee complaints have certain expectations about diagnostics and treatment when they come to the consult* (-)	134 (94.7)
Most patients find it difficult that the CW-recommendation for MRI also applies to them*	190 (76.9)
Most patients find it difficult that the CW-recommendation for arthroscopy also applies to them*	170 (68.8)
Social context	
Colleagues all follow the CW-recommendation for MRI and arthroscopy**	155 (63.3)
My colleagues tell me when I do not follow the guidelines**	197 (80.4)
Colleagues are in favour of non-surgical treatments (physical therapy, medication, nutritional advice, and lifestyle advice) **	220 (89.8)
Organisational context	
Able to make clear arrangements with primary care (GP, physical therapist, dietician)	188 (74.6)
Good feedback from primary care (GP, physical therapist, dietician) to orthopaedic surgeon about patient progress	139 (55.2)
Enough time to keep knowledge of guidelines up to date	156 (61.9)
Enough time to explain to the patient which diagnosis and treatment options are applicable to the patient's situation*	164 (66.4)
Pressure of production MRI**	17 (6.9)
Pressure of production arthroscopy**	17 (6.9)
Economic and political context	
Financial reasons determine patient preference (arthroscopy more often covered by insurance than non-surgical treatment*)	84 (34.0)
Medicolegal substantiation to follow the CW-recommendation for MRI**	27 (11.0)
Medicolegal substantiation to follow the CW-recommendation for arthroscopy**	7 (2.9)

n=252
*n=247, **n=245

Table 6. Influencing factors and background characteristics reported by orthopaedic surgeons for the implementation of the CW-recommendations (*n*=252) (univariate and multivariate analyses).

	Univariate analyses		Multivariate analyses	
	Acts according to CW MRI recommendation OR (95% CI)	**Acts according to Arthroscopy CW recommendation OR (95% CI)**	**Acts according to CW MRI recommendation OR (95% CI)**	**Acts according to Arthroscopy CW recommendation OR (95% CI)**
Factors influencing the implementation of CW recommendations				
Individual professional				
Orthopaedic surgeon asks about previously received non-surgical treatments	1.39 (0.14-13.65) (+)	x[#]	x	x
Orthopaedic surgeon uses step-by-step treatment strategy	2.17 (0.63-7.51) (+)	2.50 (0.72-8.70) (+)	x	x
Belief in effectivity of non-surgical treatment strategy	2.91 (1.07-7.95) (+)	2.58 (0.91-7.29) (+)	0.96 (0.22-4.27) (-)	0.31 (0.03-3.10) (-)
Knowledge about the CW-recommendation for MRI	2.09 (0.19-23.57) (+)	x	x	x
Agree with the CW-recommendation for MRI	14.88 (5.72-38.70) (+)	x	**12.10 (3.51-41.64) (+)**	x
Higher valuation of own experience with MRI than of existing evidence	0.27 (0.14-0.51) (-)	x	**0.41 (0.19-0.88) (-)**	x
Belief in value of MRI over Fixed Flexion View	0.36 (0.19-0.69) (-)	x	0.49 (0.23-1.07) (-)	x
Orthopaedic surgeon actively searches for latest knowledge about evidence and guidelines for diagnosis/treatment of knee complaints	2.46 (1.24-4.91) (+)	2.64 (1.30-5.37) (+)	1.87 (0.79-4.45) (+)	**3.28 (1.19-9.08) (+)**
Knowledge about the CW-recommendation for arthroscopy	x	15.15 (1.54-149.25) (+)	x	**58.17 (2.63-1287.24) (+)**
Agrees with the CW-recommendation for arthroscopy	x	58.86 (12.85-269.66) (+)	x	**37.45 (5.39-260.24) (+)**
Higher valuation of own experience with arthroscopy than of existing evidence	x	0.14 (0.07-0.28) (-)	x	**0.17 (0.07-0.46) (-)**

Belief in value of arthroscopy despite possible complications and risks	x	0.10 (0.05-0.22) (-)	x	**0.28 (0.10-0.81) (-)**
Important to perform arthroscopy as soon as possible	x	0.84 (0.09-7.73) (-)	x	x
Orthopaedic surgeon wants to meet patients' expectations*	0.80 (0.41-1.54) (-)	1.20 (0.62-2.34) (+)	x	x
Orthopaedic surgeon is able to clarify to the patient whether an MRI scan is necessary, even if the patient has a contradictory opinion at first*	1.29 (0.66-2.52) (+)	x	x	x
Orthopaedic surgeon is able to clarify to the patient whether an arthroscopy is necessary, even if the patient has a contradictory opinion at first*	x	1.29 (0.62-2.72) (+)	x	x
Patient				
Orthopaedic surgeon notices that patients are well prepared for the consult by gaining of knowledge	0.62 (0.32-1.20) (-)	0.64 (0.32-1.30) (-)	x	x
Patients' level of knowledge is sufficient to make a shared decision about treatment	0.55 (0.29-1.04) (-)	1.00 (0.50-2.00)	**0.38 (0.17-0.88) (-)**	x
Patients ≥ 50 years with knee complaints have certain expectations about diagnostics and treatment when they come to the consult*	0.76 (0.16-3.57) (-)	0.86 (0.18-4.01) (-)	x	x
Most patients find it difficult that the CW-recommendation for MRI also applies for them*	0.26 (0.09-0.75) (-)	x	0.34 (0.10-1.16) (-)	x
Most patients find it difficult that the CW-recommendation for arthroscopy also applies for them*	x	0.53 (0.24-1.17) (-)	x	x
Social context				
All colleagues follow the CW-recommendation for MRI and arthroscopy**	2.09 (1.10-3.97) (+)	4.79 (2.37-9.69) (+)	1.54 (0.66-3.60) (+)	2.51 (0.94-6.70) (+)
My colleagues speak to me when I do not follow the guidelines**	1.78 (0.85-3.72) (+)	1.79 (0.84-3.81) (+)	x	x

Positive attitude of colleagues towards non-surgical treatments (physical therapy, medication, nutritional advice, and lifestyle advice) **	3.30 (1.38-7.91) (+)	1.99 (0.77-5.11) (+)	1.13 (0.32-3.94) (+)	x
Organisational context				
Orthopaedic surgeon is able to make clear arrangements with primary care (GP, physical therapist, dietician)	1.22 (0.61-2.46) (+)	1.68 (0.83-3.38) (+)	x	x
Good feedback from primary care (GP, physical therapist, dietician) to orthopaedic surgeon about patient's progress	1.00 (0.54-1.88)	1.60 (0.83-3.09) (+)	x	x
Enough time to keep knowledge of guidelines about diagnosis/treatment of knee complaints up to date	1.75 (0.93-3.28) (+)	0.81 (0.41-1.61) (-)	2.14 (0.95-4.84) (+)	x
Enough time to explain the patient which diagnosis and treatment options are applicable to the patients' situation*	1.03 (0.52-2.00) (+)	0.95 (0.47-1.90) (-)	x	x
Pressure of production MRI**	1.84 (0.41-8.36) (+)	x	x	x
Pressure of production arthroscopy**	x	0.99 (0.27-3.62) (-)	x	x
Waiting time for MRI scan	1.00 (0.53-1.89)	x	x	x
Waiting time for arthroscopy	x	1.64 (0.80-3.36) (+)	x	x
Economic and political context				
Financial reasons determine patient preference because arthroscopy is more often covered by insurance than non-surgical treatment is*	x	1.88 (0.88-4.03) (+)	x	x
Medicolegal substantiation to follow the CW-recommendation for MRI**	0.64 (0.25-1.62) (-)	x	x	x
Medicolegal substantiation to follow the CW-recommendation for arthroscopy**	x	0.52 (0.10-2.78) (-)	x	x
Centre has its own MRI scan	0.73 (0.44-1.20) (-)	x	x	x

Background characteristics				
Gender	0.96 (0.34-2.70) (-)	1.12 (0.37-3.45) (+)	x	x
Age***	1.00 (0.97-1.04)	0.96 (0.92-1.00) (-)	x	1.10 (0.88-1.36) (+)
Years of experience as an orthopaedic surgeon	1.00 (0.96-1.04)	0.95 (0.92-0.99) (-)	x	0.88 (0.70-1.11) (-)
Work setting				
University medical centre	2.20 (0.47-10.30) (+)	1.95 (0.42-9.19) (+)	x	x
Teaching hospital	1.61 (0.77-3.67) (+)	1.89 (0.85-4.18) (+)	x	x
Private clinic	0.63 (0.27-1.47) (-)	0.55 (0.23-1.31) (-)	x	x
General hospital	Reference category	Reference category	x	x
Work region				
North	Reference category	Reference category	x	Reference category
Middle	1.39 (0.69-2.82) (+)	2.54 (1.17-5.53) (+)	x	1.97 (0.61-6.37) (+)
South	1.60 (0.69-3.71) (+)	1.52 (0.67-3.44) (+)	x	0.98 (0.30-3.16) (-)

OR (95% CI) = odds ratio (95% confidence interval)
(-) Barrier, OR <1
(+) Facilitator, OR >1

In bold: P-values ≤ 0.05

n=252
**n*=247, ***n*=245, ****n*=244
Could not be estimated

DISCUSSION

That the implementation of CW recommendations to reduce unnecessary MRIs and knee arthroscopies was hampered by patient preferences for MRI, positive experiences with arthroscopies in the patient's environment, orthopaedic surgeons' preferences for arthroscopy and their beliefs in the added value as well as valuing their own clinical experience to be more important than existing evidence were the most important findings of this study. On the other hand, orthopaedic surgeons' knowledge of and agreement with the CW-recommendations, as well as a proactive attitude towards searching for new evidence and guidelines facilitate implementation. Furthermore, older age of patients increased implementation of CW-recommendations regarding MRI.

Previous studies were limited in only presenting the clinician perspective and mentioned clinician beliefs in the effectiveness of arthroscopic surgery[24,28], clinicians' need to meet patient expectations[12], perverse financial incentives[24,28], fragmented clinical decision pathways[24], and insurance coverage[32] as possible barriers for implementation of CW recommendations regarding MRI and arthroscopy in degenerative knee disease. Our study results confirm that clinician beliefs hamper implementation, but perverse financial incentives for clinicians/hospitals, fragmented clinical decision pathways and insurance coverage were not identified as barriers. Possibly this can be explained by a different healthcare system in which the studies are performed. In our study only 7% of the orthopaedic surgeons felt pressure to perform MRIs and arthroscopies because of production agreements and 75% of the orthopaedic surgeons reported that they were able to make clear agreements with GPs, physical therapists and dieticians about care delivery (*Table 5*). Furthermore, in our study 85% of the patients have reported that they have additional coverage for physical therapy treatment (*Table 1*).

Previous studies also showed that clinicians felt CW-recommendations are hard to accept for patients[46], were worried about malpractice claims and did not have enough time to discuss the risks and benefits of imaging with the patient[36]. Around 70% of the orthopaedic surgeons reported in our survey that they thought patients had difficulties to accept the CW-recommendations (*Table 5*), but these were not independently associated with implementation in multivariate regression analyses. In addition, fear for malpractice claims and lack of time to discuss risks and benefits of imaging with the patients was also not found to hamper implementation: less than 11% of the orthopaedic surgeons felt they needed to request an MRI or perform an arthroscopy for medicolegal substantiation (*Table 5*). Sixty-six percent of orthopaedic surgeons reported

they had enough time to explain treatment options to patients (*Table 5*) and 69% of the patients felt that their orthopaedic surgeon spent sufficient time to explain treatment options including risks and benefits (*Table 3*). This underlines the importance of assessment of factors influencing the implementation of every CW-recommendation for different countries, but also to include both the clinician and the patient perspective.

That the implementation of CW-recommendations can also be influenced by patients was shown by this study, in addition to other studies. While previous studies regarding the use of MRI and arthroscopies in degenerative knee disease mainly mentioned clinician-related barriers[24,28], our study showed that also patients' preferences for MRIs and positive experiences of people in their environment with arthroscopies hampered implementation of the CW-recommendations. This is an important finding for future initiatives to improve implementation of CW-recommendations. These should include both patient and orthopaedic surgeon-directed strategies.

Implications for clinical practice are that the use of unnecessary MRI's and knee arthroscopy for patients with degenerative knee disease can potentially be reduced by strategies tailored to the identified barriers for implementation of the CW-recommendations[11]. This reduction is of great importance as MRI's and arthroscopies for patients with degenerative knees provide no benefit for the patient, waste resources and may even cause harm to the patient[17,35].

Although this study identified important starting points for improving implementation of CW-recommendations, there are also limitations. First, only three patients and three orthopaedic surgeons were interviewed for survey development. However, after the second interview with the orthopaedic surgeon, no new information was obtained so more interviews were not required. Besides, the interviews were only used to explore if other factors should be included in the survey than already found in the literature. The second limitation is the retrospective nature of our study and the use of self-reported questions. Both patients and orthopaedic surgeons were asked to report the characteristics of received care/care delivery and barriers/facilitators retrospectively, and the use of CW-recommendation. Therefore, it is possible that some patients and orthopaedic surgeons were not able to fully recall their respective care trajectory and provided care. Third, patients were self-selected after seeing the advertisements in the newspapers or on the websites, which may have caused selection bias. However, it seems that the patients who completed the survey represented the target group well[5].

CONCLUSIONS

The identified factors give important starting points for improving implementation of the CW-recommendations regarding MRIs and arthroscopies in degenerative knee disease. It seems important to search for strategies to change clinician beliefs on the added value of arthroscopies and MRIs. Moreover, these strategies should focus on the importance of clinical experiences based on evidence. Furthermore, patient directed strategies are needed to address patient 'subjective' preferences based on social feedback from environment and social media. These may add to underlying misbeliefs on the value of MRI and arthroscopies in degenerative knee disease.

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Appendix 1: Items survey patient

Background characteristics	
Age	In years
Gender	Male, Female
Region of residence	North (Friesland, Groningen, Flevoland, Noord-Holland, Drenthe, and Overijssel), middle (Zuid-Holland, Utrecht, and Gelderland), and south (Noord-Brabant, Zeeland, and Limburg))
Education level	Basic education (no or only primary education), intermediate education (prevocational secondary education, senior secondary vocational training, senior secondary general education, pre-university education), or higher education (higher professional education or university (bachelor, master, or PhD degree))
Start of disease symptoms	0-3 months, 3-6 months, 6-12 months, and > 1 year
Diagnosis of locking symptoms by orthopaedic surgeon if patient received arthroscopy	Yes, No
Pain before visiting an orthopaedic surgeon	Visual Analogue Scale (VAS)
Pain at the moment of the survey	Visual Analogue Scale (VAS)
Health insurance	Basic insurance or additional coverage*
Characteristics of the received care	
History of caregivers	General practitioner (GP), physical therapist, orthopaedic surgeon, dietitian, and/or other
Received care modalities	MRI, arthroscopy and/or physical therapy (yes/no)
Time between start of knee complaints and visiting the GP	< 1 week, 1-6 weeks, > 6 weeks, or no idea
Waiting time between GP and orthopaedic surgeon	1-2 weeks, 3-4 weeks, 5-6 weeks, more than 6 weeks, or no idea
Waiting time MRI	1-2 weeks, 3-4 weeks, 5-6 weeks, more than 6 weeks, or no idea, not applicable (NA)
Waiting time arthroscopy	waiting time arthroscopy (1-2 weeks, 3-4 weeks, 5-6 weeks, more than 6 weeks, or no idea, NA)
Preferred and actual role of the patient in treatment decision making process	Control Preference Scale (CPS) [17]

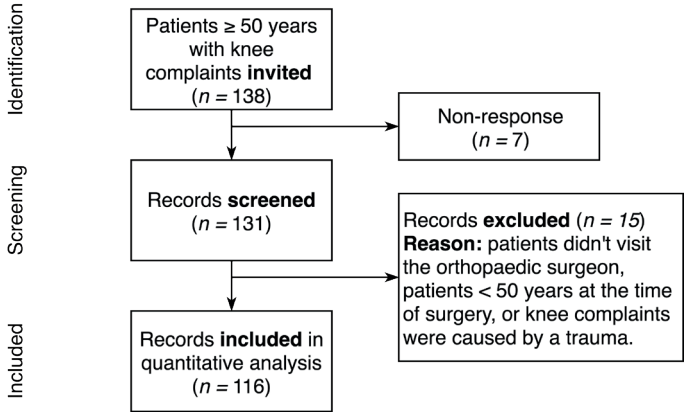
* In the Netherlands, applying for a basic insurance is compulsory. In addition, patients can choose for an additional coverage.

Appendix 2: Items survey orthopaedic surgeon

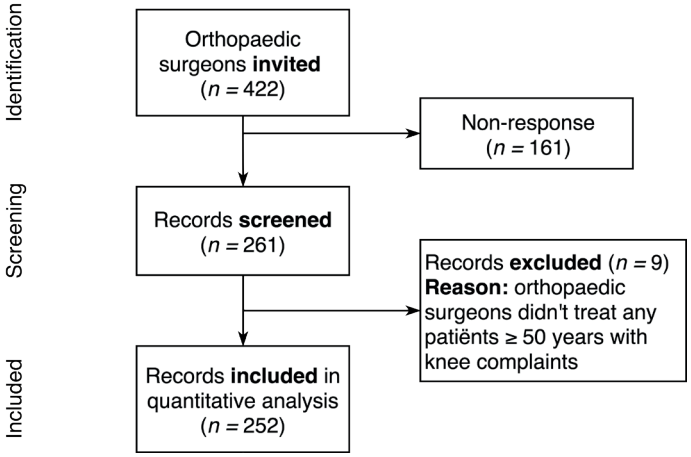
Background characteristics	
Age	
Gender	Male, Female
Years of working experience	
Work setting	university medical centre, teaching hospital, general hospital, independent treatment centre
Work region	North (Friesland, Groningen, Flevoland, Noord-Holland, Drenthe, and Overijssel), middle (Zuid-Holland, Utrecht, and Gelderland), and south (Noord-Brabant, Zeeland, and Limburg))
Number of new patients per month	
Number of MRIs and arthroscopies per month	
Percentage of patients undergoing an arthroscopy with locking symptoms	
Characteristics of care delivery	
Availability of MRI scan in hospital	Yes, No
Waiting time MRI	0-1 week, 1-2 weeks, 3-4 weeks, 4-5 weeks, or more than 5 weeks
Waiting time arthroscopy	0-1 week, 1-2 weeks, 3-4 weeks, 4-5 weeks, or more than 5 weeks
Implementation of CW-recommendation	4-point likert scale, ranging from “totally agree” (coded 1) till “totally disagree” (coded 4)

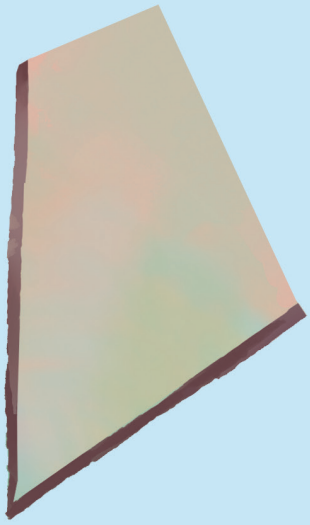
Appendix 3: Flowcharts

Flowchart patients



Flowchart orthopaedic surgeons





4

A tailored intervention does not reduce low value MRI's and arthroscopies in degenerative knee disease when the secular time trend is taken into account: a difference-in-difference analysis

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Knee Surgery, Sports Traumatology, Arthroscopy (2022)

ABSTRACT

Purpose

To evaluate the effectiveness of a tailored intervention to reduce low value MRIs and arthroscopies among patients ≥ 50 years with degenerative knee disease in 13 Dutch orthopaedic centers (intervention group) compared with all other Dutch orthopaedic centers (control group).

Methods

All patients with degenerative knee disease ≥ 50 years admitted to Dutch orthopaedic centers from January 2016 to December 2018 were included. The tailored intervention included participation of clinical champions, education on the Dutch Choosing Wisely recommendation for MRI's and arthroscopies in degenerative knee disease, training of orthopaedic surgeons to manage patient expectations, performance feedback, and provision of a patient brochure. A difference-in-difference analysis was used to compare the time trend before (admitted January 2016 - June 2017) and after introduction of the intervention (July 2017 - December 2018) between intervention and control hospitals. Primary outcome was the monthly percentage of patients receiving an MRI or knee arthroscopy, weighted by type of hospital.

Results

136,446 patients were included, of whom 32,163 were treated in the intervention hospitals. The weighted percentage of patients receiving an MRI on average declined by 0.15% per month (ß=-0.15, p<0.001) and by 0.19% per month for arthroscopy (ß= -0.19, p<0.001). However, these changes over time did not differ between intervention and control hospitals, neither for MRI (ß= -0.74, p=0.228) nor arthroscopy (ß=0.13, p=0.688).

Conclusions

The extent to which patients ≥ 50 years with degenerative knee disease received an MRI or arthroscopy declined significantly over time, but could not be attributed to the tailored intervention. This secular downward time trend may reflect an overall focus of reducing low value care in The Netherlands.

INTRODUCTION

Due to the ageing population more people will suffer from degenerative knee disease in the future[23,48]. Nowadays, around 25% of patients aged 50 years and over experience symptoms of degenerative knee disease[38,45]. These patients suffer from complaints during walking, climbing stairs and squatting[14,23]. Some patients also experience locking symptoms: a limited range of motion of the knee due to loose bodies or meniscal tears. Meniscal tears in this age group occur as part of a degenerative process and can be considered a feature of an early stage of osteoarthritis[17,21].

Since 2014, clinical practice guidelines from professional orthopaedic associations[1,4,6,7] as well as literature on diagnosis and treatment of these patients advise regular weight bearing radiographs including a fixed flexion view (Rosenberg view) to examine the cartilage status of the knee, and non-surgical treatment modalities including pain medication, dietary advice and exercise therapy. Routine use of an MRI for diagnosis of degenerative knee disease is not recommended for this specific patient group due to the poor association with symptoms[13,20,21,32]. Similarly, arthroscopic interventions are not recommended for routine use in degenerative knee disease because limited benefits are found that are absent one to two years after surgery[16,27,28,39,40,43]. Only when locking symptoms are present, a knee arthroscopy may be warranted. As the use of MRI and knee arthroscopy provides limited benefit, require resources and – as for any procedure - may cause harm to the patient[16,37], both are considered low value care for patients with degenerative knee disease[29,37].

Nevertheless, many patients are still referred for an MRI or knee arthroscopy for symptomatic degenerative knee complaints [8,12,15,16,22,24-26,30,35,42,44]. Smith et al.[41] showed that in Australia knee MRI rates for patients aged 55 years and older increased from 216 per 100,000 to 1509 per 100,000 in 2017. Parent et al.[32] showed that only 38% of patients 50 years and over with degenerative knee disease had a plain radiograph in the 24 months preceding the MRI. Regarding knee arthroscopy, Rietbergen et al.[35] showed that in 2016 35% of knee arthroscopies in the Netherlands was performed without a documented valid surgical indication. Even more important 26% of these arthroscopies were performed on the patient's request.

To create more awareness and reduce the routine use of MRI and knee arthroscopy in degenerative knee disease, "Choosing Wisely" recommendations were developed in several countries[2,5,9,47]. These are evidence-based recommendations by professional medical specialist societies regarding use of diagnostic

tests and surgical procedures. It has been shown that low value care is not reduced by a passive approach of only publishing these "Choosing Wisely" recommendations[36]. Tailored, active, interventions are more likely to succeed in orthopaedic centers that still routinely perform these low value care diagnostics and surgical procedures. The aim of this study is to evaluate the effectiveness of such a tailored intervention to reduce low value MRIs and arthroscopies in patients ≥ 50 years with degenerative knee disease in 13 Dutch orthopaedic centers (intervention group) compared with all other Dutch orthopaedic centers (control group). The hypothesis was that orthopaedic centers receiving the tailored intervention will reduce the use of low value MRI and knee arthroscopy to a greater extent than all other Dutch orthopaedic centers.

MATERIALS AND METHODS

The Medical Ethical Committee (CME P16.190/NV/nv) of the Leiden University Medical Center waived the need for ethical approval for this study under Dutch law. A difference-in-difference design was used to compare the change in time trend before and after introduction of the intervention between intervention and control hospitals. Anonymized patient-level data were extracted from the Dutch National Basic Registration of Hospital Care (LBZ)[3] for all patients aged 50 years and over with knee complaints (Diagnosis Treatment Codes (DTC) 1801–1899) and a closed care trajectory in a Dutch hospital between January 1, 2016 to December 31, 2018. Dutch Hospital Data, the national organization that collects the data from all the hospitals, gave permission to use the anonymized patient data. When a patient visits a hospital the first time for knee complaints, this will generate an initial care trajectory and a follow-up care trajectory if the patient still has complaints within 120 days after the start of this initial care trajectory. All procedures including MRI and arthroscopy are assigned to this care trajectory. Patients with all their diagnostic and surgical procedures carried out in a care trajectory, were assigned to the month at which the trajectory for a specific DTC opened. All patients diagnosed and treated in intervention hospitals were included, except patients from one daycare orthopedic private clinic, since those patient data were not collected in the LBZ. The control group existed of patients diagnosed and treated in all other Dutch orthopaedic hospitals providing data to the LBZ in the same period (2016: n=49; 2017: n=55, 2018: n=54).

For each anonymized patient and care trajectory, information was obtained on patient characteristics (age, sex), type of orthopaedic center (University Medical Center, Teaching Hospital, and General Hospital), Diagnosis Treatment Code (1801 – 1899), group (intervention or control), MRI conducted (yes/no),

arthroscopy conducted (yes/no), number of MRIs conducted, number of arthroscopies conducted, month and year care trajectory opened and closed, date of MRI, date of arthroscopy, number of other care trajectories open at that time point, and type of care trajectory (initial or follow-up treatment). It was defined the period January 2016 - June 2017 as before the intervention, and July 2017 - December 2018 as during/after the intervention. If patients had multiple care trajectories for the same DTC (e.g. for every visit and/or treatment), it is likely that these all belong to the same care path so only the DTC for the last opened care trajectory were then used.

Intervention

A tailored intervention was developed and implemented from July 2017 to February 2018 in the 13 intervention hospitals that participated in the 'SMART' (Step-down MRI's and ARThroscopies) study. This intervention consisted of the following five components that were geared at previously identified barriers and facilitators[33] and based on previous literature were shown to have the greatest potential to reduce low value care (see also *Box 1*):

- A local clinical leader who encouraged colleagues to follow the clinical practice guidelines (July 2017),
- Education for orthopaedic surgeons to increase their knowledge about the Dutch Choosing Wisely recommendation (July 2017),
- Training to improve their skills to manage patient expectations (September 2017),
- Feedback of performance data to orthopaedic surgeons (September 2017, February 2018), and
- A patient brochure that professionals could use in their consultations (January 2018).

Outcomes

The primary outcome was the monthly percentage of patients receiving an MRI or knee arthroscopy in their care trajectory. Patients with degenerative knee disease were identified by diagnostic codes: arthrosis (DTC 1801) or meniscus lesion (DTC 1805). As a secondary outcome the monthly percentage of patients aged 50 years and over with a cruciate ligament injury (DTC 1820 and 1830) receiving an MRI or knee arthroscopy was calculated, which was expected not to be influenced by the tailored intervention.

Statistical analysis

Descriptive statistics were used to compare characteristics of patients treated in intervention or control hospitals, stratified by type of hospital (general hospital, teaching hospital, university medical center) as this is known to affect the hospitals' patient-mix.

A difference-in-difference approach was used to examine the change in monthly percentage of patients receiving a knee arthroscopy/MRI before and after introduction of the intervention between intervention and control hospitals[19]. The monthly percentage of patients receiving an MRI or knee arthroscopy was therefore also weighted for the distribution across type of hospital. The key assumption for performing a difference-in-difference analysis is a parallel trend, that is a similar time trend before introduction of the intervention for both intervention and control group[19]. This assumption was tested by visual examination and by assessing the significance of the interaction term (time (months) x group (intervention or control group)) before introduction of the intervention, which showed that the assumption was met.

For the difference-in-difference analysis, the following formula was used: weighted monthly % patients receiving an MRI or Arthroscopy=α + ß1time + ß2introduction + ß2group + ß4introduction×group, using linear regression analysis. In this equation, *time* covers 36 months, *introduction* refers to the period of introduction of the intervention (0= before introduction of the tailored intervention, 1= after introduction of the tailored intervention), and *group* indicates intervention or a control hospital (0= control, 1= intervention). The interaction term *introduction x group* therefore indicates whether the difference before and after introduction of the intervention differed between intervention and control hospitals. The same analyses were carried out for the secondary outcome in cruciate ligament injured patients, to assess whether there was a change in use of MRI or arthroscopy for a patient group not targeted by the intervention.

Since the components of the intervention were implemented over a period of time, these may not all have resulted in an immediate effect. Sensitivity analyses were therefore employed assuming different lag periods after the introduction of the intervention in July 2017 to account for the time it takes an intervention to affect care delivery: 3 months, 6 months, and 8 months. In addition, sensitivity analyses were performed excluding patients with a start of the initial care trajectory before January 2016, and excluding patients with a start of the initial care trajectory in November - December 2018. These analyses were done since only partial care trajectories might have been included in the data, resulting in

missing MRIs or arthroscopies. All analyses were carried out with R statistics (version 3.6.2). A *p*-value <0.05 was considered significant in all analyses.

RESULTS

215,293 records for patients ≥ 50 years and over with degenerative knee disease were identified, which involved 136,446 patients with a care trajectory. *Table 1* shows that patients did not differ in age, but that there was a difference in the distribution of sex, % DTC 1801, and % of multiple DTCs per patient between intervention and control hospitals stratified by hospital type.

Figures 1 and *2* show the observed time trends in weighted monthly percentage of patients receiving MRI or arthroscopy respectively, for intervention and control hospitals with the vertical line indicating the start of the intervention. The results of the difference-in-difference analysis based on these time series data, are shown in *Table 2a* and *2b* for use of MRI and arthroscopy respectively. The variable time is significant in both tables, as also apparent in the figures, indicating a secular declining trend of 0.15% per month in percentage of patients receiving an MRI and 0.19% per month for arthroscopy i.e. 5.4% and 6.8% fewer patients receiving MRI and arthroscopy during the study period. The variable group is also significant in both tables, indicating that intervention hospitals on average had lower percentages of patients receiving MRI/arthroscopy than control hospitals (0.86% lower for MRI and 0.83% lower for arthroscopy, also shown in *Figures 1* and *2* with the lines for intervention hospitals consistently lower than control hospitals. The interaction term *introduction x group* is the variable of interest to show the effect of the intervention, which is non-significant meaning that the change in percentage of patients receiving an MRI or arthroscopy before and after the introduction of the intervention, did not differ significantly between intervention and control group. In other words, the intervention did not significantly change the time trend in intervention hospitals beyond what already occurred elsewhere.

These analyses were repeated for patients with a cruciate ligament injury (diagnosis code 1820/1830) who were not targeted by the intervention (*Appendix A*). Again, a significant reduction in patients receiving an MRI was shown of 0.29% per month, but was non-significant for arthroscopy. As expected because the intervention was not targeted at these patients, no effect of the intervention was found as shown by the non-significant interaction term (introduction x group).

Sensitivity analyses for the different lag periods (3, 6, and 8 months) showed similar results *(Appendix B and C)*. Other sensitivity analyses excluding patients with a DTC open before January 2016 and excluding patients with a DTC open in November 2018 or December 2018, also showed similar results (data not shown).

Table 1. Background characteristics of patients with degenerative knee disease in intervention and control group at baseline.

Background characteristics*	**Intervention (n=32163)**				**Control (n= 104283)**				
	General Hospital (*n*=7691)	**Teaching Hospital (*n*=23,015)**	**University Medical Center (*n*=1457)**	**Total (*n*=32,163)**	**General Hospital (*n*=58,724)**	**Teaching Hospital (*n*=43,349)**	**University Medical Center (*n*=2210)**	**Total (*n*=104,283)**	**p-value**
Age in years, mean (SD)	65.7 (SD 9.9)	65.8 (SD 9.7)	63.3 (SD 9.1)	65.6 (SD 9.7)	65.8 (SD 9.9)	65.7 (SD 9.9)	64.2 (SD 9.4)	65.7 (SD 9.9)	-
Male, n (%)*	3196 (9.9%)	9503 (29.5%)	642 (2.0%)	13341 (41.5%)	23970 (23.0%)	17508 (16.8%)	903 (0.9%)	42381 (40.6%)	< 0.001
DTC 1801, n (%)*	6159 (19.1%)	18834 (58.6%)	1162 (3.6%)	26155 (81.3%)	45985 (44.1%)	36327 (34.8%)	2064 (2.0%)	84376 (80.9%)	< 0.001
More than 1 care trajectory open, n (%)*	3672 (11.4%)	13144 (40.9%)	1304 (4.1%)	18120 (56.3%)	28432 (27.3%)	21553 (20.7%)	838 (0.8%)	50823 (48.7%)	< 0.001
Follow-up care trajectory, mean (SD)	1.1 (SD 1.4)	1.1 (SD 1.3)	1.5 (SD 1.6)	1.1 (SD 1.4)	1.2 (SD 1.5)	1.1 (SD 1.4)	1.3 (SD 1.6)	1.1 (SD 1.5)	-

* The chi-square test showed a significant difference between group and type of hospital for sex, % DTC 1801, and the percentage of patients with multiple care trajectories.

Figure 1. Weighted monthly percentage of patients with degenerative knee disease having an MRI.

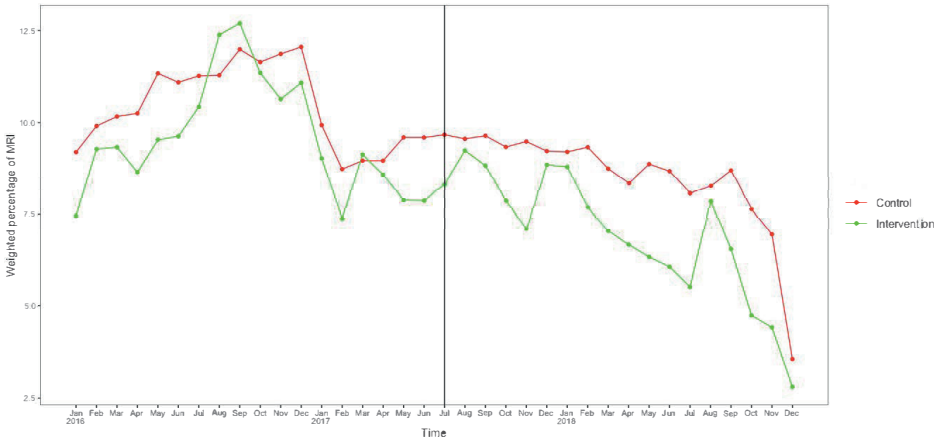

Figure 2. Weighted monthly percentage of patients with degenerative knee disease patients having knee arthroscopy.

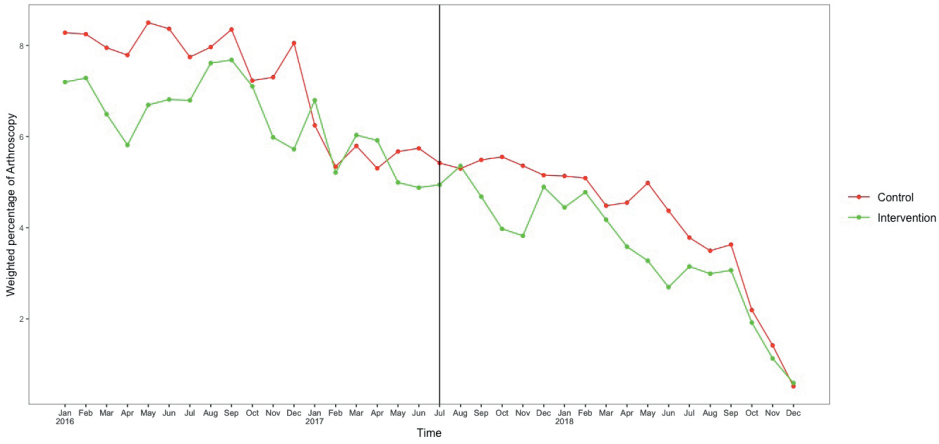

Table 2a. Results of the difference-in-difference analyses for the weighted monthly percentage of patients receiving an MRI.

Parameter	Estimate (SE)	P-value
Intercept	11.83 (0.41)	< 0.001
Time	-0.15 (0.03)	< 0.001
Introduction (before vs. after)	0.72 (0.68)	0.293
Group (intervention vs. control)	-0.86 (0.43)	0.048
Introduction*Group	-0.74 (0.60)	0.228

Table 2b. Results of the difference-in-difference analyses for the weighted monthly percentage of patients receiving an arthroscopy.

Parameter	Estimate (SE)	P-value
Intercept	9.03 (0.22)	< 0.001
Time	-0.19 (0.02)	< 0.001
Introduction (before vs. after)	0.43 (0.37)	0.246
Group (intervention vs. control)	-0.83 (0.23)	< 0.001
Introduction*Group	0.13 (0.33)	0.688

DISCUSSION

The most important finding of the present study was that a secular time trend reduced the weighted monthly percentage of patients with degenerative knee disease receiving an MRI and arthroscopy across both intervention and the control hospitals. The tailored intervention designed to reduce low value care did not further reduce the percentage of patients receiving an MRI or arthroscopy.

Previous research has shown that de-implementation of low value care in orthopaedic surgery is challenging and that providing a substitute will likely be more effective than doing nothing[46]. This might explain the lack of an effect in the present study, as no clear substitute was provided as part of the intervention, although the orthopaedic surgeons could offer patients non-surgical treatments, like advice on possible weight loss in overweight patients, physical exercises, short periods of pain killers and even adequate explanation for the presence of the knee symptoms. That substitution may be more effective is also supported by the recent study of Barlow et al.[11] who showed that providing a substitute conservative care pathway rather than knee arthroscopy is able to reduce low value knee arthroscopies. However, the study of Barlow did not use a control group, so that the observed reduction may have been part of a secular trend. Therefore, more research is needed to investigate the effectiveness of such substitute interventions.

Increasing awareness among clinicians has been shown previously to result in changes in clinical practice, particularly for issues receiving widespread attention. For instance, Kiadaliri et al.[26] showed that the development of national guideline's recommendation against the use of knee arthroscopy in patients with knee osteoarthritis was associated with a decrease in knee arthroscopy in Sweden. In addition, Reeves et al.[33] showed, that clinical practice change occurred even before actual findings of orthopaedic trials were published. The latter phenomenon is known as the 'rising tide'[18] i.e. a pronounced secular trend created by social responses to a particular issue which has gained widespread attention. The current study could be another example of changing overall awareness regarding non-indicated procedures, substantiated by the growing number of studies published about the non-indicated use of MRI and arthroscopy[8,12,15,16,22,24,26,30,31,35,42,44] as well as by discussions about the Dutch guideline for knee arthroscopy at meetings of the Netherlands Orthopaedic Association from 2017 onwards and the dissemination of (inter)national clinical guidelines.

Other studies have identified additional barriers that may influence decisions around performing MRI or arthroscopy, which may have been insufficiently addressed with the tailored intervention in the present study. Barlow et al.[10] found, for example, that the desire to help patients and to meet their expectations, the belief that those expectations did not involve non-surgical treatment modalities, time pressure in de clinic, and a perceived (or real) pressure from patients for an arthroscopy, were substantial barriers for reducing the use of arthroscopy in knee osteoarthritis. For the Netherlands, Rietbergen et al.[34] have previously shown relevant barriers and facilitators for reducing the use of knee arthroscopy in degenerative knee disease which informed the intervention in the present study. These barriers included orthopedic surgeons' beliefs in the added value of MRI's and knee arthroscopies as well as positive experiences with MRI's and knee arthroscopies among friends and family in the patient's environment, which both may influence the decision making for MRI and arthroscopy[34].

A strength of this study is that a control group was included to take into account any secular time trends and separate this for the intervention effect. In the absence of such a control group, the change over time might be incorrectly attributed to the introduction of the intervention, as may have been the case in previous studies[11]. However, there are also some limitations that should be noted. First, the percentage of patients with a low value MRI or arthroscopy may have been overestimated, as in some patients there may be a valid reason for an MRI or knee arthroscopy (e.g. a truly locked knee; an extension limitation of the knee due to an intra-articular blockage)[33], which cannot be deducted from the administrative data that were used in this study. Secondly, data of orthopaedic private clinics were not available in the LBZ database so the results of this study cannot be generalized to these centers. However, a previous study[35] showed that these orthopaedic private clinics perform low value care in this patient group comparable to other hospitals. Thus it is likely that they will have been influenced by the same time trend observed in all other Dutch hospitals.

The findings of this study emphasize that it is unclear when additional quality improvement interventions are needed to reduce low value care, and when the 'rising-tide' phenomenon is enough to increase awareness and to implement new insights from trials or guideline recommendations. More qualitative research is needed to gain further insight into the 'rising tide' phenomenon, identifying when interventions are needed to de-implement low value care. Based on the findings of the study, orthopaedic surgeons are advised to improve their care by considering for which patients MRI or arthroscopy have added value and by explaining to patients why MRI or arthroscopy does not have added value, potentially supported by patient brochures.

CONCLUSIONS

This study showed that the weighted monthly percentage of patients ≥ 50 years with degenerative knee disease who receive an MRI or arthroscopy was reduced across both intervention and control hospitals as part of a secular trend. The tailored intervention did not have an additional effect beyond this secular downward time trend.

Box 1. SMART intervention

1. **Clinical champions (July 2017):** Local clinical leaders who encouraged colleagues to follow the clinical practice guidelines developed for diagnosing and treating patients aged 50 years and over with degenerative knee disease (e.g. during team meetings about patients).
2. **Education to increase knowledge about the Dutch Choosing Wisely recommendation (July 2017):** To increase knowledge of orthopaedic surgeons about the Dutch Choosing Wisely recommendation against the use of low value MRIs and knee arthroscopies for diagnosis and treatment of degenerative knee disease in patients aged 50 years and over, clinical champions were educated about this recommendations and the corresponding literature. Clinical champions subsequently disseminated this information among their colleagues using a power point presentation that was prepared by the research team.
3. **Training to improve skills to manage patient expectations (September 2017)):** To improve orthopaedic surgeons' skills to manage expectations regarding the value of MRI and arthroscopy within diagnosis and treatment of degenerative knee disease, orthopaedic surgeons and residents were trained how to explain patients why it is not recommended to perform an MRI or knee arthroscopy for patients with degenerative knee disease. This was done in a meeting in each hospital/private clinic making use of videos of a consultation with a patient with degenerative knee disease. These videos included were developed in collaboration with specialised Dutch orthopaedic surgeons [RJ, RD, EvL], and included scenarios in which an orthopeadic surgeon prescribed an MRI or arthroscopy, but also scenarios in which the orthopaedic surgeons succeeded to explain to the patients that a MRI and/ or arthroscopy were not indicated. These videos were used to initiate a discussion among colleagues.
4. **Feedback of data regarding MRI and arthroscopy use (September 2017, February 2018):** Data about the total number of patients with degenerative knee disease (including diagnosis code 1801 arthrosis and 1805 meniscus lesion, and the number of patients with degenerative knee disease who received a MRI and/or arthroscopy was requested from each participating hospital/private clinic from 2016 until 2018. The data were analysed and presented twice to all orthopaedic surgeons in the participating hospitals/ private clinics with a specialization in the treatment of knee injuries and

to the residents (September 2017 and February 2018). Feedback was presented once by a researcher and once by the clinical champion or by e-mail.

5. **Patient Brochure (January 2018):** A patient brochure was developed to provide patients information about degenerative knee complaints, recommended treatments and an explanation why and in which cases MRI's and arthroscopies can be regarded as low value care in diagnosis and treatment of degenerative knee disease. The patient brochure could be used during the consultation or could be given after the consultation to provide information about a stepped care strategy and the risks of an MRI and knee arthroscopy.

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Appendix A: Difference-in-difference analysis MRI and arthroscopy for 1820/1830

Table 3a. Results of the difference and difference analyses for the percentage of patients with an MRI for 1820/1830.

Parameter	Estimate (SE)	P-value
Intercept	13.36 (1.67)	< 0.001
Time	-0.29 (0.12)	0.018
Introduction (before vs. after)	1.52 (2.76)	0.584
Group (intervention vs. control)	2.19 (1.74)	0.213
Introduction*Group	-1.04 (2.47)	0.675

Table 3b. Results of the difference and difference analyses for the percentage of patients with an arthroscopy for 1820/1830.

Parameter	Estimate (SE)	P-value
Intercept	25.84 (2.48)	< 0.001
Time	-0.14 (0.18)	0.417
Introduction (before vs. after)	0.30 (4.09)	0.941
Group (intervention vs. control)	1.96 (2.58)	0.451
Introduction*Group	-0.25 (3.65)	0.945

Appendix B: Sensitivity analyses MRI for different lag periods (3, 6, and 8 months)

Table 4a. Results of the difference and difference analyses for the percentage of patients with an MRI, 3-month lag period.

Parameter	Estimate (SE)	P-value
Intercept	11.70 (0.45)	< 0.001
Time	-0.13 (0.03)	< 0.001
Introduction (before vs. after)	0.46 (0.81)	0.574
Group (intervention vs. control)	-0.86 (0.44)	0.056
Introduction*Group	-0.89 (0.65)	0.180

Table 4b. Results of the difference and difference analyses for the percentage of patients with an MRI, 6-month lag period.

Parameter	Estimate (SE)	P-value
Intercept	11.22 (0.46)	< 0.001
Time	-0.19 (0.02)	< 0.001
Introduction (before vs. after)	2.17 (0.62)	< 0.001
Group (intervention vs. control)	-1.27 (0.64)	0.053
Introduction*Group	0.03 (0.73)	0.967

Table 4c. Results of the difference and difference analyses for the percentage of patients with an MRI, 8-month lag period.

Parameter	Estimate (SE)	P-value
Intercept	11.23 (0.47)	< 0.001
Time	-0.19 (0.02)	< 0.001
Introduction (before vs. after)	2.15 (0.63)	0.001
Group (intervention vs. control)	-1.27 (0.65)	0.057
Introduction*Group	0.01 (0.75)	0.989

Appendix C: Sensitivity analyses Arthroscopy for different lag periods (3, 6, and 8 months)

Table 5a. Results of the difference and difference analyses for the percentage of patients with an arthroscopy, 3-month lag period.

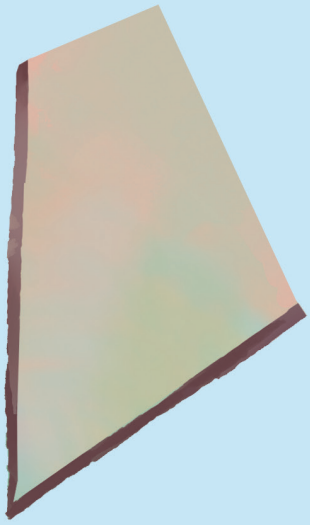
Parameter	Estimate (SE)	P-value
Intercept	9.07 (0.25)	< 0.001
Time	-0.19 (0.02)	< 0.001
Introduction (before vs. after)	0.56 (0.44)	0.211
Group (intervention vs. control)	-0.83 (0.24)	0.001
Introduction*Group	0.08 (0.36)	0.831

Table 5b. Results of Results of the difference and difference analyses for the percentage of patients with an arthroscopy, 6-month lag period.

Parameter	Estimate (SE)	P-value
Intercept	8.90 (0.26)	< 0.001
Time	-0.19 (0.01)	< 0.001
Introduction (before vs. after)	0.45 (0.35)	0.209
Group (intervention vs. control)	-1.40 (0.37)	< 0.001
Introduction*Group	0.84 (0.42)	0.051

Table 5c. Results of the difference and difference analyses for the percentage of patients with an arthroscopy, 8-month lag period.

Parameter	Estimate (SE)	P-value
Intercept	8.91 (0.26)	< 0.001
Time	-0.20 (0.01)	< 0.001
Introduction (before vs. after)	0.43 (0.35)	0.223
Group (intervention vs. control)	-1.40 (0.36)	< 0.001
Introduction*Group	0.83 (0.42)	0.052



5

Effects of de-implementation strategies aimed at reducing low value nursing procedures: a systematic review and meta-analysis

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ABSTRACT

Background

In the last decade, there is an increasing focus on detecting and compiling lists of low value nursing procedures. However, less is known about effective de-implementation strategies for these procedures. Therefore, the aim of this systematic review was to summarize the evidence of effective strategies to de-implement low value nursing procedures.

Methods

PubMed, Embase, Emcare, CINAHL, PsycINFO, Cochrane Central Register of Controlled Trials, Web of Science and Google Scholar were searched till January 2020. Additionally, reference lists and citations of the included studies were searched. Studies were included that described de-implementation of low value nursing procedures, i.e. procedures, test or drug orders by nurses or nurse practitioners. PRISMA guideline was followed, and the 'Cochrane Effective Practice and Organisation of Care' (EPOC) taxonomy was used to categorize de-implementation strategies. A meta-analysis was performed for the volume of low value nursing procedures in controlled studies, and Mantel–Haenszel risk ratios (95% CI) were calculated using a random effects model.

Results

Twenty-seven studies were included in this review. Studies used a (cluster) randomized design (n=10), controlled before-after design (n=5), and an uncontrolled before-after design (n=12).

Low value nursing procedures performed by nurses and/or nurse specialists that were found in this study were: restraint use (n=20), inappropriate antibiotic prescribing (n=3), indwelling or unnecessary urinary catheters use (n=2), ordering unnecessary liver function tests (n=1) and unnecessary antipsychotic prescribing (n=1). Fourteen studies showed a significant reduction in low value nursing procedures. Thirteen of these fourteen studies included an educational component within their de-implementation strategy. Twelve controlled studies were included in the meta-analysis. Subgroup analyses for study design showed no statistically significant subgroup effect for the volume of low value nursing procedures (p=0.20).

Conclusions

The majority of the studies with a positive significant effect used a de-implementation strategy with an educational component. Unfortunately, no

conclusions can be drawn about which strategy is most effective for reducing low value nursing care due to a high level of heterogeneity and a lack of studies. We recommend that future studies better report the effects of de-implementation strategies and perform a process evaluation to determine to which extent the strategy has been used.

BACKGROUND

Healthcare professionals intentionally or unintentionally order tests, treatments and perform procedures on a daily basis that offer little or no benefit to patient care. This low value care is proven to be ineffective or has not been proven to be effective, can even harm patients and waste valuable resources[1-3]. In addition, it wastes time that the healthcare professional can spend on more effective practices or care that is left undone[4,5]. The Institute of Medicine estimates up to 30% of care provided in the United States is wasted on low value care[6]. If even a fraction of this low value care could be eliminated, the resulting quality improvement and cost savings would be transformational[7].

Most initiatives to eliminate low value care are mainly focused on care provided by doctors[8], but many low value procedures are also routinely performed by nurses[4,9]. Well-known examples of low value nursing procedures include the use of physical restraints in patients with a delirium, the use of bandages for wounds closed by primary intention, and performing a bladder washout[4]. Since nurses are the largest group of healthcare providers[4] there is a great potential in improving quality of care by involving and targeting them in de-implementation initiatives[4,10]. As a first step to reduce low value nursing procedures, 'Choosing Wisely' lists of nursing procedures are recently created in several countries[1,4,11,12]. The next step is to translate these 'Choosing Wisely' lists into action[13]. To actually reduce the use of low value nursing procedures, awareness should be created for the 'Choosing Wisely' lists and effective de-implementation strategies need to be developed and executed[7,14,15]. These de-implementation strategies should be theory- and evidence based and informed by analysis of barriers and facilitators that influence the use of low value care, since this is expected to increase the adherence, adoption, and effectiveness of these de-implementation strategies[5,16,17].

A previous systematic review performed by Colla et al.[7] already reveals that multifaceted de-implementation strategies targeted at healthcare providers and patients have the greatest potential to reduce the use of low value care. Besides, clinical decision support tools, performance feedback and education (alone or as part of a multifaceted strategy), are promising strategies for reducing low value care. However, Colla et al.[7] also noted that little is known about interventions directed at non-physician staff members such as nurses, and that most interventions targeted at non-physician staff are aimed at assisting physician's decision-making. So, it is still unknown whether the conclusions about effective de-implementation strategies also apply for the reduction of low value nursing procedures. Since nurses might have other learning styles

than physicians[18], other strategies could be more effective to de-implement low value nursing procedures. Therefore, the aim of this systematic review is to summarize the evidence of effective de-implementation strategies aiming to reduce or eliminate low value nursing procedures.

METHODS

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA)[19]. The review protocol was registered in the PROSPERO database of systematic reviews (registration number: CRD42018105100, (www.crd.york.ac.uk/prospero/display_record.php?RecordID=105100).

Search strategy

To identify all eligible studies reporting on effective de-implementation strategies aiming to reduce low value nursing procedures, a systematic literature search was performed in PubMed, Embase, Emcare, CINAHL, PsycINFO, Cochrane Central Register of Controlled Trials, Web of Science and Google Scholar. The full search strategy is included in *Appendix A*. The search was limited to the literature published till January 2020. Search terms were based on 43 unique terms for de-implementation that were used for the process of reducing low value care found by Niven et al.[20], and there were no language or other search filter limits. After the initial search, the reference lists and citations of all included studies were explored to find more relevant studies. An expert health librarian at the Leiden University Medical Center guided the search.

Selection of studies

Two researchers (TR, AB, or LvB) first independently reviewed title and abstract of the studies, followed by full texts review. If there was no consensus between the two reviewers and differences could not be solved by discussion, a third reviewer was consulted.

Studies were eligible for inclusion in the systematic review if they fulfilled the following inclusion criteria:

- Focus of the study: reduction of low value nursing procedures. Low value nursing procedures were in this review defined as actual treatments and actions that are unlikely to benefit the patient given the harms, costs, available alternatives, or preferences of patients, and are initiated independently by

a nurse and/ or nurse specialist (i.e. without an order of another healthcare provider).
- Type of study: all studies that use a reference group (including pre-post comparisons), i.e. randomized controlled trials, cluster randomized trials, quasi-randomized controlled trials, non-randomized controlled trials, controlled before-after studies, interrupted time series studies or uncontrolled before-after studies.
- Setting: hospitals, nursing homes, long-term care facilities and community settings.
- Outcome: the study had to report on the effect of the de-implementation strategy on the volume of low value nursing procedures.

Case studies of individual patients, letters and editorials were excluded. Controlled studies were included in the meta-analysis if they reported data on the change in volume of low value nursing procedures or if this data was available to the researchers after sending a request to the authors of the included paper.

Data extraction

Data of the included studies was extracted in a standardized data extraction form in Microsoft Access (version 2016) by one researcher (TR or AB). A second researcher (TR, AB, or DS) independently checked the extracted data. Any discrepancy was resolved by discussion between the researchers until consensus was reached. If this was not possible, a third researcher (LvB) made a judgement on the data entered. The following information was collected from all included studies: country of origin, design, setting, location of care, type of low value nursing procedure, de-implementation strategy based on barrier assessment, de-implementation strategies, participants, reimbursement and funding, primary and secondary outcomes. The primary outcome was the change in volume of the low value nursing procedure. The secondary outcomes were: adherence to the de-implementation strategy, changes in patient outcomes (e.g. pain), changes in patient satisfaction with care, changes in costs due to de-implementation of low value nursing procedures, and changes in costs of the delivery of care. Authors of the included studies were contacted when more information was needed about unreported or missing data, and about the bias issues. If they did not respond, we sent a reminder after two to six weeks. We used the 'Cochrane Effective Practice and Organisation of Care' (EPOC) taxonomy[21] to categorize the different types of de-implementation strategies. The EPOC taxonomy includes four categories of strategies: a) delivery

arrangements, b) financial arrangements, c) governance arrangements, and d) implementation strategies.

The quality of the studies was assessed by using two risk of bias tools by two independent researchers (TR, AB, or DS). The Cochrane Effective Practice and Organisation of Care (EPOC)[22] was used for studies with a separate control group (randomized trails, and controlled before-after studies), and the Newcastle-Ottawa Scale (NOS)[23] was used for uncontrolled studies. The EPOC tool consists of nine suggested risk of bias criteria: random sequence generation, allocation concealment, baseline outcome measurements similar, baseline characteristics similar, incomplete outcome data, knowledge of the allocated interventions adequately prevented during the study, protection against contamination, selective outcome reporting and other risks of bias. Every criterion was scored with low, high or unclear risk. The NOS consists of three categories: a) selection, b) comparability and c) outcome. A certain number of stars could be given for each category, resulting in a score of good, fair or poor quality of the studies. Disagreements in the risk of bias scoring was resolved by consensus or by discussion with a third researcher (TR, LvB, or DS).

Statistical analyses

To summarize the overall evidence of de-implementation strategies aiming to reduce low value nursing procedures in a descriptive and narrative synthesis, the data from all included studies was extracted in Microsoft Access (version 2016) and analyzed in Microsoft Excel (version 2016). The synthesis is performed separately for controlled and uncontrolled studies to reduce the risk of selection bias. To assess the effectiveness of de-implementation strategies to reduce low value nursing procedures data of the controlled studies on the use of low value care was analyzed in Review Manager 5.3. Data about the use of low value nursing procedures was pooled using a random effects model of Mantel-Haenszel[24], and risk ratios were calculated with 95% confidence intervals. The I^2 statistics of Higgins[25] was used to measure heterogeneity between the included studies, which can be interpreted as the percentage of the total variability in a set of effect sizes between trials in a meta-analysis. When the I^2 was 50% or higher we considered the results as a moderate or high level of heterogeneity[25]. If heterogeneity was present, subgroup analyses were performed. Subgroup analyses were performed by design of the study (RCT, Cluster RCT, and controlled studies), type of low value care, and type of de-implementation strategy (single versus multifaceted, and type of strategy). Subgroup analyses by type of design were performed because failure to use adequately concealed random allocation can distort the apparent effects of care in either direction[26].

Subgroup analyses for type of low value nursing procedure were performed because the characteristics of the type of low value nursing procedure that needs to be de-implemented (including underlying evidence, advantages of practice, credibility, attractiveness, feasibility) could be of influence on the effectiveness of the de-implementation strategy. Subgroup analyses for type of de-implementation strategy (including single versus multifaceted strategies and type of strategy according to EPOC taxonomy) were performed since we wanted to learn which strategy is most effective. A subgroup for type of design, low value nursing procedure or de-implementation strategy was only performed when at least two studies with respectively the same design, low value nursing procedure or de-implementation strategy could be included in each subgroup. Finally, sensitivity analyses for the subgroups were performed without studies with a high-risk score on 3 or more risk of bias criteria of the EPOC tool. Funnel plots were created to assess the publication bias.

RESULTS

Study selection

The search strategy resulted in 4278 studies. The reference and citation search resulted in an additional 586 studies. After removing 64 duplicates, 4800 abstracts remained. After screening on title and abstract, 162 full texts were reviewed. A total of 27 studies were found to be eligible for inclusion (*Figure 1*), including 12 uncontrolled studies[9, 27-37] and 15 controlled studies[38-52]. Reasons for exclusion were: 1) de-implementation strategy was not directed at reducing low value nursing procedures (but at low value care provided by other healthcare professionals or at low value nursing procedures that require an order of other healthcare professionals (*n*=84) such as medication prescribing or requests for lab testing by physicians), 2) Study does not include an assessment of the effectiveness of a de-implementation strategy (*n*=26), 3) full text was not available (*n*=13), and 4) other (e.g. non-response authors and no results reported on volume of low value care) (*n*=12).

Figure 1. PRISMA flow diagram

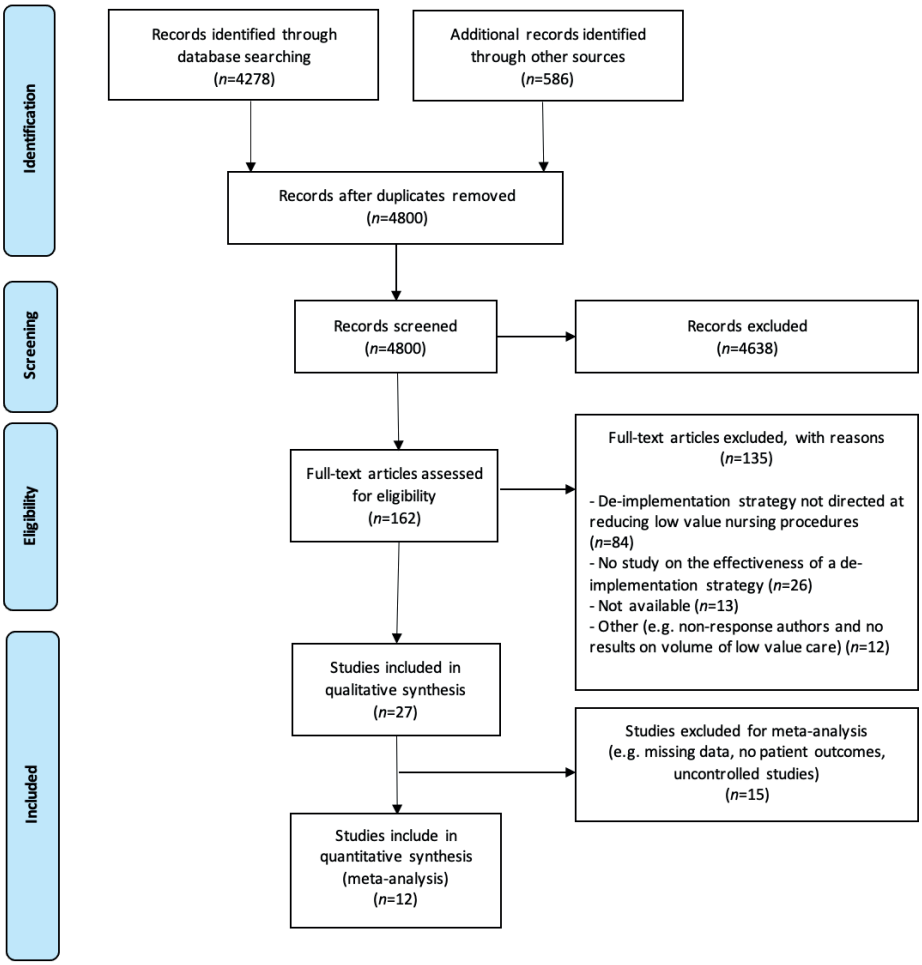
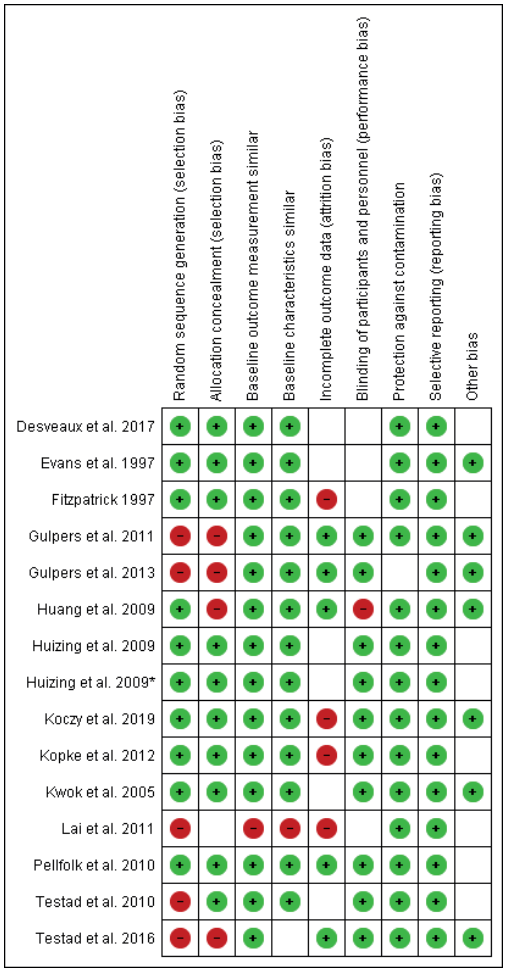


Table 1. Risk of Bias Newcastle-Ottawa Scale (NOS) of uncontrolled studies (*n*=12)

Author	Score Selection	Score Comparability	Score Outcome	Conclusion
Alexaitis et al. 2014 (27)	★★★★			Poor
Amato et al. 2006 (28)	-		★	Poor
Andersen et al. 2017 (29)	★★		★	Poor
Davis et al. 2008 (30)	★★★		★	Poor
Eskandaria et al. 2018 (31)	★★	★	-	Poor
Hevener et al. 2016 (32)	-	-	-	Poor
Link et al. 2016 (33)	★★★★	-	-	Poor
McCue et al. 2004 (34)	★	-	★★	Poor
Mitchell et al. 2018 (9)	-	-	★★	Poor
Sinitsky et al. 2017 (35)	★	-	★	Poor
Thakker et al. 2018 (36)	★★★	-	★	Poor
Weddle et al. 2016 (37)	★★	-	★★★	Poor

Poor quality; 0 or 1 star in selection domain OR 0 stars in comparability domain OR 0 or 1 stars in outcome/exposure domain. Fair quality: 2 stars in selection domain AND 1 or 2 stars in comparability domain AND 2 or 3 stars in outcome/exposure domain. Good quality: 3 or 4 stars in selection domain AND 1 or 2 stars in comparability domain AND 2 or 3 stars in outcome/exposure domain[23].

Figure 2. Risk of Bias Cochrane Effective Practice and Organisation of Care (EPOC) of controlled studies (*n*=15)



Randomization Low risk if randomization method is described
Allocation concealment Low risk if unit of allocation was by team/institution OR by patient with some kind of randomization method
Baseline measurement similar Low risk if baseline measurements were performed and no important difference present across groups OR imbalanced but appropriate adjusted
Baseline characteristics similar Low risk if characteristics were reported and similar
Incomplete outcome data Low risk if missing outcomes were unlikely to bias the results
Blinding Low risk if the authors stated blind assessment OR objective outcomes
Contamination Low risk if allocation was by team/ institution/practice and unlikely control group received intervention
Selective reporting Low risk if there is no evidence that outcomes were selectively reported, and
Other Low risk if there is no evidence of other risk of bias
Green circle: low risk of bias, red circle: High risk of bias, empty box: unclear risk of bias.

Quality of the included studies

The risk of bias of the uncontrolled studies (*n*=12), estimated with the Newcastle-Ottawa scale, is shown in *Table 1*. Overall, the quality of the included uncontrolled studies was poor, mainly due to a low score on the comparability domain due to lack of matching of exposed and non-exposed individuals in the study design and/or a lack of correction for confounders in the analyses.

The risk of bias of the controlled studies (*n*=15), scored with EPOC, showed that nine studies scored low risk on seven of the nine risk of bias criteria (*Figure 2*). For only five studies[41-43,50,52], the missing outcomes were unlikely to bias the results. For the other studies, there was an unclear or high risk for missing outcomes that were likely to bias the results[38-40,44-49,51]. Three studies did not perform statistical tests for measuring the effect of their de-implementation strategy[9,28,36].

Study characteristics

Uncontrolled studies

Twelve of the 27 studies (44%)[9,27-37] had an uncontrolled before-after design (*Table 2*). Of these twelve studies, six focused their intervention on reducing restraint use[9,28,29,31,32,34], three on reducing inappropriate antibiotic prescribing[30,33,37], two on reducing time of indwelling urinary catheters[27,36], and one on reducing unnecessary liver function tests[35]. The de-implementation strategy used within the uncontrolled studies were directed at nursing staff working in a hospital (*n*=10)[9,27-32,34-36] and in an urgent care center (*n*=2)[33,37]. Most of the uncontrolled studies had a single center design (*n*=9) and were performed in North America (*n*=9)[9,27,28,30,32-34,36,37]. Most uncontrolled studies did not report on the characteristics of the patients and/or on the characteristics of the healthcare providers. Four uncontrolled studies (33%) have not clearly described the duration of the intervention[37,38,48,50]. For the uncontrolled studies that mentioned the duration of the intervention it differed from 2 to 14 months. The follow up time after de-implementation of the studies that reported these results differed from 1 month follow up till 12 months.

Controlled studies

Fifteen of the 27 studies (56%) had a controlled design, including three RCTs (11%), seven cluster RCTs (26%) and five controlled before-after designs (19%) (*Table 3*). Of the controlled studies, fourteen studies focused their intervention on reducing restraint use[39-52], and one on reducing inappropriate antipsychotic prescribing[38]. The de-implementation strategy used within the controlled studies were directed at nursing staff working in a nursing home (*n*=10)[38,39, 41, 42, 44-47, 51, 52],

in a hospital (*n*=4)[40,43,48,49], and in a residential care facility (*n*=1)[50]. Most of the controlled studies had a multicenter design (*n*=12) and were performed in Europe (*n*=9). Not all controlled studies reported on the patients' characteristics and/or on the characteristics of the healthcare providers. Three controlled studies (20%) have not clearly described the duration of the intervention[27,31,39]. For the controlled studies that mentioned the duration of the intervention it differed from 1 to 12 months. The follow up time after de-implementation of the studies that reported these results differed from no follow up till 24 months.

Strategies to reduce low value care

Uncontrolled studies

The de-implementation strategies of six uncontrolled studies resulted in a positive significant effect on the volume of low value nursing procedures (*Table 2*). The reduction in volume of low value nursing procedure in the uncontrolled studies with a positive significant effect and with available data (*n*=5) ranged from 0.4%[34] reduction of low value nursing care till 61.9%[33]. Four of the positive significant studies had a single de-implementation strategy[31,33,35,37], which means that the strategies consisted of only one strategy component (*Table 4*). Five of the six studies used an educational component (meetings and/or materials) as an intervention strategy[31-34,37]. However, none of the studies with a positive significant effect on the primary outcome based their de-implementation strategy on a barrier assessment. Only one uncontrolled study without a positive significant effect performed a barrier assessment[9].

None of the uncontrolled studies reported about adherence to the de-implementation strategy, changes in patient satisfaction with care, changes in costs made by the de-implementation strategy, and changes in costs of the delivery of care.

Controlled studies

The de-implementation strategies of eight of the fifteen controlled studies resulted in a positive significant effect on volume of low value nursing procedures (*Table 3*). The reduction in volume of low value nursing procedure in the controlled studies with a positive significant effect who measured patient outcomes (*n*=7) ranged from 6.5%[47] till 28.7%[39]. Seven of the eight positive significant studies had a multifaceted de-implementation strategy (*Table 5*) and all eight studies focused their strategy at reducing the use of restraints[39, 41-43, 47, 50-52]. Besides, the eight studies with a positive significant effect had an educational component (educational meetings, educational materials, educational outreach visits, and educational games) in their de-implementation strategy. However, none of the studies with a positive significant effect on the primary outcome based their

de-implementation strategy on a barrier assessment. Only one controlled study without a positive significant effect performed a barrier assessment[38].

None of the studies reported about adherence to the de-implementation strategy, changes in patient satisfaction with care, changes in costs made by the de-implementation strategy, and changes in costs of the delivery of care. Five studies aiming to reduce restraint use, reported about falls[39,46-49]. However, different outcome measurements (e.g. risk of falls, total number of falls, fall related injuries, the proportion of those who suffered from one or more falls, and the percentages of falls) have been used for these studies.

Table 2. Design and characteristics of uncontrolled studies (*n*=12)

Author (y), Country	Design study	Setting	Target group	Type of low value care	Primary outcome (s)	Before	After	Difference/ statistical test results	Statistical analyses performed (Yes/No)	Positive significant effect (ps 0.05) (Yes/No)
Alexaitis et al. (2014), USA[27]	Uncontrolled Before-after	Hospital	ICU nurses	Catheter use	The average percentage of catheter utilization	74.14%	76.2%	2.08%	Yes	No
Amato et al. (2006), USA[28]	Uncontrolled Before-after	Hospital	Nurses	Restraint use	The percentage of restraint use (2 units)	-	-	-29.2% stroke rehabilitation unit, -16,2% brain injury unit	No	/
Andersen et al. (2017), Denmark[29]	Uncontrolled Before-after	Hospital	Nurses	Restraint use	The percentage of restraint use	-	-	-38%	Yes	No
Davis et al. (2008), USA[30]	Uncontrolled Before-after	Hospital	Nurse Practitioner	Antibiotic prescribing	The rate of antibiotic prescribing	-	-	F= 0.076	Yes	No
Eskandaria et al. (2018), Malaysia[31]	Uncontrolled before-after	Hospital	Nurses	Restraint use	The incidence rate of physical restraint use	5.57%	3.81%	-1.76%	Yes	Yes
Hevenver et al. (2016), USA[32]	Uncontrolled-before after	Hospital	ICU nurses	Restraint use	The incidence rate of restraint use	-	-	-32%	Yes	Yes

Link et al. (2016), USA[43]	Uncontrolled Before-after	Urgent care center	Nurse practitioner (NP) and Physician Assistant (PA)	Antibiotic prescribing	The rate of antibiotic prescribing	91.7%	29.8%	-61.9%	Yes	Yes
McCue et al. (2004), USA[34]	Uncontrolled before-after	Hospital	Psychiatric nurses	Restraint use	The number of restraints/1000 patient-days	0.8%	0.4%	-0.4%	Yes	Yes
Mitchell et al. (2018), USA[9]	Uncontrolled Before-after	Hospital	ICU nurses	Restraint use	The rate of restraint use	61%	31%	-30%	No	/
Sinitsky et al. (2017), UK[35]	Uncontrolled Before-after	Hospital	Pediatric intensive care nurses	Liver function tests (LFT)	Total number of LFTs per bed day	N/A	N/A	N/A	Yes	Yes
Thakker et al. (2018), Canada[36]	Uncontrolled Before-after	Hospital	Orthopaedic nurses	Catheter use	The average rate of indwelling catheter use	55.2%	19.8%	-35.4%	No	/
Weddle et al. (2016), USA[37]	Uncontrolled Before-after	Urgent care center	Nurse practitioner	Antibiotic prescribing	The rates of inappropriate antibiotic prescribing per month	9%	6%	-3%	Yes	Yes

N/A = Not Available

Table 3. Design and characteristics of controlled studies (*n*=15)

Author (y), Country	Design study	Setting	Target group	Type of low value care	Primary outcome (s)	Posttest intervention group (%)#	Posttest Control group (%)#	Statistical analyses performed (Yes/No)	Positive significant effect (Yes/No)
Desveaux et al. (2017)[38*]	Cluster RCT	Nursing home	Nurses	Antipsychotic prescribing (APM)	The days dispensed APM in the previous week	624/2947 (21.2%)	898/4162 (21.6%)	Yes	No
Evans et al. 1997, USA[39]	RCT	Nursing home	Gerontologic nurses	Restraint use	The prevalence of restraint use	18/127 (14.2%)	79/184 (42.9%)	Yes	Yes
Fitzpatrick (1997), USA[40]	Controlled before after	Hospital	Critical care and intermediate nurse	Restraint use	The incidence of restraint use	29/91 (31.9%)	8/51 (15.7%)	Yes	No
Gulpers et al. (2011), The Netherlands[41]	Controlled before after	Nursing home	Psychogeriatric nurses	Restraint use	The rate of residents with at least 1 physical restraint	135/250 (54.0%)	107/155 (69.0%)	Yes	Yes
Gulpers et al. (2013), the Netherlands[42]	Controlled before after	Nursing home	Psychogeriatric nurses	Restraint use	The rate of residents with at least 1 physical restraint	80/134 (59.7%)	68/91 (74.7%)	Yes	Yes
Huang et al. (2009)[43**]	Controlled before after	Hospital	Nurses	Restraint use	The reported Practice of Physical Restraint Use	40.88	39.20	Yes	Yes
Huizing et al. (2009), The Netherlands[44]	Cluster RCT	Nursing home	Nurses and registered Nurses	Restraint use	The use of restraints per residents	25/53 (47.2%)	15/37 (40.5%)	Yes	No
Huizing et al. (2009), The Netherlands[45]	Cluster RCT	Nursing home	Nurses	Restraint use	The use of restraints per residents	81/126 (64.3%)	69/115 (60.0%)	Yes	No

Koczy et al. (2011), Germany[46]	Cluster RCT	Nursing home	Nurses	Restraint use	The complete cessation of restraint use	173/208 (83.2%)	114/125 (91.2%)	Yes	No
Kopke et al. (2012), Germany[47]	RCT	Nursing home	Nurses	Restraint use	The percentage of residents with at least 1 physical restraint	423/1868 (22.6%)	525/1802 (29.1%)	Yes	Yes
Kwok et al. (2005), China[48*]	RCT	Hospital	Geriatric nurses	Restraint use	The proportion of subjects ever restrained	N/A	N/A	Yes	No
Lai et al. (2011), China[49]	Controlled before after	Hospital	Nurses	Restraint use	The prevalence of restraint use	299/612 (48.9%)	21/155 (13.5%)	Yes	No
Pellfolk et al. (2010), Sweden[50]	Cluster RCT	Residential care facilities	Registered nurses, licensed practical nurses and nurse's aides	Restraint use	The use of restraint use	30/149 (20.1%)	53/139 (38.1%)	Yes	Yes
Testad et al. (2010), Norway[51*]	Cluster RCT	Nursing home	Nurses	Restraint use	The use of restraint use	N/A	N/A	Yes	Yes
Testad et al. (2016), Norway[52]	Cluster RCT	Nursing home	Nurses	Restraint use	The use of restraint use	15/83 (18.1%)	10/114 (8.8%)	Yes	Yes

N/A = Not Available
Numbers based on the extracted results used for the meta-analyses
*Data for meta-analyses not available
** Data was not measured at patient level

Table 4. Type of intervention of the uncontrolled studies (*n*=12)

Author (y)	Type of low value care	Single or multifaceted intervention strategy	Interventions from the EPOC taxonomy													Description of intervention strategy (Sorted by EPOC Taxonomy)	Positive Significant effect (p≤ 0.05) (Yes/No)
			E	AF	P	C	CQ	H	L	M	MP	O	S	T	TI		
Alexaitis et al. 2014[27]	Catheter use	Multifaceted	X	X		X			X							<u>Educational meetings:</u> • Education about alternatives to indwelling catheters and routine catheter care • Education about the protocol • Didactic education encompassed routine catheter maintenance, bedside bladder ultrasound indications, and criteria in the nurse-driven protocol. Simulation education to assess proficiency in using the bladder ultrasonography was provided to nurses by the clinical leaders and charge nurses <u>Audit and Feedback:</u> • Compliance monitoring to ensure adherence to the protocol and guidelines for routine catheter care • Analysis of identified CAUTIs • Daily catheter rounds to assess the need for catheter continuation <u>Clinical guidelines:</u> • Evidence-based, nurse-driven protocol for urinary catheter management <u>Local consensus processes:</u> • Protocol approval by NSICU stakeholders	No

Author (y)	Type of low value care	Single or multifaceted intervention strategy	Interventions from the EPOC taxonomy													Description of intervention strategy (Sorted by EPOC Taxonomy)	Positive Significant effect (p≤ 0.05) (Yes/No)
			E	AF	P	C	CQ	H	L	M	MP	O	S	T	TI		
Amato et al. 2006[28]*	Restraint use	Multifaceted	X	X					X							Educational meetings: • Formal and informal information sessions for all levels of nursing staff about the restraint and seclusion policy as well as the hospital's philosophy regarding restraint use • A local vendor demonstrated restraint alternatives • Training on proper use of the devices Educational outreach visits: • Consultation rounds of a clinical nurse specialist Audit and feedback: • The nurses' adherence to the plan of care was monitored and reviewed during the ongoing consultation rounds, at which time individual nurse-to-nurse feedback was provided • The quality management department provided aggregate data in the form of monthly run charts for fall rates and physical restraint use on each unit Local consensus processes: • The administrative component involved gaining the active support of the director of nursing, nurse managers, patient care coordinators, physician leaders, and therapists prior to implementation of the program	/

Author (y)	Type of low value care	Single or multifaceted intervention strategy	Interventions from the EPOC taxonomy													Description of intervention strategy (Sorted by EPOC Taxonomy)	Positive Significant effect (p≤ 0.05) (Yes/No)
			E	AF	P	C	CQ	H	L	M	MP	O	S	T	TI		
Andersen et al. 2017[29]	Restraint use	Multifaceted	X										X			<u>Educational meetings:</u> • Education by occupational therapists. The occupational therapists on the project unit completed a 3-day course and a 1-day workshop with the rest of the staff four months later <u>Sensory modalities for the patient:</u> • Access to a variety of sensory modalities located in the unit and a sensory room	No
Davis et al. 2008[30]	Antibiotic prescribing	Multifaceted	X	X												<u>Educational meetings:</u> • The standards of care for the treatment of a viral upper respiratory tract infections were presented to the individual healthcare provider <u>Audit and feedback:</u> • Thirty randomly selected charts coded by the individual healthcare providers • Individual provider and group statistics regarding rates of prescribing.	No

Author (y)	Type of low value care	Single or multifaceted intervention strategy	Interventions from the EPOC taxonomy													Description of intervention strategy (Sorted by EPOC Taxonomy)	Positive Significant effect (p≤ 0.05) (Yes/No)
			E	AF	P	C	CQ	H	L	M	MP	O	S	T	TI		
Eskandaria et al. 2018[31]	Restraint use	Single	X													<u>Educational meetings:</u> • Lectures • Group discussion • Demonstration on some types of physical restraint and proper use of physical restraint • Three video demonstrations	Yes
Hevenver et al. 2016[32]	Restraint use	Multifaceted	X					X								<u>Educational meetings:</u> • 1-on-1 discussion about proper use of restraints and alternatives <u>Educational materials:</u> • Online educational activity <u>Health information system:</u> • Restraint decision tool	Yes
Link et al. 2016[33]	Antibiotic prescribing	Single	X													<u>Educational meetings:</u> • The intervention consisted of a 60-min face • to-face interactive provider education activity. • Small group discussion • Case studies with didactic lecture • Treatment algorithms	Yes

Author (y)	Type of low value care	Single or multifaceted intervention strategy	Interventions from the EPOC taxonomy													Description of intervention strategy (Sorted by EPOC Taxonomy)	Positive Significant effect (p≤ 0.05) (Yes/No)
			E	AF	P	C	CQ	H	L	M	MP	O	S	T	TI		
McCue et al. 2004[34]	Restraint use	Multifaceted	X				X		X					X		<u>Educational materials:</u> • All clinical staff on the psychiatric inpatient service received training on crisis intervention techniques that can be used as an alternative to restraint (videotapes) • A stress/anger management group for patients was added to the inpatient service's therapeutic programming. <u>Continuous quality improvement:</u> • Daily review of all restraints <u>Local Consensus processes:</u> • Identification of restraint prone patients <u>Team:</u> • Crisis response team • Incentive system for the staff	Yes

Author (y)	Type of low value care	Single or multifaceted intervention strategy	Interventions from the EPOC taxonomy													Description of intervention strategy (Sorted by EPOC Taxonomy)	Positive Significant effect (p≤ 0.05) (Yes/No)
			E	AF	P	C	CQ	H	L	M	MP	O	S	T	TI		
Mitchell et al. 2018[9*]	Restraint use	Multifaceted	X								X					<u>Educational meetings:</u> • Presentations <u>Educational materials:</u> • Flyers • Posters <u>Monitoring the performance of the delivery of healthcare:</u> • Monthly prevalence is determined on all units by bedside nurses. If a patient has restraints in place, the patient's chart is reviewed for orders and proper documentation	/
Sinitsky et al. 2017[35]	Liver function tests	Single						X								<u>Health Information System:</u> • Blood test form	Yes
Thakker et al. 2018[36*]	Catheter use	Multifaceted	X	X												<u>Educational meetings:</u> • Education about the guidelines to ensure adherence and to standardize the criteria for catheter use. <u>Audit and Feedback:</u> • Reminders about adhering to the CAUTI prevention guidelines in daily safety huddles and weekly staff meetings	/

Author (y)	Type of low value care	Single or multifaceted intervention strategy	Interventions from the EPOC taxonomy													Description of intervention strategy (Sorted by EPOC Taxonomy)	Positive Significant effect (p≤ 0.05) (Yes/No)
			E	AF	P	C	CQ	H	L	M	MP	O	S	T	TI		
Weddle et al. 2016[37]	Antibiotic prescribing	Single	X													Educational meetings: • Educational session used evidence-based guidelines and a local antibiogram to provide specific recommendations for the best prescribing practices	Yes

Intervention strategies are classified using the EPOC Taxonomy[21]: E= Education (meetings, materials, games and outreach visits), AF = Audit and Feedback, P= Packages of Care, C= Clinical guidelines, CQ = Continuous quality improvement, H = Health information system, L = Local consensus processes, M = Monitoring, MP = Monitoring the performance of the delivery of healthcare, O = Organisational culture S = Sensory modalities for patients, T = Team and TI = Tailored interventions. *No statistical testing.

Table 5. Type of intervention of the controlled studies (*n*=15)

Author (y)	Type of low value care	Single or multifaceted intervention strategy	Interventions from the EPOC taxonomy E AF P C CQ H L M MP O S T TI	Description of intervention strategy (Sorted by EPOC Taxonomy)	Positive significant effect (ps 0.05) (Yes/No)
Desveaux et al. 2017[38]	Antipsychotic prescribing	Multifaceted	X	Educational outreach visits: • Academic detailing (educational outreach) intervention delivered by registered health professionals following an intensive training program including relevant clinical issues and techniques to support health professional behavior change Educational materials: • Online practice reports	No
Evans et al. 1997[39]	Restraint use	Single and multifaceted	X	**Restraint education (RE) group** Educational meetings: • Intensive education by a masters-prepared gerontologic nurse on restraint use **Restraint education-with-consultation (REC) group** Educational meetings: • Intensive education by a masters-prepared gerontologic nurse Educational outreach visits: • Unit-based nursing consultation	Yes

Author (y)	Type of low value care	Single or multifaceted intervention strategy	Interventions from the EPOC taxonomy E AF P C CQ H L M MP O S T TI	Description of intervention strategy (Sorted by EPOC Taxonomy)	Positive significant effect (p≤ 0.05) (Yes/No)
Fitzpatrick 1997[40]	Restraint use	Single and Multifaceted (2 groups)	X	**Single faceted group** <u>Educational materials:</u> • Educational program: restraint education in service administered in the form of a self-learning module and the option to construct a poster in each unit **Multifaceted group** <u>Educational materials:</u> • Educational program: restraint education in service administered in the form of a self-learning module and the option to construct a poster in each unit. • Critical care restraint decision guide (CCRDG).	No
Gulpers et al. 2011[41]	Restraint use	Multifaceted	X X	<u>Educational meetings:</u> • Nursing home staff education • Availability of alternative interventions <u>Educational outreach visits:</u> • Consultation by a nurse specialist aimed at nursing home staff <u>Local consensus processes:</u> • Promotion of institutional policy change that discourages use of belt restraint	Yes

Author (y)	Type of low value care	Single or multifaceted intervention strategy	Interventions from the EPOC taxonomy													Description of intervention strategy (Sorted by EPOC Taxonomy)	Positive significant effect (ps 0.05) (Yes/No)
			E	AF	P	C	CQ	H	L	M	MP	O	S	T	TI		
Gulpers et al. 2013[42]	Restraint use	Multifaceted	X						X							Educational meetings: • Intensive educational program offered by two registered nurses with extensive experience in physical restraint reduction • Availability of alternative interventions Educational outreach visits: • Consultation from the two nurse specialists (who delivered the educational program) to individual nurses on the intervention wards Local consensus processes: • Policy change by the nursing home management, with new use of belts prohibited and current use reduced	Yes
Huang et al. 2009[43]	Restraint use	Single	X													Educational meetings: • Power-Point presentations • Discussion • Scenario reflections	Yes
Huizing et al. 2009[45]	Restraint use	Multifaceted	X													Educational meetings: • Educational program Educational outreach visits: • Consultation with a nurse specialist	No

Author (y)	Type of low value care	Single or multifaceted intervention strategy	Interventions from the EPOC taxonomy												Description of intervention strategy (Sorted by EPOC Taxonomy)	Positive significant effect (ps 0.05) (Yes/No)
			E	AF	P	C	CQ	H	L	M	MP	O	S	T	TI	
Huizing et al. 2009[44]	Restraint use	Multifaceted	X													Educational meetings: • Educational program Educational outreach visits: • Consultation with a nurse specialist	No
Koczy et al. 2011[46]	Restraint use	Multifaceted	X					X							X	Educational meetings: • The training course included information on epidemiology, the side effects of restraint use, legal aspects and alternatives Health information system: • Technical aids, such as hip protectors and sensor mats Tailored interventions: • Problem-Solving Tools • Advice by telephone from the research team	No
Kopke et al. 2012[47]	Restraint use	Multifaceted	X													Educational meetings: • Group sessions for all nursing staff • Additional training for nominated key nurses Educational materials: • Supportive material for nurses, residents, relatives, and legal guardians.	Yes

Author (y)	Type of low value care	Single or multifaceted intervention strategy	Interventions from the EPOC taxonomy													Description of intervention strategy (Sorted by EPOC Taxonomy)	Positive significant effect (ps 0.05) (Yes/No)
			E	AF	P	C	CQ	H	L	M	MP	O	S	T	TI		
Kwok et al. 2005[48]	Restraint use	Multifaceted	X					X								Educational meetings: • Education about how to use of the bed-chair pressure sensors and the importance of restraint reduction in improving patients' outcomes Health information system: • Bed-chair pressure sensors	No
Lai et al. 2011[49]	Restraint use	Multifaceted	X									X				Educational meetings: • Staff education package Educational outreach visits: • Consult with the project team for uncertainties and on an individual Organisational Culture • The setup of a restraint reduction committee (RRC)	No
Pellfolk et al. 2010[50]	Restraint use	Multifaceted	X													Educational meetings: • One volunteer from each unit attended the whole education program • Educational seminar Educational materials: • Videotaped lectures. Three of the lectures also included a clinical vignette presented in writing, which could be used for group discussions.	Yes

Author (y)	Type of low value care	Single or multifaceted intervention strategy	Interventions from the EPOC taxonomy E AF P C CQ H L M MP O S T TI	Description of intervention strategy (Sorted by EPOC Taxonomy)	Positive significant effect (ps 0.05) (Yes/No)
Testad et al. 2010[51]	Restraint use	Multifaceted	X	Educational meetings: • Two-day seminar • Monthly group guidance for six months Educational materials: • Teaching manual	Yes
Testad et al. 2016[52]	Restraint use	Multifaceted	X	Educational meetings: • Two-day seminar • Monthly seven step guidance groups for six months Educational materials: • Manual of the updated intervention and the seven-step guidance group • Poster DMP model	Yes

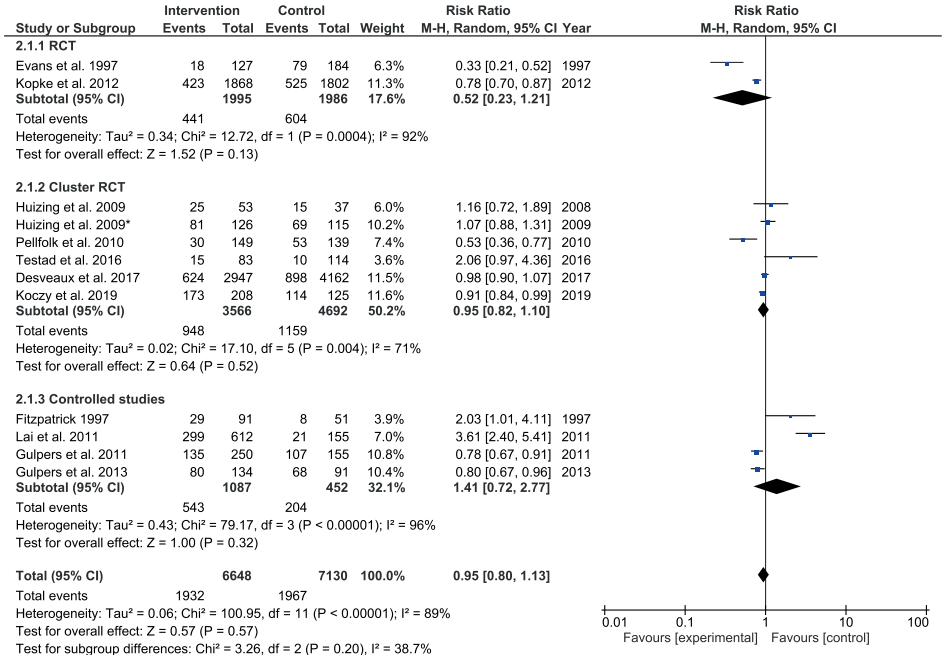
Intervention strategies are classified using the EPOC Taxonomy (21): E= Education (meetings, materials, games and outreach visits), AF = Audit and Feedback, P= Packages of Care, C= Clinical guidelines, CQ = Continuous quality improvement, H = Health information system, L = Local consensus processes, M = Monitoring, MP = Monitoring the performance of the delivery of healthcare, O = Organisational culture S = Sensory modalities for patients, T = Team and TI = Tailored interventions. *No statistical testing.

Effectiveness of de-implementation strategies (meta-analysis) of controlled studies

The effectiveness of de-implementation strategies to reduce low value nursing procedures is only assessed for the controlled studies. Twelve of the fifteen controlled studies were eligible for inclusion in the meta-analyses[38-42, 44-47, 49, 50, 52]. Two controlled studies were excluded after no response of the author after sending a request for missing data[48,51], and one study was excluded because the volume of low value nursing procedures was not measured at patient level[43]. The relative risk ratio for the use of low value nursing procedures for all 12 studies was 0.95 [95% CI 0.80, 1.13]. Considerable heterogeneity was present in the effect estimate (I^2 = 89%) (*Figure 3*). Subgroup analyses could only be performed for type of design (*Figure 3*). A subgroup analysis for type of de-implementation strategy could not be performed due to a lack of studies with the same strategy. Also a subgroup analyses for single vs. multifaceted strategies could not be performed due to a lack of studies with a single component strategy. A subgroup analyses for type of low value care could not be performed due to a lack of studies assessing de-implementation strategies to reduce types of low value nursing procedures other than restraint use.

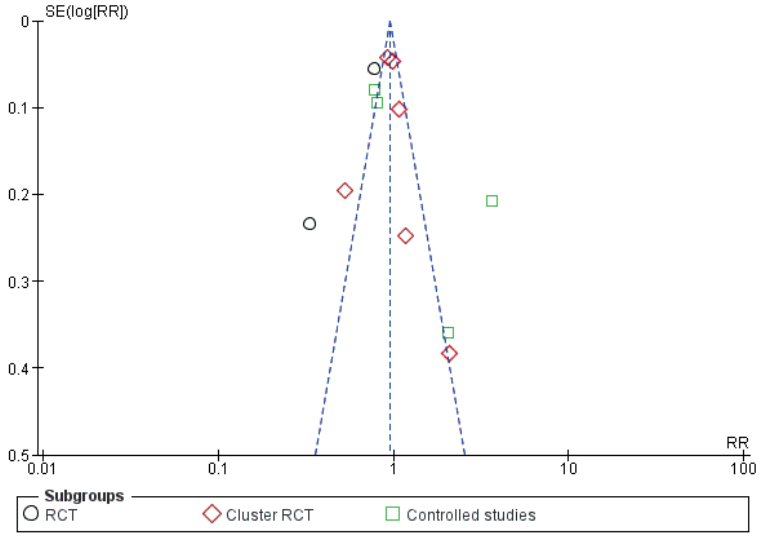
Subgroup analyses for the type of design of the studies (RCT, Cluster RCT, and controlled studies) showed no statistically significant subgroup effect (χ^2 = 3.26, p=0.20), a moderate level of heterogeneity between the studies (I^2= 39%), and a high level of heterogeneity within the subgroups (RCT= 92%, Cluster RCT= 71%, controlled studies= 96%) (*Figure 3*). Based on the funnel plots we suggest that there is no publication bias (*Figure 4*).

Figure 3. Subgroup analyses controlled studies: Design study*



* All studies included in the meta-analysis targeted their intervention at restraint use.

Figure 4. Funnel plot: design study



DISCUSSION

To our knowledge, this is the first systematic review on de-implementation strategies for low value nursing procedures. This systematic review identified both uncontrolled and controlled studies for the reduction of a limited range of low value nursing procedures, namely physical restraint use, antibiotic and antipsychotic prescribing, requests for liver function tests and urinary catheter use. The majority of the controlled and uncontrolled studies with a positive significant effect used a de-implementation strategy with an educational component (educational meetings, educational materials, educational outreach visits, and educational games) and focused their de-implementation strategy at reducing the use of restraints. An important difference between the controlled and uncontrolled studies with a positive significant effect is that the majority of the controlled studied used a multifaceted de-implementation strategy, and the majority of the positive significant uncontrolled studies used a single faceted de-implementation strategy. However, the use of educational components cannot be directly linked to successful de-implementation since both studies with a positive significant effect and studies without an effect or with a negative effect included these components. Due to heterogeneity and a lack of same strategies in the controlled studies no conclusions can be drawn from the meta-analyses about the effectiveness of de-implementation strategies for low value nursing procedures.

Despite increasing attention for the de-implementation of low value nursing procedures, we only found 27 articles that we could include in our systematic review. However, the number of studies increased within the last decade. Only one study was found in the nineties, where seven studies were found from 2000 till 2010, and eighteen studies from 2010 till 2020. This shows the attention for this important topic, however more variation in the strategies to be evaluated is needed to get a full picture of effective or non-effective de-implementation strategies for nurses. Additionally, this study showed from the high number of excluded studies in which dependent nursing procedures are de-implemented, i.e. nursing procedures that require an order of another healthcare professional, that nurses have an important role in the de-implementation of low value care. Due to differences in responsibilities in different countries some nursing procedures are in some countries independently and in other countries dependently performed, for example the use of urinary catheters. As a consequence, some studies on this kind of topics are included in this review (as nurses are allowed independently to decide) or excluded (as nurses need an order for the nursing procedure).

The results of this systematic review showed some similarities and differences with previous findings in the literature regarding effective types of de-implementation strategies. A similarity is that our review showed as in a previous study of Colla et al.[7] that most studies used multifaceted strategies including an educational component. A difference with the study of Colla et al.[7] is that our review did not identify successful multifaceted de-implementation strategies that included a clinical decision support tool and/or performance feedback in their strategy. This may be the result of different inclusion criteria and focus of the study. While Colla et al.[7] focused on successful de-implementation strategies in health services, we only included studies that assessed the effectiveness of strategies to de-implement low value nursing procedures.

To increase the effectiveness of de-implementation strategies it is recommended in the literature to use a strategy which is geared at barriers and facilitators that influence the use of low value care[5,16,17]. However, this review was not able to support this recommendation since only two studies included in this review performed a barrier and facilitator assessment before executing their de-implementation strategy[9,38]. The other studies did not describe whether they have based their de-implementation strategy on prior barrier and facilitator assessment. One study that performed a barrier assessment showed a reduction of low value nursing care (no statistical testing)[9] and the other did not show an effective de-implementation strategy[38]. The absence of de-implementation strategies that are fully connected towards factors influencing the use of low value nursing procedures could have contributed to ineffective de-implementation strategies in this review[17].

Another way to increase the effectiveness of de-implementation strategies may be to match de-implementation strategies to the target action (stop, replace, reduce, restrict the low value nursing procedure) for de-implementation as different actions are underpinned by different theories, frameworks, and models for change as proposed by Norton and Chambers[17]. In this review most studies aimed to reduce the use of restraints. Theories of habit transformation and disruption suggest that the most effective way to reduce the use of inappropriate interventions may be to change the context and environmental cues. However, studies included in this review that aimed to reduce the use of low value restraints mostly used educational interventions (including skills training). According to theories of individual and organizational learning and unlearning strategies, this better fits with the replacement of low value nursing procedures. Future studies should reveal whether a better match between de-implementation strategies and target actions result in more significant reductions.

This review has several strengths and limitations. The first strength is that we performed a meta-analysis to assess the effectiveness of the de-implementation strategies while Colla et al.[7] only reported whether studies were effective or not. This may have caused an overestimation of the results of the used de-implementation strategies in the review of Colla et al.[7], because the quality of the uncontrolled studies could be poor as shown in our study. Another strength is that that the number of 'missed' studies is limited because our search strategy was based on the 43 unique terms referring to the process of de-implementation found by Niven et al.[20] and these terms are also used in implementation studies such as 'reduce, stop and avoid'. Implementation studies may have the same purpose as de-implementation studies. An example of this, is an implementation study that aims to implement a guideline recommendation that states 'not to use of bandages for wounds closed by primary intention'. In future research, the search strategy may be further improved by adding nursing procedures that are marked as low value nursing procedures in guidelines[1,4,11,12].

A limitation of this review is the quality of the included studies. The uncontrolled studies had a poor quality, which resulted in an overall low evidence based, precluding drawing conclusions. In addition, the included studies lacked measurements of patient reported outcomes. As a result, it was not possible to determine whether the reduction of low value nursing procedures have adverse effects on patient outcomes. Furthermore, the included studies did not report on the adherence to the intended de-implementation strategy. As a consequence, it was not possible to determine whether the de-implementation strategy has been executed as planned and the effect can be attributed to the de-implementation strategy. Therefore, further research should not only focus on developing and evaluating the effectiveness of de-implementation strategies, but also to evaluate the process of the de-implementation including the identification of changes in multi-level barriers and facilitators that should be the target of the strategies[17,53,54]. Finally, not all controlled studies could be included in the meta-analysis due to missing data. Although we contacted the authors of the two papers with missing data on the change in volume of low value in nursing, we were not able to obtain the data of two studies due to non-response of the authors.

CONCLUSIONS

Most controlled and uncontrolled studies with a positive significant effect used a de-implementation strategy with an educational component (educational meetings, educational materials, educational outreach visits, and/or educational games) and focused their de-implementation strategy at reducing the use of restraints. Unfortunately, no conclusions can be drawn about which strategy is most effective for reducing low value nursing.

Future studies are needed that assess whether de-implementation strategies that fully connect their strategy towards influencing factors and match their strategy to the target action (stop, replace, reduce, restrict the low value nursing procedure) are more effective for de-implementation. In order to improve future appraisal of available evidence on de-implementation strategies in nursing we recommend that future studies should report the results on the change in the volume of low value nursing procedures more extensively and should perform a process evaluation.

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APPENDIX A: SEARCH STRATEGY

PUBMED

(("Deprescriptions"[Mesh] OR Deprescription*[tw] OR De-prescription*[tw] OR Deprescri*[tw] OR De-prescri*[tw] OR (("Health Services Misuse"[Mesh] OR "overuse"[tiab] OR "overusing"[tiab] OR "overused"[tiab] OR "overuses"[tiab] OR "over use"[tiab] OR "over using"[tiab] OR "over used"[tiab] OR "over uses"[tiab] OR "over-use"[tiab] OR "over-using"[tiab] OR "over-used"[tiab] OR "over-uses"[tiab] OR "Inappropriate Prescribing"[Mesh] OR "inappropriate prescribing"[tw] OR "inappropriately prescribed"[tw] OR "inappropriate prescription"[tw] OR "choosing wisely"[tiab] OR "overtreatment"[tw] OR "overtreatments"[tw] OR "overtreating"[tw] OR "overtreated"[tw] OR "overtreats" OR "overdiagnosis"[tw] OR "overdiagnosing"[tw] OR "overdiagnoses"[tw] OR "overdiagnosed"[tw] OR "overmedication"[tw] OR "overmedicate"[tw] OR "overmedicating"[tw] OR "overmedicates"[tw] OR "overmedicated"[tw] OR (("low value care"[ti] OR "unnecessary"[ti] OR "established"[ti] OR "ineffective"[ti] OR "practices"[ti] OR "care"[ti] OR "overuse"[ti] OR "procedure"[ti] OR "procedures"[ti]) AND ("reduction"[ti] OR "reduce"[ti] OR "reducing"[ti] OR "reduced"[ti] OR "reduces"[ti] OR "disinvestment"[ti] OR "disinvest"[ti] OR "disinvesting"[ti] OR "disinvested"[ti] OR "disinvests"[ti] OR "de-implementation"[ti] OR "de-implement"[ti] OR "de-implements"[ti] OR "de-implemented"[ti] OR "de-implementing"[ti] OR "abandoning"[ti] OR "abandon"[ti] OR "abandons"[ti] OR "abandoned"[ti] OR "abandonment"[ti] OR "discontinue"[ti] OR "disontinues"[ti] OR "discontinuing"[ti] OR "discontinued"[ti] OR "discontinuation"[ti] OR "undiffusion"[ti] OR "undiffuse"[ti] OR "undiffuses"[ti] OR "Undiffused"[ti] OR "undiffusing"[ti] OR "stop"[ti] OR "stopping"[ti] OR "stops"[ti] OR "stopped"[ti] OR "avoid"[ti] OR "avoiding"[ti] OR "avoids"[ti] OR "avoided"[ti])))) AND ("Practice Patterns, Nurses'"[Mesh] OR "Nurses"[Mesh] OR "nurse"[tw] OR "nurses"[tw] OR "Nursing"[Mesh] OR "nursing"[tw] OR "Nurse's Role"[Mesh])) NOT (news[pt] OR comment[pt] OR editorial[pt] OR congresses[pt])

EMBASE

((("Deprescription"/ OR Deprescription*.mp OR De-prescription*.mp OR Deprescri*.mp OR De-prescri*.mp OR (("overuse".ti,ab OR "overusing".ti,ab OR "overused".ti,ab OR "overuses".ti,ab OR "over use".ti,ab OR "over using".ti,ab OR "over used".ti,ab OR "over uses".ti,ab OR "over-use".ti,ab OR "over-using".ti,ab OR "over-used".ti,ab OR "over-uses".ti,ab OR exp "Inappropriate Prescribing"/ OR "inappropriate prescribing".mp OR "inappropriately prescribed".mp OR "inappropriate prescription".mp OR "choosing wisely".ti,ab OR "overtreatment".mp OR

"overtreatments".mp OR "overtreating".mp OR "overtreated".mp OR "overtreats". mp OR "overdiagnosis".mp OR "overdiagnosing".mp OR "overdiagnoses".mp OR "overdiagnosed".mp OR "overmedication".mp OR "overmedicate".mp OR "overmedicating".mp OR "overmedicates".mp OR "overmedicated".mp OR (("low value care".ti OR "unnecessary".ti OR "established".ti OR "ineffective".ti OR "practices" .ti OR "care".ti OR "overuse".ti OR "procedure".ti OR "procedures".ti) AND ("reduction".ti OR "reduce".ti OR "reducing".ti OR "reduced".ti OR "reduces". ti OR "disinvestment".ti OR "disinvest".ti OR "disinvesting".ti OR "disinvested". ti OR "disinvests".ti OR "de-implementation".ti OR "de-implement".ti OR "de-implements".ti OR "de-implemented".ti OR "de-implementing".ti OR "abandoning". ti OR "abandon".ti OR "abandons".ti OR "abandoned".ti OR "abandonment".ti OR "discontinue".ti OR "disontinues".ti OR "discontinuing".ti OR "discontinued". ti OR "discontinuation".ti OR "undiffusion".ti OR "undiffuse".ti OR "undiffuses". ti OR "Undiffused".ti OR "undiffusing".ti OR "stop".ti OR "stopping".ti OR "stops". ti OR "stopped".ti OR "avoid".ti OR "avoiding".ti OR "avoids".ti OR "avoided".ti))))) AND (exp *"Nurse"/ OR "nurse".ti OR "nurses".ti OR exp *"Nursing"/ OR "nursing". ti OR *"nurse attitude"/ OR *"Nursing Practice"/)) OR ((*"Deprescription"/ OR Deprescription*.ti OR De-prescription*.ti OR Deprescri*.ti OR De-prescri*.ti OR (("overuse".ti OR "overusing".ti OR "overused".ti OR "overuses".ti OR "over use".ti OR "over using".ti OR "over used".ti OR "over uses".ti OR "over-use".ti OR "over-using". ti OR "over-used".ti OR "over-uses".ti OR exp *"Inappropriate Prescribing"/ OR "inappropriate prescribing".ti OR "inappropriately prescribed".ti OR "inappropriate prescription".ti OR "choosing wisely".ti OR "overtreatment".ti OR "overtreatments". ti OR "overtreating".ti OR "overtreated".ti OR "overtreats".ti OR "overdiagnosis". ti OR "overdiagnosing".ti OR "overdiagnoses".ti OR "overdiagnosed". ti OR "overmedication".ti OR "overmedicate".ti OR "overmedicating".ti OR "overmedicates".ti OR "overmedicated".ti OR (("low value care".ti OR "unnecessary". ti OR "established".ti OR "ineffective".ti OR "practices" .ti OR "care".ti OR "overuse". ti OR "procedure".ti OR "procedures".ti) AND ("reduction".ti OR "reduce".ti OR "reducing".ti OR "reduced".ti OR "reduces".ti OR "disinvestment".ti OR "disinvest". ti OR "disinvesting".ti OR "disinvested".ti OR "disinvests".ti OR "de-implementation". ti OR "de-implement".ti OR "de-implements".ti OR "de-implemented".ti OR "de-implementing".ti OR "abandoning".ti OR "abandon".ti OR "abandons".ti OR "abandoned".ti OR "abandonment".ti OR "discontinue".ti OR "disontinues".ti OR "discontinuing".ti OR "discontinued".ti OR "discontinuation".ti OR "undiffusion".ti OR "undiffuse".ti OR "undiffuses".ti OR "Undiffused".ti OR "undiffusing".ti OR "stop".ti OR "stopping".ti OR "stops".ti OR "stopped".ti OR "avoid".ti OR "avoiding".ti OR "avoids". ti OR "avoided".ti))))) AND (exp "Nurse"/ OR "nurse".mp OR "nurses".mp OR exp

"Nursing"/ OR "nursing".mp OR "nurse attitude"/ OR "Nursing Practice"/))) NOT (conference review or conference abstract OR editorial).pt

Web of Science

(TI=("Deprescriptions" OR Deprescri* OR "De prescri*" OR (("Health Services Misuse" OR "overuse" OR "overusing" OR "overused" OR "overuses" OR "over use" OR "over using" OR "over used" OR "over uses" OR "over-use" OR "over-using" OR "over-used" OR "over-uses" OR "inappropriate prescribing" OR "inappropriately prescribed" OR "inappropriate prescription" OR "choosing wisely" OR "overtreatment" OR "overtreatments" OR "overtreating" OR "overtreated" OR "overtreats" OR "overdiagnosis" OR "overdiagnosing" OR "overdiagnoses" OR "overdiagnosed" OR "overmedication" OR "overmedicate" OR "overmedicating" OR "overmedicates" OR "overmedicated" OR (("low value care" OR "unnecessary" OR "established" OR "ineffective" OR "practices" OR "care" OR "overuse" OR "procedure" OR "procedures") AND ("reduction" OR "reduce" OR "reducing" OR "reduced" OR "reduces" OR "disinvestment" OR "disinvest" OR "disinvesting" OR "disinvested" OR "disinvests" OR "de-implementation" OR "de-implement" OR "de-implements" OR "de-implemented" OR "de-implementing" OR "abandoning" OR "abandon" OR "abandons" OR "abandoned" OR "abandonment" OR "discontinue" OR "disontinues" OR "discontinuing" OR "discontinued" OR "discontinuation" OR "undiffusion" OR "undiffuse" OR "undiffuses" OR "Undiffused" OR "undiffusing" OR "stop" OR "stopping" OR "stops" OR "stopped" OR "avoid" OR "avoiding" OR "avoids" OR "avoided"))))) AND TS=("Nurses" OR "nurse" OR "nursing"))

Cochrane

(("Deprescriptions" OR Deprescri* OR "De prescri*" OR (("Health Services Misuse" OR "overuse" OR "overusing" OR "overused" OR "overuses" OR "over use" OR "over using" OR "over used" OR "over uses" OR "over-use" OR "over-using" OR "over-used" OR "over-uses" OR "inappropriate prescribing" OR "inappropriately prescribed" OR "inappropriate prescription" OR "choosing wisely" OR "overtreatment" OR "overtreatments" OR "overtreating" OR "overtreated" OR "overtreats" OR "overdiagnosis" OR "overdiagnosing" OR "overdiagnoses" OR "overdiagnosed" OR "overmedication" OR "overmedicate" OR "overmedicating" OR "overmedicates" OR "overmedicated" OR (("low value care" OR "unnecessary" OR "established" OR "ineffective" OR "practices" OR "care" OR "overuse" OR "procedure" OR "procedures") AND ("reduction" OR "reduce" OR "reducing" OR "reduced" OR "reduces" OR "disinvestment" OR "disinvest" OR "disinvesting" OR "disinvested" OR "disinvests" OR "de-implementation" OR "de-implement" OR "de-implements" OR "de-implemented" OR "de-implementing" OR "abandoning" OR

"abandon" OR "abandons" OR "abandoned" OR "abandonment" OR "discontinue" OR "disontinues" OR "discontinuing" OR "discontinued" OR "discontinuation" OR "undiffusion" OR "undiffuse" OR "undiffuses" OR "Undiffused" OR "undiffusing" OR "stop" OR "stopping" OR "stops" OR "stopped" OR "avoid" OR "avoiding" OR "avoids" OR "avoided")))):ti AND ("Nurses" OR "nurse" OR "nursing"):ti,ab,kw)

Emcare

(("Deprescription"/ OR Deprescription*.mp OR De-prescription*.mp OR Deprescri*.mp OR De-prescri*.mp OR (("overuse".ti,ab. OR "overusing".ti,ab. OR "overused".ti,ab. OR "overuses".ti,ab. OR "over use".ti,ab. OR "over using".ti,ab. OR "over used".ti,ab. OR "over uses".ti,ab. OR "over-use".ti,ab. OR "over-using".ti,ab. OR "over-used".ti,ab. OR "over-uses".ti,ab. OR exp "Inappropriate Prescribing"/ OR "inappropriate prescribing".mp OR "inappropriately prescribed".mp OR "inappropriate prescription".mp OR "choosing wisely".ti,ab. OR "overtreatment".mp OR "overtreatments".mp OR "overtreating".mp OR "overtreated".mp OR "overtreats".mp OR "overdiagnosis".mp OR "overdiagnosing".mp OR "overdiagnoses".mp OR "overdiagnosed".mp OR "overmedication".mp OR "overmedicate".mp OR "overmedicating".mp OR "overmedicates".mp OR "overmedicated".mp OR (("low value care".ti OR "unnecessary".ti OR "established".ti OR "ineffective".ti OR "practices" .ti OR "care".ti OR "overuse".ti OR "procedure".ti OR "procedures".ti) AND ("reduction".ti OR "reduce".ti OR "reducing".ti OR "reduced".ti OR "reduces".ti OR "disinvestment".ti OR "disinvest".ti OR "disinvesting".ti OR "disinvested".ti OR "disinvests".ti OR "de-implementation".ti OR "de-implement".ti OR "de-implements".ti OR "de-implemented".ti OR "de-implementing".ti OR "abandoning".ti OR "abandon".ti OR "abandons".ti OR "abandoned".ti OR "abandonment".ti OR "discontinue".ti OR "disontinues".ti OR "discontinuing".ti OR "discontinued".ti OR "discontinuation".ti OR "undiffusion".ti OR "undiffuse".ti OR "undiffuses".ti OR "Undiffused".ti OR "undiffusing".ti OR "stop".ti OR "stopping".ti OR "stops".ti OR "stopped".ti OR "avoid".ti OR "avoiding".ti OR "avoids".ti OR "avoided".ti))))) AND (exp "Nurse"/ OR "nurse".mp OR "nurses".mp OR exp "Nursing"/ OR "nursing".mp OR "nurse attitude"/ OR "Nursing Practice"/)) NOT (conference review or conference abstract).pt

PsycINFO

TI(("Deprescriptions" OR "depresciption" OR depresci* OR (("overuse" OR "overuse" OR "overusing" OR "overusing" OR "overused" OR "overused" OR "overuses" OR "overuses" OR "over use" OR "over use" OR "over using" OR "over using" OR "over used" OR "over used" OR "over uses" OR "over uses"OR "over-use" OR "over-use" OR "over-using" OR "over-using" OR "over-used" OR "over-used" OR "over-uses"

OR "over-uses" OR "inappropriate prescribing" OR "inappropriately prescribed" OR "inappropriate prescription" OR "choosing wisely" OR "choosing wisely" OR "overtreatment" OR "overtreatments" OR "overtreating" OR "overtreated" OR "overtreats" OR "overdiagnosis" OR "overdiagnosing" OR "overdiagnoses" OR "overdiagnosed" OR "overmedication" OR "overmedicate" OR "overmedicating" OR "overmedicates" OR "overmedicated" OR (("low value care" OR "unnecessary" OR "established" OR "ineffective" OR "practices" OR "care" OR "overuse" OR "procedure" OR "procedures") AND ("reduction" OR "reduce" OR "reducing" OR "reduced" OR "reduces" OR "disinvestment" OR "disinvest" OR "disinvesting" OR "disinvested" OR "disinvests" OR "de-implementation" OR "de-implement" OR "de-implements" OR "de-implemented" OR "de-implementing" OR "abandoning" OR "abandon" OR "abandons" OR "abandoned" OR "abandonment" OR "discontinue" OR "disontinues" OR "discontinuing" OR "discontinued" OR "discontinuation" OR "undiffusion" OR "undiffuse" OR "undiffuses" OR "Undiffused" OR "undiffusing" OR "stop" OR "stopping" OR "stops" OR "stopped" OR "avoid" OR "avoiding" OR "avoids" OR "avoided")))) AND ("Nurses" OR "Psychiatric Nurses" OR "Public Health Service Nurses" OR "School Nurses" OR "nurse" OR "nurses" OR "Nursing" OR "nursing")) OR (TI("Deprescriptions" OR "depresciption" OR depresci* OR (("overuse" OR "overuse" OR "overusing" OR "overusing" OR "overused" OR "overused" OR "overuses" OR "overuses" OR "over use" OR "over use" OR "over using" OR "over using" OR "over used" OR "over used" OR "over uses" OR "over uses"OR "over-use" OR "over-use" OR "over-using" OR "over-using" OR "over-used" OR "over-used" OR "over-uses" OR "over-uses" OR "inappropriate prescribing" OR "inappropriately prescribed" OR "inappropriate prescription" OR "choosing wisely" OR "choosing wisely" OR "overtreatment" OR "overtreatments" OR "overtreating" OR "overtreated" OR "overtreats" OR "overdiagnosis" OR "overdiagnosing" OR "overdiagnoses" OR "overdiagnosed" OR "overmedication" OR "overmedicate" OR "overmedicating" OR "overmedicates" OR "overmedicated" OR (("low value care" OR "unnecessary" OR "established" OR "ineffective" OR "practices" OR "care" OR "overuse" OR "procedure" OR "procedures") AND ("reduction" OR "reduce" OR "reducing" OR "reduced" OR "reduces" OR "disinvestment" OR "disinvest" OR "disinvesting" OR "disinvested" OR "disinvests" OR "de-implementation" OR "de-implement" OR "de-implements" OR "de-implemented" OR "de-implementing" OR "abandoning" OR "abandon" OR "abandons" OR "abandoned" OR "abandonment" OR "discontinue" OR "disontinues" OR "discontinuing" OR "discontinued" OR "discontinuation" OR "undiffusion" OR "undiffuse" OR "undiffuses" OR "Undiffused" OR "undiffusing" OR "stop" OR "stopping" OR "stops" OR "stopped" OR "avoid" OR "avoiding" OR "avoids" OR "avoided")))) AND DE("Nurses" OR "Psychiatric Nurses" OR "Public Health Service Nurses" OR "School Nurses" OR "nurse" OR "nurses" OR

"Nursing" OR "nursing")) OR (TI("Deprescriptions" OR "depresciption" OR depresci* OR (("overuse" OR "overuse" OR "overusing" OR "overusing" OR "overused" OR "overused" OR "overuses" OR "overuses" OR "over use" OR "over use" OR "over using" OR "over using" OR "over used" OR "over used" OR "over uses" OR "over uses"OR "over-use" OR "over-use" OR "over-using" OR "over-using" OR "over-used" OR "over-used" OR "over-uses" OR "over-uses" OR "inappropriate prescribing" OR "inappropriately prescribed" OR "inappropriate prescription" OR "choosing wisely" OR "choosing wisely" OR "overtreatment" OR "overtreatments" OR "overtreating" OR "overtreated" OR "overtreats" OR "overdiagnosis" OR "overdiagnosing" OR "overdiagnoses" OR "overdiagnosed" OR "overmedication" OR "overmedicate" OR "overmedicating" OR "overmedicates" OR "overmedicated" OR (("low value care" OR "unnecessary" OR "established" OR "ineffective" OR "practices" OR "care" OR "overuse" OR "procedure" OR "procedures") AND ("reduction" OR "reduce" OR "reducing" OR "reduced" OR "reduces" OR "disinvestment" OR "disinvest" OR "disinvesting" OR "disinvested" OR "disinvests" OR "de-implementation" OR "de-implement" OR "de-implements" OR "de-implemented" OR "de-implementing" OR "abandoning" OR "abandon" OR "abandons" OR "abandoned" OR "abandonment" OR "discontinue" OR "disontinues" OR "discontinuing" OR "discontinued" OR "discontinuation" OR "undiffusion" OR "undiffuse" OR "undiffuses" OR "Undiffused" OR "undiffusing" OR "stop" OR "stopping" OR "stops" OR "stopped" OR "avoid" OR "avoiding" OR "avoids" OR "avoided"))))) AND AB("Nurses" OR "Psychiatric Nurses" OR "Public Health Service Nurses" OR "School Nurses" OR "nurse" OR "nurses" OR "Nursing" OR "nursing"))

Academic Search Premier

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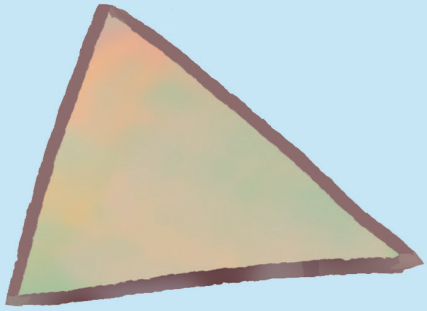

6

Implementation strategies used to implement nursing guidelines in daily practice: A Systematic Review

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ABSTRACT

Objectives

Research specifically addressing implementation strategies regarding nursing guidelines is limited. The objective of this review was to provide an overview of strategies used to implement nursing guidelines in all nursing fields, as well as the effects of these strategies on patient-related nursing outcomes and guideline adherence. Ideally, the findings would help guideline developers, healthcare professionals and organizations to implement nursing guidelines in practice.

Design

Systematic review. PROSPERO registration number: CRD42018104615.

Data sources

We searched the Embase, Medline, PsycINFO, Web of Science, Cochrane, CINAHL and Google Scholar databases until August 2019 as well as the reference lists of relevant articles.

Review methods

Studies were included that described quantitative data on the effect of implementation strategies and implementation outcomes of any type of a nursing guideline in any setting. No language or date of publication restriction was used. The Cochrane Effective Practice and Organisation of Care taxonomy was used to categorize the implementation strategies. Studies were classified as effective if a significant change in either patient-related nursing outcomes or guideline adherence was described. Strength of the evidence was evaluated using the 'Cochrane risk of bias tool' for controlled studies, and the 'Newcastle-Ottawa Quality Assessment form' for cohort studies.

Results

A total of 54 articles regarding 53 different guideline implementation studies were included. Fifteen were (cluster) Randomized Controlled Trials or controlled before-after studies and 38 studies had a before-after design. The topics of the implemented guidelines were diverse, mostly concerning skin care (*n*=9) and infection prevention (*n*=7). Studies were predominantly performed in hospitals (*n*=34) and nursing homes (*n*=11). Thirty studies showed a positive significant effect in either patient-related nursing outcomes or guideline adherence (68%, *n*=36). The median number of implementation strategies used was 6 (IQR

4-8) per study. Educational strategies were used in nearly all studies (98.1%, *n*=52), followed by deployment of local opinion leaders (54.7%, *n*=29) and audit and feedback (41.5%, *n*=22). Twenty-three (43.4%) studies performed a barrier assessment, nineteen used tailored strategies.

Conclusions

A wide variety of implementation strategies are used to implement nursing guidelines. Not one single strategy, or combination of strategies, can be linked directly to successful implementation of nursing guidelines. Overall, thirty-six studies (68%) reported a positive significant effect of the implementation of guidelines on patient-related nursing outcomes or guideline adherence. Future studies should use a standardized reporting checklist to ensure a detailed description of the used implementation strategies to increase reproducibility and understanding of outcomes.

INTRODUCTION

Nurses are increasingly expected to provide evidence-based care intended to enhance quality of care[1]. Therefore, an increasing number of nursing guidelines are being published. A guideline in general contains evidence-based recommendations for healthcare providers, policy makers, and patients about health interventions intended to optimize patient care. Guidelines are published with the aim of reducing unwarranted variation in healthcare delivery[2-4]. Still, healthcare providers' adherence to guideline recommendations has proven suboptimal[5-8]. Publishing or disseminating a guideline alone will not ensure adequate use of a guideline in practice. An essential second step is to apply strategies to effectively implement the guideline[9]. Using a theory, model or framework, is expected to increase the probability of success of the implementation[10]. This also holds for performing a barrier assessment and tailoring strategies[11], which are often elements in theories, models or frameworks.

As nursing and medical care, as well as the associated guidelines, differ in nature, other strategies may be needed to anchor nursing guidelines in practice. Previous reviews about nursing guideline implementation considered studies addressing a single implementation strategy, such as education[12] or facilitation[13], or a specific setting, such as nursing homes[14]. More and more implementation studies in the field of nursing are being conducted[15]. However, to the best of our knowledge, the implementation strategies of nursing guidelines, independent of type or setting, have not been systematically reviewed to this date. A systematic review could provide insights useful in all areas of nursing.

The objective of this review was to provide an overview of strategies used to implement nursing guidelines in all nursing fields, as well as the effects of these strategies on patient-related nursing outcomes and guideline adherence. Ideally, the findings would help guideline developers, healthcare professionals and organizations in implementing nursing guidelines in practice.

METHODS

Design

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines[16]; the research protocol was registered on PROSPERO (registration number: CRD42018104615).

Search

Relevant studies were searched in the Embase, Medline, PsycINFO, Web of Science, Cochrane, CINAHL and Google Scholar databases until August 2019. Various search terms were purposefully selected to cover all nursing fields and implementation synonyms. A biomedical information specialist of the medical library of the Erasmus MC – University Medical Centre Rotterdam guided the search. The full search strategy is presented in *Supplement 1. Search strategy*. The titles and abstracts of all search results were screened on relevance by DS and EI independently, according to specified eligibility criteria, using Endnote®[17]. Next, the full texts of possibly relevant articles were checked for inclusion by DS. Consensus on final inclusion was achieved by discussion (DS, EI). After the initial search, a reference and citation check were performed for all relevant studies (by DS, EI). To ensure having a complete overview of all published studies, several previously published systematic reviews were screened for relevant included studies[12-14,18].

Eligibility criteria

The scope of the review was limited to studies that considered the implementation of a nursing guideline, defined as recommendations about health interventions mainly provided by nurses (>50%), intended to optimize patient care and based on either national or international guidelines. The following inclusion criteria were applied: 1) studies had to describe the implementation strategies and outcomes of the implementation of the nursing guideline; 2) studies had to measure either the effects of the implemented nursing guideline on patient-related nursing outcomes (e.g. pain, falls, pressure ulcers), or adherence to the guideline by the healthcare professionals measured by observation or documentation; 3) studies had to include a reference group (e.g., with and without guideline). Case studies of individual patients, letters and editorials were not eligible. To optimize the objectivity of the included study results, we excluded studies with only survey outcomes. We excluded bundle implementation studies because of their protocol-like characteristics. No search limitations were imposed on language.

Outcome measures

The primary outcomes were; 1) impact on patient-related nursing outcomes, and 2) adherence to the guideline. Studies were classified with a positive effect when a statistically significant improvement in patient-related nursing outcomes and/or adherence was reported.

The secondary outcomes were the number and types of implementation strategies per study. The different strategies used were categorized according

to the Cochrane Effective Practice and Organisation of Care taxonomy[19]. The Effective Practice and Organisation of Care taxonomy includes four domains of interventions: Implementation strategies, Delivery arrangements, Financial arrangements and Governance arrangements.

Data extraction

Relevant information from the included articles was extracted in a data abstraction form. This form was piloted for the first five studies and finalized after discussion (DS, TR, EI). Data included country of origin, setting, type of guideline, participants, implementation strategies, barrier assessment, use of implementation theory or framework, and outcomes. Depending on the measurements performed in the included studies, both or either of the primary outcomes (i.e. patient-related nursing outcomes or adherence to the guideline) were collected. All data abstraction forms were initially completed by DS and checked by either TR or EI. Differences were discussed when necessary.

Risk of bias assessment

The risk of bias of the included studies was assessed with two tools. The Cochrane risk of bias tool was used for the controlled studies[20]. This tool consists of nine items, of which each is scored high, low or unclear risk of bias. The 'Newcastle-Ottawa Quality Assessment form for Cohort studies' was used for cohort before-after studies[21]. The Newcastle-Ottawa Quality Assessment consists of three parts; selection, comparison and outcome. For each part a number of stars can be assigned, resulting in an overall score (good, fair or poor). Both risk of bias tools were included in the data abstraction form, initially completed by DS and checked by either TR or EI. Discrepancies were resolved by discussion.

The Newcastle-Ottawa Quality Assessment form for Cohort Studies contains a question on whether the follow-up was long enough for the outcome to appear[21]. In line with recommendations of the World Health Organisation (WHO) on implementation research, we took it that a period of at least of 3 months, for baseline and after measurement each, was sufficient[22]. After discussion DS, TR, and EI jointly decided that a three-month period was sufficient. Regarding the before-after studies, a follow-up period less than three months therefore resulted in poor scores on the outcome part of the Newcastle-Ottawa Quality Assessment form for Cohort Studies. The Cochrane tool does not contain such a parameter.

Analysis and synthesis

Meta-analysis was precluded due to heterogeneity across studies. This heterogeneity concerned differences in guidelines, implementation strategies, outcome measures, timing of follow-up measurements, and the level of detail of the used strategies. Instead we provided a descriptive and narrative synthesis of the primary outcomes guideline adherence and patient-related nursing outcomes of the individual implementation studies. We provided a summary table with all crucial elements of the implementation processes (duration, used implementation strategies, barrier assessment, use of implementation framework, used implementation outcomes *Supplement 2*. The number of implementation strategies were categorized into the four EPOC categories (Delivery, Financial, Government and Implementation strategies). The total number of implementation strategies that were used in the implementation studies were summarized as median with IQR. The median number of used implementation strategies was provided for all studies, per EPOC category (Delivery, Financial, Government and Implementation strategies), for the studies that presented a positive significant change on one or more of their primary outcomes, and for the studies who reported no significant change.

Further, the relative change percentage was calculated for the studies providing patient-related nursing outcomes. Calculating a relative change of guideline adherence before the (re)implementation of a guideline is expected to be of low value, because the adherence rate to a not yet implemented guideline will always be low at baseline. Moreover, not all studies measured adherence at baseline. Therefore, we chose not to calculate the relative change of our other primary outcome 'adherence'. For the before-after studies, the relative change was computed by dividing the absolute outcome by the baseline level, preferably for the primary outcome of that individual study. However, in some studies the patient-related nursing outcome was a secondary outcome. For controlled studies, we first computed the relative change separately for the intervention group and the control group. Subsequently, the calculated relative change percentage in the intervention group was divided by the calculated relative change in the control group[23]. *Supplement 3. Calculations of relative change percentage for the patient-related nursing outcomes* provide an example of how the relative changes were calculated for both study groups. Of note is that the relative change for the before-after studies could have been overestimated due to the lack of a control group.

The association between the relative change and the total number of EPOC strategies used in the included studies was visualized in a scatterplot, for the controlled studies and the before-after studies separately. The difference

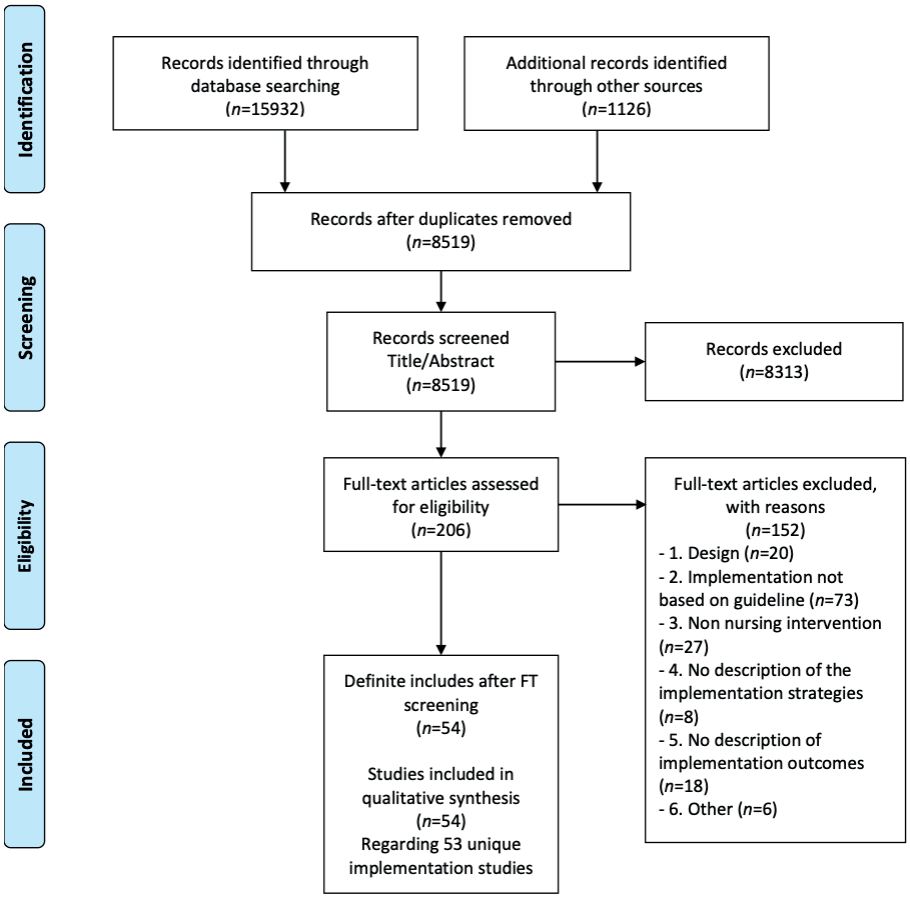
between the median relative change for studies using only strategies from the EPOC category Implementation strategies or using a combination of strategies from different EPOC categories was assessed using the Mann-Whitney U test. For comparable groups of similar guidelines with similar outcomes (at least 3 studies), the median relative change was assessed and related to the use of EPOC category implementation strategies alone or to the use of a combination of strategies from different EPOC categories.

RESULTS

Study selection

The initial search strategy and the cross-reference check yielded a total of 17,058 records. After 8539 duplicates were removed, 8519 abstracts were assessed for eligibility. Two-hundred-and-five full-text records remained and were assessed for eligibility, after which eventually 54 records, regarding 53 unique studies, were included for the synthesis' *(Figure 1 Flow diagram for identification, screening and eligibility according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses protocol).*

Figure 1. Flow diagram for identification, screening and eligibility according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses protocol[16].



Study characteristics

Study design, setting and guideline topic

The 54 papers described 53 unique implementation studies on 21 guideline topics. Fifteen had a controlled before-after, randomized controlled trial or cluster randomized controlled trial design; 38 studies (71.7%) had a before-after design. Most studies were conducted in western countries (USA *n*=10, Netherlands *n*=9, Australia *n*=8). Half of the studies were performed in a single centre (*n*=27, 50.9%). Most of the guidelines regarded skin care (*n*=9) and infection prevention (*n*=7). Two studies addressed the implementation of a combination of several guidelines, respectively six[24] and three[25,26]. The most studied setting was a hospital (*n*=34, 64.2%), followed by a nursing home (*n*=11), general practice (*n*=5), home care (*n*=2), and inpatient rehabilitation centre (*n*=1). *Table 1. Study characteristics broken down by guideline topic* shows the study characteristics of the included studies, *Supplement 2. Description of included studies* provides a more detailed description of the included studies.

Table 1. Study characteristics broken down by guideline topic

Author, Year	Country	Design	Setting, Single/Multi centre	Guideline topic
Van den Boogaard, 2009[27]	Netherlands	Before-After	Hospital - Intensive Care Unit (PICU and Intensive Care Unit) in a tertiary hospital, Single centre	Agitation - Delirium
Trogrlic, 2019[28]	Netherlands	Before-After	Hospital - Intensive Care Units in 1University Medical Centre and five community hospitals, Multi centre	Agitation - Delirium
Pun, 2005[29]	USA	Before-After	Hospital - Intensive Care Unit wards of the Van der Bilt University Medical Centre in Nashville and the Veterans Administration Tennessee Valley Healthcare System-York Campus, Multi centre	Agitation - Delirium and sedation
Edwards, 2007[24]	Canada	Before-After	Hospital and nursing homes - 7 hospitals + 2 home visiting nursing service organisations and one public health unit, Multi centre	Combination of multiple guidelines - Asthma, breastfeeding, delirium-dementia-depression, smoking cessation, venous leg ulcers, diabetes
Van Gaal (a,b), 2011[25,26]	Netherlands	Cluster Randomized Controlled Trial	Hospital and nursing homes - 1 university hospital. 2 large teaching hospitals, one small hospital and 6 nursing homes. 10 hospital wards + 10 Nursing home wards, Multi centre	Combination of multiple guidelines - Pressure ulcer, urinary tract infection and falls
Seto, 1991[30]	China	Before-After	Hospital - 6 wards, 3 male, 3 female, Single centre	Infection prevention - Catheter associated urinary tract infections
Huis, 2013[31]	Netherlands	Cluster Randomized Controlled Trial	Hospital - 3 hospitals in the Netherlands, Multi centre	Infection prevention - hand hygiene
Rao, 2009[32]	United Kingdom	Cluster Randomized Controlled Trial	Nursing home - 12 nursing homes in and surrounding south London, Multi centre	Infection prevention - Hand hygiene, environmental and disposal hygiene.

Author, Year	Country	Design	Setting, Single/Multi centre	Guideline topic
Zhu, 2018[33]	China	Before-After	Hospital - Shanghai Public Health Clinical Centre, Single centre	Infection prevention - Non-pharmacological fever management in HIV patients
Cabilan, 2014[34]	Australia	Before-After	Hospital, Single centre	Infection prevention - Peripheral cannula infections
Frigerio, 2012[35]	Italy	Before-After	Hospital - 6 Orthopaedic Surgery, 2 Traumatology, 1 Neurosurgery, 1 Neurology, 1 General Surgery, 2 General Medicine, Single centre	Infection prevention - Peripheral venous catheter management
Gomarverdi, 2019[36]	Iran	Cluster Randomized Controlled Trial	Hospital -Intensive Care Unit wards in two different hospitals, Multi centre	Infection prevention - Standard precautions in Intensive Care Units
Abraham , 2019[37]	Germany	Cluster Randomized Controlled Trial	Nursing home - 120 nursing homes, Multi centre	Mobility - physical restraint use
Ward, 2010[38]	Australia	Cluster Randomized Controlled Trial	Nursing home - residential aged care facilities with at least 20 beds, 88 facilities included, Multi centre	Mobility - Preventing falls
Köpke, 2012[39]	Germany	Cluster Randomized Controlled Trial	Nursing homes, 36 in total, Multi centre	Mobility - Use of physical restraints
Lockwood, 2018[40]	Australia	Before-After	Hospital - Two private hospitals in a regional area, Multi centre	Mobility - Venous - thromboembolism prevention programme
Törmä, 2014[41]	Sweden	Controlled Before-After	Nursing homes - 4, Multi centre	Nutritional

Author, Year	Country	Design	Setting, Single/Multi centre	Guideline topic
Cahill, 2014[42]	Canada / USA	Before-After	Hospital - 5 participating Intensive Care Unit's (one divided in 3 units) in Canada and the USA. In non- and teaching hospitals, Multi centre	Nutritional - Enteral nutrition in the Intensive Care Unit
Johnson, 2017[43]	United Kingdom	Before-After	Hospital - tertiary neonatal intensive care unit, Single centre	Nutritional - improve nutrition and growth of preterm infants in neonatal intensive care.
Giugliani, 2010[44]	Angola	Before-After	Hospital - Therapeutic feeding centre, consists of a separate ward for severely malnourished children only, Single centre	Nutritional - Malnutrition care in rural Africa
Lopez, 2004[45]	China	Before-After	Hospital - Tertiary care teaching hospital, Single centre	Nutritional - nutrition support in mechanically ventilated, critically ill adult patients.
Ames, 2011[46]	USA	Before-After	Hospital - 4 different critical care units, Multi centre	Oral Care - Prevention of VAP
De Visschere, 2012[47]	Belgium	Cluster Randomized Controlled Trial	Nursing homes - In Flanders Belgium, Multi centre	Oral care
Van der Putten, 2013[48]	Netherlands	Cluster Randomized Controlled Trial	Nursing homes - Within 100km radius of the centre of the Netherlands, Multi centre	Oral care
Lozano, 2004[49]	USA	Cluster Randomized Controlled Trial	Primary care paediatric practices, Multi centre	Other - Asthma treatment
Clark, 2001[50]	United Kingdom	Before-After	Hospital - a large teaching hospital, Single centre	Other - Blood transfusion
Tian, 2017[51]	Belgium	Before-After	Hospital, Single centre	Other - Cancer related fatigue

Author, Year	Country	Design	Setting, Single/Multi centre	Guideline topic
Van Lieshout, 2016[52]	Netherlands	Cluster Randomized Controlled Trial	General Practices, Multi centre	Other - Cardiovascular risk management in general practices
Downey, 2015[53]	Australia	Before-After	Hospital - A 18 bed Head, neck and lung medical oncology ward, Single centre	Other - Crushing medication in case of Tube feeding only
Sipila, 2008[54]	Finland	Before-After	General practices - 31 in total, Multi centre	Other - Early detection, prevention and treatment of CVD (Cardiovascular disease)
Snelgrove-Clarke, 2015[55]	Canada	RCT	Hospital - University affiliated teaching hospital in Atlantic, Single centre	Other - Foetal Health Surveillance
Featherston, 2018[56]	USA	Before-After	Community mental health centre, Single centre	Other - Paediatric mental healthcare
Jagt-van Kampen, 2015[57]	Netherlands	Before-After	Hospital - Academic children's hospital, Single centre	Other - Paediatric palliative care
Duff, 2013[58]	Australia	Before-After	Hospital - a 250-bed magnet designated private hospital, Single centre	Other - Prevention of venous thromboembolism
Vander Weg, 2017[59]	USA	Before-After	Hospital - General medical units of four US Department of Veterans Affairs hospitals, Multi centre	Other - Smoking cessation
Reynolds, 2016[60]	USA	Before-After	Hospital - Neuro critical care unit, Single centre	Other - Stroke care
Cheater, 2006[61]	United Kingdom	Cluster Randomized Controlled Trial	Family practice, Multi centre	Other - Urinary incontinence
Savvas, 2014[62]	Australia	Before-After	Nursing home - Residential aged care facilities across three Australian states, Multi centre	Pain - Australian Pain Society

Author, Year	Country	Design	Setting, Single/Multi centre	Guideline topic
Dulko, 2010[63]	USA	Before-After	Hospital, Single centre	Pain - Cancer related
Choi, 2014[64]	South-Korea	Before-After	Hospital - A university affiliated tertiary hospital, Single centre	Pain - Cancer related
Kingsnorth, 2015[65]	Canada	Before-After	Hospital - a large academic paediatric rehabilitation hospital, Single centre	Pain - Paediatric pain
Habich, 2012[66]	USA	Before-After	Hospital - Paediatric Intensive Care Unit at a community hospital located in a suburb of Chicago, IL, Single centre	Pain - Paediatric pain assessment and management guidelines
Bale, 2004[67]	USA	Before-After	Nursing homes - 6, Multi centre	Skin care
Harrison, 2005[68]	Canada	Before-After	Home care - The Ottawa Community Care Access Centre, an eastern Ontario home care-authority, Multi centre	Skin care - Leg ulcers
De Laat, 2006[69]	Netherlands	Before-After	University hospital, Single centre	Skin care - pressure ulcer
Paquay, 2010[70]	Belgium	Before-After	Home care - 5 participating home nursing agencies, Multi centre	Skin care - pressure ulcer
De Laat, 2007[71]	Netherlands	Before-After	Hospital - Critical care unit in an academic hospital, Single centre	Skin care - pressure ulcer
Beeckman, 2013[72]	Belgium	Cluster Randomized Controlled Trial	Nursing home - 11 wards, Multi centre	Skin care - pressure ulcer care
Koh, 2018[73]	Singapore	Before-After	Hospital - Two orthopaedic wards, Single centre	Skin care - pressure ulcer prevention
Rosen, 2006[74]	USA	Before-After	Nursing home, Single centre	Skin care - pressure ulcer prevention
Lopez, 2011[75]	Australia	Before-After	Hospital - Australian Capital Territory hospitals, Single centre	Skin care - Skin tears
Jolliffe, 2019 [76]	Australia	Before-After	Other - Inpatient Rehabilitation setting, Single centre	Stroke care
Bjartmarz, 2017[77]	Iceland	Before-After	Hospital - Neurology and rehabilitation ward in university hospital, Single centre	Stroke care

Participants

Twenty-seven studies provided no description of the targeted professionals other than 'nurses'. In some studies, nurse aids, student nurses or nurse practitioners were (part of) the target group, few studies targeted multiple professionals (physicians, physical therapists, etc.). The median number of involved caregivers per study (*n*=27) was 118 (IQR 34-238); twenty-six studies did not provide the number of involved caregivers.

Sixteen studies did not describe any details of the targeted patients; the other studies described basic characteristics regarding age and gender. Several studies described baseline characteristics related to the guideline of interest. Regarding 35 of all included studies, the median sample size of included patients was 373 (IQR 140-1577); seventeen studies did not report the sample size. Also shown in *Supplement 2.*

Risk of bias assessment

Nine controlled studies scored low risk of bias on most items (seven or more out of the nine items), as shown in *Supplement 4. Cochrane risk of bias for controlled studies.* The remaining six studies scored unclear or high risk of bias on three or more out of nine items. Thirty-two of the 38 before-after studies scored poor, assessed with the Newcastle-Ottawa Quality Assessment form for Cohort Studies (*Supplement 5*). Thirty of these 32 studies scored poor on the comparability part. These studies did not control for age, sex, or other factors, or did not correct for confounding when comparing the before and after groups. Four before-after studies were assessed as good; two as fair.

Implementation outcomes

All studies used a variety of implementation strategies, which were rarely comparable and with variable outcomes. The duration of the measurements, the intensity and the degree of details of the used strategies varied across studies. Twenty-one studies measured both patient-related nursing outcomes and guideline adherence. Eleven of these studies found a significant improvement on both outcomes. Overall, thirty-six studies (68%) measured a significant positive change on either patient-related nursing outcome measure(s) or guideline adherence.

Patient-related nursing outcomes

Patient-related nursing outcomes were measured in 30 studies. Twenty-one (70%) measured a significant positive change, seven measured no change,

and two studies did not perform statistical tests. All studies reported findings indicating a positive change or no change. However, one study[41] reported a significant negative effect on one of the patient-related nursing outcome measures that were addressed. Törmä et al.[41] compared two implementation strategies (external facilitation and education outreach visits) in order to introduce nutritional guidelines. Besides no differences in nutritional parameters after 18 months, they found significant deteriorations for functional and cognitive status, as well as for the EQ-5D index (quality of life questionnaire), (p<0.05) in the intervention group that received educational outreach visits.

Ten of the controlled studies (n=15) measured patient-related nursing outcomes. Six found a significant positive effect; four found no effect. Twenty-two of the before-after studies (n=37) measured patient-related nursing outcomes. Thirteen found a significant positive effect, seven found no significant effect (n=7), and two performed no statistical tests (n=2). When comparing the controlled and before-after studies, we found no significant difference between these groups on reported significant change in patient-related nursing outcomes (p≥0.05).

Relative change percentage on the patient-related nursing outcomes

All relative changes are shown in *Supplement 6 and Supplement 7*. The median relative change measuring patient-related nursing outcomes was 2.7% (IQR 1.0-40.6) for the controlled studies (n=10), and 22.1% (IQR 8.7-81.4) for the before-after studies (n=19). This differed significantly between the controlled and before-after groups (p=0.009).

The scatterplots for the controlled (*Figure 2*) and before-after (*Figure 3*) studies show that there was no association between the total number of used strategies and the relative change on the patient-related nursing outcomes. For the controlled studies the slope suggests that using more strategies, will result in a lower relative change. However, the sample is too small to conclude this (n=10).

The median relative change for studies that used strategies from the EPOC category implementation strategies alone was 13.8% (IQR 3.6-81.9). For the studies that used a combination of strategies from the EPOC categories the median was 20.1% (IQR 3.2-67.3), however this was not statistically different (p=0.95).

Figure 2. Scatterplot relating the total number of EPOC implementation strategies used to the relative change percentage in patient-related nursing outcomes for the controlled studies

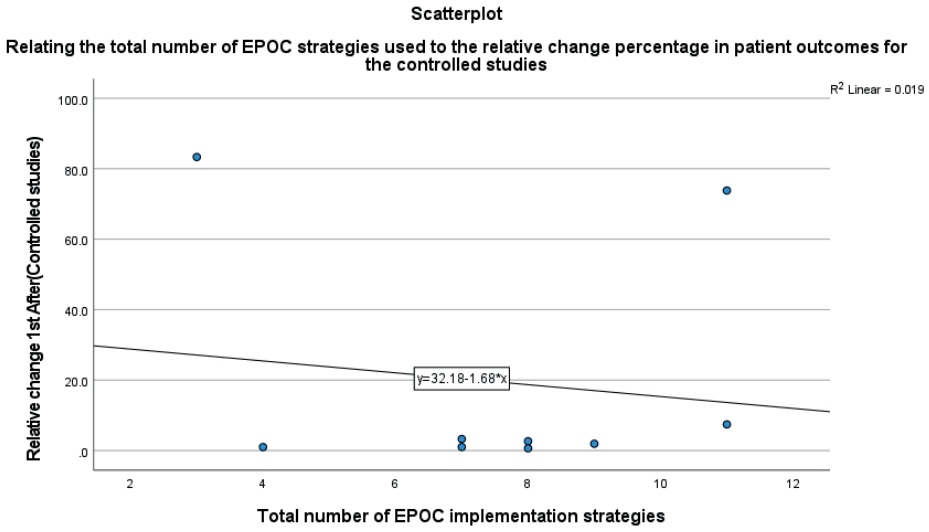
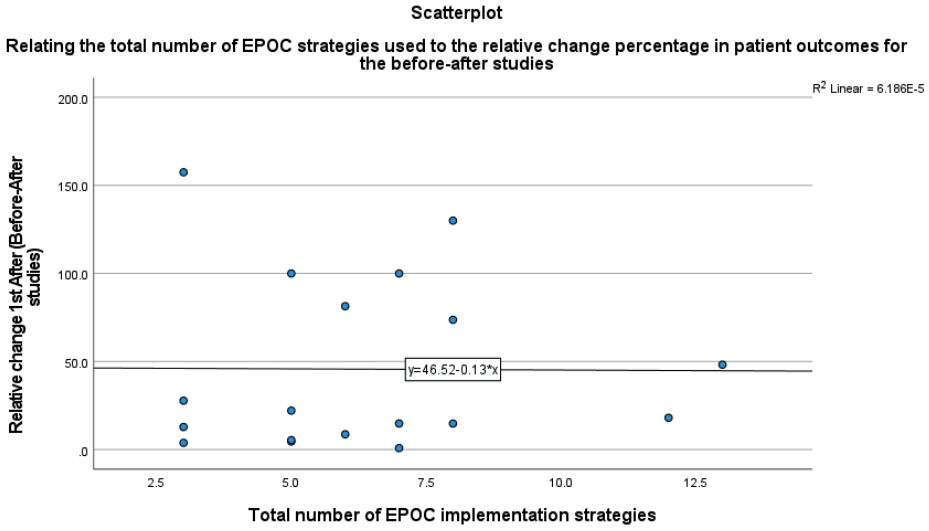


Figure 3. Scatterplot relating the total number of EPOC implementation strategies used to the relative change percentage in patient-related nursing outcomes for the before-after studies



We created three groups of studies with comparable patient-related nursing outcomes regarding comparable nursing guidelines. One group consisted of five studies[69,71-74] regarding pressure ulcers. The median relative change percentage for these studies was 27.8 (IQR 11.1-58.3). The outcomes were comparable between these studies, but not exactly derived in the same way. For example, Koh et al.[73] reported that they measured the incidence of pressure ulcers on the heel only. The other four studies provided no details about the location of pressure ulcers. The second group consisted of four studies[41-44] regarding nutritional intake. The median relative change percentage for these studies was 3.3 (IQR 0.9-11.0). The third group consisted of three studies[46-48] regarding oral care, with a median relative change percentage of 3.3.

Guideline adherence

Guideline adherence was measured in 44 studies, of which 26 (59,1%) showed a significant improvement, fourteen measured no change, and four did not perform statistical tests. Due to the heterogeneity in measuring adherence across all studies, we cannot draw an overall conclusion on the change in adherence rates. For example, several studies measured adherence rates regarding pain management (assessment and/or treatment). Kingsnorth et al.[65] found a significant and clinically relevant improvement in the documentation of pain scores, from 9% adherence rate at baseline to 100% adherence rate two years later. Dulko et al.[63] showed an increase in adherence rate for initial comprehensive pain assessment from 1% to 43% (p = 0.008).

Twelve of the controlled studies (*n*=15) measured adherence. In six studies a significant positive effect on adherence was found (*n*=6); six found no effect (*n*=6). Thirty-two of the before-after studies (*n*=32) measured adherence. Twenty studies found a significant positive effect on adherence (*n*=20), eight found no effect (n=8), and four performed no statistical tests (*n*=4). When comparing the controlled and before-after studies, we found no significant difference between these groups on effect on adherence (Pearson Chi-Square 0.564, $p>0.05$).

Implementation strategies

Description of the details of the implementation strategies varied widely between studies. Some provided a detailed process description, others just mentioned the type of strategy (e.g., audit and feedback).

Table 2 provides an overview of applied strategies categorized according to the Cochrane Effective Practice and Organisation of Care taxonomy and *Supplement 2*. provides a detailed description of the implementation strategies. Each study used more than one strategy, with a median of 6 (IQR 4-8). Apart from one study[63], studies applied at least one educational strategy; e.g., educational material (*n*=38, 71.7%), meeting (*n*=43, 81.1%), outreach (*n*=10, 18.9%) or inter-professional education

(*n*=14,26.4%). Next to educational strategies, the use of local opinion leaders (*n*=29, 54.7%), and audit and feedback (*n*=22, 41.5%) were regularly applied. Only one study, Rosen et al.[74] described a governance arrangement, in this case; formal reprimands and subject to termination in case of failing to complete training.

For all studies, the median number of used strategies was 6 (IQR 4-8), with a median of 0 for the EPOC category delivery (IQR 0-1), and 0 for the EPOC category financial (IQR 0-0), and 0 for the EPOC category government arrangements (IQR 0-0), and a median of 6 (IQR 4-7) for the EPOC category implementation strategies. The median number of strategies in studies measuring patient-related nursing outcomes was 7.0 (IQR 5-8, *n*=21) for studies which reported a significant improvement, and was 6.0 (IQR 4.5-8.5, *n*=9) for studies which reported no change. The median number of strategies in studies measuring adherence was 6.0 (IQR 4.8-8, *n*=26) for studies that reported a significant improvement, and was 6.0 (IQR 4-7, *n*=18) for studies that reported no change.

Most studies did not apply strategies in the control group, or did not provide a description of usual care. Eight studies[37-40,48,49,61,72] applied strategies in the control group, in most cases printed study material or availability of products e.g. providing pH-strips.

Effects of implementation strategies

Fifteen cluster randomized controlled trials studied the effects of specific implementation strategies. The individual strategies and the combinations of strategies applied in these trials varied[25,26,31,32,36-39,41,47-49,52,55,61,72].

For example, two cluster randomized controlled trials, by De Visschere et al.[47], and van der Putten et al.[78], described a supervised implementation strategy for an oral hygiene guideline. Both found a decrease of denture plaque after a 6-month follow-up (respectively; $p<0.01$ and $p<0.0001$). Other randomized controlled trials did not use a supervised implementation strategy, which limited the ability to conclude effectiveness of this specific implementation strategy.

Lozano et al.[49] created three groups to implement an asthma treatment guideline. One group received a peer leader intervention, one received a planned care intervention, and one served as a control group, receiving care as usual. They only found an effect on patient-related nursing outcomes in the planned care intervention group; i.e., a decrease in asthma symptom days per year compared to usual care ($p=0.02$). We could not compare these outcomes with those of another cluster randomized controlled trial, because no similar implementation strategies were used in other randomized controlled trials.

Table 2. Applied strategies per study categorized with the Cochrane Effective Practice and Organisation of Care taxonomy, reported effect on adherence and patient related nursing outcomes.

Author	Year	Implementation strategies[1]																		Effect	
		Organisational Change	Audit and Feedback	Clinical incident reporting	Monitoring	Communities of practice	Educational materials	Educational meetings	Educational outreach	Inter-professional Education	Local Consensus Process	Local Opinion leaders	Managerial supervision	Patient mediated intervention	Reminders	Routine PROMS	Tailored	Delivery Arrangements	Financial Arrangements	Governance Arrangements	Total number of EPOC implementation strategies	Adherence	Patient-related nursing outcomes
(Cluster) Randomized Controlled Trials																						
Abraham	2019																					
Updated version			1				1	1			1	1			1		1	1 a			9	NC	NC
Concise version			1				1					1			1		1	1 a			7	NC	NC
Control							1														1	NC	NC
Beeckman	2013																					
Intervention (Intrinsic-motivation oriented strategies)			1		1		1	1		1		1			1		1	2¥, a			11	P	P
Control							1	1													2	NC	NC
Cheater	2006																					
Audit and feedback (AF)			1				1														2	NC	NC
Educational outreach (EO)			1				1	1	1							1					6	NC	NC
AF + EO			1				1	1	1							1					5	NC	NC
Control							1														1	NC	NC
De Visschere	2012																					
Intervention (supervised implementation)					1		1	1		1		1		1				1 a			8	-	P

Control																		0	-	NC
Gomarverdi	2019																			
Intervention (multi-component education-l)							1	1							1			5	P	-
Control																		0	NC	-
Huis	2013																			
Team and leaders-directed		1	1		1		1	1			1	1	1		1	1		11	P	NC
State of the art		1	1				1	1							1			6	P	NC
Köpke	2012																			
Intervention (guideline-and theory-based multicomponent intervention)		1		1	1		1	1			1	1		1	1	1		11	P	P
Control							1	1										2	NC	NC
Lazano	2004																			
Peer leader intervention							1	1		1				1	1	1		9		NC
Planned care intervention							1		1			1			1			5		P
Control							1											2		NC
Rao	2009																			
Intervention (infection control team)			1			1		1		1								6	NC	-
Control																		0	NC	-
Snelgrove-Clarke	2015																			
Intervention (Action learning)								1								1	1 €	4	NC	-
Control																		0	NC	-
Törmä	2014																			
External Facilitator Strategy			1						1									4	-	NC
Educational Outreach Visits									1									1	-	NC
Van der Putten	2013																			
Intervention (supervised implementation)					1		1	1				1		1				7	-	P
Control																		1	-	NC
Van Gaal(a) & Van Gaal(b)	2011																			

Intervention (education, patient involvement, feedback)		1			1	1			1	1	1			1			8	NC	P
Control																	0	NC	NC
Van Lieshout	2016																		
Intervention (tailored improvement programme)		1			1	1					1			1			7	NC	P
Control																	0	NC	NC
Ward	2010																		
Intervention (full-time project nurse)						1			1								3	NC	NC
Control												1					1	NC	NC
Before after																			
Seto	1991																		
Opinion leader							1		1					1			4	P	-
Lecture (control)						1											1	NC	-
Opinion leader & Lecture						1	1		1								3	P	-
Ames	2011				1	1					1						5	-	P
Bale	2004				1	1		1	1		1						6	-	P
Bjartmaz	2017				1	1			1			1					5	P	-
Cabilan	2014	1				1		1	1			1		1			7	NC	-
Cahill	2014	1					1		1					1			5	NC	NC
Choi	2014	1			1	1				1		1		1			8	P	-
Clark	2001				1	1		1		1							5	P	-
De Laat	2006							1		1							7	P	P
De Laat	2007				1	1		1		1		1					3	P	P
Downey	2015	1		1		1		1				1					6	NC	-
Duff	2013				1		1		1	1							5	-	NC
Dulko	2010	1				1											3	P	P
Edwards	2007	1				1								1			3	NC	-
Featherston	2018			1	1	1											5	P	-
Frigerio	2012				1	1			1								4	P	-
Giugliani	2010					1				1							3	-	P

Habich	2012					1																3	P	-
Harrison	2005	1					1				1											3	-	P
Jagt-van Kampen	2015					1	1															3	NC	-
Johnson	2017	1				1			1	1	1											7	P	P
Joliffe	2019		1			1	1							1								6	P	P
Kingsnorth	2015		1			1	1		1		1		1	1								8	P	P
Koh	2018		1			1					1	1		1		1						8	P	NC
Lockwood	2018					1	1			1												5	P	NC
Lopez	2004					1	1							1								7	-	NC
Lopez	2011		1			1	1				1	1		1								5	P	P
Paquay	2010		1			1	1				1				1							6	P	P
Pun	2005					1	1							1								4	NC	NC
Reynolds	2016					1		1			1											4	NC	-
Rosen	2006			1		1	1					1		1				1$		1		8	-	P
Savvas	2014						1				1											3	NC	-
Sipila	2008		1	1		1	1		1	1	1							1£				9	NC	-
Tian	2017	1	1			1	1									1						6	NC	-
Troglic	2019		1	1		1	1	1	1	1	1		1	1		1						13	P	P
Van den Boogaard	2009		1			1		1			1			1		1						8	P	P
Vander Weg	2017		1			1	1	1			1	1	1	1				1				12	-	NC
Zhu	2018					1	1					1	1			1						7	P	-

Implementation strategies:1 All Cochrane Effective Practice and Organisation of Care taxonomy implementation strategies except: clinical practice guideline (applied in all studies), educational games and continuous quality improvement (applied in none of the studies). Delivery Arrangements: *Self-management support. ¥ - Health information systems. - Procurement and distribution of supplies. Disease management. - The use of information and communication technology. - Care pathway. Financial Arrangements: €Nurses received $50,- per meeting to acknowledge their effort in off-duty meeting. $$75,- for each staff member if the desired reduction in Pressure Ulcer incidence was achieved. $10 for attending training session. £Facilitators per site were motivated by a small financial increment on their monthly salary. For the patients, first $10,- then $20,-. Governance arrangements: Professional competence. NA Not applicable ; NC no change ; P positive

Barrier assessment

A barrier assessment was performed in twenty-three (43%) studies. 'Nineteen studies explicitly used the outcomes of the barrier assessment to select tailored implementation strategies. Lack of knowledge was the most common found barrier, described by eleven studies (48%). Other barriers were accessibility of products (6%), time limitations (4%), and lack of leadership/motivation (4%). There was no difference in studies who described a positive significant effect on patient-related nursing outcomes or guideline adherence between studies that did or did not perform a barrier assessment. From the studies which measured patient-related nursing outcomes, eleven studies performed a barrier assessment, of which seven reported a positive significant effect on patient-related nursing outcomes, and four did not report a change (Pearson Chi-Square 0.335, df 1, p=0.56). From the studies which measured adherence, nineteen studies performed a barrier assessment, of which twelve showed a positive significant effect on adherence (Pearson Chi-Square 0.229, df 1, p=0.63).

Use of Implementation theory, models or frameworks

Seventeen (31%) studies used a theory, model or framework. The Johanna Briggs Institute Getting Research in to Practice model was used in six studies, the Implementation Model of Change by Grol and Wensing in four, and the Promoting Action on Research Implementation in Health Services in two. The Normalisation Process Theory, Knowledge to action model, Theory of Change, AIM model, and Awareness Desire Knowledge Ability Reinforcement (ADKAR) Change management model were used once. Nine of the studies which measured patient-related nursing outcomes used a theory, model or framework, of which six reported a positive significant effect on patient-related nursing outcomes (Pearson Chi-Square 0.68, p=0.79). Sixteen of the studies which measured adherence used a theory, model or framework, of which eight reported a positive significant effect on adherence (Pearson Chi-Square 0. 860, p=0.35).

Study duration

The duration of the implementation studies varied widely, from a few weeks up to several years. Some studies used point prevalence measures, others used continuous data. Several studies did not describe the duration and/or interval of the measurements performed. Seventeen studies did not mention the duration of the baseline measurements, twenty-four the implementation phase, and eleven the post-implementation phase.

Overall, among the studies providing the respective information, baseline measurements were collected over a median period of three months (IQR 1-6), and the implementation phase lasted a median of three months (IQR 2-9.5). The post-implementation phase had a median duration of 3.5 months (IQR 1.75-6.0). Fourteen studies performed a second post-implementation measurement, with a median duration of 6 months (IQR 3.8-12.8). One study performed a third post-implementation measurement lasting 16 months.

DISCUSSION

To our knowledge, this is the first systematic review on the effects of implementation of nursing guidelines in all fields of practice and the used implementation strategies. The broad view across the field of implementation science regarding nursing guidelines identified a diverse range of implementation strategies, combinations of different strategies, guidelines, outcome measures and settings. These findings provide a good reflection of current practices and considerations. We presented the findings as a descriptive and narrative synthesis because a meta-analysis was not possible in view of the heterogeneity of guidelines, implementation and clinical outcomes, the variety of used (combinations of) strategies and the varying timing in follow-up measurements among the included studies.

More than half of the studies showed a significant positive effect of the implementation of nursing guidelines on patient-related nursing outcomes and/or adherence to the guideline(s). There was no association between relative change on patient-related nursing outcomes and the number of implementation strategies in total or the use of combined strategies from the different EPOC categories. There was a significant difference in the relative change in favour of the before-after studies, however this seems to be related to the study design. There is not one strategy, or combination of strategies, which can be linked directly to successful implementation. We could not assess whether implementation success was related to the use of a theory, model or framework, performing a barrier assessment or using tailored strategies, due to the small number of studies describing this.

In line with findings from previous reviews[12,79], we found that education was the most used strategy to implement evidence-based nursing, and noted that education is less to moderate effective on its own[80,81]. However, somewhat less than half of the studies that performed a barrier assessment found a lack of knowledge as a barrier. In contrast to other medical professions, nurses are not always –differs per country– required to take continuing education courses to keep their licensing[82]. Taken that into account, it makes sense to apply at least an educational strategy for the implementation of nursing guidelines.

In this review, it was identified that most strategies were quite traditional, such as using posters and written material, instead of apps, screensavers, or educational games. Several studies recommend investing in online and social media, which can substantially advance implementation science[83-85].

The scope of this review was to get a complete overview of strategies used to implement nursing guidelines, and subsequently get insights in the effects of implementation strategies across all settings and guideline topics. We were able to gain insight in the strategies used on a regular basis. Nevertheless, because of the varying strengths and limitations of the included studies, we could not identify a single or combination of implementation strategies that is most effective in getting nursing guidelines into practice. We think that narrowing the scope of settings and guideline topics will not result in better understanding of the effectiveness of implementation strategies. Only a comparison of studies with detailed descriptions of the delivered strategies and the same timeline might achieve this.

Strengths and Limitations

This review has several strengths and limitations. First, we are confident that we present a complete overview of implementation studies regarding nursing guidelines. Most studies were found with the initial search strategy. Second, due to the collaboration in data extraction between TR, EI and DS we warranted that the collected data from the individual studies are reliable. Repeated discussion about several implementation strategies led to a better understanding of the individual data, and resulted in a consistent reliable assessment of each included study. Third, for the interpretation of the effectiveness of the implementation strategies the outcomes were dichotomized into effect or no effect for patient-related nursing outcomes or guideline adherence. Using these two primary outcomes to assess the impact of the implementation studies is consistent with Curran et al.[86]. These authors suggest that a dual focus in assessing clinical effectiveness and implementation could speed the translation of research findings in routine practice.

A limitation is the quality of the before-after studies, which resulted in an overall low evidence base, precluding drawing conclusions. Which caused a high risk of bias across all studies, so caution is needed in drawing conclusions.

A second limitation is the probable publication bias, in that studies achieving negative results tend to go unpublished. Still, nearly half of the published studies showed no change.

A third limitation regards the wide variety in degree of details of the used strategies. All described implementation strategies classified according the EPOC taxonomy independent to the provided description and operationalisation of the strategy were considered equally in this study. It can be questioned, however, whether the described implementation strategies were comparable for all studies that used the same type of strategies. The potential lack of comparability may have affected the interpretation of the effects of the implementation strategies. Strategies were poorly described and operationalized; for example, only the type of strategy was provided, such as audit and feedback. We propose that strategies must be precise enough to enable measurement and reproducibility, following the recommendation of Proctor et al.[87] or using The Standards for Reporting Implementation Studies (StaRI) Statement[88]. These checklists could help standardize the way these studies are described. To fully understand the effect of a strategy such as audit and feedback, information on the extent, the number of audits and the fraction of the participants in the target group must be available.

Fourth, calculating the relative change for controlled studies and before-after studies separately might lead to an overestimation for the before-after studies, and an underestimation for the controlled studies. In some controlled studies there were signs of contamination between groups, what could have caused an effect in the control group, thus leading to an underestimation of the relative change.

Lastly, we found a wide variety in the duration and interval of measurements, and many studies did not provide an indication of their baseline, implementation and/or post-implementation phase, or provided a 'short' follow-up. An adequate follow-up time provides information about the sustainability; i.e., whether the guideline is maintained or institutionalized within a service setting's ongoing, stable operations[87]. The problem is of course that research projects are sponsored for a limited period and evaluating the long-term effects are often not feasible.

Recommendations

We recommend well-designed studies to test the effectiveness of implementation strategies. In future research the implementation details should ideally be reported according to standardized formats, for example as suggested by Proctor et al.[87] or Pinnock et al.[88]. A more detailed description of the implementation process makes it easier to understand the change mechanism. Abraham et al.[37] provided a detailed supplemental file containing the components, description and actual

dose delivered of their intervention components. This inventory is helpful for future research, but also for clinical practice.

We recommend guideline developers to think about audit criteria while developing a nursing guideline. Most studies described developing an audit criteria checklist as one of their preparations. A predefined audit criteria checklist could help healthcare professionals and organizations in the execution, goal-setting and evaluation of the implementation of nursing guidelines. We noted a lack of goal-setting in most studies. The study of Jolliffe et al.[76] was one of the exceptions: the goal was for staff to adhere to minimally 75% of applicable guideline indicators per patient prior to commencing the study. When pre-defined audit criteria are available it might be possible to set goals and evaluate the implementation of guidelines without extensive preparations.

Less than half of the studies included in this review performed a barrier assessment, and most were poorly described. Further, we could not relate performing a barrier assessment to a positive effect on the primary outcomes. Four studies that performed a barrier assessment did not state that the identified barriers were used to select the implementation strategies. In line with other reviews, we think that tailoring strategies based on a barrier assessment is important[8,9,14]. A barrier assessment can provide crucial information about the context where the implementation will take place. Finding and describing barriers and facilitators in detail can help in choosing adequate implementation strategies, this may increase the effectiveness of the implementation of nursing guidelines.

CONCLUSION

This systematic review provides an extensive, up-to-date review of the implementation of nursing guidelines and the used implementation strategies. More than half of the studies showed a positive significant effect of the implementation of guidelines on patient-related nursing outcomes or guideline adherence. A wide variety of implementation strategies were identified in implementing nursing guidelines. Education is the most frequently used strategy to implement nursing guidelines in practice. Not one single strategy, or combination of strategies, can be linked directly to successful implementation of nursing guidelines. Consistency in reporting of the used implementation strategies and the duration of measurement of the impact of the strategy should be improved in future studies.

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SUPPLEMENTAL FILES

Supplement 1. Search strategy

Table 3. *Search strategy*

embase.com	**Hits**
('practice guideline'/de OR 'nursing protocol'/de OR 'good clinical practice'/de OR 'nursing care plan'/de OR 'protocol compliance'/de OR 'clinical protocol'/de OR 'evidence based nursing'/de OR standard/de OR 'evidence based medicine'/de OR (protocol* OR guideline* OR (evidence-based NEAR/3 (nurs* OR pratice*))):ab,ti) AND ('nursing'/exp OR 'nurse'/exp OR (nurs*):ab,ti) AND ('implementation'/de OR 'dissemination'/de OR 'information dissemination'/de OR (implement* OR disseminat* OR (knowledge NEXT/1 (translation* OR transfer*))):ab,ti) AND ('protocol compliance'/de OR 'behavior change'/de OR (complian* OR adher* OR noncomplian* OR nonadher* OR (behav* NEAR/3 change*) OR effect*):ab,ti) NOT ([Conference Abstract]/lim OR [Letter]/lim OR [Note]/lim OR [Editorial]/lim)	5268
Medline Ovid	
(Practice Guidelines as Topic/ OR Patient Care Planning/ OR Guideline Adherence/ OR Clinical Protocols/ OR Evidence-Based Medicine/ OR Standard of Care/ OR Evidence-Based Medicine/ OR (protocol* OR guideline* OR (evidence-based ADJ3 (nurs* OR pratice*))).ab,ti.) AND (nursing/ OR nurse/ OR (nurs*).ab,ti.) AND (Health Plan Implementation/ OR Information Dissemination/ OR (implement* ORdisseminat* OR (knowledge ADJ (translation* OR transfer*))).ab,ti.) AND (Guideline Adherence/ OR (complian* OR adher* OR noncomplian* ORnonadher* OR (behav* ADJ3 change*) OR effect*).ab,ti.) NOT (letter* OR news OR comment* OR editorial* OR congres* OR abstract* OR book* OR chapter* OR dissertation abstract*).pt.	4249
Web of science	
TS=(((protocol* OR guideline* OR (evidence-based NEAR/2 (nurs* OR pratice*)))) AND ((nurs*)) AND ((implement* OR disseminat* OR (knowledge NEAR/1 (translation* OR transfer*)))) AND ((complian* OR adher* OR noncomplian* OR nonadher* OR (behav* NEAR/2 change*) OR effect*))) AND DT=(article) AND LA=(english)	2805
Cochrane CENTRAL	
((protocol* OR guideline* OR (evidence-based NEAR/3 (nurs* OR pratice*))):ab,ti) AND ((nurs*):ab,ti) AND ((implement* OR disseminat* OR (knowledge NEXT/1 (translation* OR transfer*))):ab,ti) AND ((complian* OR adher* OR noncomplian* OR nonadher* OR (behav* NEAR/3 change*) OR effect*):ab,ti)	972

CINAHL EBSCOhost	
(MH Practice Guidelines OR MH Guideline Adherence OR MH Medical Practice, Evidence-Based OR TI(protocol* OR guideline* OR (evidence-based N2 (nurs* OR pratice*))) OR AB(protocol* OR guideline* OR (evidence-based N2 (nurs* OR pratice*)))) AND (MH nurses+ OR TI(nurs*) OR AB(nurs*)) AND (MH Program Implementation OR TI(implement* OR disseminat* OR (knowledge N1 (translation* OR transfer*))) OR AB(implement* OR disseminat* OR (knowledge N1 (translation* OR transfer*)))) AND (MH Guideline Adherence OR TI(complian* OR adher* OR noncomplian* OR nonadher* OR (behav* N2 change*) OR effect*) OR AB(complian* OR adher* OR noncomplian* OR nonadher* OR (behav* N2 change*) OR effect*)) NOT PT(letter* OR news OR comment* OR editorial* OR congres* OR abstract* OR book* OR chapter* OR dissertation abstract*)	1740
Google scholar	
protocol|guidelines|"evidence-based nursing|pratice" nurse|nurses|nursingimplementation|dissemination|"knowledge translation|transfer" compliance|adherence|noncompliance|nonadherence|"behavior|behaviour change"|effect	698
PsycINFO Ovid	
(Treatment Guidelines/ OR Treatment Planning/ OR Professional Standards/ OR Evidence Based Practice/ OR (protocol* OR guideline* OR (evidence-based ADJ3 (nurs* OR pratice*))).ab,ti.) AND (nursing/ OR nurses/ OR (nurs*).ab,ti.) AND (Information Dissemination/ OR (implement* ORdisseminat* OR (knowledge ADJ (translation* OR transfer*))).ab,ti.) AND ((complian* OR adher* OR noncomplian* ORnonadher* OR (behav* ADJ3 change*) OR effect*).ab,ti.) NOT (letter* OR news OR comment* OR editorial* OR congres* OR abstract* OR book* OR chapter* OR dissertation abstract*).pt.	200

SUPPLEMENT 2. DESCRIPTION OF INCLUDED STUDIES

Table 4. Description of included studies, in alphabetic order

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Abraham, 2019, Germany	Cluster RCT, Nursing home – 120 nursing homes, Multi centre, Mobility – physical restraint use Before: Unclear Impl: Unclear After: 6 and 12m	Not specified. -- Total sample: *n*= 8800. Intervention 1: *n*=2972, Intervention 2: *n*=2523, control: *n*=3305, mean age 83.5 (SD10) Females 73%	Interventions were implemented on cluster level. Intervention group 1 received an updated version of the original program. In each cluster key nurses received intensive training, followed by structured support for three months. All nurses were offered with a 90-minute information session. A policy statement addressing a least-restraint policy was signed by the nursing home leader. Intervention group 2 received a concise version, comprising the intensive training for the key nurses, the organizational component and all supplemental materials.	Primary: Compliance The primary outcome (mean physical restraint prevalence on cluster level) was 17.4% at baseline in intervention group 1, 19.6% in intervention group 2 and 18.8% in the control group. After twelve months, prevalence declined in all study groups (14.6% intervention group 1, 15.7% intervention group 2, 17.6% control group) (Table 2).The baseline-adjusted difference between intervention group 1 and control group was -2.0% (97.5% CI, -5.8 to 1.9; P = .25) and between intervention group 2 and control group -2.5% (97.5% CI, -6.4 to 1.4; P = .14). Both differences were not significant on the level of 0.025 (Bonferroni-adjusted) Secondary: Intervention's effect The number of residents with at least one fall or fall-related fracture during the study period did not differ statistically significant between groups. There was also no statistically significant difference in the mean number of falls per resident and in the mean number of falls per resident with at least one fall (Table 8).	No change	No change

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Ames, 2011, USA	Before-After, Hospital - 4 different critical care units, Multi centre, Infection prevention - Prevention of Ventilation Acquired Pneumonia (VAP) Before: 11 m Impl:2 m After: 14 m	Not specified. Sample size: Control; *n*=51 Treatment; *n*=65 Divided over 3 hospitals.	A structured educational program. Initial introduction by researcher, a dentist or dental hygienist provided each patient care unit with instructions. Education was repeated several times, according to each units need and current staff. A recorded educational session was available on all units for the nursing staff. A pocket-flip chart-booklet was distributed to all patients in an oral care kit. Containing chlorhexidine spray, a child's toothbrush, an instruction booklet and an oral care documentation card.	Primary: Patient-related nursing outcomes measured with Beck Oral assessment scale (BOAS), Mucosal plaque score. Results indicated a significant difference among the 3 times (p=0.01) with no difference in the pattern of scores between treatment and control groups and time (p=0.21) The pattern of BOAS scores differed significantly across the 5 days depending on the group (p=0.02). The difference in BOAS scores was also significant over time, day 1, 3, or 5 (p=0.009),and between groups, treatment or control, (p<0.001).	NA	Positive

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Bale, 2004, USA	Before-After, Nursing homes - 6, Multi centre, Skin care Before: 6 m Impl: at least 3 m After: Unclear	Not specified. Sample size: Before: *n*=79. After *n*=85	Educational meetings regarding: The educational programme: All staff received a basic educational programme that comprised three elements: 1. A lecture on the physiology and pathophysiology of the skin 2. A group discussion to highlight and clarify areas of uncertainty 3. An interactive session that outlined the skin care protocol to be implemented, which included a demonstration of how and when to use the new skin care products. All patients were provided with their own individual skin care protocol, a laminated card detailing the products to be used and the frequency of application, which was usually kept at their bedside.	Primary: Adherence. 99% post (no before measurement) Secondary: Patient-related nursing outcomes; Mild incontinence dermatitis Before *n*=13, After *n*=2 (*p*=0.021) Pressure ulcer damage grade 1 Before *n*=16 After *n*=8 (*p*=0.042)	NA	Positive

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Beeckman, 2013, Belgium	Cluster Randomized Controlled Trial, Nursing home - 11 wards, Multi centre, Skin care - pressure ulcer care Before: 1 d Impl: 4 m (4 data points) After: Directly after implementation (d 120)	Sample size: Intervention: *n*=65. Control: *n*=53. 89.2-98.1% females. Nurse assistants 43.1-49.1% Diploma nurse 18.9-21.5% Bachelor nurse 10.8-13.2% Sample size: Intervention: *n*=225 Control n=239. 76-82.8% females. 25.8-26.4% at risk for pressure ulcers	Electronic clinical decision support system, multi-faceted tailored implementation containing; (interactive) education, monitoring and feedback, reminders, leadership. Availability of preventive materials. Nurses in control group were provided with pressure ulcer prevention protocol in hard copy format.	Primary: Adherence. Behavioural change of the professionals. A significantly overall positive effect was found on the allocation of fully adequate proportion when seated in a chair. 60% vs 13.2% (p=0.003) Residents receiving no prevention was significantly lower. Secondary: Knowledge & Patient-related nursing outcomes. Pressure ulcer prevalence was significantly lower for cat 1-4, no difference in cat 2-4. No difference in knowledge of professionals appeared, attitude did improve significantly.	Positive	Positive

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Bjartmarz, 2017, Iceland	Before-After, Hospital - Neurology and rehabilitation ward in university hospital, Single centre, Stroke care Before: Nursing 3 m, patients 1 y Impl: 8 m After: Nursing: Quantitative unclear; Qualitative 10/11 m Patients: 1 y	Sample size: *n*=33, registered nurses *n*=18 (54%) Nursing auxiliaries *n*=15 (46%) Sample size: *n*=78. Before: *n*=44 Mean age 65.6 (13.12) 34% females. After *n*=34 Mean age 58.2 (17.9) 47% females	Registered nurses and auxiliary nurses received both plasticized printed and digital version. Education and training sessions (one 4h education) opinion leaders (*n*=7). Posters and reminders. Regular emails explaining the intervention protocol.	Primary: Adherence. Documentation of the 37 items on screening and application of key interventions in stroke care, was improved in 23 items after implementation. Significant improvement was found on the six following items: a) three items in ADL and mobility: Assess with Functional Independence Measure < 72 h of admission (p = 0.002), Mobilization facilitation within 24 h (p = 0.024), Training of ADL (p = 0.022) and b) three items on patient education: Patient education (p = 0.001), Educational brochure provided (p = 0.000) and Education repeated (p = 0.049). No change was found in the documentation of five items (4 pain variables, 1 depression). Significant worse documentation was found for the item Patients asked about pain (p = 0.012), whereas the worse documentation on the remaining eight items was non-significant (3 ADL, 4 pain, 1 depression).	Positive	NA

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Cabilan, 2014, Australia	Before-After, hospital, Single centre, Infection prevention - Peripheral cannula infections Before: 2 m Impl: 1 m After: 5 m	Not specified. Sample size: before: *n*=20 after: *n*=20	Organisational change in protocol. Form for standard documentation was made available. Audit and feedback, reminders, 15-minute educational meetings.	Primary: Adherence. Based on 8 audit points. No statistical tests performed.	No change	NA
Cahill, 2014, Canada / USA	Before-After feasibility study, hospital - 5 participating Intensive Care Unit's (one divided in 3 units) in Canada and the USA. In non- and teaching hospitals, Multi centre, Nutritional - Enteral nutrition in the Intensive Care Unit (ICU) Before: 6 m or less Impl: 12 m After: 6 m	ICU nurses - all critical care staff, of which 74% were nurses at baseline. In follow-up 79%. A response rate of 39% for nurses Sample size: Before: *n*=140. After: *n*=138. Median age 61 (IQR 51-72). 45% females. Median 27 (IQR 23-32) BMI	Local nutrition opinion leaders in an interdisciplinary team were responsible for study coordination, data collection, and implementing the tailored intervention. Other strategies used were audit & feedback, and educational outreach.	Primary; Adherence and experience based on survey outcomes. Secondary: Patient-related nursing outcomes: The change in caloric adequacy from total nutrition at each site. While some sites did not improve, an increase of >10% was observed at two sites (51 to 63% at Site 1, and 39 to 57% at Site 4). Similar results were observed for protein adequacy from total nutrition. No significant effect.	No change	No change

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Cheater, 2006, United Kingdom	Cluster Randomized Controlled Trial, Family practice, Multi centre, Urinary incontinence Inclusion: over 6 w Follow-up: 6 m	Family practice nurses. Sample size: *n*=176 Sample size: Before *n*=966, Post: *n*=700 (Control *n*=166, AF *n*=166, EO *n*=179, EO+AF *n*=166)	Comparison of Audit & Feedback (AF), Educational Outreach (EO), AF + EO and control group. AF; personal feedback on performance, consisted of tables and text, highlighting good practice and areas for improvement. Including educational material. EO; personal feedback, 1 to 3 EO visits by link nurses and minimum of 1 follow-up telephone call. Link nurses are community nurses with special interest in continence care. Control: received only educational material.	Primary: individual adherence rates showed no evidence of improvement. There was some evidence to suggest a negative interaction between AF and EO. Moderate improvement in patient management criteria, but similar across all groups. Secondary: Patient-related nursing outcomes, no marked differences in improvement for specific symptoms, severity score and use of UI absorbent pads.	No change	No change
Choi, 2014, South-Korea	Before-After, hospital - A university affiliated tertiary hospital , Single centre, Pain - cancer related Before: Unclear Impl: Unclear After: 6 m	Not specified No description	Providing a better understanding in Evidence Based Practice. Modification of Electronic medical record, posters, leaflets, hard copy instructions for documentation. Meals and refreshments were provided. Tailored time before/after shift. Managerial and research team supervision was provided, feedback on documentation was provided informally.	Primary: Adherence. 4 criteria measured. 1 criteria 100% adherence at baseline and after. Criteria 2,3,4 showed a positive significant change. Secondary: Patient-related nursing outcomes: No significant difference in pain intensity between baseline and follow-up	Positive	NA

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Clark, 2001, United Kingdom	Before-After, hospital - a large teaching hospital , Single centre, Blood transfusion Before: unclear. Impl: > 3 m After: 18 m	Not specified. No data collection	An educational package, developed by hospital's nurse educators, transfusion nurse specialist and medical staff. A lecture in the first three months of the programme was provided to the majority of senior nurses. The senior nurses acted as instructors for other members of staff in their wards.	Primary: Adherence. Significant effect on adherence 5 out of 7 audit criteria.	Positive	NA
De Laat, 2006, Netherlands	Before-After, University hospital, Single centre, Skin care - pressure ulcer Before: 2 separate 1 day measurements in a year Impl: unclear After: 4 m, 1 d measurement 2nd After: 11 m, 1 d measurement	Not specified. Sample size: Before: *n*=7657. After: *n*=735 2nd After: *n*=755	A pressure ulcer consultant was appointed and established a network of contact nurses (one on every ward). This contact nurse was trained by the nurse consultant and introduced the new guideline in a staff meeting or clinical lesson. After the official introduction of the guideline, the existence of the guideline was announced in several hospital media (newspaper, intranet). Furthermore, all hospital bed frames were equipped with a high quality pressure reducing viscoelastic foam mattress.	Primary: Adherence 1. The changes in adherence with prevention activities (mattress included) were significant (p<0.000). Without mattress, these changes were statistically insignificant. 2. The changes in adherence with treatment activities (mattress included) were significant (p<0.016). Without mattress, these changes were statistically insignificant. Secondary: Patient-related nursing outcomes. Groups I–IV, frequency of pressure ulcers patients grades I – IV in all patients (*n*=2147). The decreases in prevalence were significant (p<0.009). Groups II–IV, frequency of pressure ulcers patients grades II – IV in all patients (n=2147). The decreases in prevalence were significant (p<0.011).	Positive	Positive

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
De Laat, 2007, Netherlands	Other, hospital - Critical care unit in an academic hospital, Single centre, Skin care - pressure ulcer Before: 3 m Impl: 3 m After: 3-6 m 2nd After: 12-15 m	ICU nurses. Not specified Sample size: Baseline: *n*=110 age 59.7(16) Females 38%. After *n*=130 age 57.6(15) females 38%. 2nd After *n*=159 age 58.1(16) females 42%.	A pressure ulcer consultant was appointed in the study hospital and established a network of so-called contact nurses (one on every nursing ward and Intensive Care Unit). These contact nurses were trained by the nurse consultant and introduced the new guideline in a staff meeting or clinical lesson on the Intensive Care Units. After the official introduction of the guideline at the end of the baseline period, the existence of the guideline was announced in several hospital media (newspaper, intranet).	Primary: Patient-related nursing outcomes. Pressure ulcer incidence; decrease with (p=0.04). Pressure ulcer free time; increased with (p=0.01) NNT after 1 y was 6 (p=0.02). Secondary: Adherence. Adequate mattress use increased from 28% at baseline to 60% in period III (p=0.003).	Positive	Positive
De Visschere, 2012, Belgium	Cluster Randomized Controlled Trial, Nursing homes - In Flanders Belgium, Multi centre, Oral care Before: Unclear Impl: Unclear After: 6 m	Not specified. Sample size: Control: Before *n*=186 After *n*=146. mean age 84.5(8.5) females 68,4% Intervention: Before: *n*=187 After *n*=151 mean age 84.9(7,6) 78% females	A supervised implementation, in each institution a project supervisor was appointed. An oral healthcare team was installed, consisting of an institution project supervisor, two oral healthcare organizers (nurse/nurse aides), a physician and optionally an occupational or speech therapist. A 1,5h informative oral presentation of the protocol was provided. A 2 h lecture and 1h practical education session and a 1,5h theoretical and executive education session at each ward was provided. Residents were provided a free-of-charge oral healthcare materials and products	Primary: Patient-related nursing outcomes. Oral hygiene level; dental, denture and tongue plaque. Significant differences were observed between the intervention and control group for mean denture plaque at 6-month follow-up (p<0.01).	NA	Positive

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Downey, 2015, Australia	Before-After, hospital - A 18 bed Head, neck and lung medical oncology ward, Single centre, Crushing medication in case of Tube feeding only Before: 4 w Impl: Unclear After: 5 w	Not specified. No description.	A number of improvement strategies were implemented using targeted education sessions with the sole focus on improving medication modification methods for this patient cohort.	Primary: Adherence. No statistical test performed. An observational change is shown for all 3 criteria. Safe preparation before 45% after 91%. Optimal preparation before 33% after 60%. Not prepared accordingly before 55% after 9%.	No change	NA

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Duff, 2013, Australia	Before-After, hospital - a 250-bed magnet designated private hospital, Single centre, Prevention of venous thromboembolism (VTE) Before: unclear Impl: 2 m After: unclear	Most were registered nurses. Population divided in Received intervention and declined. Received *n*=85, median age 29 (25-35) 86% females. Declined *n*=35 86% females Total sample: *n*=192. Before: *n*=98 Median age 72 (58-82), 56.1% females. After: *n*=94, median age: 75.5 (63.5-85) 46.8% females	Educational outreach visits, with an expert registered nurse in VTE as EO facilitator. The research team attended a 2-day intensive workshop. The content of the EO was limited to 4 key messages.	Primary: Experience, acceptability, utility. Acceptability measured with survey, 76 nurses returned the post-intervention, 97% felt that EOV was effective or extremely effective to increase their knowledge about VTE prophylaxis for medical inpatients. Utility: process outcomes in planning, time spent, adherence and location. Secondary: Patient-related nursing outcomes. There was no measurable improvement in the proportion of patients with a documented VTE risk assessment after the intervention period (10.2% to 8.5%;1.7% improvement; *p*=0.68). There was also no improvement in the proportion of patients who received appropriate mechanical VTE prophylaxis (42.8% to 42.6%; 0.3% improvement: *p*=0.96). Removing patients who were at low risk for VTE from the analysis made no difference to this result (37.2% to 40.2%; 3.0% improvement; *p*=0.68)	NA	No change

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Dulko, 2010, USA	Before-After, hospital, Single centre, Pain - cancer related Before: 3 m Impl: 3 m After: unclear	Sample size: Nurse Practitioners *n*=8 Sample size: Before: *n*=96 Mean age 58 (SD 13,5) Range 24-86 After *n*=96 Mean age 59 (SD 11,5) Range 3-82. 59% females in both groups	Educational meeting of 30 minutes where feedback on baseline data was discussed with NP. A laminated pocket-sized version of the guideline was provided to the NP's which included the selected audit criteria. During intervention the NP's were given weekly feedback on patient pain scores and adherence to guideline criteria during a 15 min session. If no face-to-face meeting was possible a sealed envelope with the feedback was provided. Feedback on pain scores, mean pain ratings, and highest level of pain were provided in graph form. In addition to individual practice feedback, each NP was provided with aggregate data of overall patient pain scores and NP performance for all patients. All data were identified by a code number and placed in a sealed envelope. Practice data were kept confidential and only aggregate data were shared with the institution.	Primary: Adherence. There was a great deal of variability in the overall adherence rates for each of the eight criteria during the pre-intervention phase. During the intervention phase, six of the eight criteria had a ≥87% adherence rate, including initial pain reassessment by the prescribing NP within the suggested timeframe, which had been at only 5% during the pre-intervention phase. Adherence rate for initial comprehensive pain assessment increased from 1% to 43% (p=0.008). The adherence rate for repeat comprehensive pain assessment remained low during the intervention phase (7%). Less lorazepam prescriptions in intervention phase. Secondary: Patient-related nursing outcomes. There was a significant difference between pre-intervention and intervention group patients for overall pain interference (p<0.001) interference with general activity (p=<0.0001), and interference with sleep (p=<0.004).	Positive	Positive

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Edwards, 2007, Canada	Before-After, Hospital and nursing homes - 7 hospitals + 2 home visiting nursing service organisations and one public health unit, Multi centre, Combination of multiple guidelines - Asthma, breastfeeding, delirium-dementia-depression, smoking cessation, venous leg ulcers, diabetes Before: 6 to 8 w Impl: unclear. After: 6 to 9 m with a duration of 6 to 8 w	Sample size: *n*=257. 93.7% females. 72.5% >6 years' experience. 77.7% working full-time. 35.5% bachelor or higher No description	At each site, a clinical research nurse (CRN) led implementation of the BPG recommendations. CRNs used a multi-strategy approach including educational sessions with staff nurses, reviews of policies and procedures with administrators and staff nurses, and modelling new clinical skills such as implementing and demonstrating the utility of new assessment tools or providing smoking cessation counselling. A standard toolkit was used by nurses to guide their BPG implementation activities. Regular Teleconference calls with the program director provided an opportunity for CRNs to address problem issues and to share their implementation strategies. CRNs tailored their implementation strategies to the organizational context, the patient population needs and the clinical gaps as assessed by their organization through patient satisfaction surveys and quality assurance programs.	Primary: Adherence measured with referral rates. For three BPGs (delirium-depression-dementia, smoking cessation and venous leg ulcer), a sequential sample of patient charts was retrieved from medical records for a period of six to eight weeks pre- and post-implementation; There were some distinctive referral patterns reported by nurses, documented in the charts and ascertained through patient interviews. These included higher rates of referrals for services that were part of the organization where nurses were employed and almost a complete lack of referrals to Internet sources. In addition, for one of the BPGs (venous leg ulcers), the only statistically significant increase in referrals to individual resources observed on the chart audit was to other nurse specialists (e.g. enterostomal nurse or wound care specialist; 28.2% versus 50.6%, $p<0.0001$).	No change	NA

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Featherston, 2018, USA	Before-After, Community mental health centre, Single centre, Paediatric mental healthcare Before: 2 w Impl: 12 w After: total 12 w	Sample size: *n*=4 psychiatric mental health nurse practitioners. *n*=2 psychiatrists Sample size: *n*=70 No description	Hard copy checklist to prompt recommended screenings. During the pilot study, multiple processes, such as use of the checklist, clinic flow changes, laboratory ordering, and receiving of results, were tested and the feedback was incorporated. The checklist and process were modified to reflect necessary changes in process flow optimisation.	Primary: Adherence: 7 criteria, all showed a significant positive change. With a gain percentage between 16% and 40%	Positive	NA
Frigerio, 2012, Italy	Before-After, hospital - 6 Orthopaedic Surgery, 2 Traumatology, 1 Neurosurgery, 1 Neurology, 1 General Surgery, 2 General Medicine, Single centre, Infection prevention - Peripheral venous catheter management Before: 2 d measurements Impl: unclear After: 2 d measurements 4 m after baseline.	Sample size: Baseline data in the survey group. *n*=238 Mean age: 35.7(6.8) range 32-38.1. Mean years of experience 9.2(6.7) Range 5.7-12.4 No specified description of educational level. No data collection	A taskforce was established to revise Peripheral Venous cannula's protocol according to CDC guidelines. Consisting of 2 nurses from hospital Quality Office and 2 nurses from infection control committee. These nurses trained liaison nurses from each ward. The liaison nurses presented the poster, circulated the protocol using strategies most appropriate to their own settings, informed the ward managers, provided nurses with copies. During dedicated and/or informal meetings	Primary: Adherence. management of Peripheral Venous cannulas . The new protocol significantly improved the management of Peripheral Venous cannulas .Indeed the risk of using inappropriate dressing was significantly reduced (OR 0.43;95% CI 0.27-0.70), while the use of transparent dressing increased OR 2.39;95% CI 1.46-3.89). Secondary: Patient-related nursing outcomes. There were also increased numbers of cases of tenderness and induration around the insertion site or along the cannulated vein (OR 1.84; 95% CI 1.12–3.02), but the differences were not statistically significant.	Positive	NA

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Giugliani, 2010, Angola	Cohort with historical controls, hospital - Therapeutic feeding centre, consists of a separate ward for severely malnourished children only., Single centre, Nutritional - Malnutrition care in rural Africa Before: 7 m Impl; 7 m After: NA	Sample size: *n*=18 nurses. *n*=14 basic level (2 years of midlevel general nursing training) and *n*=4 medium (4 years of mid-level general nursing training) Sample size Before: *n*=358. After: *n*=379. No specific description provided	Physician supervision, a 1-day workshop regarding basic concepts of malnutrition. Supervision of physician and a general practitioner to review cases interactively and educationally. At proposal of the nurses a study group started to form a review on the WHO guidelines.	Primary: Patient-related nursing outcomes: Positive effect on successful treatment rates (increase 13% RR1.13; 95% CI 1.04 to 1.22). Fatality declined from 15.6% to 8.7%, RR 0.56; 95 CI 0.37 to 0.83.	NA	Positive

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Habich, 2012, USA	Before-After, hospital - Paediatric Intensive Care Unit at a community hospital located in a suburb of Chicago, IL, Single centre, Pain - Paediatric pain assessment and management guidelines Before: Unclear Impl: Unclear After: 3 m 2nd After: 6m	Sample size: *n*=51 nurses (49 completed education). No specific description No description	A computer-based course. Introduction of the new guideline. New electronic medical record system.	Primary: Knowledge and attitude. No statistical difference between nurses' knowledge and attitudes regarding paediatric pain before and after implementation of the guideline was found. Secondary; Adherence. A significant increase in minimum pain assessments was noted at T2 and T3 compared with T1 ($p<0.001$). Results also showed at T3 that patients were assessed for pain using a developmentally and clinically appropriate scale compared to T1 and T2.	Positive	NA

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Harrison, 2005, Canada	Before-After, home care - The Ottawa Community Care Access Centre, an eastern Ontario home care-authority, Multi centre, Skin care - Leg ulcers Before: 12 m Impl: 2 w After: 12 m	Not specified. Sample size: total *n*= 258 . Before: *n*=78 mean age 72.7 (13.8) 66.7% females. After: *n*=180 mean age 73.4 (13.7) 60% females	Category: Authority and accountability for Healthcare professionals --> Scope of practice; Redesigning; materials. Organizational and clinical changes: switching to primary nursing delivery model. Each patient was assigned a primary nurse at admission. Community nurses received training. Clinical changes entailed adopting an evidence-informed protocol developed by an interdisciplinary task force, whose members made use of the Practice Guideline Evaluation and Adaptation Cycle	Primary: Patient-related nursing outcomes: Treatment frequency dropped significantly. Use of compression therapy increased significantly. Healing rates increased significantly. Secondary: the median supply cost per case was reduced from $1923 to $406 (*p*=0.005).	NA	Positive

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Huis, 2013, Netherlands	Cluster Randomized Controlled Trial, hospital - 3 hospitals in the Netherlands, Multi centre, Infection prevention - hand hygiene Before: Unclear. Impl: 6 m After: directly after 2nd After: 6 m	Sample size: Pre intervention: *n*=905. During: Intervention State of the Art (control): *n*=490 Intervention Team directed + state of the art: *n*=396. After: Control: *n*=518 Intervention: *n*=415. Nurses working at surgical wards, internal medicine wards, intensive care units, paediatrics No description	For the state-of-the-arts. A, education, b reminders, c feedback, d adequate products. For the team and leaders (a-d) supplemented with; e gaining active commitment, f modelling by informal leaders, g setting norms and targets within the team.	Primary: Adherence: Observed adherence rates. Analysis showed an Odds Ratio of 1.64 (p<0.001) in favour of the team and leaders-directed strategy, indicating that the difference in improvement between the team and leaders directed strategy and the state-of-the-art strategy was statistically significant. Secondary The largest decline in wearing jewellery was seen in the wards that had received the team and leaders-directed strategy, from 15% (T1) to 5% (T2) and to 3% at T3. Wearing jewellery in the state-of-the-art group decreased from 15% (T1) to 11% (T2) and then to 6% at T3. The multi-level regression analysis showed an Odds Ratio of 2.56 (p<0.01) in favour of the team and leaders-directed strategy.	Positive	NC

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Jagt-van Kampen, 2015, Netherlands	Before-After, Hospital - Academic children's hospital, Single centre, Paediatric palliative care Before: 8 m Impl: 1 m After: 6 m	5 Nurse Specialists No description	E-learning modules and an interactive educational meeting to stimulate regular review of the CPG and get familiar with using the CPG. E-learning containing a test for correctness in documentation, direct electronic feedback is provided.	Primary: Knowledge (survey). Displayed in percentage of good answers on e-learning per nurse specialist. No differences between participants, no baseline data. Secondary: Adherence. No significant change for 9 audit criteria. 3 criteria both before and after >80% adherence rate. No clear description about who gathered data and how data. Adherence also measured by asking parents about given treatment, no statement on timing of these questions; risk for recollection bias. Possible that documentation was poor, but care was sufficient.	No change	NA

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Johnson, 2017, United Kingdom	Before-After, hospital - tertiary neonatal intensive care unit, Single centre, Nutritional - improve nutrition and growth of preterm infants in neonatal intensive care. Before: 6 months. Implementation phase: 17 months. After: 6 months	Sample size: total *n*=219 Respondents were nurses' band 3 to 7 and ANNP's (Advanced Neonatal Nurse Practitioner) Total sample size *n*=198. Before: *n*=52 females 55.8%. Partial implementation *n*=36 50% females. Main implementation *n*=75 50.7% females. After: *n*=35 37.1% females	The development of the comprehensive guideline. A multi-disciplinary nutrition support team. Nurse champions seconded 1 day to nutrition team to improve knowledge and skills, the other 4 working in clinic, supporting colleagues in the new ways of working. A weekly round was introduced. Introduce improved enteral and parenteral nutrition products and nutrition team.	Primary: Patient-related nursing outcomes: Interventions effect from chart data. Data from patients adjusted for sex, gestational age and weight at birth. Significant positive change for most outcomes e.g.; change in weight SDS from birth, Mean difference in daily protein intake. Secondary: Adherence: Adherence measured with surveys, a linear regression of mean nutritional audit adherence demonstrated a significant increase with a regression coefficient of 1.1 (p=0.009)	Positive	Positive

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Kingsnorth, 2015, Canada	Before-After, Hospital - a large academic paediatric rehabilitation hospital, Single centre, Pain - Paediatric pain Before: 3 m Impl: Unclear After: 1 y 2nd After: 2 y	Paediatric registered nurses. Full and part-time clinical nursing staff. Total 89, 69 completed surveys Total sample: *n*=108. Before: *n*=35, After: *n*=33, 2nd After: *n*=40	Several strategies. Educational/ instructional resources. Electronic reminders, revised policies and standards of practice, stakeholder engagement, evaluation of practice changes, promotional activities and materials.	Primary: Adherence and Patient-related nursing outcomes. Significant reductions in overall mean pain score for each client between T1 and T3 and between T2 and T3 ($p<0.0005$). A significant and clinically relevant reduction in the frequency of ''high'' pain scores (>6) was found across the data collection windows from 65% in 2009 to 9% in 2011. Documentation of the pain scores. At T1, 1,681 of 1,848 (91%) of records were missing pain scores. At T2, this number remains high at 87%. At T3, there were no missing cases, indicating 100% (adherence; pain scores were noted for 80% (3,174/3,957) of the records, with the remaining 20% (783/3,957) coded as sleeping.) Second: Knowledge: before (mean=79%,SD=8.13) to After (mean 83%, SD=5.33, $p<0.05$).	Positive	Positive

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Koh, 2018, Singapore	Before-After, Hospital, two orthopaedic wards, Single centre, Skin care – Pressure ulcer prevention Before: 2y Impl: Unclear After: 3m, 1y 2nd After: 9m, 2y 3rd After: 16m, 3y 4th After: 24m	Not specified. Sample size: total *n*=120. Before *n*=30, After 30, 2nd After *n*=30, 3rd After *n*=30.	Education with a pictorial guide to aid nurses in performing consistent heel off-loading practice. The pictorial guide was placed on the nurses' work desk and case-file trolleys and reminders through an on-line platform from the organization.	Primary: Compliance baseline, no documentation in nursing notes. Post implementation, increase in heel-off loading 76.7% documentation 66.7% Criterion 1 showed 63.3% compliance (documented and performed) ($p<0.05$). Secondary: Intervention's effect, no statistical testing described	Positive	No change

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Köpke, 2012, Germany	Cluster Randomized Controlled Trial, nursing homes, 36 in total, Multi centre, Mobility - Use of physical restraints Before: Unclear. Several data collection points Impl: Unclear After: 3 m 2nd After: 6 m	Not specified. Sample size: total *n*=3771 Intervention: *n*=1952 Mean age 83 (10), 73% females. Control *n*=1819 Mean age 85 (9), 77% females	Posters, information evenings for relatives were encouraged. Printed versions for nurses, guardians and visitors. 1-day intensive training workshop for nominated key nurses. Structured support for key nurses. practice guideline. Printed supportive material. Publicity. NB. Usual care: head nurses received written information about the use of physical restraints and methods to avoid physical restraints, using three 12- to 24-page brochures previously developed by a Hamburg-based multidisciplinary group. Also, the topic of physical restraints was discussed during a short presentation by one of the researchers. Apart from the experimental intervention, control group and intervention group clusters were treated equally. In Germany, nursing homes are legally required that at least 50% of nursing staff be fully trained, e.g. registered, (geriatric) nurses with 3 years of vocational training. Other nursing staff have completed 1 year of training or on-the-job training.	Primary: Adherence: Physical restraint use. At baseline, prevalence of physical restraint use was comparable between groups: 31.5% in the intervention group vs 30.6% in the control group. After 6 months, physical restraint prevalence was significantly lower in the intervention group, 22.6%, vs 29.1% in the control group (difference, 6.5%; cluster-adjusted p=0.03). The eFigure provides a graphical illustration of the results. All physical restraints were used less frequently in the intervention group compared with the control group. Secondary: Patient-related nursing outcomes; for falls, fall-related fractures, and prescriptions of psychotropic medication showed no statistically significant differences between groups	Positive	Positive

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Lockwood, 2018, Australia	Quasi-experimental, hospital - Two private hospitals in a regional area, Multi centre, Mobility - Venous - thromboembolism prevention programme Before: Unclear Impl: Unclear After: Unclear	Not specified. Total *n*=383, Intervention *n*=196 mean age 66.1 (8.6), 50.5% females. Control: *n*=187 mean age 69.1(9.2), 60.4% females. (age and weight significantly different between groups)	Nurses were provided with education pamphlets. Clinical leadership by nurses' team leaders and nurse champions. The evidence-based guidelines were translated into patients clinical pathway's.	Primary: Adherence by nurses significantly higher adherence at the intervention study site. Primary: Patient-related nursing outcomes in terms of VTE and readmission rates, both showed no significant difference between study sites. Secondary: Adherence by patients. NB: No adjusted data shown, described in text that adjustment didn't lead to differences (Adjusting for operation type, admission diagnosis, age and weight resulted in negligible change to the parameter estimate for the site term). No collinearity was suggested by the computed variance inflation factors. At the control site, there was no hospital policy or clinical leadership focused on VTE prevention the participants received usual VTE prevention practices.	Positive	NC

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Lopez, 2004, China	Before-After, hospital - Tertiary care teaching hospital, Single centre, Nutritional - nutrition support in mechanically ventilated, critically ill adult patients. Before: Unclear Impl: 3 m After: 3 m	Most were registered nurses (few ward manager, nursing officer or nurse specialist). Survey sample: Before: *n*=169 76.9% females After *n*=172 80.2% females Sample size: Before: *n*=393 Mean age 62.7 (17.8) females 51.9%. After *n*=393 Mean age 63.0 (19.2) females 49.9%. Groups differed significantly on the following variables: Age, chronic respiratory disease, and current admission problem.	An educational intervention was provided over a period of 3 months. A 2-hour workshop was given to all registered nurses on the CDC's Guidelines for the Prevention of Intravascular Catheter-related Infections. Posters and fact sheets were distributed to the wards.	Primary: Knowledge (survey). Significant improvement after educational intervention. Secondary Adherence & Patient-related nursing outcomes. Adherence showed a significant change in documentation and correct site dressing. No significant change in incidence of phlebitis or extravasation.	Positive	NC

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Lopez, 2011, Australia	Before-After, hospital - Australian Capital Territory hospitals, Single centre, Skin care - Skin tears Before: 1 day audit. Impl: Unclear After; 2 m after baseline audit, 1 day audit	Sample size: Before: *n*=20, After: *n*=15. No further description Sample size: Before: *n*=96 Mean age 78,2 (10.92) 62,5% females After: *n*=95 mean age 78,74 (0.89) 60% females	Pre-audit results were discussed and disseminated to the ward staff. Repeated education workshops including educational material. Each clinical unit was provided with the skin tear prevention management algorithm. Appropriate skin tear dressing materials in the unit were checked and supplied if needed.	Primary: Adherence. 8 criteria measured. No statistical tests performed. Percentage of change ranged from 0% to 78%.	NA	No change

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Lozano, 2004, USA	Cluster Randomized Controlled Trial, Primary care paediatric practices, Multi centre, Asthma treatment Before; 3 m Impl: Unclear After: Unclear Total study period of 2 years	Not specified. Total sample: *n*=638. Usual care: *n*=199 mean age 9,6, 40% girls. Peer leader intervention: *n*=226 mean age 9,3 43% girls. Planned care intervention: *n*=213, mean age 9,4, 38% girls	Peer leader intervention: training 1 physician per site to serve as asthma champion. Including 2 workshops, central support, an ongoing learning network via national and local teleconferences. Several materials, including reference articles, pocket cards and reminders. Planned Care Intervention: Planned asthma care (PAC) visits with a trained asthma nurse constitute the core of this intervention. Asthma nurses were trained in the guideline and in self-management support techniques. In addition to reading the manual, nurses attended a full day training session, learning motivational enhancement, problem-solving, and met weekly or every other week for 10 weeks for 1h conference calls. Usual care: Practices randomized to this arm received a copy of the guideline and a tool kit of patient education materials 1 year into the study.	Primary: Patient-related nursing outcomes: We observed a secular trend (usual care intervention) toward a decrease in asthma symptom days during the study period of 14.8 (95% confidence interval [CI]−22.4 to−7.28) fewer asthma symptom days per year of intervention. Children in the planned care arm experienced an additional reduction of 13.3 (95% CI,−24.7 to−2.1) fewer ASD-14 per year of intervention (p=0.02) relative to children in usual care. This decrease attributable to the planned care intervention represented a 12% reduction (95% CI, 2% to 23%) from the baseline of 107.5 days per year. Children in the peer leader arm experienced 6.5 (95% CI, −16.9 to 3.6) fewer asthma symptom days per year as compared with children in usual care, but this decrease did not attain statistical significance.	NA	No change Positive No change

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Paquay, 2010, Belgium	Before-After, home care - 5 participating home nursing agencies, Multi centre, Skin care - pressure ulcer Before: 1 m, 1 d collection. Impl: unclear, 1 d? After: 6 m, 1 d collection, 2nd After: 18 m, 1 d collection	Home care nurses, not specified Before; *n*=5999. After 6m *n*=5894 After 18 m *n*=6097. 69% women, ~70% between 70 and 90 years of age	Sensitization and education of nurses, making documentation available for nurses. Training on pressure prevention. A leaflet for informing patients and informal caregivers was designed by an interdisciplinary working group of wound care experts and experts in patient teaching (pilot tested). One tissue viability nurse from each regional department attended a conference on BGPDU. These nurses organized training sessions for all nurses. Feedback after the first post-measurement was given by means of an automated information report. Reference nurses were involved in providing feedback and explanation to the regional departments.	Primary: Adherence/adherence. Application of preventive measures and materials, Chi-square showed a significant increase. Secondary: Patient-related nursing outcomes. Less patients had signs of pressure ulcer lesions (Wilcoxon two sample test) and less number of lesions per patient (Wilcoxon two sample test)	Positive	Positive

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Pun, 2005, USA	Before-After, hospital - Intensive Care Unit wards of the VanderBilt University Medical Centre in Nashville and the Veterans Administration Tennessee Valley Healthcare System-York Campus (VUMC resp York-VA), Multi centre, Delirium and sedation VUMC: Before:1 m Impl: 1 w After: 12 m York-VA B: 2 w Impl 1 w After 6 m	Total sample size: *n*=64. VUMC *n*=40. York-VA *n*=24. Mean years of experience 7.4 to 13.9 (VUMC resp. York-VA) Total sample size. *n*=711. VUMC *n*=614 York-VA *n*=97. Mean age 52.5 - 65.9 (VUMC resp. York-VA) Females: 49.7% - 1 % (VUMC resp. York-VA)	Both institutions modified their documentation systems to incorporate the RASS and CAM-ICU into the neurologic assessment of the hourly flow sheet below vital signs. VUMC used a paper documentation system, whereas York-VA used a computerized charting system and inserted both scales into the hourly data record portion, Education began with display of a 3x 3-foot poster containing bulleted concepts about sedation and delirium. A 20-min unit-wide in-service was then attended by all nurses; this included in-depth descriptions of the RASS and CAM-ICU (utilizing bulletin boards, handouts, laminated pocket cards, and case studies), followed by bedside demonstration rounds.	Primary: Adherence. Presented in figures, no statistical test performed. No difference between baseline and after implementation is discussed for adherence Secondary: Experience & patient-related nursing outcomes. Agreement data (bedside nurse and expert reference-standard) No difference between baseline and after implementation is discussed	No change	No change

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Rao, 2009, United Kingdom	Cluster Randomized Controlled Trial, nursing home - 12 nursing homes in and surrounding south London , Multi centre, Infection prevention - Hand hygiene, environmental and disposal hygiene. All stages Unclear. Overall 2-year project	Average sample size per nursing home; Control: *n*=34, of different educational levels. RN *n*=11, Healthcare assistants *n*=20. Temporary staff *n*=3. Intervention: *n*=54 RN *n*=12, Healthcare assistants *n*=41. Temporary staff *n*=1. Average sample size number of residents per nursing home. Control: *n*=38 (median 27 range 19-51). 65% females. Intervention: *n*= 51 (median 49 (23-81) 60% females	Infection control team consisting of a dedicated infection control nurse. Who was supported by a senior nurse specialist in infection control and an infection control doctor. Teaching and training. Providing feedback. Providing personal alcohol-containing gels to improve hygiene. 24-hour telephone support for management in specific infection control problems	Primary: Adherence. No statistical difference found after implementation.	No change	NA

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Reynolds, 2016, USA	Before-After, Hospital - Neuro critical care unit , Single centre, Stroke care Before: Unclear Impl: Unclear After: direct 2nd After: 3 w	Neuro critical care nurses. *n*=88 employed on the unit of interest. No description	Combination of 3 interventions. 1. Local opinion leaders; experts in stroke, were noted by staff and leadership to be informal leaders (consisting of clinical nurse specialist, clinical educator, stroke coordinator, direct care nurses). 2. Printed educational material; availability and streamlining of information (access to packet in each patient room). 3. Educational outreach; one-on-one, face to face educational sessions from the implementation team, with a script for consistency	Primary: Adherence, increase in adherence not significant. Secondary: Knowledge, NIHSS/ neurological and other assessment frequency questions (p=0.000)	No change	NA
Rosen, 2006, USA	Before-After, Nursing home , Single centre, Skin care - pressure ulcer prevention Before: 3 m Impl: 3 m After: 3 m 2nd After: 6 m	Not specified. Total sample: *n*=455 Before: *n*=134. Impl *n*=107. After *n*=107. 2nd After *n*=107.	Ability, Incentives and Management. Ability; Obligated computer-based interactive video education. Incentives: financial incentive in case of success. Management feedback: real-time feedback of Pressure Ulcer incidence weekly updated and posters in non-public staff lounge. Small financial reward ($10) completion of training, this also served to support the staff needing to train during their off hours.	Primary: Patient-related nursing outcomes. Incidence R (incidence of the number of residents developing 1 or more PU's) Incidence P: (incidence of new ulcers per mean number of occupied beds). There was a significant reduction the emergence of stage 1-4 PU's with an incidence-P of 28.3% and 9.3% for the pre-intervention and intervention periods, respectively (p<0.001) For PUs stage 2 and greater, the incidence-R was 15.7% and 9.3% for the pre-intervention and intervention periods (p>0.05). The incidence-P for stage 2 and greater was 23.1% and 9.3% (p<0.05) for the pre-intervention and intervention periods respectively.	NA	Positive

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Savvas, 2014, Australia	Before-After, nursing home - Residential aged care facilities across three Australian states, Multi centre, Pain - Australian Pain Society Before: Unclear Impl: Unclear After: 1 y	Not specified. No description	Several educational sessions. Tailored to specific staff roles. Lectures, workshops (four three-hour sessions) and one-on-one on-the-job training sessions (two half-day sessions). Use of local pain champions, or pain teams (typically staffed by combination of managers, pain champions, and allied health staff)	Primary: Adherence. No statistical test performed. Data shown in table. All facilities showed an increase in adherence. Approached adherence showed significant improvements in approaching the expectations of those standards. Secondary: Staff efficacy. Showed a significant change in questions about pain identification, assessment and management	No change	NA

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Seto, 1991, China	Before-After, hospital - 6 wards, 3 male, 3 female, Single centre, Infection prevention - Catheter associated urinary tract infections Before: 3 w Impl: 1 m After: 1 m, 1-week daily assessments	Nurses, including student nurses. Three groups, total *n*=220. Group A (Opinion leaders and lecture) *n*= 72, staff nurses *n*=45, 83% females. Group B (Opinion leaders - OL) *n*=73, Staff nurses *n*=42, 82% females. Group C (Lecture) *n*=75, staff nurses *n*=47, 81% females No description	Opinion leader and lecture (gr A) Opinion leaders (gr B) Lecture (gr C. Educational outreach: in-service) (30 min provided by infection prevention nurse) to group A & C) and demonstration (tutorials in small groups to group A & B)	Primary: Adherence(measured by survey) there was no difference (p = 0.36) in the scores between group A (OL and lecture group; 5.63) and B (OL group: 4.96) when analysed by ANCOVA. However, the change in mean practice score in group C (lecture group; 3.29) was significantly lower than that of both groups A and B ($p<0.05$, and $p<0.05$, resp.). Secondary: Adherence(measured by observation). The percentage of correct practices in group A, and OL and lecture group (50%) was significantly higher ($p<0.05$) than group C (lecture group; 38%). However, the percentage in group A is also significantly higher ($p<0.05$) than that of group B (OL group; 35%).	Positive Positive No change	NA

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Sipila, 2008, Finland	Before-After, General practices - 31 in total, Multi centre, Early detection, prevention and treatment of CVD (Cardiovascular disease) Unclear. Overall 2-year project	Sample size: Before: Self audit - nurses: *n*=266 After: *n*=233. Before: self-audit - doctors: *n*=140 After: *n*=134. No description	Self-audit, brainstorming, cause/ effect analysis (fishbone) patient cases and open discussions, audit and feedback. Facilitators per site were motivated by a small financial increment on their monthly salary	Primary: Adherence self-reported. Secondary: Patient-related nursing outcomes. No statistical tests performed.	No change	NA
Snelgrove-Clarke, 2015, Canada	RCT, hospital - University affiliated teaching hospital in Atlantic, Single centre, Foetal Health Surveillance Before: 1 m Impl: 6 m After: 1 m	Intervention group before: *n*=44 After: *n*=17. Control before: *n*=45 After: *n*=35. No specific description provided No description	Repeated Action learning meetings. Where enablers and inhibitors were discussed. Action Learning is a facilitative approach that allows for the inclusion of interventions that would align well with the elements proposed in the PARIHS model (Kitson et al. 2008). It is a complex approach that can incorporate participant inclusion, social exchange, and contextual issues; all-important in understanding the pace and complexity of practice change. Risk of contamination, control and experimental were working on the same ward.	Primary: Adherence. Guideline adherence collected as 100% yes, if less; no. No significant change between groups. Secondary: Enablers & Inhibitors. Practice environment, Doppler availability, events during labour, ambulation.	No change	NA

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Tian, 2017, Belgium	Before-After, Hospital, Single centre, Cancer related fatigue Before: 3 m (survey). Impl: 3 m After Unclear	Not specified. *n*=6 university schooled, *n*=10 junior college, *n*=2 technical in group A. In group B respectively *n*=13, *n*=6, *n*=1 & *n*=1 postgraduate. Mean age 31, all females No description	1st a steering group for evidence was composed. Based on baseline survey context evidence and facilitation were targeted items of interest. The steering group formulated proposed changes based on baseline survey. First starting with training on evidence-based nursing for the participating nurses. Using printed material and educational meeting. Using a quality review sheet. Steer group collected feedback periodically. Interventions were targeted on the organisational culture, no specific description available (fig 1).	Primary: Adherence. On Screening/ assessing & intervention (resp. 1-6, 1-5) Secondary: Knowledge and actions of nurses (survey). Surveys for patient experience	No change	NA

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Törmä, 2014, Sweden	Controlled Before-After, Nursing homes - 4, Multi centre, Nutritional Unclear. 18 m between pre and post measurement.	Not specified. 172 participants. 55 in EF, 46 EOV, 71 lost to follow-up. Mean age was 83.8 to 86.5 (EF-EO)	EF: External Facilitator strategy. EO: Education outreach visit. The EF was multifaceted; feedback on baseline characteristics, mealtime observation. encouraging critical inquiry regarding nutritional practices to highlight need for change. meetings every 3-4 weeks for a year. practice audits were performed. such as dietary assessments (internal) and mealtime observations (external). EO a personal visit by trained person to healthcare professionals in their own setting. A three-hour lecture at one occasion regarding operationalized nutritional guidelines. including limited feedback on mealtime observations and clinical measurements of the NH residents.	Primary: Patient-related nursing outcomes. Nutritional variables (weight, BMI, etc.). No significant improvement found. However found significant deteriorations for functional and cognitive status, as well as for the EQ-5D index ($p<0.05$) in the intervention group who received Educational Outreach Visits.	NA	No change Negative
Troglic						

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Van den Boogaard, 2009, Netherlands	Before-After, hospital - Intensive Care Unit (PICU and Intensive Care Unit) in a tertiary hospital , Single centre, Delirium Before: 2 collections in 4 m Impl: 4 m After: 4 m	Not specified. Sample size: Total *n*=1742 Before: *n*=512 mean age 57.5 (16.4) 33.8% females. During *n*=589 mean age 58.9 (16.6) 37.2% females. After: *n*=641 mean age 59.5 (15.6) 36.2% females.	Educational outreach visits, prior a knowledge test, then a 1h group training. Appointment of delirium key-nurses. Supplementary individual training on the job by researcher and the key nurses, whenever the adherence rates dropped. Posters, material to perform assessment was made available. Digital option instead of paper. Reminders and feedback on performance was provided.	Primary: Adherence positive significant change 77% to 92%. Secondary: Adherence: The median dose per patient decreased from 18 mg to 6 mg (p=0.01) Secondary: Patient-related nursing outcomes: the median duration of treatment with haloperidol decreased from five (IQR 2-9) to three days (IQR 1-5) (p=0.02)	Positive	Positive
Van der Putten, 2013, Netherlands	Cluster Randomized Controlled Trial, Nursing homes - Within 100km radius of the centre of the Netherlands, Multi centre, Oral care Before: Unclear Impl: Unclear After 6 m	Not specified. Sample size: Intervention: baseline *n*=177, after *n*=115. Mean age 80.4 (9.4) 66% females. Control: baseline *n*=166 After *n*=117 mean age 80.7 (10.9) 69% females	WOO's (ward nurse acting as ward oral healthcare organizer). Several education sessions, WOO's were trained first and acted as trainers for their own ward. WOO's assisted and encourage nurses. Patients received products and materials as well. Control group received oral care products and materials as well	Primary: Patient-related nursing outcomes. Dental status there was not significantly different between the intervention and the control group. Mean dental and denture plaque was significantly different at 6 months with a bivariate analysis. However, as a result of the multilevel analysis, the reduction of mean dental plaque scores could not be explained exclusively by the intervention.	NA	Positive

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Van Gaal (a), Van Gaal (b), 2011, Netherlands	Cluster Randomized Controlled Trial, Hospital and nursing homes - 1 university hospital. 2 large teaching hospitals, one small hospital and 6 nursing homes. 10 hospital wards + 10 Nursing home wards, Multi centre, Combination of multiple guidelines - Pressure ulcer, urinary tract infection and falls Before: 3 m Impl: 14 m After: 9 m	Not specified. Hospital: Before: Intervention: *n*=346, mean age 66 (14.5), 53.2% females. Usual care: *n*=341 mean age 64 (16.9), 59.8% females. Follow-up: Intervention: *n*=1081 mean age 66 (14.7) 52.7% females. Usual care: *n*=1120 mean age 67 (16.1) 57.7% females. Nursing homes: Baseline: Intervention: *n*=114 mean age 78(9.9) 61.4% females. Usual care: *n*=127 mean age 78 (11.7) 66% females. Follow-up Intervention *n*=196 mean age 80 (10.9) 66.8% females. Usual care *n*=1120 mean age 79 (10.5) 64.3% females	Educational group lessons. A CD-ROM with educational material and knowledge test. Case discussions on every ward. Patient involvement through information folders and oral information by nurses. Feedback; digital feedback based on the computerized registration system.	Primary: Patient-related nursing outcomes, In both hospitals and nursing homes, patients in the intervention groups developed fewer adverse events compared to patients in the usual care groups. Secondary: Adherence PU: No statistically significant difference in patients at risk receiving adequate preventive care was found between the intervention and the usual care group (estimate = 6%, CI: 7–19). Urinary tract infections: Statistically significantly fewer patients at risk in the intervention group received adequate preventive care (estimate = 19%, CI: 17–21). Falls: The numbers were too low for statistical analysis, but it seems obvious that there was no difference between the intervention and the usual care group in adequate preventive care given.	No change	Positive

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Van Lieshout, 2016, Netherlands	Cluster Randomized Controlled Trial, General Practices, Multi centre, Cardiovascular risk management in general practices Before: Unclear Impl: Unclear After: 6 m	General practitioner nurses. Intervention group *n*=20. Mean age 42. Mean years of experience as a nurse 12. Mean number of hours previous training in Motivational Interviewing 14.7. Control group *n*=14. Mean age 43, years of experience 11, number of hours previous MI training 14.8 Intervention: *n*=1250. Mean age 72.6 (9.7) Female 35.1% Control: *n*=979. Mean age 71.6 (9.7) Female 34.9%	Structured feedback on Motivational interviewing skills in practice. Access to online educational program, guidance on relevant eHealth options for patients. A planned twitter consultation hour for patients. Flow chart for dealing with depressive CVD patients. Treating depression before giving any lifestyle advice.	Primary: Adherence. No found effect . Secondary: Patient-related nursing outcomes. Physical exercise RAPA: improved in the intervention group compared to the control group. The RAPA score improved on a scale from 1 to 7 from 4.8 to 4.9; in the control group, the activity diminished reflected in a score diminishing from 4.9 to 4.8 ($p < 0.05$). On the other cardiovascular risk factors assessed (SBP, LDL cholesterol, smoking status, BMI, and diet), the improvement program had no significant effect. We found no difference in the effect of the intervention between the high cardiovascular risk group and the group with established CVD. However, CVD patients had their LDL cholesterol and SBP level more often on target (OR 3.8, 95 % CI 2.9–5.1 and OR 1.5, 95 % CI 1.2–1.8, respectively).	No change	P

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Vander Weg, 2017, USA	Before-After, Hospital - General medical units of four US Department of Veterans Affairs hospitals, Multi centre, Smoking cessation Before: 8 m Impl: 8 m After 6 m 7-day point prevalence of smoking abstinence	Education not specified. Total sample *n*=226. Gr 1 *n*=42. Gr 2 *n*=72. Gr 3 *n*=60. Gr 4 *n*=52 Before: *n*=498. After: *n*=394	Enhanced academic detailing of staff nurses, consisted of face-to-face training of inpatient registered nurses, performance feedback, periodic check-ins with nurse managers and peer leaders. Adaptation of the electronic medical record, patient self-management, and organizational support and feedback.	Primary: Patient-related nursing outcomes , No statistically significant differences in 7- or 30-day PPA(point prevalence abstinence)-rates. Approximately 55–65% of participants reported making at least one quit attempt at the three- and six-month follow-ups, with no statistically significant differences observed across period ((AOR= 1.00; CI95: 0.76–1.34) and (AOR = 1.01; CI95: 0.74–1.35) respectively).	NA	No change

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Ward, 2010, Australia	Cluster Randomized Controlled Trial, nursing home - residential aged care facilities with at least 20 beds, 88 facilities included, Multi centre, Mobility - Preventing falls Before: 7 m Impl: 17 months After: Unclear	Not specified. Total sample: *n*=5391. Control: *n*= 2586, median age 85 (Range: 27-107) 72% females. Intervention: *n*=2807, median age 86 (range: 32-107), 73% females.	The project nurse provided link people from each intervention facility with information and resources to assist with preventing falls and fractures. Intervention facility staff were also invited to attend a workshop to learn how to plan and run exercise programs.	Primary: Patient-related nursing outcomes; Mean number of falls per month, No significant differences between intervention and control groups at commencement, or after. Rates of femoral neck fractures were similar in both groups (p=0.8). There was no difference in rates of fractured neck of femur between intervention and control groups during the 17 months of intervention, and no difference in fracture rates in the entire cohort between the first 6 months of the intervention and the last 6 months. Secondary: Adherence. there were significant increases in the provision of hip protectors and use of vitamin D supplementation in both intervention and control facilities. No difference between control and intervention group.	No change	No change

Author, Year, Country	Design Setting, Single/ Multi centre, Guideline, Duration	Professionals Patients	Short description of implementation strategies	Outcomes measured	Effect on adherence	Effect on patient related nursing outcome
Zhu, 2018, China	Before-After, hospital - Shanghai Public Health Clinical Centre, Single centre, Infection prevention - Non-pharmacological fever management in HIV patients Before: 1 m Impl: 2 m After: 2w	Nurses, no specific description provided. *n*=10 No description *n*=30	Two tailored education programs. Work manuals and educational materials were provided to nurses and patients to raise their knowledge and skills in HIV/ aids-related fever management. Before the project, the content of education materials mainly focused on basic knowledge about HIV/AIDS and strict adherence to antiretroviral therapy. Although these two topics are an indispensable part of education among PLWHs, effective symptom management is a critical skill for both patients and nursing staff. Delivering knowledge on fever and febrile symptom management not only improves patients' quality of life, butis also a viable option to decrease healthcare costs. Consequently, all nurses in the department receiveda training program on fever and febrile symptom management among PLWHs, which improved the patient quality of education.	Primary: Adherence/adherence. Criteria 1 to 7. significant increase (0% before for criteria 1,2,4,5,6,7). (*n*=30) Secondary: Nurses' knowledge. Significantly increased (*n*=10)	Positive	NA

h=hour; d=day; m=month; w=week; y=year; impl=Implementation phase; resp.=respectively; NA=Not applicable; VAP=Ventilation Acquired Pneumonia; BOAS=Beck Oral Assessment Scale; ADL=Activities of Daily Living; ICU=Intensive Care Unit; AF=Audit & Feedback; EO= Educational Outreach; NNT=Number Needed to Treat; VTE= Venous ThromboEmbolism; BPG=Best Practice Guidelines; CRN=Clinical Research Nurse; CDC=Centers for Disease Control and Prevention; WHO=World Health Organisation; CPG=Clinical Practice Guideline; ANNP=Advanced Neonatal Nurse Practitioner; PAC=Planned Asthma Care; VUMC= VanderBilt University Medical Centre; York-VA= Valley Healthcare System-York Campus; RASS= Richmond Agitation and Sedation Scale; CAM-ICU=Confusion Assessment Method for the Intensive Care Unit; NIHSS=National Institutes of Health Stroke Scale; PU=Pressure Ulcer; OL=Opinion Leaders; PARIHS= Promoting Action on Research Implementation in Health Services; EF=External Facilitator Strategy; BMI=Body Mass Index; PICU=Paediatric Intensive Care Unit; WOO's=Ward nurse acting as ward Oral healthcare Organizer; HIV=Human Immunodeficiency Virus; AIDS= acquired immune deficiency syndrome; PLWH=People Living with HIV/AIDS

Supplement 3. Calculations of relative change percentage for the patient-related nursing outcomes

Example 1 De Laat, 2006: Uncontrolled study

Outcome: Frequency of pressure ulcer patients grade I-IV

Results presented in table 3 (De Laat et al., 2006):

Before: 121/657 (18%)

After: 98/735 (13%)

2nd After: 82/755 (11%)

Relative change 1st After: ((13 –18) / 18) * 100 = -27.78%

Relative change 2nd After: ((11-18) / 18) * 100 = -38,89%

Example 2 Van Lieshout, 2016 : Controlled study

Outcome: Physical Exercise (RAPA, 1-7)

Results presented in table 5 (Van Lieshout et al., 2016):

Time	Baseline	Follow-up
Intervention	4.8	4.9
Control	4.9	4.8

Relative change Intervention (RCI): ((4.9 – 4.8) / 4.8) * 100 = 2.08

Relative change Control (RCC): ((4.8 – 4.9) / 4.9) * 100 = -2.04

Relative change: (RCI)/(RCC) = 2.08/-2.04 = -1.02

Supplement 4. Cochrane risk of bias for controlled studies

Table 5. Cochrane risk of bias for controlled studies

Author	Year	Randomization	Allocation concealment	Baseline measurement simular	Baseline characteristicesimular	Incomplete oucome data	Blinding	Contamination	Selective reporting	Other	Guideline
Van Lieshout	2016	low	low	low	low	low	low	low	low	low	Cardiovascular risk management in general practices
Van Gaal(a,b)	2011	unclear	low	low	low	unclear	low	low	low	low	Combination of multiple guidelines - Pressure ulcer, urinary tract infection and falls
Snelgrove-Clarke	2015	low	high	low	high	unclear	low	high	low	unclear	Foetal Health Surveillance
Huis	2013	low	low	high	unclear	low	low	low	low	low	Infection prevention - hand hygiene
Rao	2009	unclear	low	high	low	low	low	low	low	low	Infection prevention - Hand hygiene, environmental and disposal hygiene.
Lozano	2004	unclear	low	low	low	unclear	high	low	low		Mobility - Use of physical restraints
Törmä	2014	high	high	low	low	high	high	low	low	unclear	Nutritional
De Visschere	2012	unclear	low	low	low	unclear	low	low	low	unclear	Oral care
Van der Putten	2013	unclear	low	low	low	low	low	low	low	unclear	Oral care
Abraham	2019	low	low	low	low	low	low	low	low	low	Pain - Paediatric pain
Beeckman	2013	low	low	low	low	unclear	high	high	low	low	Skin care - pressure ulcer care

Author	Year	Randomization	Allocation concealment	Baseline measurement simular	Baseline characteristicesimular	Incomplete oucome data	Blinding	Contamination	Selective reporting	Other	Guideline
Ward	2010	low	low	low	low	low	high	low	low	unclear	Skin care - pressure ulcer prevention
Köpke	2012	low	low	low	low	low	low	low	low	low	Stroke care
Gomarverdi	2019	unclear	low	low	low	high	low	low	high	unclear	Stroke care
Cheater	2006	low	low	low	low	unclear	low	low	low	low	Urinary incontinence

Randomization Low risk if randomization method is described
Allocation concealment Low risk if unit of allocation was by team/institution OR by patient with some kind of randomization method
Baseline measurement similar Low risk if baseline measurements were performed and no important difference present across groups OR imbalanced but appropriate adjusted
Baseline characteristics similar Low risk if characteristics were reported and similar
Incomplete outcome data Low risk if missing outcomes were unlikely to bias the results
Blinding Low risk if the authors stated blind assessment OR objective outcomes.
Contamination Low risk if allocation was by team/ institution/practice and unlikely control group received intervention
Selective reporting Low risk if there is no evidence that outcomes were selectively reported
Other Low risk if there is no evidence of other risk of bias

Supplement 5. Risk of bias before-after studies – Newcastle-Ottawa Quality Assessment

Table 6. Risk of bias before-after studies - Newcastle-Ottawa Quality Assessment

Author	Year	Selection	Comparability	Outcome	Overall	Guideline
Jolliffe	2019	2	0	2	Poor	Asthma treatment
Clark	2001	2	0	1	Poor	Blood transfusion
Tian	2017	1	0	0	Poor	Cancer related fatigue
Edwards	2007	3	0	2	Poor	Combination of multiple guidelines - Asthma, breastfeeding, delirium-dementia-depression, smoking cessation, venous leg ulcers, diabetes
Downey	2015	3	0	1	Poor	Crushing medication in case of Tube feeding only
Van den Boogaard	2009	4	0	2	Poor	Delirium
Pun	2005	3	0	1	Poor	Delirium and sedation
Sipila	2008	2	0	0	Poor	Early detection, prevention and treatment of Cardiovascular disease
Ames	2011	3	1	2	Good	Infection prevention - Prevention of Ventilation Acquired Pneumonia
Kingsnorth	2015	3	0	3	Poor	Infection prevention - Catheter associated urinary tract infections
Zhu	2018	1	0	0	Poor	Infection prevention - Non-pharmacological fever management in HIV patients
Cabilan	2014	3	0	1	Poor	Infection prevention - Peripheral cannula infections
Frigerio	2012	3	1	0	Poor	Infection prevention - Peripheral venous catheter management
Duff	2013	4	0	1	Poor	Infection prevention - Standard precautions in Intensive Care Unit
Seto	1991	4	0	1	Poor	Mobility - physical restraint use
Rosen	2006	2	0	3	Poor	Mobility - Preventing falls
Lockwood	2018	3	1	2	Good	Mobility - Venous - thromboembolism prevention programme
Cahill	2014	3	0	1	Poor	Nutritional - Enteral nutrition in the Intensive Care Unit

Johnson	2017	4	1	2	Good	Nutritional - improve nutrition and growth of preterm infants in neonatal intensive care.
Giugliani	2010	3	0	0	Poor	Nutritional - Malnutrition care in rural Africa
Lopez	2004	2	0	1	Poor	Nutritional - nutrition support in mechanically ventilated, critically ill adult patients.
Savvas	2014	1	0	1	Poor	Pain - Australian Pain Society
Dulko	2010	3	0	2	Poor	Pain - cancer related
Choi	2014	3	0	2	Poor	Pain - cancer related
Habich	2012	3	0	2	Poor	Pain - Paediatric pain assessment and management guidelines
Featherston	2018	2	0	1	Poor	Paediatric mental healthcare
Jagt-van Kampen	2015	2	0	2	Poor	Paediatric palliative care
Bjartmaz	2017	4	0	2	Poor	Prevention of venous thromboembolism
Bale	2004	2	0	0	Poor	Skin care
Harrison	2005	4	0	2	Poor	Skin care - Leg ulcers
De Laat	2006	3	0	3	Poor	Skin care - pressure ulcer
Paquay	2010	2	1	2	Fair	Skin care - pressure ulcer
De Laat	2007	3	1	1	Poor	Skin care - pressure ulcer
Koh	2018	3	0	2	Poor	Skin care - pressure ulcer prevention
Lopez	2011	4	0	2	Poor	Skin care - Skin tears
Vander Weg	2017	2	1	2	Fair	Smoking cessation
Reynolds	2016	2	0	1	Poor	Stroke care

Selection: 1.Representativeness of the exposed cohort (truly or somewhat representative score 1). 2. Selection of the non-exposed cohort (drawn from the same cohort score 1). 3. Ascertainment of exposure (secure record and structured interview score 1). 4. Demonstration that outcome of interested wat not present at start of the study (yes scores 1). Maximum 4
Comparability: Study controls for age, sex (scores 1) or other factors to increase comparability (scores 1) Maximum 2
Outcome; 1. Blinding of outcome (independent blind assessment and secure record scores 1). 2. Follow-up was >3 months scores 1. 3. Adequacy of follow-up (complete follow-up or lost to follow up unlikely to introduce bias or number lost less than or equal to 20% scores 1. Maximum 3
Overall: Good; Selection 3 or 4, Comparability 1 or 2, Outcome 2 or 3, Fair; Selection 2, Comparability 1 or 2 , Outcome 2 or 3, Poor; Selection 0 or 1, Comparability 0 , Outcome 0 or 1

Supplement 6. Relative change percentage in the controlled studies on the patient-related nursing outcomes

First author	Year	Design	Guideline topic	After 1 in months	After 2 in months	Delivery Arrangements	Financial Arrangements	Government Arrangements	Implemenation Strategies	Total EPOC	Outcome	Relative Change Percentage Controlled studies	Relative Change Percentage Controlled studies 2nd After	Report-ed a significant change in clinical outcomes
Beeckman	2013	controlled	Skin care	3		2	0	0	9	11	Pressure ulcers (I-IV). *	-7,44	2,71	yes
Van Lieshout	2016	controlled	Other – Cardiovas-cular risk manage-ment in general practices	6		1	0	0	6	7	Physical exercise (Rapid assessment of physical activity RAPA. 1-7). *	-1,02		yes
Van Gaal	2011	controlled	Combi-nation of multiple guidelines	9		0	0	0	8	8	Incidence rate of Adverse events per patient week in hospital	-2,67		yes
De Visschere	2012	controlled	Oral care	6		1	0	0	7	8	Mean tongue plaque	0,66		yes
Van der Putten	2013	controlled	Oral care	6		1	0	0	6	7	Denture plaque	3,29		yes

Köpke	2012	controlled	Mobility	3	6	0	0	0	11	11	Residents with any physical restraint %	73,83	5,76	yes
Cheater	2006	controlled	Other – Urinary inconti-nence	6		0	0	0	6	6	Severity of UI (percent-age with improved outcome). *	1,16		no
Törmä	2014	controlled	Nutritional	0		0	0	0	4	4	MNA-SF Mean. I	1		no
Abraham	2019	controlled	Mobility	6	12	1	0	0	8	9	Mean prevalence of residents with any physical restraint	-1,94	2,52	no
Ward	2010	controlled	Mobility			0	0	0	3	3	Mean no falls per month	83,33		no

* Secondary outcome in this study.
I No specific primary clinical outcome provided. Chose the Mini Nutritional Assessment- Short Form (MNA-SF) mentioned in abstract. Two intervention groups. No control. To calculate relative change EOV functioned as control.

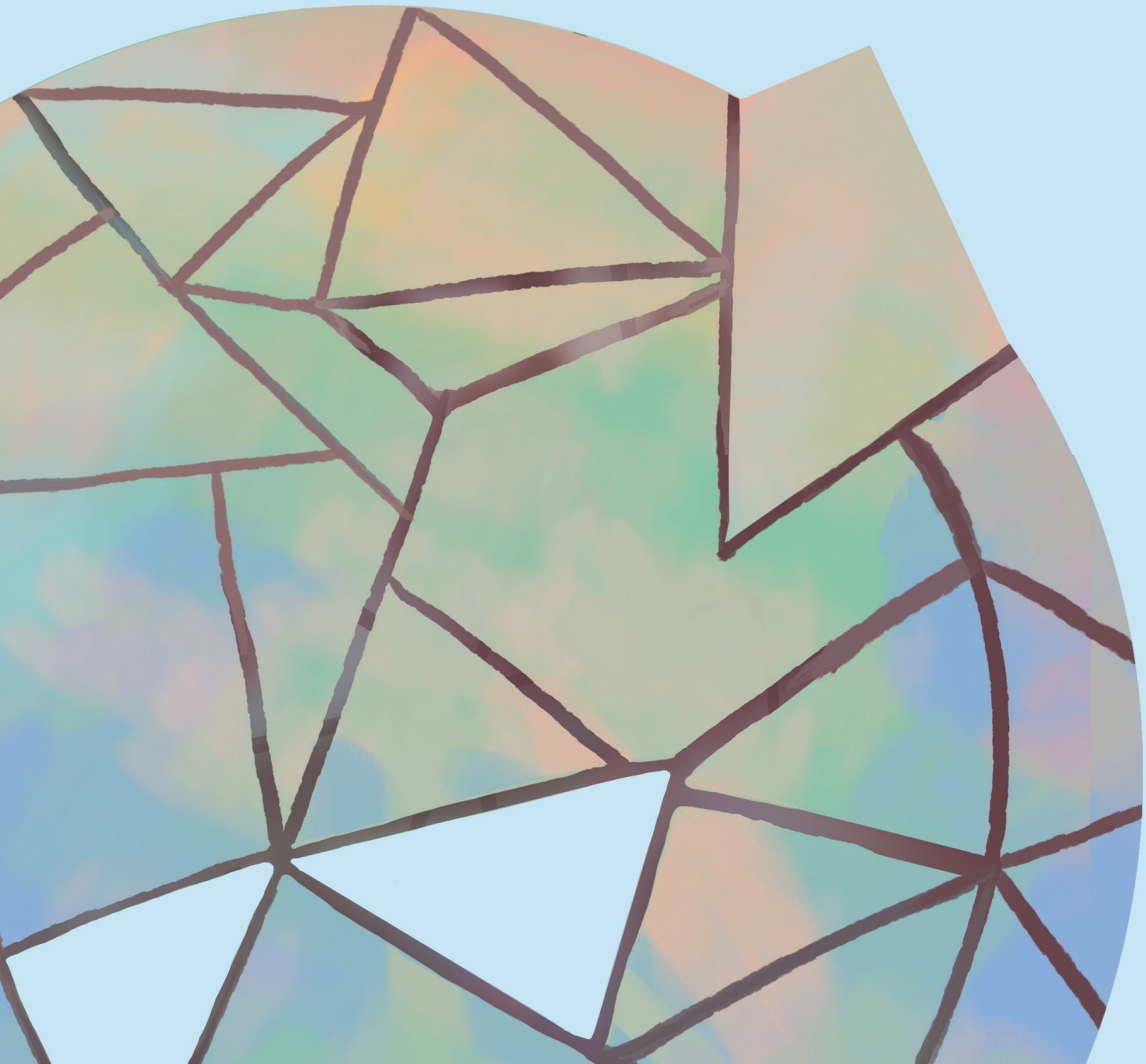
Supplement 7. Relative change percentage in the before-after studies on the patient-related nursing outcomes

First author	Year	Design	Guideline topic	After 1 in months	After 2 in months	After 3 in months	Delivery Arrangements	Financial Arrangements	Government Arrangements	Implemenation Strategies	Total EPOC sstrategies	Outcome	Relative change percentage (%) Before - 1st After (A negative percentage indicates a decrease)	Relative change percentage (%) Before - 2nd After	Relative Change Percentage (%) Before 3rd After	Reported a significant change in patient related nursing outcomes
Ames	2011	before-after	Oral care	14		1	0	0	4	5		Beck Oral Assessment scale over time (day 1,3 and 5)	-22,12			yes
Tian	2017	before-after	Other – Cancer related fatigue			0	0	0	6	6		Patients' scores of CRF self-management scale pre- and post-implementation	NA[k]			yes
Bale	2004	before-after	Skin care			0	0	0	6	6		Severity of incontinence dermatitis (severe, mild and moderate)	-81,42			yes
De Laat	2006	before-after	Skin care	0	11	1	0	0	3	3		Pressure ulcer frequency (grade I-IV) *	-27,78	-38,89		yes
Paquay	2010	before-after	Skin care	6	18	0	0	0	6	6		Most severe skin condition per subject: Blanchable erythema (%) *	-8,7	-23,91		yes

Dulko	2010	before-after	Pain			0	0	0	3	3	Change in worst pain from admission to discharge	3,85			yes
Lopez	2004	before-after	Nutritional	3		1	0	0	4	5	Incidence of extravasation in percentage.*	-100			yes
De Laat	2007	before-after	Skin care	6	15	1	0	0	6	7	Pressure ulcer grade II-IV incidence density	-14,81	-40,74		yes
Giugliani	2010	before-after	Nutritional			0	0	0	3	3	Successful treatment in percentage (Defined as: weight-for-height Z score of more than −2 or ≥80% of NCHS reference median)	12,84			yes
Johnson	2017	before-after	Nutritional	6		1	0	0	6	7	Mean Daily Energy intake (kcal/kg/day) [y]	0,87	1,74	5,22	yes
Van den Boogaard	2009	before-after	Delirium	4		1	0	0	7	8	Number of delirious patients (%) (Because of better screening)*	130			yes
Harrison	2005	before-after	Skin care	12		0	0	0	3	3	Healing rates from venous deseas. *	157,46			yes
Rosen	2006	before-after	Skin care	3	3	0	1	1	6	8	Total pressure ulcers. *	-73,68	-50	-50	yes
Kingsnorth	2015	before-after	Pain	12	24	0	0	0	8	8	Mean pain score for each client (NRS). [u]	-14,79	-82,75		yes

Trogrlic	2019	before-after	Delirium	4	4		1	0	0	12	13	Mean Delirium Duration.*	-48,21	-41,07	yes
Vander Weg	2017	before-after	Other – Smoking cessation	0			2	1	0	9	12	Seven day point prevalence abstinence of smoking	-18,06	-6,45	no
Cahill	2014	before-after	Nutritional	6			0	0	0	5	5	Adequacy of calories from total nutrition (%)	5,41		no
Lockwood	2018	before-after	Mobility				1	0	0	4	5	Diagnosis of VTE (Venous tromboembolism).*	-4,59		no
Lopez	2011	before-after	Skin care	2			1	0	0	7	7	Hospital acquired skin tear prevalence	-100		Unclear
Koh	2018	before-after	Skin care	3	9	16	1	0	0	7	8	Heel PU incidence in Orthopedic wards.*	-42,92		Unclear

* Secondary outcome in this study.
[k] Tian did not provide sufficient data to calculate the relative change percentage for their patient-related nursing outcomes
[y] Results from figure only. Unadjusted and adjusted data were similar. unadjusted data were used to calculate relative change percentage
[u] One of plenty primary outcomes. A lot of missing values



7

General discussion

GENERAL DISCUSSION

This thesis aimed to extend the knowledge on effective strategies for de-implementation of low value care and the implementation of underused medical services in orthopedic surgery as well as in nursing practice. Two research questions were formulated:

1. What are effective de-implementation strategies for reducing low value care in orthopedic surgery as well as in nursing practice?
2. What are the differences and similarities between effective de-implementation and implementation strategies in nursing practice?

In this chapter, the main findings of the studies are described and discussed with regard to the two research questions and to the overarching research aim. In addition, the implications for clinical practice and suggestions for future perspective on (de-)implementation strategies are given in the last part of the discussion.

Main findings

Effective de-implementation strategies for reducing low value care

To obtain more insight in effective de-implementation strategies for reducing low value care in orthopedic surgery, a tailored strategy to de-implement low value MRI and knee arthroscopy in patients with degenerative knee disease aged 50 years and over was developed and evaluated ***(Chapter 2-4)***. For the second focus area on nursing practice, a systematic review on the effectiveness of de-implementation strategies for low value nursing practices was performed ***(Chapter 5)***.

Before developing a tailored strategy to de-implement low value MRI and knee arthroscopy for degenerative knee disease, we first determined the proportion of low value knee arthroscopies and its indications in patients with degenerative knee disease treated in a sample of Dutch hospitals (***Chapter 2***). The study showed that two third of the patients with degenerative knee disease had a valid indication for a knee arthroscopy based on their medical record, thus one third of patients might have had low value care based on their medical records. In the latter group, the main reason for performing a knee arthroscopy was that the arthroscopy was made during a shared decision between patient and orthopedic surgeon or on patient's request. This study confirmed earlier literature[1-3] in that low value MRI and knee arthroscopy for degenerative knee

disease for patients aged 50 years and over is still performed, with subsequent potential for improvement by reducing this type of low value care.

In ***Chapter 3***, the determinants (i.e. barriers and facilitators) for de-implementing low value MRIs and knee arthroscopies in patients with degenerative knee disease were investigated among orthopaedic surgeons as well as patients. The study showed that belief of the orthopaedic surgeon in the added value of MRI and knee arthroscopy, and preferences of both patient and orthopaedic surgeon influenced clinical decision making on the diagnostic and therapeutic policy, although it was considered low value. Besides, patients indicated that positive experiences from peers with MRI diagnostics and arthroscopy influenced the clinical decision to a great extent. Evaluation of the identified determinants in the decision-making process, showed that low value MRI and knee arthroscopy can be reduced by strategies changing clinician's "beliefs" on the added value of MRIs and arthroscopies, as well as focus on patient-directed strategies addressing patient's expectations, preferences and their "beliefs" on the added value of MRI and arthroscopies, which was based on experiences from peers.

Next, in ***Chapter 4*** a de-implementation strategy was developed based on the findings of ***Chapters 2 and 3***, and previous literature[4,5]. The tailored de-implementation strategy for reducing low value MRI and knee arthroscopy consisted of the following components: 1) appointing local clinical leaders, 2) education on the Dutch Choosing Wisely recommendation for MRI's and arthroscopies in degenerative knee disease, 3) training of orthopaedic surgeons to manage patient expectations, 4) performance feedback, and 5) provision of a patient brochure. The tailored de-implementation strategy was evaluated on its effectiveness in Dutch orthopaedic centers using a difference-in-difference analysis that compared the time-trend in the monthly percentage of patients with degenerative knee disease receiving an MRI or arthroscopy weighted by the type of hospital before and after the introduction of the de-implementation strategy between intervention (13 Dutch orthopedic centers) and control centers (all other Dutch orthopaedic centers). All patients aged 50 years and over with degenerative knee disease admitted to Dutch orthopaedic clinics from January 2016 to December 2018 were included in the analyses. The results showed that the weighted percentage of patients in the intervention group receiving a knee arthroscopy on average declined by 0.19% per month. For MRI this declined by 0.15% per month. However, these changes over time did not differ between the intervention and the control group, neither for MRI nor arthroscopy. Because the decline in the percentage of patients aged 50 years and over with degenerative knee disease that received an MRI or arthroscopy was shown in both the intervention and control group, the decline could not be attributed to

the tailored de-implementation strategy. Instead, the overall reduction may also indicate an overall focus by orthopaedic surgeons on reducing low value MRI and knee arthroscopy for patients with degenerative knee disease in the Netherlands.

In the second part of this thesis, we reviewed the effectiveness of multiple de-implementation strategies to reduce low value nursing practices (***Chapter 5***). Both (cluster) randomized design (*n*=10), controlled before-after design (*n*=5), and an uncontrolled before-after design (*n*=12) were included in the systematic review. The included studies focused on the reduction of restraint use, inappropriate antibiotics prescriptions, unnecessary use of indwelling urinary catheters, unnecessary order for laboratory liver function tests, and unnecessary antipsychotic prescriptions. More than half of the studies included in this review showed a significant reduction in low value care during the evaluation period. The majority of the studies with a positive effect included an educational component as part of their de-implementation strategy, like educational meetings, educational materials, educational outreach visits, and educational games. Since studies with and without a positive significant effect included an educational component in their de-implementation strategy, the use of educational components cannot be linked to successful de-implementation. A difference found between studies with or without control group with a positive significant effect showed that the majority of the effective uncontrolled studies used a single faceted strategy, whilst the majority of the effective controlled studies used a multifaceted de-implementation strategy. The results also showed the majority of included studies did not perform a barrier assessment before performing the de-implementation strategy. For that matter and considering the large heterogeneity and small number of studies, no clear conclusions could be made on which strategy is most effective for reducing low value nursing procedures.

The differences and similarities between effective de-implementation and implementation strategies in nursing

To learn more about the differences and similarities between effective de-implementation and implementing strategies in nursing practices, two systematic reviews in nursing were performed (***Chapter 5 and 6***). The results of the systematic review in ***Chapter 5***, which evaluated the effectiveness of de-implementation strategies in nursing, were described in the previous section. The systematic review in ***Chapter 6*** evaluated the effectiveness of implementation strategies on guideline adherence and patient-related nursing outcomes. Both controlled studies (*n*=15) and uncontrolled studies (*n*=38)

were included in the review. The studies included in the review focused on the implementation of guidelines for several topics, including skin care and infection prevention. The majority of the included studies showed a positive and statistically significant effect for either patient-related nursing outcomes or guideline adherence. Most of the studies used a multifaceted implementation strategy including education. Less than half of the studies included in this implementation nursing review (***Chapter 6***) performed a barrier assessment to inform the implementation strategy, and unfortunately if they did, most of them were poorly described. Besides, less information was described in the included articles about whether the tailored implementation strategies were executed as planned (intervention fidelity and engagement)[6]. No specific strategy (single-faceted or multifaceted) could be associated to successful implementation of nursing guidelines regardless the context and type of guideline. Comparison of the review about effective implementation strategies for nursing guidelines (***Chapter 6***) and the review about effective strategies to de-implement low value nursing care (***Chapter 5***) reveals that there is no specific strategy associated to both successful de-implementation of low value nursing care and the implementation of nursing guidelines.

Discussion of the main findings

This thesis aimed to extend the knowledge on effective strategies for de-implementation of low value care and the implementation of underused medical services in patients with degenerative knee disease who consulted an orthopedic surgeon as well as in nursing practice. This paragraph discusses how the main findings on the research questions contribute to this aim.

De-implementation strategies

The effectiveness of de-implementation strategies seems to depend on different factors that are related to A) the selection of low value care to be de-implemented and B) the process of developing the de-implementation strategy.

A. Selection of low value care to be de-implemented: should we take the rising tide phenomenon into account?

Most process models for de-implementation start with prioritizing low value care within the clinical setting to be de-implemented based on identifying the strength of evidence, safety issues related to the low value care (i.e. harmful practices are de-implemented first), potential health impact and cost-effectiveness, and the availability of alternatives[7]. However, based on the results

of ***Chapter 4*** the rising tide phenomenon (a secular time trend created by the social response on a topic with widespread attention), may also be considered for prioritizing which type of low value care should be de-implemented first[8]. In ***Chapter 4***, both the intervention and the control group showed a decrease in the use of low value MRI and knee arthroscopy, meaning that the result could not be attributed towards the developed de-implementation strategy. During the study there was a lot of widespread attention for this topic within the orthopedic community, which had developed and disseminated national Choosing Wisely statements on eliminating low value care. For that matter, this has influenced the de-implementation of low value MRI and knee arthroscopy in both the intervention and control group. In addition, several articles related to the topic were published, (international) meetings were organized to discuss the use of low value MRI and knee arthroscopy, and national and international guidelines were published. Consistent with our findings, the study of Kiadaliri et al.[9] showed that the development of a national guideline against the use of knee arthroscopy in patients with knee osteoarthritis was associated with a decrease in knee arthroscopy. Reeves et al.[10] showed that clinical practice could change by publishing study results or could be influenced by external factors, which is described by the researchers as the rising tide phenomenon. Overall, this suggests that it is important to examine whether the overall awareness surrounding a certain low value care type is not only increasing within the targeted group of health professionals, but also is accepted with succinct evidence. The level of overall awareness and acceptance should be included as selection criteria for the prioritization of low value care eligible for an active de-implementation process. So, if the overall level of awareness and acceptance are high, a growing number of studies is likely to discuss these low value care policies which stimulate discussions at meetings, thus defining the "low value care" principle for a particular diagnostic or treatment pathway even better. The latter will also result towards a more sustainable deployment of de-implementation capacity. Performing a de-implementation project requires time and involves costs.

B. <u>The development of de-implementation strategies:</u>

To develop more effective de-implementation strategies in the future the role of tailoring, the number of components (single versus multifaceted), and the components themselves should be taken into account.

1. The role of tailoring (de-)implementation strategies

Previous literature shows that tailored (de-)implementation strategies that address determinants for (de-)implementation are more effective[11-13]. To tailor a (de-)implementation strategy, first the barriers and facilitators for (de-) implementation need to be explored. Using a determinant framework for this exploration is expected to increase the effectiveness of the implementation[14]. However, although the developed de-implementation strategy in ***Chapter 4*** was tailored towards the barriers and facilitators identified for the de-implementation of low value MRI and knee arthroscopy (***Chapter 3***), and was developed according to the steps of the process-model of Grol and Wensing[15], this strategy was not effective to reduce low value MRI and arthroscopy. As described in ***Chapter 4***, there are multiple possible explanations for the ineffectiveness of the tailored de-implementation strategy for reducing low value MRIs and arthroscopy (e.g. widespread attention). Due to the multiple factors influencing the effectiveness of a strategy, it is impossible to make conclusions about the importance of tailoring strategies based on this single study. Also the results of both systematic reviews on nursing services (***Chapter 5 and 6***) did not reveal that tailored (de-)implementation strategies to determinants for (de-)implementation are more effective. However, in both systematic reviews on de-implementation and implementation, no conclusions could be drawn on the importance of tailoring strategies due to a lack of studies that performed a barrier assessment before developing a (de-)implementation strategy. Furthermore the majority of studies did not describe the barrier assessment in detail, thus comparisons were not possible. Finally, the small number of studies that did perform a barrier assessment did not always tailor the strategy towards these factors (***Chapter 6)***. This is in line with the findings of Baker et al.[16] who described that studies used different methods to identify determinants of clinical practice and different approaches to selecting interventions to address the determinants. Thus, the absence of studies which did analyze these determinants might have contributed for not finding an association between tailored (de-)implementation strategies and its effectiveness. To extend the knowledge on the importance of tailored strategies, future studies should describe these tailored strategies in more detail (i.e. details of the performed barrier assessment, the use of a determinant framework, and the matching process of de-implementation strategies towards the determinants).

2. Single versus multifaceted strategies

The majority of the effective controlled studies in **Chapter 5** used a multifaceted de-implementation strategy, where the uncontrolled studies with a positive effect used a single faceted strategy. This seems to support the recommendation that a de-implementation strategy for reducing low value care should be multifaceted, and addressing both patient and clinician roles[17]. However, different findings were found in the literature regarding the use of single-faceted and multifaceted intervention strategies. Where some articles suggest that multifaceted interventions have the greatest potential to be successful in reducing the use of low value care[5,18,19], the review of van Dulmen et al.[13] found no difference in effectiveness between single-faceted and multifaceted strategies. These overall results might suggest that the number of strategy components does not matter. More research is needed to confirm these findings.

3. Strategy components

The systematic review in ***Chapter 5***, performed to assess effective de-implementation strategies for reducing low value care in nursing, showed that almost all controlled studies used a multicomponent de-implementation strategy and included an educational component (e.g., educational meetings and educational materials). However, both studies with a positive effect as well as studies without an effect or with a negative effect included in the systematic review contained an educational component, thus the educational component as such could not be directly linked to a successful de-implementation. Therefore, the results are comparable to those of previous literature, where it was found that educational component is often used for de-implementation[5,22], but that the use of education on its own, especially passive education (lectures and educational materials), is mostly not enough to reduce low value care[23]. Besides, education has different dimensions and its content is not always explained in detail[13].

Furthermore, the results of this thesis showed that there is not a most effective strategy for reducing low value care in nursing and orthopedic practice, and that the de-implementation strategies that are currently used (e.g. strategy with an educational component) are not always effective. This can possibly be explained by the fact that there are differences between the type of low value care (e.g. an unnecessary MRI scan or the unnecessary use of indwelling urinary catheters) and that the use of it is context-related; indicating that every type of low value care and every context could require other de-implementation strategies based on different (context-related) determinants.

Evaluation of de-implementation strategies

In order to learn more about (de-)implementation strategies in the future, it is important that strategies are well reported and evaluated. Strategies should use an appropriate methodological design and suitable outcome measures.

A. Reporting

As described in ***Chapter 5 and 6***, detailed information on the development and performance of (de-)implementation strategies are frequently missing in studies assessing the effectiveness of (de-)implementation studies. Neither did the majority of studies report on barrier assessment, nor matched these determinants towards strategy components, nor adherence to the de-implementation strategy. To compare different (de-)implementation strategies on its effectiveness for reducing low value care, more details should be reported in articles to specify: 1) the development of the de-implementation strategy including the barrier assessment and matching these determinants towards strategy components, 2) the use of theories, models and framework within the developmental process, 3) details of the components of the de-implementation strategy, and 4) the (de-)implementation strategy fidelity (the extent to which the strategy components are delivered in line with the intended plan). Proctor et al.[20] already described that a consistent and a detailed description of used strategies in implementation studies could make it easier to compare the results of those studies and could create a higher reproducibility. To accomplish that studies include a consistent and detailed description, future research should ideally report (de-) implementation details according to standardized formats to compare the results of quality improvement studies[20,21].

B. Methodological study design

In order to conclude on effectiveness of de-implementation studies, the methodological design used should fit the research question. Using a design without a control group may lead to wrong conclusions about the effectiveness of the de-implementation strategies. For example, if in ***Chapter 4*** the effect of the tailored de-implementation strategy on the percentage of patients aged 50 years and over with degenerative knee disease that received an MRI or arthroscopy was not compared with a control group the conclusion could be drawn that the tailored de-implementation strategy showed a positive effect. However, also in the control group a reduction of the use of low value care occurred, indicating that this result could not be attributed towards the tailored de-implementation strategy. In addition, in both implementation and de-implementation studies a before-after design is often used to make causal

inferences (***Chapter 5 and 6***). However, these designs are often not sufficiently reliable to do so and any secular time trend could not be observed. Therefore, for (de-)implementation studies a comparison with a control group is important to evaluate the result of a (de-)implementation strategy and to check for a secular time trend.

Differences between implementation and de-implementation strategies

The reviews in ***Chapter 5 and 6*** explored effective strategies for (de-)implementing in nursing practice. Due to a lack of high-quality studies and a consistent description of the (de-)implementation strategy, no conclusion could be drawn on a strategy or combination of strategies that could be linked towards successful implementation and/or de-implementation in nursing care. The results of both reviews were compared to detect any similarities and differences between (de-) implementation strategies used. A similarity found for both implementation as de-implementation was that an educational component was often used as part of the (de-)implementation strategy, but that it was mostly not effective on its own. This is in line with previous literature where it is described that only education is not enough[22].

Based on both reviews (***Chapter 5 and 6***), no differences were found between the implementation and de-implementation strategies used in nursing, which does not automatically indicate that implementation and de-implementation strategies are indeed the same. Patey et al.[23] showed namely, that the techniques used to change the behavior within strategies differ between implementation and de-implementation. Unfortunately, the reviews in ***Chapter 5 and 6*** did not review the used behavior change techniques underlying the strategies. Furthermore, the results of the reviews do not automatically indicate that the strategy components of implementation and de-implementation strategies should be the same. After all, no conclusions could be drawn on the effectiveness of (de-)implementation strategies. Based on literature, we expect that effective strategies for implementation and de-implementation will show some similarities, but also some differences. As literature describes that strategies tailored to determinants for (de-)implementation are likely more effective and that determinants for implementation and de-implementation differ, effective strategies are also expected to be different. A previous study of van Bodegom-Vos et al.[24] showed, for example, signals that organizational determinants are more related to implementation; where motivational, economic and political determinants are more associated with de-implementation. This indicates that different types of determinants could play a role for both implementation and de-

implementation. In addition, Van Bodegom et al.[25] described "uncertainty" about the consequences of withholding tests or treatments as important determinant that hampers de-implementation. This uncertainty includes among healthcare professionals fear to make a mistake, being sued by patients or get complaints, and for financial consequences. Among patients and the public, this uncertainty is related to a poor willingness of patients, society and healthcare providers to accept that there is always a degree of uncertainty. All these different forms of uncertainty could result in the use of more unnecessary diagnostic testing and treatments, driven by several cognitive biases[14]. Examples of these biases are the tendency to favor action over inaction (action bias) and to avoid experiencing regret by not performing a medical service (anticipated regret). Based on these differences in determinants influencing implementation and de-implementation other strategies maybe effective. In literature it is assumed that strategies that address these biases may be more effective for de-implementation. Besides other strategies, de-implementation is viewed as more challenging as it is harder to stop doing things than starting something new because reducing low value care requires different knowledge, mindset and/or skills (e.g., skills for communicating with patients and/or colleagues) of healthcare professionals[26].

Implications for clinical practice and further research

In this paragraph the implications of the research described in this thesis for (research) practice will be discussed and suggestions will be made to improve research about improving quality of care (*Table 1*).

More high-quality research is needed regarding strategies for effective implementation of nursing guidelines and for de-implementation of low value nursing and orthopedic care, which use reporting guidelines for a more transparent description of the (de-) implementation strategy. Based on the findings of ***Chapter 4-6*** we notice that many different (de-)implementation strategies are used to improve quality of care. Unfortunately, there is not a strategy or a combination of strategies that seems to be the most effective for implementing nursing guidelines or for de-implementing low value nursing and orthopedic care. To be able to compare the effectiveness of (de-)implementation strategies, reporting guidelines should be used for a more detailed description of the (de-)implementation strategy[20,21]. Using these reporting guidelines could also contribute to a higher reproducibility.

Future (de-)implementation studies should perform a barrier assessment, report how strategy components are matched to identified determinants, and evaluate the fidelity of the (de-)implementation strategy. Previous literature showed that tailored (de-)implementation strategies that address determinants for (de-)

implementation seems to be more effective[11-13]. Furthermore, to explain or improve the effectiveness of a (de-)implementation strategy, insight is needed into the extent to which the intervention is delivered as intended (intervention fidelity)[6]. Nowadays, it is often unclear why a (de-)implementation strategy is chosen and why it is expected to be effective. Besides, more research is needed about the best way to tailor interventions towards the determinants.

Future studies should use a control group (usual care) to assess the effectiveness of the (de-)implementation strategy. Based on the results ***Chapter 2-4*** where a tailored de-implementation for reducing the use of low value MRI and knee arthroscopy was developed, it could be concluded that that it is important for the assessment of (de-)implementation strategies to use a control group (usual care). In ***Chapter 4*** there was already a declining trend (a secular time trend) for both intervention and control group, which ensured that the wrong conclusion was made about the effectiveness of the tailored strategy.

For the selection of low value care to be de-implemented in daily practice, the rising tide phenomenon should be considered. Based on the results of ***Chapter 4***, it seems important to identify for which type of low value care there is a rising tide phenomenon (a secular time trend created by the social response on a topic with widespread attention). In that case, there is less priority to start an active de-implementation process for this certain type of low value care.

For clinical practice, it is recommended for education of healthcare professionals that knowledge about (de-)implementation and associated skills should be trained, even as the mindset among healthcare professionals about seeing quality improvement as a continuum of healthcare evaluation. The evolving knowledge on clinical evidence stresses that also daily clinical practice is evolving and should be seen as a continuum of healthcare evaluation aimed at reducing risks to patients by eliminating low value care or alternately proposing more effective, sometimes more efficient, healthcare. This continuum process of healthcare evaluation is complex and requires knowledge about de-implementation. Besides, it might require a different mindset and/or skills (e.g., skills for communicating with patients and/or colleagues) of healthcare professionals than for implementation initiatives. In addition, it is easier to start doing something new than to stop with old behavior[26], even more so in the surgical field it was easier to introduce a new surgical technique for wrist surgery then de-implement surgical treatment for plaster[27].

Table 1. An overview of implications for clinical practice and further research.

Implications for clinical practice and further research:
• More research is needed about a strategy/combination of strategies for effective implementation of nursing guidelines or de-implementation of low value nursing and orthopedic care, with studies using reporting guidelines for a more transparent description of the (de-)implementation strategy.
• (De-)implementation studies should perform a barrier assessment, report how strategy components are matched to identified determinants, and evaluate the fidelity of the (de-)implementation strategy. More research is needed about the best way to tailor interventions towards the determinants.
• Future studies should use a control group (usual care) to assess the effectiveness of the (de-)implementation strategy.
• For the selection of low value care to be de-implemented in daily practice, it is advised to consider the rising tide phenomenon.
• In the education of healthcare professionals' knowledge about (de-) implementation and associated skills should be trained, even as the mindset among healthcare professionals about seeing quality improvement as a continuum of healthcare evaluation.

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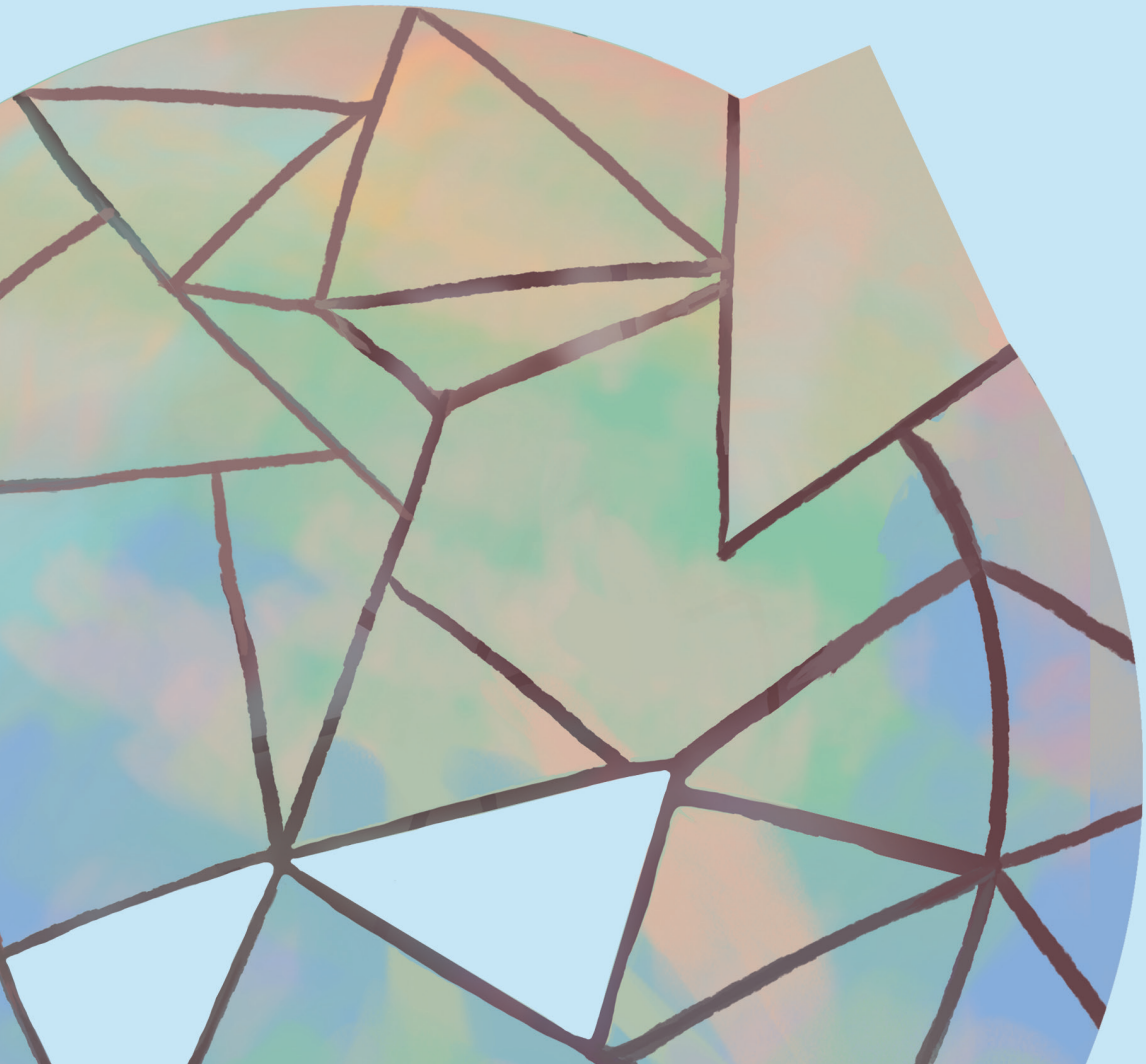

8

Nederlandse samenvatting

Curriculum Vitae

List of publications

Dankwoord

NEDERLANDSE SAMENVATTING

Hoofdstuk 1

In de gezondheidszorg wordt niet altijd optimale zorg geboden. Soms krijgen patiënten bepaalde zorg (bijvoorbeeld diagnostiek en behandelingen) niet, terwijl ze er potentieel wel baat bij kunnen hebben. Anderzijds kan het voorkomen dat patiënten zorg ontvangen waar ze juist geen baat bij hebben. Deze situaties worden respectievelijk onderbenutting en overbenutting van zorg genoemd. Onderbenutting van gepaste zorg, oftewel bewezen effectieve medische interventies, komt wereldwijd voor en verschilt significant tussen landen[1]. Mogelijke verklaringen voor het te weinig inzetten van bewezen effectieve medische interventies zijn het niet navolgen van de richtlijnen door artsen en het gebrek aan toegang tot medische diensten (bijv. ziekenhuizen, zorgverzekeringen en medische technologie in ziekenhuizen)[1]. Het gebruik van niet-gepaste zorg, ook wel bewezen niet-effectieve medische interventies genoemd, kan onnodig belastend en soms schadelijk zijn voor de patiënt. Het kan daarnaast zorgen voor verspilling van middelen en/of voor onnodige gezondheidszorgkosten[2]. Om de kwaliteit van zorg te verbeteren en om een duurzaam gezondheidszorgsysteem te creëren, moet onderbenutting voorkomen worden en overbenutting gereduceerd of gestopt worden. Implementatie kan worden beschreven als het geplande proces om het gebruik van effectieve medische interventies te introduceren of te verbeteren met als doel dat het een structurele plek krijgt binnen de zorgpraktijk[3]. De-implementatie is een gepland proces waarbij bewezen niet-effectieve zorg structureel wordt gereduceerd of gestopt[4]. Naar de zorg waarvan we nog niet weten of deze meerwaarde heeft voor de patiënt, moet onderzoek worden gedaan zodat duidelijk wordt of de patiënt wel of geen baat heeft van de betreffende zorg.

Het doel van dit proefschrift is om de kennis uit te breiden over effectieve strategieën voor de implementatie van bewezen effectieve zorg en de de-implementatie van bewezen niet-effectieve zorg, zowel in de orthopedie als in de verpleegkundige praktijk. Bovendien is er binnen de verpleegkundige praktijk gekeken of er verschillen waren tussen effectieve implementatie en de-implementatie strategieën. In het eerste deel van het proefschrift worden de studies beschreven die betrekking hebben op de de-implementatie van MRI's en knieartroscopieën bij patiënten met degeneratieve knieklachten (*Hoofdstuk 2-4).* In het tweede deel van het proefschrift worden de onderzoeken naar effectieve (de-)implementatie strategieën in de verpleegkunde beschreven (*Hoofdstuk 5-6*).

Deel 1: De-implementatie van MRI's en een knieartroscopieën bij patiënten met degeneratieve knieklachten.

In deel 1 van dit proefschrift is onderzocht hoe MRI's en artroscopieën bij patiënten met degeneratieve knieklachten effectief gedeïmplementeerd kunnen worden. Patiënten van 50 jaar of ouder met degeneratieve knieklachten kunnen pijn en stijfheid ervaren tijdens het lopen, staan en traplopen[5]. De klachten ontstaan geleidelijk en zijn wisselend van aard. Daarnaast kunnen sommige patiënten slotverschijnselen ervaren. Dat zijn klachten die zorgen voor een beperkte bewegingsrange van de knie als gevolg van losse delen of meniscusscheuren. Meniscusscheuren zijn bij deze leeftijdsgroep meestal onderdeel van het degeneratieve proces en kunnen worden beschouwd als een kenmerk van een vroeg stadium van artrose[6,7]. Orthopedische richtlijnen[8-11] adviseren om eerst een röntgenfoto voor te schrijven, bij voorkeur een Fixed Flexion view, om de conditie van het kraakbeen van de knie te onderzoeken. Verder adviseert men om eerst niet-chirurgische behandelingen (pijnmedicatie, dieetadvies en fysiotherapie) aan te bieden. Alleen wanneer er sprake is van slotklachten door losse fragmenten (bot of meniscus) in de knie, waardoor de knie blokkeert, kan een artroscopie overwogen worden. Ondanks de bestaande richtlijnen en verstandige keuzes waarin een MRI en artroscopie bij patiënten met degeneratieve knieklachten wordt afgeraden, wordt er toch nog regelmatig een MRI en/of knieartroscopie voorgeschreven. Onduidelijk is hoe deze niet gepaste zorg verder gereduceerd kan worden. Om een effectieve strategie te ontwikkelen voor het reduceren van MRI's en knieartroscopieën bij patiënten met degeneratieve knieklachten is inzicht nodig in de mate waarin deze niet-effectieve behandelingen nog uitgevoerd worden en de factoren die invloed hebben op het voorschrijven van deze medische interventies.

Hoofdstuk 2

Hoofdstuk 2 beschrijft welk percentage patiënten met degeneratieve knieklachten een artroscopie hebben gehad zonder adequate indicatie volgens de richtlijnen op basis van dossieronderzoek in 13 orthopedische centra. Hieruit bleek dat bij een derde van de patiënten geen adequate indicatie werd gerapporteerd in het medisch dossier van de patiënt. In het dossier van deze patiënten werd vaak gerapporteerd dat in overleg met de patiënt of op verzoek van de patiënt besloten was tot het uitvoeren van een knieartroscopie.

Hoofdstuk 3

In hoofdstuk 3 wordt op basis van een interview- en vragenlijststudie beschreven welke factoren volgens orthopedisch chirurgen en patiënten van invloed zijn op het besluit om een MRI en knieartroscopie bij degeneratieve knieklachten uit te voeren. De studie toonde aan dat zowel het geloof in de toegevoegde waarde als de voorkeur van de patiënt en/of orthopedische chirurg voor een MRI en/of artroscopie het gebruik van MRI's en artroscopieën in de praktijk stimuleren. Daarnaast bleek dat positieve ervaringen van vrienden en/of familie met een MRI of artroscopie de verwachtingen van patiënten op zo'n manier beïnvloeden dat zij ook graag voor deze zorg in aanmerking wilden komen. Op basis van de gevonden factoren wordt verwacht dat een de-implementatiestrategie die zich richt op het geloof in de toegevoegde waarde van zowel de orthopedisch chirurg als de patiënt en op de verwachtingen en voorkeuren van de patiënt kan bijdragen aan het reduceren niet-gepaste MRI's en artroscopieën bij patiënten met degeneratieve knieklachten.

Hoofdstuk 4

Op basis van de gevonden factoren uit hoofdstuk 3 en de bestaande literatuur is in hoofdstuk 4 een de-implementatiestrategie ontwikkeld om het gebruik van MRI's en knieartroscopieën bij patiënten met degeneratieve knieklachten te reduceren. Deze de-implementatiestrategie is uitgevoerd in 13 orthopedische centra in Nederland. Het effect van de de-implementatie strategie werd geëvalueerd door het gebruik van MRIs en artroscopieën in de 13 deelnemende centra (interventiegroep) te vergelijken met het gebruik in de overige Nederlandse orthopedische centra (controlegroep) waar geen de-implementatiestrategie werd ingezet middels een difference-in-difference analyse. De primaire uitkomstmaat was het percentage patiënten per maand die een MRI en/of een artroscopie hadden ondergaan, gecorrigeerd voor het type ziekenhuis (universitair ziekenhuis, algemeen ziekenhuis, topklinisch ziekenhuis). Alle patiënten van 50 jaar of ouder met degeneratieve knieklachten die werden behandeld in een Nederlands orthopedisch centrum tussen 1 januari 2016 en 31 december 2018 werden geïncludeerd. Voor zowel de interventiegroep als de controlegroep werd een vergelijkbare afname gevonden in het gebruik van MRI's en artroscopieën, waardoor de afname in het gebruik van MRI's en knieartroscopieën niet kon worden toegewezen aan de ingezette de-implementatiestrategie.

Deel 2: Effectieve (de-)implementatie strategieën in de verpleegkunde

In deel 2 van dit proefschrift is onderzocht wat effectieve strategieën zijn om verpleegkundige richtlijnen te implementeren en niet-effectieve verpleegkundige handelingen te de-implementeren. In verschillende landen worden steeds meer verpleegkundige richtlijnen en Beter laten/Beter doen lijsten gepubliceerd[1,4,11,12] waarin aanbevelingen worden gedaan over welke verpleegkundige handelingen wel toegepast moeten worden in de praktijk en welke handelingen niet meer uitgevoerd moeten worden, omdat ze niet waarde toevoegend zijn. Desondanks worden deze richtlijnen en Beter doen/Beter laten lijsten nog niet altijd toegepast in de dagelijkse praktijk. Het is nog onduidelijk wat effectieve strategieën zijn om richtlijnaanbevelingen en Beter doen/Beter laten aanbevelingen op te volgen en dus effectieve zorghandelingen te implementeren en niet gepaste zorghandelingen te de-implementeren.

Hoofdstuk 5

In hoofdstuk 5 is door middel van een systematische literatuur review en een meta-analyse gekeken welke de-implementatiestrategieën effectief zijn voor het verminderen van niet-gepaste verpleegkundige handelingen. Er werden 27 studies gevonden die de effectiviteit van een strategie voor het reduceren van niet-gepaste verpleegkundige handelingen onderzochten. Hiervan hadden 15 studies een gecontroleerd design en 12 studies een ongecontroleerd design. De studies onderzochten het reduceren van het niet-gepast gebruik van vrijheidsbeperkende interventies (VBI), het niet-gepast voorschrijven van antibiotica, niet-gepast katheter gebruik, het voorschrijven van niet-gepaste levertesten en het niet-gepast voorschrijven van antipsychotica. Meer dan de helft van de geïncludeerde studies lieten een significante afname zien in het gebruik van de niet-gepaste zorg die zij beoogden te reduceren. De meerderheid van de studies met een positief significant effect had een educatieve component als onderdeel van hun de-implementatiestrategie. Denk hierbij aan educatieve bijeenkomsten, scholingsmaterialen en educatieve spellen. Desalniettemin liet het onderzoek zien dat ook de studies zonder een positief significant effect tijdens hun de-implementatiestrategie een educatieve component hadden ingezet. Hierdoor kan het gebruik van een educatieve component niet per definitie worden gezien als een succesvolle de-implementatiestrategie voor het reduceren van niet-gepaste verpleegkundige handelingen. Een verschil tussen de gecontroleerde en ongecontroleerde studies met een positief significant effect is dat de meerderheid van de effectieve ongecontroleerde studies een de-implementatiestrategie had die bestond uit één component,

waar de effectieve gecontroleerde studies met een positief significant effect een meervoudige strategie gebruikten.

Hoofdstuk 6

Hoofdstuk 6 beschrijft de resultaten van een systematische literatuur review over de effectiviteit van strategieën om verpleegkundige richtlijnen te implementeren in de praktijk. Naast het effect van de implementatie strategieën op het naleven van de richtlijn, is in dit review ook gekeken naar het effect van de strategieën op patiënt gerelateerde uitkomstmaten. In het systematische review werden 54 studies, waarvan 53 unieke implementatiestudies, geïncludeerd. Hiervan hadden 15 studies een gecontroleerd design en 38 studies een ongecontroleerd design. Deze studies onderzochten de implementatie van richtlijnen over diverse onderwerpen, waaronder huidverzorging en infectiepreventie. De meerderheid van de geïncludeerde studies liet een positief significant effect zien op de patiënt gerelateerde verpleegkundige uitkomstmaten of op de naleving van de richtlijnen. In de meeste studies werd er gebruik gemaakt van een meervoudige implementatiestrategie met daarin een educatieve component. Er is geen specifieke strategie gevonden die geassocieerd is met de succesvolle implementatie van verpleegkundige richtlijnen.

Hoofdstuk 7

Tot slot worden in hoofdstuk 7 de algemene bevindingen ten aanzien van het overkoepelende doel van dit proefschrift bediscussieerd en worden op basis van deze bevindingen aanbevelingen gedaan voor de klinische praktijk en voor toekomstig onderzoek. Het doel van dit proefschrift was om de kennis uit te breiden over effectieve strategieën voor de-implementatie van niet gepaste zorg en de implementatie van gepaste zorg, waarbij zowel de orthopedie als de verpleegkundige praktijk zijn onderzocht. Er zijn voor zowel de implementatie van verpleegkundige richtlijnen als voor de de-implementatie van niet-gepaste verpleegkundige handelingen en orthopedische zorg geen (de-)implementatiestrategie of een combinatie van strategieën gevonden die het meest effectief waren. Om de effectiviteit van strategieën in de toekomst meer te kunnen vergelijken, moet het onderzoek naar de effectiviteit van strategieën beter gerapporteerd worden en moeten de ingezette (de-) implementatiestrategieën gedetailleerder worden beschreven volgens de daarvoor beschikbare richtlijnen[12,13]. Ook is het van belang dat onderzoekers in kaart brengen wat de beïnvloedende factoren zijn bij het wel of niet uitvoeren van bepaalde zorg, hoe die factoren zich verhouden tot de gekozen strategie en hoe de strategie in de praktijk daadwerkelijk is uitgevoerd. Verder is het aan

te raden om voorafgaand aan het inzetten van de (de-)implementatiestrategie te kijken naar de trend van het gebruik van de gepaste of niet-gepaste zorg om zo te kunnen inschatten of het van toegevoegde waarde is om een actief (de-)implementatieproces te doorlopen. Bij de evaluatie van het effect van een (de-)implementatiestrategie draagt het gebruik van een controlegroep bij aan het vaststellen van een eventuele trend in de groep die de gebruikelijke zorg krijgt (controlegroep) vast te stellen. Hierdoor wordt een eventuele toename of afname in het gebruik van zorg niet onterecht toegeschreven aan een uitgevoerde (de-)implementatiestrategie.

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CURRICULUM VITAE

Tessa Rietbergen werd geboren op 5 oktober 1993 in Haarlem en is opgegroeid in Hoofddorp. In 2011 behaalde ze haar VWO diploma aan de Katholieke Scholengemeenschap Hoofddorp. In datzelfde jaar begon ze met haar studie Bewegingswetenschappen aan de Vrije Universiteit Amsterdam. In 2014 behaalde ze haar bachelor Bewegingswetenschappen met daarbij een erkend diploma in de psychomotorische therapie. In 2015 behaalde ze haar master Human Movement Sciences aan de Vrije Universiteit Amsterdam in de richting sport psychologie. Tijdens haar studie raakte ze ook steeds meer geïnteresseerd in kwaliteitsverbetering in de zorg.

In 2016 startte zij met haar promotieonderzoek op de afdeling Biomedical Data Sciences, sectie Medische Besliskunde, in het Leids Universitair Medisch Centrum. Dit deed zij onder supervisie van prof. Dr. Ewout W. Steyerberg, prof. Dr. Rob G.H.H. Nelissen en dr. Leti van Bodegom-Vos. Tijdens haar promotietraject presenteerde ze de resultaten hiervan meermaals op symposia en congressen.

In 2020 is zij gestart als beleidsadviseur bij het programma Zorgevaluatie en Gepast Gebruik (ZE&GG), waarbij zij de wetenschappelijke kennis kan verbinden met de praktijk. In het programma ZE&GG werken patiënten, zorgverleners, zorgaanbieders, zorgverzekeraars en overheid samen aan de bewezen beste zorg voor de patiënt. Tessa richt zich binnen het programma ZE&GG voornamelijk op het implementeren van bewezen passende zorg en het de-implementeren van bewezen niet-passende zorg.

LIST OF PUBLICATIONS

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