

**Nursing education interventions for managing acute pain  
in hospital settings: a systematic review  
of clinical outcomes and teaching methods**

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## Abstract

**Objectives:** To examine the effects of nursing education interventions on clinical outcomes for acute pain management in hospital settings, relating interventions to healthcare behavior-change theory.

**Methods:** Three databases were searched for nursing education interventions from 2002 to 2015 in acute hospital settings with clinical outcomes reported. Methodological quality was rated as strong, moderate or weak using the Effective Public Health Practice Project Quality Assessment Tool for quantitative studies..

**Results:** The twelve eligible studies used varied didactic and interactive teaching methods. Several studies had weaknesses attributable to selection biases, uncontrolled confounders, and lack of blinding of outcome assessors. Studies did not explicitly reference theory underlying design of their interventions. No studies made reference to behavior change theory in their design. Eight of the twelve studies investigated nursing documentation of pain assessment as the main outcome, with the majority reporting positive effects of education interventions on nursing pain assessment. Of the remaining studies, two reported mixed findings on patient self-report of pain scores as the key measure, one reported improvements in patient satisfaction with pain management after a nursing intervention, and one study found an increase in nurses' delivery of a relaxation treatment following an intervention.

**Discussion:** Improvements in design and evaluation of nursing education interventions are suggested, drawing on behavior change theory and emphasizing the relational, contextual and emotionally demanding nature of nursing pain management in hospital settings.

**Keywords:** pain assessment, behavior change, nurse behavior

## Introduction

Despite the designation of pain as “the fifth vital sign” (International Pain Summit, 2011), acute pain remains variably and often sub-optimally managed (Apfelbaum, Chen, Mehta, & Gan, 2003; Duncan et al., 2014). Poor acute pain management can lead to adverse consequences including post-surgical complications and prolonged hospital stays, increasing healthcare costs (Mackintosh, 2007; Sinatra, 2010) and patient suffering (IASP, 2010; Kehlet, Jensen, & Woolf, 2006).

Nurses’ key role in inpatient pain management (Bucknall, Manias & Botti, 2007) can extend to responsibility for pain assessment, basic analgesic prescription, and titration of patient-controlled analgesia (National Health Service, 2015). Many of these responsibilities are covered by guidelines on best practice in assessment and treatment (McCafferty & Pasero, 1999). Assessment is ideally by patient report (McCafferty & Pasero, 1999; Turk & Melzack, 2011), but nurses may fail to assess pain adequately (Sloman, Rosen, Rom & Shir, 2005) and/or may substitute their own estimates of pain (Schafheutle, Cantrill, & Noyce, 2001). Treatment may be undermined by excessive fears of unwanted analgesic effects and by inadequate appreciation of pharmacological and non-pharmacological resources to reduce suffering (Liu, So & Fong, 2008; Sloman et al., 2005).

Shortcomings in pain education during nursing training (Chow & Chan, 2014) underlie poor post-qualification pain management. An institutional needs assessment that aimed to improve postsurgical pain management found important skills deficits, particularly in nurses’ ability to recognize signs and symptoms of pain (González-Fernández et al., 2014).

Many inpatient pain initiatives have relied on education to improve nurse knowledge and beliefs (Gordon, Pellino, Enloe & Foley, 2000; Gunnarsdóttir & Gretarsdottir, 2011; Kaasalainen et al., 2014; McNamara, Harmon & Saunders, 2012), but these do not necessarily predict clinical behavior (Watt-Watson, 2001), for which self-report lacks accuracy (Dihle, Bjolseth & Helseth, 2006). There is no simple way of improving clinical practice (Oxman, Thomson, Davis, & Haynes, 1995), but effective training involves interactive learning (Forsetlund et al., 2009; Twycross, 2002) and individual feedback (Forsetlund et al., 2009, Gunnarsdóttir and Gretarsdottir 2011).

Psychological theory informing behavior change has been synthesized by Michie and colleagues (2005) to use in designing evidence-based healthcare guidelines. Twelve domains, including knowledge and skills, motivational factors, learning context, beliefs about capabilities, and the perceived role of the learner (Michie et al., 2005) map on to existing constructs from the research literature (Fishbein, Triandis, Kanfer, Becker, & Middlestadt, 2001). These domains can also be used to develop behavior change techniques (Michie, Johnston, Francis, Hardeman, & Eccles, 2008), and applying them to nurse education in pain management may enable better

distinction of helpful from unhelpful findings and guiding theory (Gunnarsdóttir & Gretarsdottir, 2011; Twycross, 2002).

We examined the effect on clinical outcomes of nurse education interventions for acute inpatient pain management, and the use of underlying theory in intervention design:

1. What types of nursing education interventions have been implemented to improve pain management in hospital settings?
2. Do nursing education interventions to improve pain management yield positive clinical outcomes?
3. Do the teaching methods used in the nursing interventions correspond to existing behavior change domains?

## **Method**

### ***Data Sources***

A search strategy was generated using several highly cited papers, and their reference lists, refined with the help of a specialist university librarian proficient in database searching. Three electronic databases - Embase, Medline and CINAHL (Cumulative Index to Nursing and Allied Health Literature) - with distinct but complementary and comprehensive coverage of medical, psychological, biological and nursing research (Petticrew & Gilbody, 2004), were searched on 11.05.15, using the following terms, subject headings and keywords in abstract and title:

Nursing education OR staff training OR staff education OR education programme OR health education

AND

Pain OR Pain measurement OR pain assessment OR Pain management OR Analgesia

AND

Acute pain OR Acute disease OR Postoperative Pain OR Surgical Pain OR Postsurgical Pain  
(Limits: 2002-2015, English Language)

The output of this search was filtered using the following inclusion criteria:

- Experimental, quasi-experimental and observational studies involving education interventions targeted at nurses in acute or surgical pain settings, and reporting quantified clinical outcomes.
- Programmes or initiatives targeted at a range of professionals in a hospital setting where the effects of the nursing education component could be identified.

- Published in English (we lacked resources for translation), in peer reviewed journals, from 2002 to May 2015. The start date was chosen to avoid including papers in the high quality review by Twycross (2002).

There were no exclusion criteria.

### ***Data extraction***

Data on participants, setting, intervention and outcomes were extracted from each papers, as per recommendations (Centre for Reviews and Dissemination). Previous studies of behavior change theory and healthcare interventions (Michie et al., 2005; Forsetlund et al., 2009; Twycross, 2002) provided useful guidance for the extraction of data on the content and methods of the interventions.

### ***Quality Rating***

The Cochrane Public Health Review Group (Armstrong et al., 2008) recommends the Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies (EPHPP), with six components combined for a global rating. A distinction is made here between methodological quality on the EPHPP and intervention quality (examined in research questions one and three) ascertained by extended examination of style, content and techniques employed. GD performed ratings on all papers and AW rated a subset of five papers. Discrepancies were discussed with reference to the accompanying dictionary until consensus was reached.

## **Results**

A PRISMA diagram of the search and selection process is shown in Figure 1. Twelve studies were eligible; 15 studies read as full papers were excluded (see Appendix I); seven implemented an intervention that did not distinguish nurses' behavior from that of other clinical staff; six combined education with a potentially confounding change to hospital medication protocol; one only introduced a new documentation tool without education; and one only reported qualitative data.

Figure 1 about here

### ***Methodological Quality assessment***

Five studies achieved a global rating of 'strong', meaning no 'weak' score on any of the six components. Two of these studies used an uncontrolled before and after design (Abdalahim et

al., 2011; Hansson Fridlund & Hallström, 2006), two used a controlled before and after design (Mac Lellan, 2004; Morisson et al., 2007), and the fifth was a controlled clinical trial (Zhang, Hsu Li, Wang, Huang, 2007).

Four studies, incorporating a similar range of designs, had just one 'weak' component rating thus a global rating of 'moderate'. Two scored 'weak' for selection bias, using convenience sampling with no indication of refusal rate (Lin, Chiang, Chiang & Chen, 2008; Michaels et al., 2007), One study scored 'weak' on blinding, as outcome assessors and participants were aware of the study question (Hong & Lee, 2004). The fourth study had important confounding differences in gender and type of surgery between control and intervention staff groups (Ravaud et al., 2004).

The remaining papers were rated as 'weak' on two components (Elshamy & Ramzy, 2011; Inness et al., 2004; Maunsaiyat et al., 2009) giving a 'weak' overall rating. These weaknesses were again in the areas of selection bias, uncontrolled confounders, and lack of blinding of outcome assessors and participants to the study question.

*Table 1 about here*

### **Main findings**

Table 1 illustrates the design, participants, settings, methods of intervention, and main findings of the 12 studies included. Studies came from 10 different countries with varied policies, protocols and guidelines on pain management informing the interventions. All took place on surgical wards (and some additionally in medical wards or emergency departments), but with varied staffing levels. Eight studies reported the numbers of nurses participating, with a mean of 87 (range: 18 to 187). The percentage of nurses approached who agreed to take part was 80-100% in five papers, (Abdalahim et al., 2011; Innis et al., 2004; Morisson et al., 2006; Ravaud et al. 2003; Zhang et al., 2008), 60-79% in two (Hansson et al., 2006; Hong & Lee, 2014), and not reported in the remaining five papers.

Only one paper (Hong et al., 2014) confirmed by power analysis that the number of patients assessed was sufficient, and their calculation of 123 data points to capture a moderate effect size suggests that most of the smaller papers may have been underpowered. Attrition of nursing staff was not an important factor in any study, but in one study (Hansson et al., 2006) it was unclear what proportion of the control group nursing staff were subsequently involved in the intervention group.

## **1. What types of nursing education interventions have been implemented to improve pain management in hospital settings?**

### *Duration of intervention*

Studies varied substantially in duration, from 20 minutes (Michaels et al., 2007) to 15 hours (Lin et al., 2008) teaching (see Table 1), with some unspecified durations, and at least one study (Ravaud et al., 2004) repeating sessions to maximize coverage. No study explained what principles informed the decision about duration. There did not appear to be any relationship between the duration of the interventions and methodological quality ratings.

### *Intervention provider*

Seven studies (Innis et al., 2004; Hansson et al., 2006; Lin et al., 2008; Maunsaiyat et al., 2009; Michaels et al., 2007; Ravaud et al., 2004; Zhang et al., 2007) were delivered by hospital-affiliated pain management experts, such as pain team members or specialist nurses. Three studies were carried out by the researchers and trained research assistants without specifying areas of expertise (Abdalahim et al., 2011; Elshamy & Ramzy, 2011), though one of these studies mentioned assimilating feedback from nurses, literature and expert opinion (Hong & Lee, 2014). One study used a mixture of nurse educators and the research team (Morrison et al., 2007) and one study (Mac Lellan, 2004) made no reference to who delivered the intervention but specified its endorsement by senior hospital staff. There did not appear to be any relationship between who provided the intervention and methodological quality ratings.

*Table 2 about here*

### *Teaching methods*

Table 2 shows similar variation in teaching methods among studies rated as methodologically strong, moderate and weak. All studies included a didactic teaching component, often focused on misconceptions about pain and current best practice guidelines, with skills training. This skills training concerned the use of an assessment tool in all but one study (Lin et al., 2006) that instead taught the application of therapeutic relaxation. Ten studies mentioned interactive teaching, and all but two (Innis et al., 2004; Ravaud et al., 2004) mentioned small group discussions where questions from nursing staff were encouraged. Five studies (Abdalahim et al. 2011; Hansson et al., 2006; Lin et al., 2008; Michaels et al., 2007; Zhang et al., 2007) also used role-plays and vignettes of a case or clinical material for nurses to discuss.

Four studies (Lin et al. 2008; Mac Lellan, 2004; Michaels et al., 2007; Ravaud et al., 2004) provided no ongoing support, whereas the remainder provided either a compact disc (Abdalahim et al., 2011; Maunsaiyat et al., 2009), a booklet for nurses to carry (Elshamy & Ramzy, 2011; Innis et al., 2004; Zhang et al., 2007), web-support (Morrison et al., 2007; Hansson et al. 2006; Hong &

Lee, 2014), or the availability of the researcher or pain experts for some time after the intervention (Abdralrahim et al., 2011; Elshamy & Ramzy, 2011).

All but three studies (Lin et al., 2008; Mac Lellan, 2004; Zhang et al., 2007) provided some form of feedback to nurses; a test or specific feedback on pain assessment performance. One study provided feedback with a cover letter signed by the nursing director (Ravaud et al., 2004), presumably to emphasize the importance of the outcome and suggest negative consequences for poor performance.

## **2. Do nursing education interventions to improve pain management yield positive clinical outcomes?**

The main aim of the majority of interventions was to improve nursing practice, assessed by clinical indicators such as documentation of assessment or use of pain assessment tools. Eight studies assessed nursing documentation of pain assessment as the main clinical outcome; of the remaining four, one used patient satisfaction with pain management (Hansson et al., 2006), two nominated pain scores as the main outcome (Hong & Lee, 2014; Mac Lellan, 2004), and one counted nurses' delivery of a relaxation intervention for pain (Lin et al., 2008). Only one of the reviewed studies relied solely on nurse report of behavior (Lin et al., 2008).

### *Nursing pain assessments*

All but one (Michaels et al., 2007) of the eight papers that measured nursing assessment reported significant improvement after intervention in the frequency of appropriate documentation. Of those seven papers reporting improvement, three included control groups, other wards or hospital sites where the intervention was not run and where documentation did not improve. (Morrison et al., 2007; Ravaud et al., 2004; Zhang et al., 2007). Three further studies, as well as assessing rates of pain assessment, also found improvements in their comprehensiveness using composite measures with items such as description of symptoms, communication with patients, and descriptions of pain management methods or resources used (Abdralrahim et al., 2011; Elshamy & Ramzy, 2011; Maunsaayat et al., 2009). Two of these (Abdralrahim et al., 2011; Elshamy & Ramzy, 2011) used a previously validated measure of nursing documentation comprehensiveness (Ehnfors & Smedby, 1993). Similar components of documentation but with scoring approved by an anaesthetist was used by one study (Maunsaayat et al., 2009).



### *Patient self-report of pain*

Five studies included patient self-report of pain as an outcome, using a visual analogue scale. Two found significant improvements in pain self-ratings on each of the several days after surgery in the intervention group but not in the control group (Hong & Lee, 2014; Mac Lellan, 2004). Three studies found no change in pain self-ratings after the intervention (Innis et al., 2004; Morrison et al., 2007; Ravaud et al., 2004).

Pain scores do not necessarily decrease after education and training in the use of pain assessment tools; average scores across patients may increase if assessment becomes more thorough and frequent. Only three studies (Hong & Lee, 2014; Mac Lellan, 2004; Morrison et al., 2007) explicitly aimed to decrease pain self-ratings as an outcome. Several excluded studies included training on a pain assessment tool alongside changes to medication protocols, suggesting that assessing pain was linked to its relief by pharmacotherapy.

### *Patient satisfaction with pain management*

Hansson and colleagues (2006) found significant improvements when asking specifically about nursing pain measurement at rest and movement, but no improvements in overall patient satisfaction with the way pain was managed. Three other studies also included patient satisfaction data; two reported significant improvements in patient satisfaction with communication or experience of pain management after the education intervention (Elshamy & Ramzy, 2011; Innis et al., 2004) and one reported no significant changes (Michaels et al., 2007).

### *Nursing provision of treatment for pain*

Lin and colleagues (2008) found that nurses trained to offer relaxation to patients (intended to decrease pre-operative anxiety and speed of recovery) were significantly more likely to do so, although this was based on nurse self-report rather than audit of patient records

There were no discernible associations between outcomes and methodological quality ratings. Overall, the data were not of sufficient quantity or quality to explore quantitative associations of outcome efficacy with type of intervention.

## **3. Do the methods used in the education interventions map on to existing behavior change domains?**

Intervention quality was examined by mapping teaching methods on to behavior change theory. Table 2 shows the teaching methods used in each intervention, and Table 3 illustrates twelve domains of behavior change in healthcare settings (Michie et al., 2005). Despite no explicit reference to behavior change theory in any study, the methods used in the reviewed studies (see table 2) corresponded to many of the domains outlined in table 3. Although different teaching methods included elements that mapped onto the same domains, coverage of the majority of behavior change domains required multiple methods, as used in some studies. Reference, below, to a particular domain in table 3 is signified by the corresponding letter in brackets (see Appendix II for details of each domain).

*Table 3 about here*

### ***Didactic lecture/Practical skills training/Group discussion***

All papers reviewed included a didactic teaching component as well as practical skills training. These teaching methods partially map onto the domains of knowledge (a) and skills (b), which include the requirement that healthcare professionals need to be aware of the rationale behind the healthcare intervention (a) but also to possess the procedural and practical skills to carry out the behavior in clinical practice (b). Lecture-based teaching (a) alone provides little opportunity to ensure learning. Studies including group discussion provided an opportunity for questions, potentially benefiting learning (a). Practical skills training provided the opportunity to acquire or consolidate the procedural knowledge (b) required to undertake, for example, appropriate documentation of pain assessment.

The majority of the education interventions included correction of common misconceptions about pain and pain assessment. This might encourage direct assessment of pain (e) rather than reliance on behavioral indicators (Schafheutle et al., 2001), and regular assessment with appropriate pain rating scales (f). given nurses' tendency to under-assess (Sloman et al., 2005). There is no way of ascertaining whether these intended effects occurred. These methods of teaching failed to address the majority of behavior change domains.

### ***Role play/vignette***

Several studies included role-plays and vignettes, which map onto several other behavior change domains. Pain in others (such as patients) can evoke an emotional response associated with a variety of desired and undesirable behaviors. By replicating the hospital environment in which pain assessments are done, role play begins to address the emotions influences on acquisition or application of learning (j); this is far less likely to occur in didactic learning. In vivo

demonstrations of pain management procedures also provide the opportunity to examine changes in attention, memory, and decision-making (g) in conditions that more closely simulate the environment in which nurses make assessment and treatment decisions. These methods also provide the opportunity for behaviors to be dismantled into component parts (k), to explore potential barriers (k), for example, to optimal use of a new pain assessment tool, and to examine whether old habits, such as previous pain assessment methods, interfere with the application of new learning (l). The addition of these interactive teaching techniques addresses a substantially greater number of behavior change domains.

### ***Feedback/test***

Several studies included some form of test or feedback on learning, methods that relate to motivation and goals (f), as well as beliefs about capabilities (d) and consequences (e), particularly where nurses believed that their performance was monitored and could affect their employment. Studies that provided feedback by senior staff members used social pressures of the medical hierarchy operating in hospital settings (i), where motivations to improve pain management practice may include avoiding threats to employment or career progression, and following examples set by senior members of staff (f, i). Little is evident in the studies reviewed about motivational factors beyond implicit pressure to perform well; there was no discussion noted of more intrinsic motivation, such as nursing role or identity (c), or the level of priority that nurses accorded to pain management (f).

### ***Extra or ongoing support***

The provision of support can facilitate continuing motivation (f) and helps to regulate emotion (j) by addressing unexpected concerns that can arise as learning is put into practice. An available researcher or nurse specialist also provides a resource to consult during decision-making (g). Some studies provided web-based or pocket guide support to aid memory (g) and to describe pain management behaviors in discrete steps (k). It is not known whether such support is routinely available to nurses (h). Where ongoing support was provided only for the duration of data gathering, as by the research staff, there is no way of estimating the impact of its removal on nurses' motivation (f), self-efficacy (d), decision-making capabilities (g), and emotion regulation (j).

## **Discussion**

The aim of this study was to review nursing education interventions for pain management in acute hospital settings, with emphasis on clinical outcomes and the teaching methods used, while drawing comparisons between these methods and domains involved in healthcare behavior change. The majority of studies used a range of didactic and interactive teaching methods, including role plays, vignettes, feedback on performance, group discussions and ongoing support (Forsetlund et al., 2009; Twycross, 2002), that mapped onto many of the domains involved in behavior change (Michie et al. 2005).

No studies referred to behavior change theory in their design, and some aspects were poorly represented. Strengthening nurses' intention or motivation is important for behavior change, (Fishbein et al., 2001; Michie et al., 2005), with positive effects on healthcare outcomes demonstrated when nurses feel autonomous (Brown & McCormack, 2011) and involved in decision-making (Chan, 2013; Dihle et al., 2006). Evidence of nurses' involvement in intervention design and behavioral outcomes, which might have facilitated intrinsic motivation, was largely absent from the studies. Neither the methods nor designs of the interventions addressed nurses' professional identity or personal interest in helping patients in pain, arguably a more lasting basis for adopting the desired behaviors.

Many of the studies reviewed cited research demonstrating the importance of empowering nurses, but it was not clear if or how empowerment was implemented in the interventions. Several studies included teaching on misconceptions about pain, aiming to increase the perceived importance of assessing pain with patient self-report rather than nurses' judgement (McCafferty & Ferrell, 1999). It is difficult to ascertain from the studies what priority pain assessments had for nurses, or whether study designers assumed without verification that nurses valued the clinical outcomes targeted. Studies appeared to rely implicitly on presumed motivation arising from strong social norms in a nursing hierarchy, and from performing in accordance with hospital protocol (Wensing et al., 1998; Michie et al., 2005). Top-down policies or protocol changes based on audits, new guidelines, or data showing suboptimal performance were the starting point for most studies, and this is not compatible with designing to empower those whose behavior is the target of change; assessment may even be experienced as punitive checks on performance (e.g. Ravaud et al., 2004).

The specialist nurses who helped to design and deliver some interventions might be perceived by nurses as role models for making pain management an essential part of their professional work (Michie et al., 2005; Michie et al., 2008). Intrinsic motivation might also be strengthened (as in one of the reviewed studies: Lin et al., 2008) by training nurses in the use of a non-pharmacological

resource that could be delivered independent of other interventions, thus facilitating nurses' autonomy in pain management (Brown & McCormack, 2011; Chan, 2013; Dihle et al., 2006).

The interactive teaching methods used in several studies fell short of capturing the challenges of nurses' everyday work, which involves shifts in attention, multi-tasking, ad hoc changes to priorities, and interruptions (Bragadóttir, Gunnarsdóttir, Ingason, 2014) These can push nurses towards discounting pain or estimating it from extraneous cues (age, sex, social class, ethnicity) rather than patient self-report (Williams, 2002). Contextual and relational factors have an important impact on pain management behaviors but are difficult to address solely by reference to misconceptions about pain or by training nurses on pain assessment instruments. Training nurses on a known pain assessment tool also fails to capture the social nature of pain assessment (Schiavenato & Craig, 2010), which is significant when considering reliability and validity of the common pain assessment instruments, such as the visual analog scale (VAS) and numerical rating scale (NRS) (Jensen & Karoly, 2011) - pain cannot be reliably captured in the same way as the other four vital signs because it is not a procedure independent of the patient's communicative or cognitive abilities or emotional state. For example, patients have been shown to use varied strategies for pain assessment completion that make meanings complex to understand (Broderick, Stone, Calvanese, Schwartz & Turk, 2006; Williams, Davies, & Chadury, 2000).

Thus training on using a pain scale is not the same as training on how to assess pain. Eliciting and examining some of the potential reasons for nurses' reliance on their own judgement over patient self-report, as well as equipping nurses to assess pain amidst other demands, including in patients who cannot communicate verbally or whose cognitive status is uncertain, could usefully be included in nursing pain management interventions.

Pain assessment and management on hospital wards usually involves patient self-report of pain alongside pharmacotherapy, guided by protocols. Using decreased pain levels by patient self-report as an outcome does not take into account the therapeutic value of good assessment in itself. Among the studies reviewed, it is possible that patients benefited from thorough assessment itself, not only from the intervention that presumably followed. Studies arguably undervalued nurses' traditional role as 'caretakers of suffering' (Morse et al., 1994) and therefore how this would inform pain management.

### ***Limitations***

A wider search of databases, with no language limit, would have ensured comprehensiveness of the review. We did not extract qualitative data on patients' experience of pain management, but recognize that it may enrich insights from the quantified outcomes. In order to identify the

specific effects of nursing interventions, we excluded studies of nursing education that were part of a wider initiative or that combined multiple staff groups – those studies could usefully be addressed in a further review using parameters from this review.

### ***Implications for Nursing***

There is no clear evidence that more recent studies built on earlier ones to maximize efficacy (Gunnarsdóttir & Gretarsdottir, 2011; Twycross, 2002). It would advance the field for future interventions to be designed with explicit reference to educational or behavior change theory and to ensure that outcomes are chosen that assess those changes. Almost twenty years ago, Watt-Watson (1997) suggested that improving nursing pain management requires more than knowledge acquisition. More recently, Michie and colleagues (2005; 2008) have demonstrated how behavior change theory can be used to develop a taxonomy of techniques for use in healthcare interventions.

This review highlights three recommends for future research and clinical practice:

1. Theory on behavior change should inform the design of interventions that aim to change behavior. Study design on a clear theoretical basis can address specific research questions, such as the efficacy of each element of the intervention package, with adequate power.
2. The inclusion of neglected components of behavior change - intrinsic motivation, professional identity, and the meaning for nurses of performing the specific tasks involved in the intervention – could enrich future nursing pain management interventions..
3. Barriers to nurses' optimal pain management require further investigation, ensuring that social and professional context, emotional impact, the meaning of the required tasks for nurses and nurses' day-to-day working conditions are addressed by pain management interventions, rather than only information and skills. Arguably, emotional barriers to behaviour change are under-addressed in the work of Michie and colleagues (2005). A good example of targeting emotion to change behavior is that of a successful intervention to boost empathy for ethnic minority patients in pain, thereby improving assessment of their pain, where education on pain had failed to overcome discounting of pain based on racial stereotyping (Drwecki, Moore, Ward & Prkachin, 2011).

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Figure 1 PRISMA diagram of review process

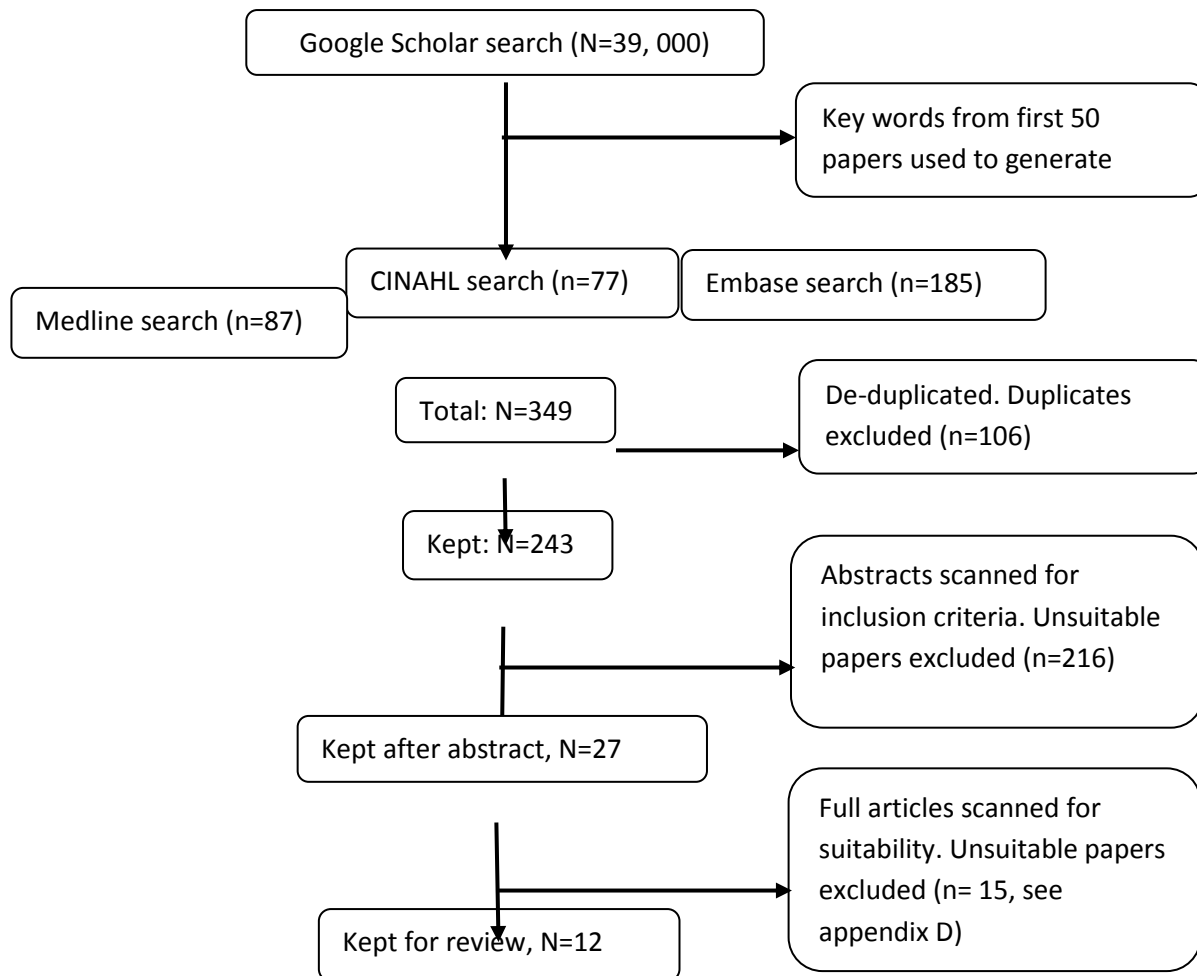


Table 1, Description of included studies ordered by summary quality category

Author(s) (year), design	Time-scale	Participants, sample size, setting	Intervention	Outcomes
<b>STRONG</b>				
<b>Abdalrahim et al. (2011)</b> Quasi-experimental uncontrolled before & after	Baseline 3 mth, Intervention 3 mth, Outcome 3 mth	<i>Staff</i> 65 nurses <i>Patients</i> 120 Two 100 bed, surgical wards, Jordan	Postoperative pain management program & CD <i>Duration</i> 2 days <i>Delivered by</i> research assistants	Audit records of pain documentation adequacy: 24% before, 77% after intervention. Mean pain score increased significantly,
<b>Hansson et al. (2006)</b> Quasi-experimental uncontrolled before and after	Baseline 2mth, Intervention 2mth, Outcome 2mth	<i>Staff</i> experimental: 101 nurses, 17 physicians; control: 86 nurses, 16 physicians <i>Patients</i> 181 5 acute medical & surgical wards, 1 emergency dept, Sweden	Quality improvement program including policy development, education, web-based support <i>Duration</i> 8 days, 6 mth <i>Delivered by</i> researchers using manual by pain experts. Nurses trained to deliver future teaching	Patient-rated changes in pain management: no change in patients' experience of pain management, no change in interference with functioning Nurse behavior: significant increase in nursing assessment of pain at rest and movement (% not specified) no change in use of non-pharmacological methods
<b>Mac Lellan (2004)</b> Quasi-experimental controlled before and after	Baseline 8 mth, intervention/control 8 mth, outcome 8 mth	<i>Staff</i> All nursing staff, no N <i>Patients</i> Intervention = 200 = control 2 teaching hospitals, Ireland	Pain education programme: lectures, posters at study days, hospital-wide pain conference <i>Duration</i> 2 afternoons interactive pain lectures; on-ward skills demonstrations over 6 mths <i>Delivered by</i> not specified	Significant reduction in mean pain scores for intervention hospital only (7.3%)
<b>Morrison et al. (2007)</b> Quasi-experimental controlled	Phase 1 0-4 mth, Phase 2 5-11 mth, phase 3 12-19 mth, phase 4 20-25 mth	<i>Staff</i> All nursing staff, not specified <i>Patients</i> Intervention = 1970,	Phased trial: education, audit & feedback, enhanced pain scale use, computerised	Enhanced pain scale compared with basic pain scale associated with:

before and after		Control = 1994 9 medical/surgical wards in 1171-bed hospital. USA	decision-support system <i>Duration</i> extended, not precisely specified <i>Delivered by</i> researchers	significantly better rates of pain assessment (64% vs 32%) prescribing for patients with moderate/severe pain (83% vs 66%) Audit & feedback compared with none associated with: significant increases in pain assessment rates (85% vs 64%) Computerised decision-support associated with: significantly increased pain assessment (79% vs 64%). None associated with change in mean pain rating.
<b>Zhang et al. (2007)</b> Controlled clinical trial	Baseline, intervention, 1 & 3 mth follow-up	<i>Staff</i> Intervention N = 105; control N = 82 <i>Patients</i> 254 patient records intervention; none control hospital 5 medical/surgical wards, 2 teaching hospitals, China	Education program & pocket pain assessment guide <i>Duration</i> 2 x 3 hour sessions <i>Delivered by</i> faculty-instructed nurses, oncologists and anaesthetists who developed program with researcher	Significantly greater use by nurses of pain scale in intervention group vs control group at follow-ups: 57/103 vs 46/62, 105/106 vs 32/90
<b>MODERATE</b>				
<b>Hong &amp; Lee (2014)</b> Quasi-experimental interrupted time series, post-test only control group design	Baseline 1 mth, intervention 3 weeks, Outcome assessment 1 mth	<i>Staff</i> 27 nurses <i>Patients</i> 124 Abdominal surgical wards, tertiary hospital, South Korea	Web-based, evidence-based guideline & educational session <i>Duration</i> 5 x 80 minute teaching sessions <i>Delivered by</i> research team	Postoperative pain measured by nurse significantly better in intervention than control at follow-ups: Group F=13.74, p<.001 Time F=113.81, p<.001 Group x time F=7.00, p<.001
<b>Lin et al. (2008)</b> Controlled clinical trial	Baseline, intervention 2 weeks, outcome assessment 1 week	<i>Staff</i> intervention: 42 nurses control: 39 nurses <i>Patients</i> 40 intervention interviewees	Education program on delivering relaxation therapy <i>Duration</i> 7 units = 15 hours of instruction <i>Delivered by</i> 4 experts, including anaesthesiologist & clinical nursing	Significantly greater application of relaxation intervention group vs control group: 2.24/3 vs 1.53/3

		7 surgical wards, medical centre, Taiwan	specialists in pain management	
<b>Michaels et al. (2007)</b>	Baseline, intervention 1 mth, outcome assessment 6 mth	<i>Staff</i> Not specified <i>Patients</i> 911 16 medical/ surgical units, SE USA	Educational session <i>Duration</i> 20-30-minute <i>Delivered by</i> Clinical Nurse specialist group	No significant difference in appropriate pain assessment documentation: 43% vs 52%  No significant difference in patients satisfied that pain treated promptly: intervention 97%, control 91%.
<b>Ravaud et al. (2004)</b>	Baseline 3-mth, intervention 3 mth, outcome assessment ~12 mth	<i>Staff</i> All nursing staff, not specified <i>Patients</i> <i>Intervention</i> Phases 1,2 = 567, 543 <i>Patients control</i> Phases 1,2 = 538, 630  Surgical ward, tertiary care hospital, France	Education program with individualised feedback <i>Duration</i> 1 hour meeting repeated 6 times per ward to allow all nurses to participate. <i>Delivered by</i> anaesthetist expert in pain and chief nurse.	Higher rates of documentation of pain assessment after intervention (0.7% vs 80.7%, p<.001), No differences in mean pain rating.
<b>WEAK</b>				
<b>Elshamy &amp; Ramzy (2011)</b>	Baseline 2 mth, intervention 2 mth, outcome assessment 2 mth	<i>Staff</i> 18 nurses <i>Patients</i> 42 General surgical wards, university hospital, Egypt	Postoperative pain assessment & management program and booklet <i>Duration</i> 3 sessions, length unspecified, over 2 weeks <i>Delivered by</i> researchers	Significantly improved pain documentation (54% vs 15%) Significantly improved pain estimate agreement researchers & nurses: >2/10 to <1/10. Significantly more comprehensive nursing records: mean score 2.1/5 vs 0.7/5. Significantly improved patient report of information (57% vs 12%) & satisfaction (55% vs 7%). No significant differences in medication timeliness (76% vs 69%) or patient discussing pain with nurses (31% vs 26%).
<b>Innis et al. (2004)</b>	Baseline 1 mth, intervention 1 mth,	<i>Staff</i> 93 nurses <i>Patients</i> 50		Significantly increased nurse pain assessment

Quasi experimental uncontrolled before and after	outcome assessment 1 mth	74 bed general medical ward, teaching hospital, Canada	Pain education session, portable cards, ward posters <i>Duration</i> 1 hour <i>Delivered by</i> member of pain service	documentation: 100% vs 52%. No change in pain rating (both 3.4/10). Significant increase in patients satisfied with pain management after intervention (82% vs 62%)
<b>Maunsaiyat et al. (2009)</b> Quasi-experimental uncontrolled before and after	Baseline, intervention 6 mth, outcome assessment	<i>Staff</i> 35 nurses <i>Patients</i> not specified 7 neurological & 2 intensive care units, Thailand	Education program, CD summarising topics <i>Duration</i> 6 hours <i>Delivered by</i> senior anaesthetist	Significant improvement in documentation (32% vs 20%).

CD compact disc, mth=month

Table 2 Teaching methods of studies grouped by methodological quality

Table 2. Teaching methods of studies ordered by methodological quality

	STRONG			MODERATE				WEAK				
	Abdalrahman et al. 2011 <sup>44</sup>	Hansson et al. 2006 <sup>40</sup>	Morrisson et al. 2007 <sup>43</sup>	Zhang et al. 2007 <sup>45</sup>	MacLellan 2004 <sup>42</sup>	Hong & Lee 2014 <sup>41</sup>	Michaels et al. 2007 <sup>47</sup>	Lin et al. 2008 <sup>46</sup>	Ravaut et al. 2004 <sup>48</sup>	Elshamy & Ramzy 2011 <sup>49</sup>	Innis et al. 2004 <sup>50</sup>	Maunsaivat et al. 2009 <sup>51</sup>
<b>Didactic/lecture-based</b>	•	•	•	•	•	•	•	•	•	•	•	•
<b>Practical skills training</b>	•	•	•	•	•	•	•	•	•	•	•	•
<b>Group discussion</b>	•	•	•	•	•	•	•	•		•		•
<b>Role play/vignette</b>	•	•		•			•	•				
<b>Feedback/test</b>	•	•	•				•	•	•	•	•	•
<b>Ongoing support</b>	•	•	•	•		•				•	•	•



*Table 3, Theoretical domains involved in healthcare behaviour-change, from Michie et al. (2005)*

	Domain
<b>1</b>	Knowledge
<b>2</b>	Skills
<b>3</b>	Professional role identity
<b>4</b>	Beliefs about capabilities
<b>5</b>	Beliefs about consequences
<b>6</b>	Motivation and goals
<b>7</b>	Memory, attention and decision-making
<b>8</b>	Environmental resources
<b>9</b>	Social influences
<b>10</b>	Emotion
<b>11</b>	Behavioural Regulation
<b>12</b>	Nature of the Behaviours

## Appendix I, table of excluded studies with reasons

### Appendix II, table of excluded studies with reasons

<b>Authors</b>	<b>Reason for exclusion</b>
Bardiau, Taviaux, Albert, Boogaerts, Stadler (2003)	Unable to distinguish impact of nursing intervention from broader intervention with other clinical staff
Cadavid-Puentes et al (2013)	Medication protocol changed
Coulthard, Patel, Bailey, Armstrong (2014)	Unable to distinguish impact of nursing intervention from broader intervention with other clinical staff
Decosterd et al (2007)	Unable to distinguish impact of nursing intervention from broader intervention with other clinical staff
Ene, Nordberg, Bergh, Johansson & Sjostrom (2008)	Medication protocol changed
Gregory & Jackson (2004)	Medication protocol changed
Haller, Agoritsas, Luthy, Piguet, Griesser & Perneger (2011)	Unable to distinguish impact of nursing intervention from broader intervention with other clinical staff
Hauser, Dyer, Pepler & Rolfe (2014)	Unable to distinguish impact of nursing intervention from broader intervention with other clinical staff
Karlsten, Ström & Gunningberg (2005)	Unable to distinguish impact of nursing intervention from broader intervention with other clinical staff
Long, Morgan, Alonzo, Mitchell & Bonnell (2010)	Only qualitative report of change, no quantitative clinical outcomes
O'Connor (2003)	No educational intervention; introduction of a new documentation tool only
<a href="#">Narasimhaswamy et al., 2006</a>	Medication protocol changed
Noe et al (2002)	Unable to distinguish impact of nursing intervention from broader intervention with other clinical staff

Appendix II, theoretical domains, component constructs, and eliciting questions for investigating the implementation of evidence-based practice from Michie et al (2005)

<b>Domains</b>	<b>Constructs</b>	<b>Interview questions</b>
(a) Knowledge	Knowledge	Do they know about the guideline?
	Knowledge about condition/scientific rationale	What do they think the guideline says?
	Schemas+mindsets+illness representations	What do they think the evidence is?
	Procedural knowledge	Do they know they should be doing x?  Do they know why they should be doing x?
(b) Skills	Skills	Do they know how to do x?
	Competence/ability/skill assessment	How easy or difficult do they find performing x to the required standard in the required context?
	Practice/skills development	
	Interpersonal skills	
	Coping strategies	
(c) Social/professional role and identity	Identity	What is the purpose of the guidelines?
	Professional identity/boundaries/role	What do they think about the credibility of the source?
	Group/social identity	Do they think guidelines should determine their behaviour?
	Social/group norms Alienation/organisational commitment	Is doing x compatible or in conflict with professional standards/identity? (prompts: moral/ethical issues, limits to autonomy)  Would this be true for all professional groups involved?

(d) Beliefs about capabilities	Self-efficacy Control—of behaviour and material and	How difficult or easy is it for them to do x? (prompt re. internal and external capabilities/constraints)
	social environment	What problems have they encountered?
	Perceived competence	What would help them?
	Self-confidence/professional confidence	How confident are they that they can do x despite the difficulties?
	Empowerment	How capable are they of maintaining x?
	Self-esteem	How well equipped/comfortable do they feel to do x?
	Perceived behavioural control	
	Optimism/pessimism	
(e) Beliefs about consequences	Outcome expectancies Anticipated regret Appraisal/evaluation/review	What do they think will happen if they do x? (prompt re themselves, patients, colleagues and the organisation; positive and negative, short term and long term consequences)
	Consequents	What are the costs of x and what are the costs of the consequences of x?
	Attitudes	What do they think will happen if they do not do x? (prompts)
	Contingencies	Do benefits of doing x outweigh the costs?
	Reinforcement/punishment/consequences	How will they feel if they do/don't do x? (prompts)
	Incentives/rewards	Does the evidence suggest that doing x is a good thing?
	Beliefs	
	Unrealistic optimism	
	Salient events/sensitisation/critical incidents	
	Characteristics of outcome expectancies—physical, social, emotional;	

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	Sanctions/rewards, proximal/distal, valued/not valued, probable/improbable, salient/not salient, perceived risk/threat	
(f) Motivation and goals	Intention; stability of intention/certainty of intention	How much do they want to do x?
	Goals (autonomous, controlled)	How much do they feel they need to do x?
	Goal target/setting	Are there other things they want to do or achieve that might interfere with x?
	Goal priority	Does the guideline conflict with others?
	Intrinsic motivation	Are there incentives to do x?
	Commitment	
	Distal and proximal goals	
	Transtheoretical model and stages of change	
(g) Memory, attention and decision processes	Memory	Is x something they usually do?
	Attention	Will they think to do x?
	Attention control	How much attention will they have to pay to do x?
	Decision making	Will they remember to do x? How?  Might they decide not to do x? Why? (prompt: competing tasks, time constraints)
(h) Environmental context and resources	Resources/material resources (availability and management)	To what extent do physical or resource factors facilitate or hinder x?
	Environmental stressors	Are there competing tasks and time constraints?
	Person × environment interaction	Are the necessary resources available to those expected to undertake x?
	Knowledge of task environment	
(i) Social influences	Social support	

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Social/group norms

To what extent do social influences facilitate or hinder x? (prompts: peers, managers, other professional groups, patients, relatives)

Organisational development

Will they observe others doing x (i.e. have role models)?

Leadership

Team working

Group conformity

Organisational climate/culture

Social pressure

Power/hierarchy

Professional boundaries/roles

Management commitment

Supervision

Inter-group conflict

Champions

Social comparisons

Identity; group/social identity

Organisational commitment/alienation

Feedback

Conflict—competing demands, conflicting roles

Change management

Crew resource management

Negotiation

Social support:  
personal/professional/organisational,  
intra/interpersonal, society/community

Social/group norms: subjective, descriptive,  
injunctive norms

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	Learning and modelling	
(j) Emotion	Affect	Does doing x evoke an emotional response? If so, what?
	Stress	To what extent do emotional factors facilitate or hinder x?
	Anticipated regret	How does emotion affect x?
	Fear	
	Burn-out	
	Cognitive overload/tiredness	
	Threat	
	Positive/negative affect	
	Anxiety/depression	
	(k) Behavioural regulation	Goal/target setting
Implementation intention		
Action planning		Are there procedures or ways of working that encourage x?
Self-monitoring		
Goal priority		
Generating alternatives		
Feedback		
Moderators of intention-behaviour gap		
Project management		
Barriers and facilitators		
(l) Nature of the behaviours	Routine/automatic/habit	What is the proposed behaviour (x)?
	Breaking habit	Who needs to do what differently when, where, how, how often and with whom?
	Direct experience/past behaviour	How do they know whether the behaviour has happened?

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Representation of tasks

What do they currently do?

Stages of change model

Is this a new behaviour or an existing behaviour that needs to become a habit?

Can the context be used to prompt the new behaviour? (prompts: layout, reminders, equipment)

How long are changes going to take?

Are there systems for maintaining long term change?

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