

Looking into mechanisms of change: Evaluation of a multifaceted implementation strategy to change pain management behavior of care workers

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Research

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Abstract

Background

Underutilization of evidence-based pain management in nursing homes is common. Evidence towards effective approaches to improve adoption of evidence-based practices in nursing homes is limited. To get a better understanding of the impact of our multi-faceted implementation strategies, care worker training workshops and the introduction of trained pain champions, this study explored the underlying mechanisms of the implementation strategies using behavioral theory.

Methods

We conducted a mixed-methods evaluation alongside an implementation- effectiveness study in four Swiss nursing homes. Based on an a priori contextual analysis in the participating homes implementation strategies were developed. Furthermore, we developed a conceptual framework describing hypotheses concerning determinants of implementation and mechanisms of change underlying our implementation strategies.

Care workers' questionnaire surveys were conducted at baseline (n=136), after three (n= 99) and six months (n=83) to assess self-efficacy in pain management and self-reported guideline adoption. We computed linear mixed-effect models to assess changes over time in self-efficacy and logistic regressions to assess associations between self-efficacy and guideline adoption. Concurrently, we conducted focus groups with care workers (n=8) to explore their response to the implementation strategies and to gain a deeper understanding of the potential mechanisms. After transcription, interview data was analyzed using content analysis.

Results

Overall, there was a significant increase in self-efficacy after three and six months ($p < 0.001$). Self-reported adoption of guideline components ranged between 44% and 73% depending on the component. We found significant associations between self-efficacy and adoption of two guideline components, i.e. performing a comprehensive pain assessment and using an observational pain assessment tool in cognitively impaired residents.

Qualitative findings showed that the training workshops and pain champions were received positively by care workers. Focus group participants reported to be more attentive to residents' pain experience and to assess and document pain more frequently and with more detail than before.

Conclusions

Our findings highlight the importance of continuous commitment of an implementation facilitator, e.g., a pain champion, within an organization. Regarding persistent implementation challenges, a theory-based conceptual model contributes to the overall understanding.

Trial registration

ClinicalTrials.gov (NCT03471390)

Contributions To The Literature

- Previous research to improve pain management in nursing homes showed mixed to low effects- yet evaluation approaches are lacking use of theory and thus impede differentiation between intervention and implementation effects and related challenges;
- Generating and testing of theory in the development and evaluation of implementation strategies contributes to an improved understanding how change can be affected in a specific context;
- This study showcases a theory-driven mixed-method evaluation approach of an implementation intervention highlighting different responses to the implementation strategies between certified and uncertified care workers

Background

Implementation of evidence-based interventions in health care organizations has been recognized to be a challenging endeavor (1). To increase the uptake of new practices, current literature recommends to systematically select and tailor implementation strategies with regard to needs of the implementation context (2). An a priori analysis of the context to identify barriers and facilitators to use the new practice, is a pivotal first step to inform the development of appropriate implementation strategies (3). Although there is some evidence that strategies tailored to determinants of change are more likely to change practice (4), little is known about the mechanisms of how implementation strategies affect change in practice (2, 5, 6).

To facilitate understanding of mechanisms of change in a specific context it has been recommended to specify implementation strategies with regard to their active components. In a next step, hypothesized mechanisms of change can be generated based on an existing program theory (5). To date, implementation science literature is vastly lacking theory about underlying mechanisms of implementation strategies, only few studies tested mechanisms empirically (6, 7). To advance the theoretical understanding of mechanisms, a current synthesis of 277 behavior change interventions used constructs of behavioral theories to link mechanisms of actions to behavior change techniques identified in the included studies (8). The most frequently identified mechanism "Beliefs about Capabilities", originates from Bandura's theory of Self- Efficacy (9). The theory describes "mastery experience", "vicarious experience", and "verbal persuasion" as strategies to improve self-efficacy, which can be translated into behavior change techniques (8). Implementation strategies that incorporate these behavior change techniques, e.g., modeling, monitoring and feedback on the behavior, hence might be able to increase self-efficacy related to the intended behavior.

This study reports the evaluation of a multifaceted implementation strategy comprising interactive training workshops and the introduction of trained pain champions to facilitate the adoption of a pain management guideline in nursing homes (NHs).

In the field of nursing home care, pain management is a critical topic with an considerable knowledge to practice gap (10). Although international guidelines for geriatric pain management are available, their adoption into daily practice of NHs is often inadequate (11, 12). Internationally, between 40–85% of NH residents report pain (13, 14). Insufficient pain management can result in severe consequences for NH residents' health and quality of life (15). Residents with cognitive impairment are at particular risk for unrecognized and undertreated pain due to their inability of communicating pain (16).

In a first phase of this project we conducted a comprehensive analysis of the implementation context to identify determinants of behavior change with regard to pain management practice (XXXblinded for review). Based on these findings we developed a multifaceted implementation strategy and tested it in a sample of NHs showing that our approach was effective in improving NH residents' pain outcomes (XXXblinded for review). The overall aim of this mixed-methods study was to gain an understanding of the underlying mechanisms of the multifaceted implementation strategy with regard to behavior change in care workers. Our specific aims were (1) to determine changes in the hypothesized central mechanism, care workers' self-efficacy, in pain management; (2) to assess associations of self-efficacy and care workers' self-reported adoption of the pain management guideline and (3) to explore care workers' response to the implementation strategies with regard to pain management practice.

Methods

Conceptual model

In the planning phase of this study we developed a conceptual model, hypothesizing how our implementation strategies might affect change in pain management practice. To underpin our hypothesis we defined the active components of the strategies using the behavior change taxonomy (17). With regard to the central strategies, training workshops and pain champions we hypothesized that 'demonstration of the behavior', 'verbal persuasion about capability' and 'feedback on the behavior' would increase self-efficacy as suggested by Bandura's theory of self-efficacy (9) (Table 1). In relation to his theory, we assumed that in a first step it would be necessary to increase general awareness and address negative beliefs towards pain in older people. Based on this precondition, an increase of self-efficacy in pain management can be achieved and ultimately lead to the adoption of the guideline in daily practice as depicted in Figure 1.

Design

A mixed-methods evaluation using quantitative and qualitative data from care workers participating in an implementation- effectiveness study (hybrid II) to improve pain management in NHs.

Sample/ Setting

This study is part of an implementation study which was conducted in a convenience sample of four NHs located in the German-speaking part of Switzerland. All institutions belong to a privately- owned NH group, which is part of a large European operator of long-term care facilities.

Intervention

A protocol for this study describing the intervention and implementation strategies in more detail was published previously (XXXblinded-for-review). We developed a pain management guideline based on international recommendations for the management of geriatric pain as in Switzerland currently no national guideline for the management of geriatric pain is available (11, 12, 18). The final guideline was adapted to the local context in collaboration with the participating NHs. Core components targeted in this study comprised (A) comprehensive pain assessment; (B) use of observational pain assessment scales, e.g. Pain Assessment in Advanced Dementia Scale (PAINAD) (19) for residents with severe cognitive impairment; (C) pain assessments and re-evaluation after treatment on a regular base and (D) standardized documentation.

Implementation strategies

The implementation strategies have been developed based on a comprehensive contextual analysis involving perspectives of multiple stakeholders (XXXblinded-for-review). An overview of the implementation strategies is displayed in Table 1. We itemized the overall implementation strategies into discrete strategies according to the Expert Recommendations for Implementing Change (ERIC) (20). Further, we determined corresponding behavior change techniques and their hypothesized mechanisms of change (17).

Quantitative part

Sampling and data collection

For our quantitative data collection, we included care workers from all educational backgrounds, i.e. registered nurses (RNs), licensed practical nurses (LPNs) and nursing assistants (NAs) who worked in direct resident care, had been employed for at least one month and were sufficiently fluent of German to understand the survey questions. We conducted a questionnaire survey collecting data at baseline (T0), three (T1) and six months (T2) after start of the intervention, lasting from November 2017 to November 2018. Local coordinators (e.g., director of nursing) were responsible for distributing questionnaires in the NHs. Participation was voluntary and anonymous. A pre-stamped envelope was provided with each questionnaire to ensure confidentiality.

Variables and measurement

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Self-efficacy in pain management was assessed at all data collection points with a self-developed 13-item scale. At the time of data collection, no measure assessing this construct was available. In developing the scale we followed guidance on creating self-efficacy scales (21). Care workers were asked to rate items assessing how confident they feel in tasks related to pain management, e.g. pain assessment, documentation and non-pharmacological treatment on an 11-point rating scale (0= not confident at all - 100= very confident). An acceptable value for the scales reliability was established (Cronbachs $\alpha = 0.94$), for evaluation a mean score of all 13 items was calculated.

A dichotomous indicator of **self-reported adoption** of each of the four guideline components was built from survey items assessed in the third data collection (T2). A detailed description of the indicator was provided in our previous study (XXXblinded). Further items of the care workers' questionnaire assessing sociodemographic data comprise age, sex, educational level (RN/LPN or nursing assistant), years of work experience and tenure in NH.

Data analysis

Descriptive statistics were computed to explore means, medians, distribution and confidence intervals of the data. To determine changes in self-efficacy over time we used unadjusted linear mixed-effect models. Indicators for the time of data collection (T0, T1, T2) were added as fixed effects. To account for the nested data structure, care workers nested in NHs and the repeated measures of individuals, we added the NHs and individual IDs as random effects. We conducted a sensitivity analysis based on a sample of care workers who have been participating in all three data collections.

To describe the self-reported adoption of core components, we built different sub-samples, considering only data from respondents who indicated to have experienced relevant situations corresponding to the core component. Further, for the indicators "comprehensive pain assessment" and "use of PAINAD", we excluded data from nursing assistants since these components are not part of their scope of practice (XXXblinded for review). In a next step, we determined associations between adherence to guideline components and self-efficacy items by calculating several simple logistic regressions based on these sub-samples.

Statistical analysis was performed using R statistical computing software (22). Linear mixed-models were computed with the LME4 package (23). Statistical significance was assigned at the $P < .05$ level.

Qualitative part

Data collection

Qualitative data was collected via focus groups conducted three months after the start of the intervention with a convenience sample of care workers in each participating NH (March- August 2018). The semi-structured interview guides included questions towards the experience of the training workshops and pain champions and perceived changes in pain management practice. Focus group discussions were moderated by the first author (XXXblinded-for-review), additionally a research assistant took notes of the discussion and summarized main points subsequent to each topic to check with the participants. Interviews have been audio-recorded and lasted between 45 and 60 minutes each.

Data analysis

After verbatim transcription of the audio data, transcripts were re-read for familiarization with the data. For data analysis a deductive approach following the directed content analysis described by Hsieh and Shannon (24) was used. In a first step, data was coded using pre-defined categories based on the implementation strategies and different intervention components. In the subsequent analysis steps, subcategories and new categories emerging from the data were added to the coding scheme. Finally, data was summarized in the pre-defined categories using subcategories and exemplary quotes to comprehensively describe the findings.

Integration

Findings of the quantitative and qualitative part of this study will be integrated in the discussion section of this paper.

Results

Quantitative data

Sample size of care workers differed between the three waves of data collection due to care worker turnover and partial decline of response rates, resulting in 136 respondents at baseline (average response rate: 84%), 99 respondents at T1 (69 %) and 83 respondents at T2 (59 %). A sub-sample of 41 care workers participated at each time point. An overview of the baseline's sample characteristics is displayed in Table 2. The characteristics of respondents did not differ significantly between the time points.

Changes of self-efficacy in pain management

In LPNs and RNs the mean score of self-efficacy increased from 69.6 (SD 14.6) at baseline to 74.2 (SD 15.2) at T1 and 76.8 (SD 14.7) at T2. In nursing assistants, the mean score changed from 64.3 (SD 15.1) at baseline to 72.4 (SD 12.1) and 69.2 (SD 12.4) at T2. Mixed models overall confirmed a significant increase ($p < .01$) of self-efficacy between baseline and T1/T2 for all educational levels (Table 3).

Associations with self-reported pain management behavior

Self-reported adherence to guideline components ranged between 44% and 73% depending on the component, detailed results were reported in an earlier paper (XXXblinded for review). We found significant associations between care workers' adherence to core component I (conducting a comprehensive assessment) and II (using PAINAD scale) and corresponding self-efficacy items. However, we did not find significant associations between the other two core components and corresponding self-efficacy items. An overview of the associations is displayed in Table 4.

Qualitative data

In total, we conducted eight focus groups in the four participating NHs, including 30 care workers (15 RNs/LPNs and 15 NAs). Overall, participants were mainly female (80%) and the average age was 36.6 years (SD = 8.6). The majority of care workers had participated in both parts of the workshop, few participated only in the first part due to logistical reasons within their NHs. Overall, care workers' perception of the project three months after the start were positive. The participants appreciated the project's focus on pain management, a topic which was recognized to be of high importance for residents' quality of life.

General experience with workshops

In general, NAs were more satisfied with the workshops than RNs and LPNs, several NAs highlighted that they have never received a training specifically targeted at them before. RNs and LPNs on the other hand, partly perceived the workshops' content to be redundant to what they already knew before (e.g. with regard to pain assessment instruments). Some RNs remarked that they would have preferred a focus on pharmacological treatment options and less on general principles of pain management. Despite some reservation towards the content, the participants agreed that the workshops were overall helpful to raise the care team's awareness for residents' pain situations. One aspect that was highlighted particularly by the NAs was the recognition that pain almost always goes beyond its physical component and can be related to psychosocial or spiritual factors. Though this was not new knowledge for most participants-reflecting this aspect in depth during the workshop was perceived as a major learning moment. Participants of all job levels reported to be more sensitized to pain when talking to residents or observing their behavior than before.

"Because we could delve into the topic of pain, so that we became more aware of what pain really means in that sense. That is a matter of opinion for everybody and that we react more conscious when people complain about pain" (RN).

In particular the perception of residents with cognitive impairment or other conditions limiting communicative abilities has changed. Participants acknowledged that they sometimes forgot that these residents might also perceive pain from time to time though they do not actively express it.

"Well, I was really shocked about the residents with dementia, I just realized: Hey, you have to keep an eye on them, they are not only having dementia and have no other issues" (LPN)

Perception of the pain champions

In general, the idea of having a pain champion on the ward was perceived as a gain by most participants. Similar to the workshops, NA expressed more positive reactions to the introduction of this new role as compared to RNs and LPNs. During the focus group discussions, most NAs agreed that they could easily approach the new pain champion in case of any questions related to resident

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"Yes, you just know... simply to whom you can go. And then you don't have to [think] who should I.. And they are also more attentive, I think, and trained, you know?" (NA)

Discussions with RNs and LPNs on the other hand, showed some variation between different NHs. RNs in one NH questioned the added value of having a nurse pain champion because ultimately the physician would decide about a resident's medication.

"I think, for me the physician is always the pain expert, in the end, he is telling us when we don't know what to do with the medication and whatever, in the end the physician is telling us what to do" (RN)

In contrast, RNs and LPNs in another NH reported to see the pain champion as a connector with the responsible physician to advocate residents' needs with regard to appropriate medication.

"The [physician] has a different understanding of applying pain killers, and I think, this is where [the pain champion] can be kind of a connector with the physician" (LPN)

Observing changes in pain management

Overall, there was agreement in most focus groups that during the past three months, changes in the care teams' pain management behavior were noticeable. However, perceptions about the extent of changes differed in parts between professional groups (NAs vs. LPNs/RNs).

One behavior, most participants highlighted to have experienced change is the assessment of residents

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pain experience, except when a resident has verbally expressed pain. In contrast, the focus group participants reported that they now ask residents actively
resident has reported pain before.

"Well, after the course, I.. tried harder to observe the resident and I took more time to look at the mimic and yes, well, I.. I was very glad about the course. And now, I pay more attention, or I ask the resident more "Do you have pain?", which I've done less before." (NA)

Another aspect that was brought up in this regard, was the newly implemented pain report in the resident documentation. Before, residents' pain was exclusively reported in the overall documentation, focus group participants acknowledged that they used to document only that a resident experiences pain without being specific about the details. However, in the new form there are fields asking for the different qualities of pain e.g., intensity, location, etc. With this new pain report form NAs felt reminded to be more detailed when describing pain situations and also to ask residents more specifically about their experience.

"Or, for example you can't just write "Mrs. X has pain". Now you have to describe, where is the pain, what kind of pain, where .. and you have to take this to pieces, in detail." (NA)

Furthermore, with regard to the use of specific assessment instruments, NA reported to have tried out different self-report scales with residents. Assessing pain in residents with severe cognitive impairment, still was perceived as a challenge by NAs, however, they reported to be more aware of signs of discomfort and changes in the behavior than before. Likewise, LPNs and RNs reported to be challenged by assessing pain in these residents. For most care workers, using the observational pain assessment scale was perceived to facilitate assessment, however, some participants reported challenges applying the scale correctly in the beginning. In addition to changes in assessing pain, participants of all job levels agreed that NAs reports of residents' pain to the charge nurse were more timely. In the mornings, they would inform the responsible nurse as soon as possible instead of waiting till the designated report time in the late morning.

Aside from changes in NAs' behavior, RNs/LPNs reported that the pain champion has motivated them to go through each resident's medication scheme to critically review if the medication is still appropriate in light of the current pain situation.

"Here, I am working together with the pain champion and we are discussing the residents, what we could do or not. Or if we should reduce something or not." (RN)

Based on their critical review, they themselves or the pain champion talked with the responsible physicians about their suggestions. Participants reported that based on the reviews they were able to adapt or reduce unnecessary pain medications in several residents.

Discussion

The current study found that interactive training workshops and introduction of a trained pain champion could significantly increase care workers' self-efficacy related to pain management. Furthermore, we could show significant associations between care workers' self-efficacy and adoption of two core components: 'conducting a comprehensive assessment' and 'use of PAINAD', however there was no significant relation with the components 'documentation' and 're-evaluation'. Our qualitative findings showed that the training workshops and pain champions were generally received positive. Care workers reported to be more attentive to residents' pain experience and to assess and document pain more frequently and with more detail. Furthermore, focus group participants reported changes in the pain reporting behavior and the pharmacological management.

This study was the first to look at the implementation of a pain management guideline in NHs using a behavioral perspective. In general, effects of previous studies in this field were mixed (25, 26), yet most evaluation approaches did not allow to differentiate between the effectiveness of the intervention and the implementation efforts. Much of the previous research was based on quality improvement approaches and did not integrate any theoretical underpinning.

Guidelines for pain management generally consist of a set of recommended actions to assess and treat pain. Pain assessment in NH residents depicts a challenge for care workers since pain is a highly subjective symptom and the ability to self-report pain is often limited in residents. In order to increase care workers

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findings it can be assumed that our implementation strategies were effective in sensitizing care workers for resident pain and furthermore motivated care workers to question their own beliefs concerning pain. The two components "conducting a comprehensive pain assessment (with newly admitted residents and those reporting new pain)" and "using an observational assessment tool (in residents with severe cognitive impairment)" require certain clinical skills and competencies beyond an increased awareness. Bandura's theory of self-efficacy states that in addition to beliefs and attitudes, confidence in the own ability to perform a specific behaviors can determine adoption of the new behavior (9). The two other components 'documentation' and 're-evaluation', on the other hand, require less advanced competencies, however, with regard to their regular performance, other factors, such as memory or motivation, play a more important role. One possible explanation why we were not able to find an association between these components and the self-efficacy items might have been the wording of the items. The self-efficacy items focused mainly on the confidence in performing specific pain management behaviors, and less on remembering these behaviors in daily practice. Changing existing routines in the daily care practice and remembering to perform the new behavior is challenging, in this context a recent systematic review and meta-analysis highlighted the potential influence of habits on healthcare professionals' behavior (27). Habits can be defined as "a process by which a stimulus generates an impulse to act as a result of a learned stimulus-response association" (28).

With our approach to introduce a pain champion on the ward, we intended to provide care workers with a role model, who helps to memorize specific behaviors, e.g. documentation, use of PAINAD and to eventually form new habits facilitates with regular behavioral cues and the provision of performance feedback. Champions have been used in other studies to improve quality of pain management in NHs (29–32). The type of strategies used by the champions reported in Kaasalainen, Brazil (31) are comparable to our approach. However, the authors did not directly assess changes at the care worker level, instead they evaluated process indicators based on the residents' documentation. Information retrieved from chart reviews can partly be informative concerning the documentation behavior, however with regard to other behaviors related to pain management they are only crude indicators of changes occurring on the level of care workers.

This was the first study in the field of pain management in NHs to use behavioral theory to gain an understanding of the underlying implementation mechanisms. A clear strength of this study was the systematic specification of our implementation strategies into behavior change techniques and the use of a conceptual model. The specification of strategies allowed the generation of hypotheses with the aim to increase our understanding of the underlying mechanisms. Clear definitions of implementation strategies enhance the comparability of studies and thus facilitate the generation of transferable knowledge. Furthermore, the mixed-methods design allowed to validate our initial findings with a set of focus groups. Besides its strengths, there are also some limitations to this study. First of all, this study was based on a quasi-experimental, uncontrolled design limiting our ability to draw direct conclusions about the effectiveness of our implementation strategies and precluding causal inferences. Secondly, the study was based on care workers' self-reports of behavior which might have introduced bias due to care workers' ability of recalling behavior or by social desirability.

Conclusions

The purpose of this current study was to explore the underlying mechanisms related to the implementation of a pain management guideline in Swiss NHs using training workshops of care workers and trained pain champions. We could show a significant increase in care workers' self-efficacy in pain management, increased awareness of care workers towards residents' pain and changes in the pain management behavior. Our findings highlight that continuous commitment of pain champions or similar implementation facilitators is pivotal to the embedding of new routines in care workers' practice. Increasing the adoption of evidence-based pain management guidelines in NHs remains of crucial importance to improve management of residents' pain and ultimately their quality of life. Future studies in the field of pain management in NHs should therefore make use of behavioral theory to understand and tackle such implementation challenges.

Abbreviations

LPN Licensed practical nurse

NA Nursing assistant

NH Nursing home

PAINAD Pain assessment in advanced dementia scale

RN Registered nurse

Declarations

Ethics approval and consent to participate

We received ethical approval for this study from the responsible ethics committee (Ethikkommission Nordwest- und Zentralschweiz: EKNZ 2017-01466) in October 2017. All care workers provided written informed consent prior to participating in focus group discussions. For the questionnaire survey, informed consent was implied by returning the questionnaire.

Consent for publication

Not applicable

Availability of data and material

The datasets generated during and/or analysed during the current study are not publicly available due to the confidentiality of respondents but are available from the corresponding author on reasonable request.

Competing interest

The authors declare that they have no competing interests.

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Author Contributions:

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data. All were involved in drafting the manuscript or revising it critically for important intellectual content; All authors gave final approval of the version to be published.

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Tables

Table 1: Overview of implementation strategies

Implementation strategy	Discrete strategies	Operationalization	Behavior change techniques	Hypothesized mechanism
Interactive training workshops	<ul style="list-style-type: none"> - Conduct educational meetings - Work with educational institutions - Make training dynamic 	<ul style="list-style-type: none"> - 2x 2h face to face training/ education according to job level (RNs & LPNs/ nursing assistants) - Interactive workshops conducted by educational institute - Content according to pain management guideline, i.e. pain assessment and treatment 	<ul style="list-style-type: none"> - Information about health consequences - Instructions on how to perform the behavior - Demonstration of the behavior - Verbal persuasion about capability 	<ul style="list-style-type: none"> - Knowledge gain - Awareness building - Increase in self-efficacy
Pain champion (PC)	<ul style="list-style-type: none"> - Identify and prepare champions - Use train-the-trainer strategies - Revise professional roles - Capture and share local knowledge - Organize clinician implementation team meetings - Develop/ distribute educational material - Conduct ongoing training 	<ul style="list-style-type: none"> - Recruitment of 1-2 care workers (RNs or LPNs) from each NH - 5x 8 h interactive training focusing on pain assessment, treatment and coaching skills - NH groups' management grants 10% of regular working time for champions' role - Quarterly meetings with all PCs and researchers to reflect on implementation experiences and extend training content - Provision of material for educational booster sessions <p><u>Role PC:</u></p> <ul style="list-style-type: none"> - Conduct regular educational booster sessions - Monitor residents' documentation and provide individual feedback - Provide guidance and practical support in complex resident pain situations 	<ul style="list-style-type: none"> - Information about health consequences - Instructions on how to perform the behavior - Demonstration of the behavior - Behavioral practice/ rehearsal - Review behavior goals - Review outcome goals - Discrepancy between current behavior and goal - Feedback on behavior - Verbal persuasion about capability - Social support 	<ul style="list-style-type: none"> - Knowledge gain - Awareness building - Increase in self-efficacy - Social influences
Meetings with NHs' leadership	<ul style="list-style-type: none"> - Mandate change - Obtain formal commitments - Use advisory boards and workgroups - Involve executive boards - Capture and share local knowledge - Provide ongoing consultation 	<ul style="list-style-type: none"> - Preparatory meetings with NH leadership prior to implementation and ongoing telephone support - Collaborative agreement between NHs and research institute - Quarterly sounding board meetings involving leadership of each participating NH, administrative leadership of NH group and researchers to discuss local barriers and progress of implementation 	<ul style="list-style-type: none"> - Restructuring the physical/ social environment 	<ul style="list-style-type: none"> - Environmental context and resources
Adaptations of the documentation software	<ul style="list-style-type: none"> - Change record systems 	<ul style="list-style-type: none"> - Adaptations of the resident documentation software (e.g. pain assessment form) - 	<ul style="list-style-type: none"> - Restructuring the physical environment 	<ul style="list-style-type: none"> - Environmental context and resources
Provision of educational material	<ul style="list-style-type: none"> - Develop educational materials - Distribute 	<ul style="list-style-type: none"> - Provision of guideline on each ward in paper form and intranet - Distribution of assessment tools (e.g. cardboard VAS scales) 	<ul style="list-style-type: none"> - 	<ul style="list-style-type: none"> -

Table 2: Characteristics of care workers at Baseline

	Care workers n= 136
Age mean (SD)	37.7 (13.9)
Female n (%)	110 (83.3)
RNs n (%)	29 (21.8)
LPNs n (%)	36 (27.1)
Nursing aides n (%)	52 (39.8)
Other personnel n (%)	15 (11.3)
Work experience mean (SD)	11.2 (10.5)
Tenure in NH mean (SD)	3.3 (4.9)

Note. RN= registered nurse, LPN= licensed practical nurse

Table 3: Coefficients of the linear mixed-models for self-efficacy mean score

	Self- efficacy β (CI)	
	A n=337	B n= 123
T1	8.84 (6.08 - 11.58)***	11.28 (7.67 - 14.89)***
T2	9.39 (6.24 - 12.49)***	10.17 (6.56 - 13.78)***

Note. A=sample includes all care workers irrespective of participation, B=sub-sample of care workers that participated in all three data collections, * p<0.05, ** p<0.01 *** p<0.001

Table 4: Associations between self- efficacy items and self- reported adoption of core elements

	I Comprehensive Assessment	II Use of PAINAD	III Re- evaluation	IV Documentation
	OR (CI)	OR (CI)	OR (CI)	OR (CI)
How confident are you ...to systematically interview residents about their pain	1.10* (1.03- 1.17)		1.00 (0.97-1.04)	
...to differentiate between different sources of residents' pain?	1.07* (1.01- 1.14)			
...to recognize when residents with dementia are in pain?		1.05* (1.00- 1.1)	1.02 (0.98-1.05)	
... to use an observational pain scale for pain assessment in residents with dementia (e.g., PAINAD)?	1.07* (1.02- 1.13)	1.05* (1.00- 1.09)	1.01 (0.99-1.04)	
...to use a standardized scale for residents' self- report of pain?	1.14* (1.03- 1.25)		1.01 (0.98-1.04)	
...to document the relevant information about residents' pain situations completely?				1.02 (0.98- 1.05)

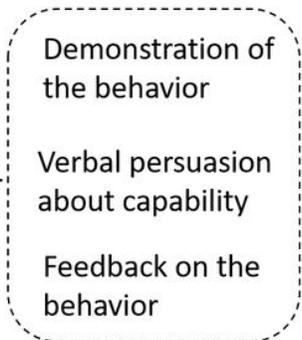
Note. OR= odds ratio, CI= confidence interval; * p<0.05

Figures

Implementation strategies



Behavior change techniques



Precondition



Mechanism



Proximal outcome



Figure 1

Conceptual model