EFFECTS OF A COMPUTERIZED DECISION SUPPORT SYSTEM ON CARE PLANNING FOR PRESSURE ULCERS AND MALNUTRITION IN NURSING HOMES: AN INTERVENTION STUDY

Mariann Fossum, RN, PhD[1, 2], Margareta Ehnfors, RNT, PhD, FACMI[1], Elisabeth Svensson, STATISTICIAN, PhD[3], Linda M. Hansen, RN, MSc[2], Anna Ehrenberg, RN, PhD[4]

1) School of Health and Medical Sciences, Örebro University, Örebro, Sweden

2) Center for Caring Research – Southern Norway, Department of Health and Nursing Science, Faculty of Health and Sport Sciences, University of Agder, Grimstad, Norway

3) Swedish Business School, Örebro University, Örebro, Sweden

4) School of Health and Social Studies, Dalarna University, Falun, Sweden

Correspondence to:

Mariann Fossum,

Department of Health and Nursing Science,

Faculty of Health and Sport Sciences,

University of Agder, PO Box 509, NO-4898 Grimstad,

NORWAY,

Tel.:+4737233756

E-mail: mariann.fossum@uia.no

Abstract

Background: Nursing documentation is essential for facilitating the flow of information to guarantee continuity, quality and safety in care. High-quality nursing documentation is frequently lacking; the implementation of computerized decision support systems is expected to improve clinical practice and nursing documentation.

Aim: The present study aimed at investigate the effects of a computerized decision support system and an educational program as intervention strategies for improved nursing documentation practice on pressure ulcers and malnutrition in nursing homes.

Design, setting and participants: An intervention study with two intervention groups and one control group was used. Fifteen nursing homes in southern Norway were included. A convenience sample of electronic healthcare records from 46 units was included. Inclusion criteria were records with presence of pressure ulcers and/or malnutrition. The residents were assessed before and after an intervention of a computerized decision support system in the electronic healthcare records. Data were collected through a review of 150 records before (2007) and 141 records after the intervention (2009).

Methods: The nurses in intervention group 1 were offered educational sessions and were trained to use the computerized decision support system, which they used for eight months in 2008 and 2009. The nurses in intervention group 2 were offered the same educational program but did not use the computerized decision support system. The nurses in the control group were not subject to any intervention. The resident records

were examined for the completeness and comprehensiveness of the documentation of pressure ulcers and malnutrition with three data collection forms and the data were analyzed with non-parametric statistics.

Results: The implementation of the computerized decision support system and the educational program resulted in a more complete and comprehensive documentation of pressure ulcer- and malnutrition-related nursing assessments and nursing interventions.

Conclusion: This study provides evidence that the computerized decision support system and an educational program as implementation strategies had a positive influence on nursing documentation practice.

Key words: decision support system, documentation, intervention studies, malnutrition, nursing audit, pressure ulcer.

Highlights

- A computerized decision support system and an educational program were implemented.

- The computerized decision support system provided evidence-based interventions.

- The implementation resulted in a more complete and comprehensive documentation.

- The total number of documented nursing problems was relatively low.

1. Introduction

Concerns about the quality of care in nursing homes have been described in international studies [1, 2]. The presence of pressure ulcers (PUs) [3] and malnutrition [4] continue to be major issues in the care of the elderly, even though the available evidence-based knowledge concerning interventions to meet these challenges has increased [5-7]. Calls to improve the quality of care in nursing homes have focused on implementing evidence-based clinical guidelines [8, 9]. The availability of evidence-based clinical guidelines has increased, but implementation is slow in many health care areas. Because the clinical guidelines for nursing home care are not routinely used [8-10], inappropriate variations in practice and flaws in the quality of care are repeatedly reported [8-10]. Multifaceted interventions have been recommended while implementing clinical guidelines [11, 12]. Studies have suggested that computerized decision support systems (CDSSs) have a positive impact on nurses' decision-making [13, 14] and may be an effective way to support clinical guideline implementation at the point of care [15, 16]. CDSSs vary from 'active systems' to more 'passive systems' providing advices to 'end-user's' decision making [17, 18]. Greenes [17 p. 6.] defined a CDSS as "the use of the computer to bring relevant knowledge to bear on the health care and well-being of the patient". A CDSS links health observations with knowledge in order to assist clinicians in decision-making and utilize the accurate and structured clinical information available in the electronic health records (EHR) to improve resident care [17]. However, simply moving the paper-based guidelines to an electronic format will not automatically achieve the benefits of using information technology and

evidence-based guidelines [13, 14]. A CDSS must be integrated with EHRs to retrieve

resident-specific data [17] and utilize the EHR's full potential [19, 20]. However,

knowledge concerning the effects of guideline implementation in the functioning of

CDSS in nursing homes is limited.

The documentation of essential data for nursing home residents is necessary for

communication between nurses and other health care providers, who facilitate the flow

of information about daily care and supports continuity, quality and safety in care [19,

21, 22]. Health records should describe relevant and necessary information about

residents and their health care [23]. The assessment of completeness in nursing

documentation includes the presence or absence of essential resident data for nursing

care, such as nursing assessments, interventions and outcome evaluations [24]. The

evaluation of documentation comprehensiveness includes assessments of the

relationships between the essential elements of the nursing process, including

assessment, diagnosis, intervention and outcome [24]. Studies have shown a lack of

accuracy and quality in nursing documentation in hospital settings [25, 26] and a lack of

accuracy in nursing documentation in nursing home settings [21, 27].

To ensure a high quality of care for nursing home residents, the gap between

knowledge about the best practices and delivery of care must be bridged. One promising

implementation strategy is a CDSS designed to support evidence-based clinical

guidelines. CDSSs have shown to improve quality of care in physicians' clinical

practice [28, 29]. However, knowledge concerning the impact of CDSS on nurses'

clinical practice is scarce.

2. Aim

The present study aimed to investigate a computerized decision support system and an educational program as implementation strategies for nursing documentation practice on PUs and malnutrition in nursing homes.

3. Methods
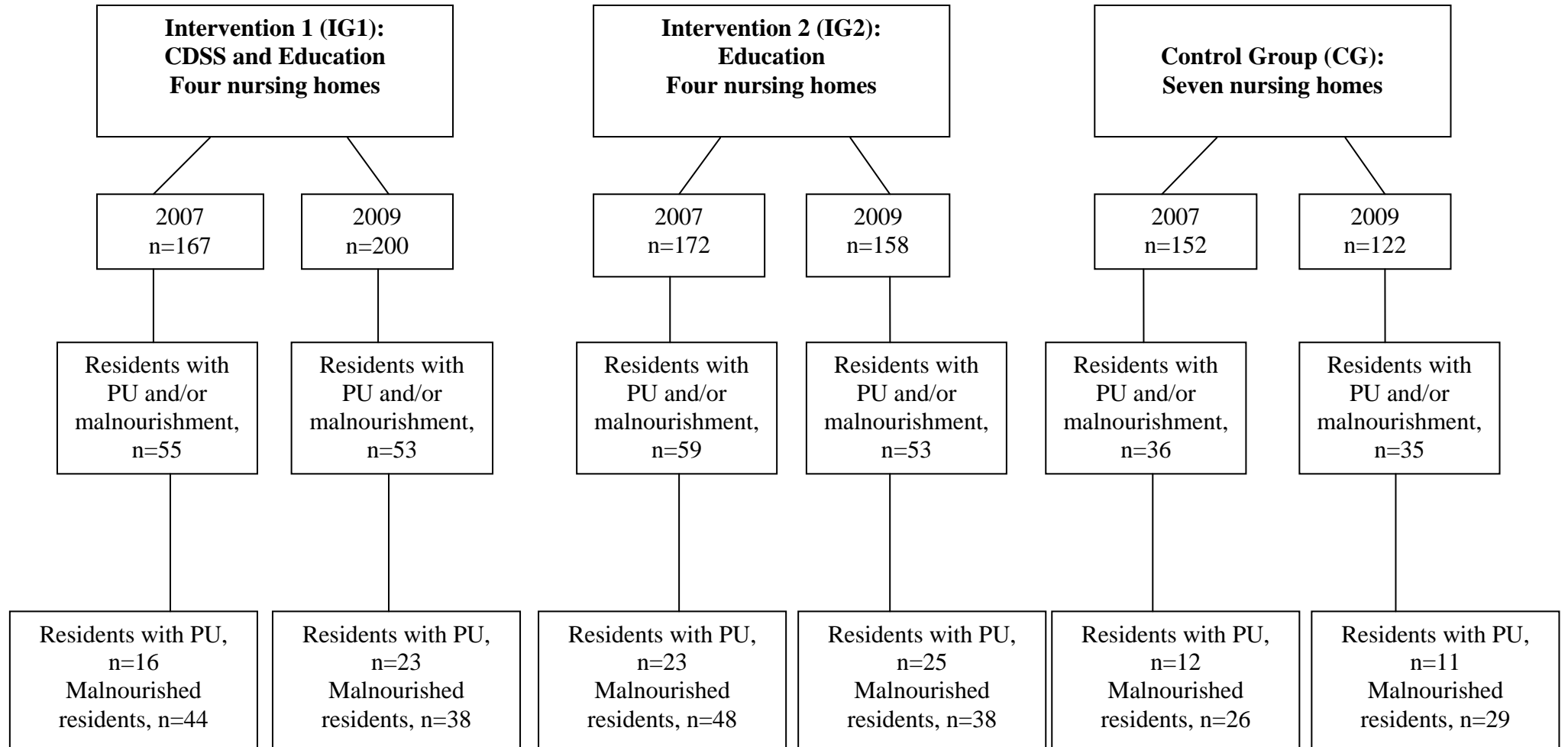
3.1 Setting and design

Nursing homes in Norway are regulated as national healthcare services, and most nursing home institutions are publicly financed. Of 997 institutions with 41,318 total beds, only 10.8% were private in 2010 [30]. Nursing personnel, including registered nurses (RNs) and nursing aides (NAs), are responsible for documenting the planned and performed care in nursing homes; however, RNs have the primary responsibility for planning the resident care [31]. The documentation performed by physicians and nursing personnel was completed in the same EHR in the nursing homes included in the study, although there was variation in how extensively the EHR was used and in how much paper documentation was used to supplement the EHR. The nursing homes each employed a physician responsible for the medical care of residents for a numbers of hours per week, depending on the number of residents.

This study was part of a larger project on the use of CDSS in nursing homes in Norway, and the primary outcome of the intervention has been reported previously [32]. The effects of implementing the CDSS and accompanying educational intervention were evaluated using a quasi-experimental design [33]. Since the intervention conditions for a CDSS refers to the users working at nursing homes and not to individual CDSS users, a group design was motivated [34]. Depending on the local managers' willingness to participate, the nursing homes were divided into three groups.

The nurses in intervention group 1 (IG1) were offered educational sessions that included risk assessments for PUs and malnutrition, the prevention and treatment of PUs and malnutrition, and the assessment of stage I-IV PUs. In addition, the nursing personnel (IG1) were trained in groups to use the CDSS, which they used for eight months in 2008 and 2009. The nurses in intervention group 2 (IG2) were offered the same educational program but did not use the CDSS. The nurses in the control group (CG) were not subject to any intervention. Most of the nursing home residents were cared for by a group of nurses. An overview of the study design and data collection is presented in Figure 1.

Figure 1. Overview of the Study Design and Data Collection

Intervention 1 (IG1): CDSS and Education Four nursing homes	Intervention 2 (IG2): Education Four nursing homes	Control Group (CG): Seven nursing homes

2007 n=167	2009 n=200	2007 n=172	2009 n=158	2007 n=152	2009 n=122
Residents with PU and/or malnourishment, n=55	Residents with PU and/or malnourishment, n=53	Residents with PU and/or malnourishment, n=59	Residents with PU and/or malnourishment, n=53	Residents with PU and/or malnourishment, n=36	Residents with PU and/or malnourishment, n=35
Residents with PU, n=16 Malnourished residents, n=44	Residents with PU, n=23 Malnourished residents, n=38	Residents with PU, n=23 Malnourished residents, n=48	Residents with PU, n=25 Malnourished residents, n=38	Residents with PU, n=12 Malnourished residents, n=26	Residents with PU, n=11 Malnourished residents, n=29

3.2 Sample

Resident records from fifteen nursing homes from seven municipalities in four Norwegian counties were included in the study. The sample size of records was based on a power analysis for the primary outcome of PU prevalence, which has previously been reported [32]. Inclusion criteria were EHRs with documented PUs assessed by the risk assessment pressure score (RAPS) scale [35] with stage I-IV PUs and/or presence of malnutrition assessed by the mini nutritional assessment (MNA® full form) score of less than 17 [36]. Exclusion criteria were records from residents residing in the nursing home for less than 24 hours, a recorded terminal illness, a lower extremity amputation or enteral and parenteral nutrition. Records from residents in special rehabilitation units were also excluded. The study was conducted between June 2007 and July 2009. The two sample sets consisted of 150 records before the intervention (2007) and 141 records after the intervention (2009) (Figure 1). Of the 150 records included in 2007, 117 (78%) referred to women, and 33 (22%) to men. The mean age was 83.8 years (SD= 8.7) and the median length of stay was 19 months (Q_1; Q_3 = 8-32 months). Correspondingly, in 2009, the 141 records were from 109 (77%) women, and 32 (23%) men. The mean age was 83.3 years (SD= 8.4) and the median length of stay 27 months (Q_1; Q_3 = 10-43 months).

3.3 Intervention

A CDSS for preventing and treating PUs and malnutrition was developed from two research-based risk assessment instruments: the RAPS [35], which is used to assess residents for the risk of PUs, and the MNA®, which is used for screening residents at risk for impaired nutritional status [36]. The CDSS was embedded in the EHR to

facilitate data collection and support clinical decision making. The CDSS used the full set of available data from the guidelines, and clinical prediction rules classified the residents into four categories, either having or not having PU or/and malnutrition based on the recommended classification for the two guidelines. In addition, the CDSS provided a choice of evidence-based interventions for care planning based on the categorization of the residents. The nurses were then able to add, delete and change the suggested interventions, but they had the opportunity to move to another element in the records without adding information to all the questions in the CDSS. The CDSS required input for all data items in the risk assessment to provide support for nursing diagnoses and interventions.

The CDSS was developed in collaboration with four RNs from the four nursing homes in IG1 and one information systems specialist. The team was led by one of the researchers in collaboration with a software developer from the EHR software vendor. The four RNs were trained in the use of the guidelines and the CDSS, and were responsible for the training of the nursing personnel (IG1) in group sessions to use the CDSS.

Before and during the intervention, follow-up group meetings with the nursing homes in IG1 were part of the CDSS development process. These meetings included the development team and nurses involved in the project from the different nursing homes.

3.4 Data collection and outcome measures

Nursing documentation was extracted from the records for a maximum of three months of the residents' stays in the nursing homes. The nursing documentation included nursing care plans, medication charts, progress notes and summaries. Following written

instructions on what information should be extracted, all residents' records were either photocopied or printed by the nurses in the units or by one of the researchers (MF).

Records that met the inclusion criteria were eligible for evaluation. Depending on whether the resident met the inclusion criteria for PUs and/or MNA® scores of less than 17, the resident records were audited with two or three data collection forms. When auditing records for completeness the presence or absence of data is checked and the record content is assessed [24], that is if record data coheres with guidelines or recommendations based on best available knowledge. In this study we only assessed content in the records that met the inclusion criteria that is those records that held documentation indicating PUs or malnutrition. The completeness of the nursing documentation for PUs was assessed with a data collection form that was based on the European Pressure Ulcer Advisory Panel (EPUAP) and modified for audits of patient records by Gunningberg and Ehrenberg [25]. The presence of nursing assessments for specified problems related to the risk of PU and/or the grade, size, location of PUs and prevention were identified and scored as "yes or no". If the problem was found in the documentation, then the extent of the problem was also audited.

Corresponding audits were completed for the presence of nursing assessments of nutritional status, intervention and prevalence of malnutrition; the data collection form was based on the MNA® full-form [36] and adapted for the review of records. The presence of nursing assessment, intervention and prevention of malnutrition in the nursing documentation was identified and scored.

When auditing records for comprehensiveness the coherence of the different phases of the nursing process is assessed [24] to ensure that data on patients' status, interventions and outcomes can be traced in the records. An instrument for determining

the comprehensiveness in nursing documentation (CIND) [37] was used. The CIND has five ordered levels of increasing comprehensiveness (Table 3), and scores of 3, 4 and 5 meet the Norwegian recommendations [23]. The CIND has been used in several other studies, and tests of inter-rater reliability have produced Cohen's kappa values between 0.57 and 1.0 [25, 37-41].

Two of the researchers (MF, LMH) calibrated their record review, and the inter-rater reliability for the audit instruments was evaluated on a sample of 42 records. The percent agreement varied from 93% to 100% for the CIND data collection form, 88% to 100% for the MNA® full form and 86% to 100% for the EPUAP data collection form; these values were considered to represent sufficient agreement.

3.5 Ethical considerations

Permission was granted from the nursing home directors. The residents or their proxies were informed, verbally and in writing, about the purpose of the study and the voluntary nature of participation, and participants were guaranteed confidentiality. The residents or their proxies provided written informed consent to participate in the study. The purpose was to assess the quality of the nursing documentation and not the residents' status. Personal identity data were removed from the records. Ethical permission was obtained.

3.6 Statistical analyses

Resident characteristics are described by proportions (%), median and quartiles (Q_1, Q_3) or mean and standard deviation (SD) when appropriate. The completeness of assessments of PUs was defined as the proportion of the indicators variables that were

assessed in all record (100%). The intervention effect, which is the change in completeness in documentation, as defined by the change in proportion of the eight indicator variables of PUs is calculated within each intervention group was calculated together with the 95% confidence interval of this within-group difference in proportion. Evidence of statistically significant change after intervention is indicated by a confidence interval that does not cover zero difference and indicated improvement in completeness was confirmed by the Fisher's exact test [42, 43].

Correspondingly possible differences in change of documented variables of malnutrition between groups were analyzed [44]. The Cochran-Mantel-Haenszel test was used for analysis of possible difference in intervention effect on the completeness in documentation of malnutrition. This test allows for small data sets and adjusts for possible differences in covariates or other factors between the groups.

The scores of comprehensiveness in the recording of residents' problems related to PUs and malnutrition were described by frequency distributions, medians, ranges, and by a bar chart. The mean number of notes per record was also calculated. Possible group differences in comprehensiveness scoring were analysed by the Wilcoxon-Mann-Whitney test with a correction for ties [45]. A p-value of less than 5% was regarded as significant after the Bonferroni–Holm adjustment for multiple tests [46]. The statistical software PASW Statistics 18 was used for data management.

4. Results

The care plans were documents with key words from the nursing process, and most diagnoses were in free-text format and were described as manifest or potential problems (i.e., 'nutrition problems, swallowing problems and PUs on the heels or/and sacrum').

There was a combination of handwritten and computerized nursing documents both before and after the intervention, although all of the nursing homes in the study had implemented EHRs by 2009.

4.1 Effects on the completeness of documentation of PU risk and prevalence

Table 1 shows the nursing documentation for assessments of PUs, PU grade, size and location, as well as the prevention of PUs before (2007) and after (2009) the intervention. In the intervention group for education and CDSS (IG1), the proportions of recorded PU indicator variables ranged from 6% to 100% before and 96% to 100% after the intervention. Corresponding proportions in IG2 (education) ranged from 9% to 91% in 2007 and 28% to 100% in 2009. After the intervention the completeness in documentation, as defined by the proportion of the eight indicator variables of PUs with 100% group assessments changed in the IG1 group from two (25%) to seven (88%). The wide but significant 95% CI of this difference (63 percentage units) in proportions was 13 to 83 percentage units (p=0.02). This mean that according to this study one can expect that after implementation of a CDSS modus group IG1 about 1 to 7 units more identified variables will be found in all the records. Corresponding proportions of completeness in the IG2 group were 0% and 50%, the 95% CI ranging from 7 to 78 percentage units (p =0.04). The control group showed a decrease in completeness from 5 (63%) to 3 (38%), the 95% CI ranging from -58 to 20 percentage units. In other words, the changes in completeness were significant in both intervention groups, but more pronounced in the IG1-group. The small number of variables (8) implies wide confidence intervals and weak evidence of overall statistically significant result (p = 0.08).

After implementing the CDSS in IG1, the health record documentation of PU prevention changed in percentage units from the highest decrease (-10%) to the highest increase (100%) on pressure-reducing equipment (detailed information; bed and chair) and risk assessment (96%). The documentation of pressure-reducing equipment (bed and chair) decreased. In the intervention group that received education only, there were changes in percentage units from -2% to 100% and the following three variables showed negative changes: pressure-reducing equipment (bed), planned repositioning (bed) and described interval for planned repositioning (bed). In the control group, documentation of the PU prevention changed in percentage units from the highest decrease (-50%) to the highest increase (83%), and the following five variables showed negative changes: documentation of pressure-reducing equipment (bed and chair), planned repositioning (bed), described category of pressure-reducing equipment (bed), interval for planned repositioning (bed) and PU risk assessment. Detailed information about the pressure-reducing equipment (bed and chair) reached 100% in IG1 and IG2 after the intervention, and detailed information regarding the pressure-reducing equipment (chair) reached 100% in the control group.

Table 1. Completeness in nursing documentation for the assessment and prevention of pressure ulcers (PUs) before and after the intervention, presented as percentage (%) and numbers (n).

Documentation in residents' records	Intervention 1 (IG1)		Intervention 2 (IG2)		Control Group (CG)	
	2007 **% of (n)** **n=16**	**2009** **% of (n)** **n=23**	**2007** **% of (n)** **n=23**	**2009** **% of (n)** **n=25**	**2007** **% of (n)** **n=12**	**2009** **% of (n)** **n=11**
Nursing assessment						
Physical health condition	94 (16)	100 (23)	87 (23)	100 (25)	100 (12)	91 (11)
*If yes, described**	20 (15)	100 (23)	40 (20)	40 (25)	0 (12)	30 (10)
Physical activity	100 (16)	100 (23)	91 (23)	100 (25)	100 (12)	100 (11)
*If yes, described**	88 (16)	100 (23)	81 (21)	96 (25)	100 (12)	82 (11)
Mobility	100 (16)	100 (23)	91 (23)	100 (25)	100 (12)	91 (11)
*If yes, described**	50 (16)	100 (23)	71 (21)	64 (25)	58 (12)	80 (8)
Degree to which skin is exposed to moisture	81 (16)	100 (23)	61(23)	96 (25)	100 (12)	100 (11)
*If yes, described**	38 (13)	100 (23)	36 (14)	33 (24)	8 (12)	55 (11)
Food intake	94 (16)	100 (23)	91 (23)	100 (25)	100 (12)	100 (11)
*If yes, described**	0 (15)	100 (23)	24 (21)	0 (25)	17 (12)	9 (11)
Fluid intake	75 (16)	100 (23)	70 (23)	92 (25)	58 (12)	91(11)
*If yes, described**	0 (12)	100 (23)	6 (16)	0 (23)	0 (12)	0 (10)
Sensory perception	44 (16)	100 (23)	57 (23)	68 (25)	50 (12)	73 (11)
*If yes, described**	0 (7)	100 (23)	0 (13)	12 (17)	0 (12)	13 (8)
Friction and shear	6 (16)	96 (23)	9 (23)	28 (25)	0 (12)	9 (11)
*If yes, described**	100 (1)	100 (22)	50 (2)	0 (77)	0 (0)	0 (1)
Pressure ulcer						
Pressure ulcer described	75 (16)	96 (23)	83 (23)	84 (25)	75 (12)	91 (11)
Grade	17 (12)	100 (22)	11 (19)	33 (21)	11 (9)	40 (10)
Size	25 (12)	32 (22)	42 (19)	24 (21)	11 (9)	10 (10)
Location	100 (12)	73 (22)	100 (19)	86 (21)	89 (9)	100 (10)
Prevention						
Pressure-reducing equipment (bed)	31 (16)	26 (23)	30 (23)	12 (25)	33 (12)	18 (11)
*If yes, described category**	80 (5)	100 (6)	86 (7)	100 (3)	100 (4)	50 (2)
Planned repositioning (bed)	44 (16)	48 (23)	70 (23)	68 (25)	50 (12)	36 (11)
*If yes, described interval**	0 (7)	18 (11)	13 (16)	12 (17)	0 (6)	0 (4)
Pressure-reducing equipment (chair)	19 (16)	9 (23)	9 (23)	28 (25)	50 (12)	36 (11)
*If yes, described category**	0 (3)	100 (2)	100 (2)	100 (7)	17 (6)	100 (4)
Planned repositioning (chair)	0 (16)	13 (23)	4 (23)	12 (25)	8 (12)	9 (11)
*If yes, described interval**	0 (0)	33 (3)	0 (1)	33 (3)	0 (1)	0 (1)
Risk Assessment	31 (16)	96 (23)	44 (23)	48 (25)	33 (12)	27 (11)

*For these "*If yes, described*" variables, **n** is based on the number of records for the main variable.

4.2 Effects on the completeness of the documentation of malnutrition risk and malnourishment prevalence

Table 2 displays the documentation completeness for assessment, intervention and prevention of variables of malnutrition before (2007) and after (2009) the intervention. After the intervention, the proportion records with body weight assessments significantly increased from 20% to 100% in IG1, which means by 80 (95% CI, 63 to 89) percentage units. Correspondingly in the IG2 the proportion recordings decreased by 10 (95% CI -28 to 9) percentage units, and by 28 (95% CI from -49 to -2) percentage units in the control group. The overall significance level of increase in IG1 after adjustments was p=0.007.

In IG1, the recording of risk assessment increased significantly with 79 (95% CI from 69 to 88) percentage units (from 18% to 97%) from 2007 to 2009 (p<0.001). In IG2, the risk assessment decreased with 9 (95% CI from -10 to 28) percentage units, and in the CG the risk assessment decreased 23 (from -1 to 43) percentage units. The recording of regular weight assessments showed a significant increase between 2007 and 2009 in the IG1 group with 37 (95% CI from 16 to 54) percentage units (p=0.002). Corresponding changes were 13 (95% CI from -5 to 31) percentage units in IG2, and 10 (95% CI from -4 to 26) percentage units in the CG.

Table 2. Completeness in nursing documentation for the assessment and prevention of malnutrition before and after the intervention, presented as percentage (%) and numbers (n).

Documentation in residents' records	Intervention 1		Intervention 2		Control Group	
	2007 % of (n) n=44	2009 % of (n) n=38	2007 % of (n) n=48	2009 % of (n) n=38	2007 % of (n) n=26	2009 % of (n) n=29
Nursing assessment						
Weight	20 (44)	100 (38)	31 (48)	21 (38)	69 (26)	41 (29)
Height	0 (44)	100 (38)	2 (48)	5 (38)	4 (26)	14 (29)
Food intake the last three months	68 (44)	100 (38)	85 (48)	90 (38)	65 (26)	100 (29)
*If yes, described**	53 (30)	100 (38)	12 (41)	12 (34)	6 (17)	24 (29)
Weight loss over the last three months	2 (44)	95 (38)	8 (48)	13 (38)	8 (26)	24 (29)
*If yes, described**	100 (1)	75 (36)	50 (4)	40 (5)	50 (2)	71 (7)
Mobility	95 (44)	100 (38)	94 (48)	100 (38)	100 (26)	100 (29)
*If yes, described**	86 (42)	100 (38)	73 (45)	97 (38)	92 (26)	100 (29)
Neuropsychological problem/disease	82 (44)	95 (38)	58 (48)	82 (38)	81 (26)	66 (29)
Serious dementia or depression	68 (44)	55 (38)	50 (28)	58 (38)	69 (26)	59 (29)
Body Mass Index (BMI)	0 (44)	100 (38)	0 (48)	3 (38)	0 (26)	10 (29)
Number of meals daily	18 (44)	97 (38)	13 (48)	0 (38)	23 (26)	10 (29)
Amount of fluid daily	16 (44)	100 (38)	15 (48)	3 (38)	4 (26)	0 (29)
Mode of feeding	50 (44)	84 (38)	46 (48)	74 (38)	77 (26)	48 (29)
Interventions						
Facilitation in connection to meals	43 (44)	18 (38)	50 (48)	16 (38)	12 (26)	14 (29)
Nutritional supplement	36 (44)	42 (38)	38 (48)	26 (38)	8 (26)	14 (29)
*If yes, described interval**	50 (16)	88 (16)	83 (18)	90 (10)	100 (2)	100 (4)
Special diet	9 (44)	37 (38)	27 (48)	21 (38)	38 (26)	21 (29)
Prevention						
Risk assessment	18 (44)	97 (38)	25 (48)	34 (38)	15 (26)	38 (29)
Weight assessment regularly	16 (44)	53 (38)	19 (48)	32 (38)	0 (26)	10 (29)

*For the *"If yes, described"* variables, **n** is based on the number of records for the main variable.

4.3 Effects on the comprehensiveness of nursing documentation of PUs and malnutrition

All text in the resident records related to planned and performed nursing care was reviewed. For IG1, nine problems related to PUs and 28 problems related to malnutrition were identified before the intervention, and ten problems related to PUs and 53 problems related to malnutrition were identified after the intervention. Table 3 shows the frequency distribution of the comprehensiveness scores in nursing records of the residents' problems related to PUs and malnutrition before and after the intervention. Before the intervention, no recording of problems related to PUs and malnutrition reached the recommended level of 3 or above in IG1 and CG. In IG2, five resident problems received a score of 3.

After the CDSS intervention, seven resident problems in IG1 were scored 3 or 4 for PUs, and 38 problems were scored 3, 4, or 5 for malnutrition. In the intervention group that received education only, two problems were scored 3 for PUs, and one problem was scored 3 for malnutrition. In the control group, one problem scored 3 for PUs, and no problem scored 3 or higher for malnutrition. The mean number of notes per residents with reported PUs and/or malnutrition varied from 0.3 to 1.0 in 2007 and 0.4 to 1.4 in 2009.

4.4 Effects on the nursing comprehensiveness in the recording of malnutrition

Figure 2 shows the distribution of identified problems on the scores of comprehensiveness in nursing documentation of residents' problems for the three groups and the two occasions. The lines of the median (50%) and quartiles (25%, 75%)

show that the median scores for comprehensiveness in nursing documentation of residents nutritional problems was 3 in IG1, 2 in IG2 , and 1 in the control group after the intervention. The differences in the level median scores in nursing documentation between IG1 and IG2 and between IG1 and the CG were statistically significant (p<0.0001), as was the difference in scores between IG2 and the CG (p=0.002).
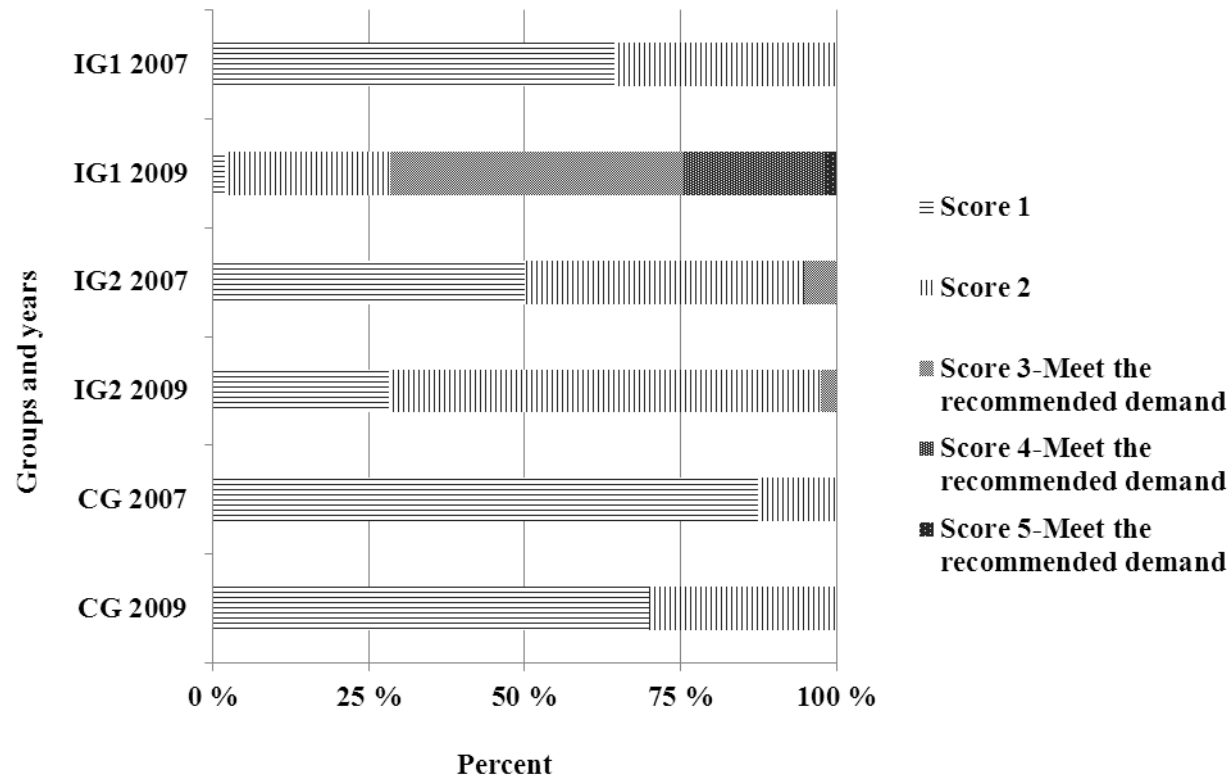
Figure 2. Distribution of comprehensiveness scores (from 1 to 5) in nursing documentation of residents' nutritional problems as a function of study groups (IG1, IG2 and CG) before (2007) and after (2009) the intervention.

4.5 Effects on the nursing comprehensiveness in the recording of PUs

Referring to Table 3, the median comprehensiveness scores in the nursing

documentation of residents' problems related to PUs were 3 (range 1 to 4) in IG1, 2

(range 1 to 4) in IG2 and 2 (range 1 to 3) in the CG. The difference in the median scores

between IG1 and IG2 was statistically significant (p=0.02).

Table 3. Frequency distribution of comprehensiveness scores in nursing recording of residents with pressure ulcers (PUs) and malnutrition (M), as measured before and after the intervention using the comprehensiveness in nursing documentation (CIND*).

Comprehensiveness scores in residents' records	Intervention 1 (IG1)				Intervention 2 (IG2)				Control Group (CG)			
	2007		2009		2007		2009		2007		2009	
	PUs	M	PUs	M	PUs	M	PUs	M	PUs	M	PUs	M
Score 1: Problem described or intervention(s) planned or implemented, n	2	18	1	1	10	19	4	11	4	7	2	14
Score 2: Problem described and intervention(s) planned and/or implemented, n	7	10	2	14	11	17	15	27	3	1	2	6
Score 3: Problem described, intervention(s) planned and/or implemented and outcome, n	0	0	4	25	3	2	1	1	0	0	1	0
Score 4: Problem described, intervention (planned and implemented) and outcome, n	0	0	3	12	0	0	1	0	0	0	0	0
Score 5: Comprehensive care plan, n	0	0	0	1	0	0	0	0	0	0	0	0
Mean number of notes per residents with reported PUs and/or malnutrition	0.6	0.6	0.4	1.4	1.0	0.7	0.8	1.0	0.4	0.3	0.5	0.7

*Ehnfors and Smeby 1993 [37].

5. Discussion

The effects of CDSS implementation on the completeness and comprehensiveness of the documentation of PUs and malnutrition were positive. The completeness in recording the risk and prevalence of PUs and malnutrition improved significantly. These results show that the use of the CDSS and the educational program improved the recording of nursing assessments and comprehensiveness in the documentation of PUs and nutritional problems. For example, recorded assessments of body weight and height increased to 100% in IG1 and were unchanged or decreased in IG2 and the CG.

To the best of our knowledge, no other studies in nursing homes have shown the effects of using a CDSS on the completeness and comprehensiveness of nursing documentation, though several studies have shown improved documentation after educational interventions in paper-based [40, 47] and electronic health records [39, 48]. CDSSs have primarily been developed to support physicians' clinical work, and only a few studies on the effects of CDSS in nursing care have been published [13, 14]. The association between using a CDSS and clinical outcome improvement has been demonstrated among physicians [28].

A structured format for recording has been effective at increasing the quality of nursing documentation [39, 49]. A study conducted in a Swedish hospital showed that both the quality and comprehensiveness of PU documentation significantly improved after implementing an EHR system with pre-formulated templates [39]; however, the study had a before-after design with no control group.

Complete and comprehensive documentation is important for communication between nurses and other members of the health care team. Proper communication ensures continuity and safety in care [50]. The present study observed more complete

and comprehensive documentation after the intervention. Implementing a CDSS with accompanying educational support in other settings should increase nursing documentation quality to meet legal demands to a higher degree. Another study of a computer-based nursing documentation system in 4 hospital wards showed similar improvements in nursing documentation [51]. However, the use of information and communication systems to increase the quality of nursing documentation has shown mixed results [20, 51, 52]. A study from a hospital setting showed that nurses only recorded 40% of what they actually provided for patients [53]. A recent literature review on the effects of documentation on the quality of care in aged care facilities identified a lack of evidence for a relationship between documentation and patient outcome [54], and the nursing personnel needed to trust the recommendation from the CDSS to actually use it in the clinical practice [55]. Therefore, our results cannot be interpreted as improvements in how nurses care for residents. Increasing the comprehensiveness in nursing documentation may be one of several important factors that contribute to positive resident outcomes [56]. However, the use of EHRs, which can be considered a simple form of a CDSS [17], has shown positive results on resident outcomes in nursing homes [57].

In the present study, the improved completeness and comprehensiveness in nursing documentation after CDSS implementation with an accompanying educational program provides support for the further development and implementation of CDSSs in nursing homes. The work context in nursing homes has been described as busy and complex and is occasionally perceived by care providers as chaotic [58]. In such working conditions, a CDSS that provides support for evidence-based practices and

facilitates communication in care may be of great value as an implementation strategy to ensure quality of care.

The impact of a CDSS on nurses' decision making must be explored in future research [59]. Studies have shown that implementing an EHR does not unilaterally indicate that documentation comprehensiveness will increase [38, 60]. Further studies should focus on nurses' actual knowledge in specific areas that CDSSs are designed to support, and these studies should evaluate the effects of CDSSs on nurses' knowledge in these specific areas.

Although the completeness and comprehensiveness in nursing documentation increased after the intervention of a CDSS and an accompanying educational program, the total number of documented nursing problems was relatively low and is a concern regarding the impact on care quality. The sample for this study consisted of records from residents with stage I-IV PUs and/or MNA® scores of less than 17. However, the mean numbers of notes per resident regarding both PUs and malnutrition were one or fewer, with the exception of IG1 in 2009 for malnutrition documentation. These findings are similar to results from other nursing home records audits that show flaws in nursing documentation [21, 41]. Information concerning nurses' general acceptance of the nursing process [61, 62] could have helped us to understand the low total number of nursing problems.

5.1 Limitations and methodological considerations

A limitation of the present study could be the non-randomized group design, which means that the nursing homes, not the individual nurses are the units of intervention. There were many practical and ethical reasons for group allocation; different

interventions within the same nursing home would increase the risk of contamination between the documentation systems. Common units of group designs, sometimes called cluster designs, are communities, schools, clinical practices, and nursing homes. The main aim was to evaluate the within-group intervention effects and such analyses are independent on possible differences between the different groups.

The result of this study refers to records that fulfill the inclusion and exclusion criteria, which deliberately gave only records with presence of PUs and/or malnutrition. This means that there may have been records that lacked documentation on PUs or malnutrition although the patients were suffering from these conditions. However, conducting intervention studies in health informatics in real life, is a common challenge [34]. The inclusion of a control group strengthened the design. Provided the group design, the inclusion criteria and the risk of lack of compliance in documentations among the nurses, strong statistical evidences in favor of the CDSS intervention were found in this study. However, one should not draw strong general conclusions from the results because of the wide confidence intervals and that there may be other factors contributing to the improvement of nursing documentation completeness and comprehensiveness.

A factor that may have introduced bias in our study was that there might have been variations among nurses in experience using clinical guidelines. At the time of this study, of fourteen countries from northwestern Europe and the USA, Norway was one of four countries without a quality assessment system in nursing homes [63]. In Norway, indicators and clinical guidelines were not commonly used by the nurses.

Another limitation of this study was that we had no control over how extensively the nurses used the CDSS. There may have been significant differences in the care

planning systems between the three groups. In addition, the standardized format of the EHR documents for care planning may have had an impact on what nurses documented, which may have influenced the results. In a systematic review by Urquhart and colleagues [52], EHRs designed for specific problems were successful, but EHRs did not necessarily lead to improvements in general nursing practice.

6. Conclusion

This study provides evidence that the computerized decision support system and an accompanying educational program as implementation strategies had a positive effect on nursing documentation practice.

Authors' contributions

Associate Professor Mariann Fossum was the primary author of the manuscript and responsible for the data collection. Professor Anna Ehrenberg guided the study design, data analysis reviews, and manuscript reviews; Professor Margareta Ehnfors guided the study design, data analysis reviews, and manuscript reviews; Professor and Statistician Elisabeth Svensson helped with data analysis and manuscript reviews; Assistant Professor Linda M Hansen assisted with analysis and manuscript reviews.

Conflict of interest

The authors have no conflict of interest to report.

Summary Points

What was already known about this topic?

1. Nursing documentation is essential for continuity, quality and safety in care.

2. Lack of accuracy and quality in nursing documentation has been reported.

3. The implementation of computerized decision support systems is expected to improve clinical practice and nursing documentation.

What this paper adds?

1. The completeness and comprehensiveness of the documentation of pressure ulcers and nutritional problems significantly improved after a computerized decision support system and an educational program were implemented.

2. Provides evidence that the computerized decision support system and an educational program as implementation strategies had a positive influence on nursing documentation practice.

17

References

1. Malmedal W, Ingebrigtsen O, Saveman B-I. Inadequate care in Norwegian nursing homes as reported by nursing staff. *Scand J Caring Sci*. 2009;**23**(2):231-42.

2. Georgiades S. Quality of nursing home care in Cyprus: are elder residents content with their treatment? *J Gerontol Soc Work*. 2008;**50**(3-4):3-24.

3. Kwong EW-y, Pang SM-c, Aboo GH, Law SS-m. Pressure ulcer development in older residents in nursing homes: influencing factors. *J Adv Nurs*. 2009;**65**(12):2608-20.

4. Meijers J, Schols J, van Bokhorst-de van der Schueren M, Dassen T, Janssen M, Halfens R. Malnutrition prevalence in The Netherlands: results of the annual dutch national prevalence measurement of care problems. *Br J Nutr*. 2009;**101**(3):417-23.

5. Heersink JT, Brown CJ, Dimaria-Ghalili RA, Locher JL. Undernutrition in hospitalized older adults: patterns and correlates, outcomes, and opportunities for intervention with a focus on processes of care. *J Nutr Elder*. 2010;**29**(1):4-41.

6. Hankey CR, Leslie WS. Nutritional issues and potential interventions in older people. *Rev Clin Gerontol*. 2011;**21**(4):286-96.

7. Sprigle S, Sonenblum S. Assessing evidence supporting redistribution of pressure for pressure ulcer prevention: A review. *J Rehabil Res Dev*. 2011;**48**(3):203-13.

8. Colon-Emeric CS, Lekan D, Utley-Smith Q, Ammarell N, Bailey D, Corazzini K, et al. Barriers to and facilitators of clinical practice guideline use in nursing homes. *J Am Geriatr Soc*. 2007;**55**(9):1404-9.

9. Wipke-Tevis DD, Williams DA, Rantz MJ, Popejoy LL, Madsen RW, Petroski GF, et al. Nursing home quality and pressure ulcer prevention and management practices. *J Am Geriatr Soc*. 2004;**52**(4):583-8.

10.   Berlowitz DR, Young GJ, Hickey EC, Joseph J, Anderson JJ, Ash AS, et al. Clinical practice guidelines in the nursing home. *Am J Med Qual*. 2001;**16**(6):189-95.

11.   Grimshaw J, Thomas R, MacLennan G, Fraser C, Ramsay C, Vale L, et al. Effectiveness and efficiency of guideline dissemination and implementation strategies. *Health Technol Assess*. 2004;**8**:(6).

12.   Grimshaw J, Eccles M, Thomas R, MacLennan G, Ramsay C, Fraser C, et al. Toward Evidence-Based Quality Improvement. *J Gen Intern Med*. 2006;**21**(2):14-20.

13.   Randell R, Mitchell N, Dowding D, Cullum N, Thompson C. Effects of computerized decision support systems on nursing performance and patient outcomes: a systematic review. *J Health Serv Res Policy*. 2007;**12**(4):242-51.

14.   Anderson JA, Willson P. Clinical decision support systems in nursing: synthesis of the science for evidence-based practice. *CIN COMPUT INFORM NURS*. 2008;**26**(3):151-8.

15.   Toth-Pal E, Wårdh I, Strender LE, Nilsson G. A guideline-based computerised decision support system (CDSS) to influence general practitioners management of chronic heart failure. *Inform Prim Care*. 2008;**16**(1):29-39.

16.   Damiani G, Pinnarelli L, Colosimo SC, Almiento R, Sicuro L, Galasso R, et al. The effectiveness of computerized clinical guidelines in the process of care: a systematic review. *BMC Health Serv Res*. 2010;**10**:2.

17.   Greenes RA. Clinical decision support: the road ahead. Boston, USA: Elsevier; 2007.

18.   Dowding D, Randell R, Mitchell N, Foster R, Lattimer V, Thompson C. Clinical decision support systems in nursing. In: Staudinger B, Höss V, Ostermann H, editors.

Nursing and clinical informatics: socio-technical approaches. Hershey, PA: Medical Information Science Reference; 2009. p. 16 s.

19.   Munyisia EN, Yu P, Hailey D. The changes in caregivers' perceptions about the quality of information and benefits of nursing documentation associated with the introduction of an electronic documentation system in a nursing home. *Int J Med Inf*. 2011;**80**(2):116-26.

20.   Zhou L, Soran CS, Jenter CA, Volk LA, Orav E, Bates DW, et al. The relationship between electronic health record use and quality of care over time. *J AM MED INFORM ASSOC*. 2009;**16**(4):457-64.

21.   Voutilainen P, Isola A, Muurinen S. Nursing documentation in nursing homes - state-of-the-art and implications for quality improvement. *Scand J Caring Sci*. 2004;**18**(1):72-81.

22.   Linder JA, Ma J, Bates DW, Middleton B, Stafford RS. Electronic Health Record Use and the Quality of Ambulatory Care in the United States. *Arch Intern Med*. 2007;**167**(13):1400-5.

23.   The Ministry of Health and Care Services. Forskrift om pasientjournal [The patient record act]. 2000 [cited 2011 5 Dec]; Available from: http://www.lovdata.no/for/sf/ho/xo-20001221-1385.html.

24.   Ehrenberg A, Ehnfors M, Smedby B. Auditing nursing content in patient records. *Scand J Caring Sci*. 2001;**15**(2):133-41.

25.   Gunningberg L, Ehrenberg A. Accuracy and quality in the nursing documentation of pressure ulcers: a comparison of record content and patient examination. *J Wound Ostomy Continence Nurs*. 2004;**31**(6):328-35.

26.   Paans W, Sermeus W, Nieweg RM, Cp. Prevalence of accurate nursing

documentation in patient records. *J Adv Nurs*. 2010;**66**(11):2481-9.

27.   Ehrenberg A, Ehnfors M. The accuracy of patient records in Swedish nursing

homes: congruence of record content and nurses and patients descriptions. *Scand J

Caring Sci*. 2001;**15**(4):303-10.

28.   Garg A, Adhikari N, McDonald H, Rosas-Arellano M, Devereaux P, Beyene J,

et al. Effects of computerized clinical decision support systems on practitioner

performance and patient outcomes. A systematic review. *JAMA*. 2005;**293** 1223-38.

29.   Kawamoto K, Houlihan CA, Balas EA, Lobach DF. Improving clinical practice

using clinical decision support systems: a systematic review of trials to identify features

critical to success. Br Med J [Internet]. 2005 12 Jan 2012; 330(7494):[765-8 pp.].

Available from:

http://www.bmj.com/content/330/7494/765?view=long&pmid=15767266.

30.   Statistics Norway. Almost status quo in nursing and care services. Oslo:

Statistics Norway; 2010 [cited 2011 11 Nov]; Available from:

http://www.ssb.no/english/subjects/03/02/pleie_en/.

31.   The Ministry of Health & Care Services. Lov om helsepersonell [The Health

Personnel Act] The Act of 2 July 1999 No. 64 relating to Health Personnell Oslo1999

[cited 2011 5 Dec]; Available from: http://www.lovdata.no/all/nl-19990702-064.html.

32.   Fossum M, Alexander GL, Ehnfors M, Ehrenberg A. Effects of a computerized

decision support system on pressure ulcers and malnutrition in nursing homes for the

elderly. *Int J Med Inf*. 2011;**80**(9):607-17.

33.   Polit DF, Beck CT. Nursing research: generating and assessing evidence for nursing practice. Philadelphia, Pa.: Wolters Kluwer/Lippincott Williams & Wilkins; 2008.

34.   Harris AD, McGregor JC, Perencevich EN, Furuno JP, Zhu J, Peterson DE, et al. The use and interpretation of quasi-experimental studies in medical informatics. *J AM MED INFORM ASSOC*. 2006;**13**(1):16-23.

35.   Lindgren M. Pressure sores risk assessment and prevention Linköping, Sweden: Linköping University Medical Dissertations No 784; 2003.

36.   Guigoz Y. The Mini Nutritional Assessment (MNA) review of the literature. What does it tell us? *J Nutr Health Aging*. 2006;**10**(6):466-85.

37.   Ehnfors M, Smedby B. Nursing care as documented in patient records. *Scand J Caring Sci*. 1993;**7**(4):209-20.

38.   Gjevjon ER, Hellesø R. The quality of home care nurses' documentation in new electronic patient records. *J Clin Nurs*. 2010;**19**(1/2):100-8.

39.   Gunningberg L, Fogelberg-Dahm M, Ehrenberg A. Improved quality and comprehensiveness in nursing documentation of pressure ulcers after implementing an electronic health record in hospital care. *J Clin Nurs*. 2009;**18**(11):1557-64.

40.   Ehrenberg A, Ehnfors M. Patient records in nursing homes: effects of training on content and comprehensiveness. *Scand J Caring Sci*. 1999;**13**(2):72-82.

41.   Ehrenberg A, Ehnfors M. Patient problems, needs, and nursing diagnoses in Swedish nursing home records. *Nurs Diagn*. 1999;**10**(2):65-76.

42.   Newcombe RG, Altman DG. Proportions and their differences. In: Altman DG, Machin D, Bryant TN, MJ. G, editors. Statistics with confidence. 2nd ed ed. Bristol: BMJ books; 2000. p. 45-57.

43.   Altman DG. Practical statistics for medical research. London: Chapman and Hall/CRC; 1991.

44.   Pocock SJ. Clinical trials: a practical approach. Chichester: Wiley; 1983. xii, 266 s. p.

45.   Siegel S, Castellan NJ. Nonparametric statistics for the behavioral sciences. New York: McGraw-Hill; 1988. XXIII, 399 s. p.

46.   Holm S. A simple sequentially rejective multiple test procedure. *Scand J Stat*. 1979;**6**(2):65-70.

47.   Bjorvell C, Wredling R, Thorell-Ekstrand I. Long-term increase in quality of nursing documentation: effects of a comprehensive intervention. *Scand J Caring Sci*. 2002;**16**(1):34-42.

48.   Törnvall E, Wahren LK, Wilhelmsson S. Advancing nursing documentation-An intervention study using patients with leg ulcer as an example. *Int J Med Inf*. 2009;**78**(9):605-17.

49.   Saranto K, Kinnunen U. Evaluating nursing documentation - research designs and methods: systematic review. *J Adv Nurs*. 2009;**65**(3):464-76.

50.   Yu P, Hailey D, Li H. Caregivers' acceptance of electronic documentation in nursing homes. *J Telemed Telecare*. 2008;**14**(5):261-5.

51.   Mahler C, Ammenwerth E, Wagner A, Tautz A, Happek T, Hoppe B, et al. Effects of a computer-based nursing documentation system on the quality of nursing documentation. *J Med Syst*. 2007;**31**(4):274-82.

52.   Urquhart C, Currell R, Grant MJ, Hardiker NR. Nursing record systems: effects on nursing practice and healthcare outcomes. *Cochrane Database Syst Rev*. 2009;**1**.

53.   Marinis MGD, Piredda M, Pascarella MC, Vincenzi B, Spiga F, Tartaglini D, et al. 'If it is not recorded, it has not been done!'? consistency between nursing records and observed nursing care in an Italian hospital. *J Clin Nurs*. 2010;**19**(11-12):1544-52.

54.   Pearson A, Peels S. Effective documentation in residential aged care facilities. *Referência: Revista Científica da Unidade de Investigação em Ciências da Saúde: Domínio de Enfermagem*. 2009;**10**:113-32.

55.   Campion TR, Jr., Waitman LR, Lorenzi NM, May AK, Gadd CS. Barriers and facilitators to the use of computer-based intensive insulin therapy. *Int J Med Inf*. 2011;**80**(12):863-71.

56.   Jansson I, Pilhammar-Andersson E, Forsberg A. Evaluation of documented nursing care plans by the use of nursing-sensitive outcome indicators. *J Eval Clin Pract*. 2010;**16**(3):611-8.

57.   Rantz MJ, Hicks L, Petroski GF, Madsen RW, Alexander G, Galambos C, et al. Cost, staffing and quality impact of bedside electronic medical record (EMR) in nursing homes. *J Am Med Dir Assoc*. 2010;**11**(7):485-93.

58.   Jakobsen R, Sørlie V. Dignity of older people in a nursing home: Narratives of care providers. *Nurs Ethics*. 2010;**17**(3):289-300.

59.   Randell R, Dowding D. Organisational influences on nurses' use of clinical decision support systems. *Int J Med Inf*. 2010;**79**(6):412-21.

60.   Larrabee J, Boldreghini S, Elder-Sorrells K, Turner Z, Wender R, Hart J, et al. Evaluation of Documentation Before and After Implementation of a Nursing Information System in an Acute Care Hospital. *Comput Nurs*. 2001;**19**(2):56-65.

61.   Ammenwerth E, Kutscha U, Kutscha A, Mahler C, Eichstädter R, Haux R. Nursing process documentation systems in clinical routine: prerequisites and experiences. *Int J Med Inf*. 2001;**64**(2-3):187-200.

62.   Ammenwerth E, Mansmann U, Iller C, Eichstädter R. Factors affecting and affected by user acceptance of computer-based nursing documentation: Results of a two-year study. *J AM MED INFORM ASSOC*. 2003;**10**(1):69-84.

63.   Du Moulin MF, van Haastregt JC, Hamers JP. Monitoring quality of care in nursing homes and making information available for the general public: state of the art. *Patient Educ Couns*. 2010;**78**(3):288-96.