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Clinical Decision Support Systems in Nursing Homes: A Scoping Review

Abir ABDELLATIF[a,b,c,1] Jacques BOUAUD[d,a], Duy NGHIEM[b], Carmelo LAFUENTE-LAFUENTE[e,b], Joël BELMIN[e,b], Brigitte SEROUSSI[a,f]

[a] *Sorbonne Université, Université Paris 13, Sorbonne Paris Cité, INSERM, UMR S_1142, LIMICS, Paris, France*
[b] *AP-HP, Hôpital Charles-Foix, Ivry-sur-Seine, France*
[c] *Teranga Software, Paris, France*
[d] *AP-HP, DRCI, Paris, France*
[e] *Sorbonne Université, Paris, France*
[f] *AP-HP, Hôpital Tenon, Paris, France*

Abstract. The world population is dramatically ageing, resulting in an increase of the prevalence of older dependent adults living in nursing homes (NHs). Because of insufficient resources in NHs, and nurses' lack of time and knowledge, adverse events, most of them being preventable, are often reported. Clinical decision support systems (CDSSs) have proven to improve the quality of care in various healthcare settings such as hospitals and primary care centers. However, the use of CDSSs in NHs is still limited and little is known about their influence on nursing practices and NH residents' clinical outcomes. We conducted a scoping review of the literature to evaluate CDSS use in NHs. Out of 1,231 retrieved papers, 15 studies were retrieved which assess 10 CDSSs applied to pressure ulcers and malnutrition prevention, drug prescription, and disease management. This review showed CDSSs could be effective in NHs for improving routine clinical practice and patient outcomes, but research is still needed to implement effective CDSSs in NHs.

Keywords. Clinical decision support systems, Nursing homes, Geriatrics, Clinical Outcomes, Evaluation, Quality of care

1. Introduction

Because of the ageing population and the rise in the prevalence of dependent older adults, an increasing number of aged people currently live in nursing homes (NHs). Studies have reported that NH residents are at risk of developing adverse events, many are preventable (e.g. pressure ulcers, urinary tract infections, falls, adverse drug events) [1]. This is often explained by insufficient staff and resources in NHs, and nurses' lack of time and knowledge [2].

Electronic Health Record systems (EHRs) contain patient's data, including nursing records and care track. EHRs have proven to provide accurate, up-to-date, and

[1] Corresponding Author: Abir Abdellatif, Hôpital Charles-Foix, 7 avenue de la République, 94200 Ivry-sur-Seine, France. E-mail : abir.abdellatif@gmail.com

holistic information about patients at the point of care, enabling more coordinated and efficient care. The use of clinical decision support systems (CDSSs) connected to EHRs have demonstrated to improve the quality of care in both hospitals and primary care settings [3]. However, the use of CDSSs in NHs is still limited and little is known about their influence on nursing practices and NH residents clinical outcomes [4].

Teranga[2] is a French vendor of an EHR called "NETSoins" used in about 40% of NHs nationwide. One objective is to develop a CDSS connected with NETSoins to improve the knowledge of nurses and support them in providing better care to NH residents. Prior to this development, we conducted a scoping review of the literature to analyze CDSSs used in NHs and assess the key factors of these systems regarding nurse satisfaction, care process improvement, and NH residents clinical outcomes.

2. Methods

PubMed was searched between 2010 and 2019 for studies describing CDSSs used in NHs. We used a combination of MeSH terms and key words to account for the management of elderly in NHs (i.e., "Geriatrics", "Long-Term Care", "Nursing homes", "Residential Facilities", "Care homes") and the use of CDSSs (i.e., "Decision support techniques", "Decision support system, Management", "Decision support system, Clinical").

Two of the authors (AA, DN) independently selected original articles describing and evaluating the implementation and use of CDSSs in NHs on the basis of titles and abstracts. The reference list of selected papers was also examined.

Selected articles were analyzed according to (i) the specific clinical application of the CDSS, (ii) the design of the study (type, CDSS users, sample size), (iii) CDSS features (reasoning process and users' interfaces), (iv) impact of the CDSS, and (v) CDSS users' acceptance and adoption in routine practice beyond the intervention period. We included observational studies (OSs), randomized (RCTs), and non-randomized controlled trials (NRCTs).

3. Results

The query used to search PubMed retrieved a total of 1,231 articles leading to 26 potentially relevant publications for full-text review after the screening step. Eleven publications were excluded (CDSS was applied to primary care, no computerized CDSS was used, no outcome was assessed) leading to 15 articles [4–18] that met our criteria for review.

The 15 selected studies assessed 10 different CDSSs that were gathered for the analysis according to their clinical application: CDSSs for prevention, CDSSs for drug prescription, and CDSSs for disease management. In all the retrieved studies, users' adoption of CDSSs in routine practice beyond the intervention study period was not well described and was finally not analyzed in this paper.

[2] https://www.teranga-software.com

3.1. CDSSs for pressure ulcers and malnutrition prevention

We retrieved five studies [4–8] assessing the implementation of three CDSSs to support pressure ulcers and malnutrition prevention. Two studies were OSs [5,8], two were RCTs [4,7], and one was a NRCT [6]. All studies enrolled nurses and nursing aides as primary CDSS users. All CDSSs were guideline-based and used the display of alerts automatically triggered when risk assessment instruments (e.g. the Risk Assessment Pressure Scale for pressure ulcer risk screening or the Mini Nutritional Assessment scale for screening nutritional status) exceeded predefined thresholds. One CDSS [4–6] is integrated into the NH EHR, the two others [7,8] are standalone systems that need to be activated by users. One CDSS [8] is a patient monitoring system to facilitate nursing staff implementation of standard care for pressure ulcer/injury prevention. The system operates from data on frequency and position of sensors worn on each resident's anterior chest, to estimate the nursing staff compliance with repositioning standard of care, before and after visual monitors were activated to cue staff.

Globally, using the CDSS lowered significantly the prevalence of malnourished residents (reduction from 28.8 to 19.8%) [4], and pressure ulcers incidence (reduction from 15.1% to 7.1%) [7]. The three CDSSs were associated with an improvement of care processes (better compliance of nursing care with clinical practice guidelines, especially concerning NH residents repositioning, improvement of practitioners' attitude and nursing culture) [5–8]. User reviews were mixed, diversely reporting ease of use, lack of training, and resistance to computer use.

3.2. CDSSs for drug prescription: medication review and daily drug prescription

We made the difference between CDSSs supporting daily drug prescription and those for "medication reviews". A medication review is a structured analysis and re-consideration of the entire patient's drug treatment aiming at simplifying and optimizing it, usually performed at least once a year in geriatrics by both physician and pharmacist.

Five studies [11,12,16-18] (among which four OSs and one NRCT), evaluated two CDSSs for medication review. Two studies [11,12] enrolled pharmacists as primary users of the CDSS whereas nurses were the CDSS principal users in the other studies [16-18]. Both CDSSs were guideline-based. One [11,12] is a standalone system and operates to support pharmacist review of physician orders. In case of drug mis-prescription, alerts are automatically triggered and displayed to the pharmacist who contacts the prescriber and indicates how to revise the wrong prescription. The second CDSS [16-18] is connected to the NH EHR. It criticizes drug prescriptions and alerts nurses about drug-related problems. All studies measured the effects of using the CDSS on care processes such as prescriptions and observed clinical practices compliance with guidelines, as well as interpersonal collaboration. The use of the CDSS was beneficial in all studies. Users were mostly satisfied by the CDSS except in one study [12], where they reported alert fatigue.

Three studies [13–15] (two OSs and one RCT) evaluated the implementation of three CDSSs to support daily drug prescription. The primary users of CDSSs were pharmacists in two studies [14,15], and physicians in the third study [13]. The knowledge bases of these systems are elaborated from clinical practice guidelines and expert opinion. All CDSSs display critics attached to non-compliant drug dosing or

prescription. One of the three CDSSs [9] is connected with the NH EHR and generates informative dosing messages or alerts for prescribers. The two other CDSSs are standalone systems where patient data have to be entered to obtain decision support. Warning messages are displayed to criticize physicians' prescriptions. CDSSs work with emails or phone calls between physicians and pharmacists.

CDSSs were successful in all studies to improve processes (e.g. increase of drug prescription compliance) and organizational aspects (e.g., time saving, team working). No clinical outcome was measured in any of the studies. Users of one study [13] expressed their dissatisfaction about unnecessary alerts (displayed in 50% of the cases).

3.3. CDSSs for disease management

Two studies (both were OSs) [9,10] assessed two CDSSs for disease management. The first CDSS [9] is applied to heart failure real time management. It includes several reporting tools to help data tracking and analysis to be used by physicians (tabular view for medications, weight-trending graph, and symptom analysis). The second CDSS [10] is applied to the management of urinary tract infections and is developed following Goal-Directed Design principles to support NH staff in differentiating urinary tract infections from asymptomatic bacteriuria, thus reducing antibiotic days.

The first CDSS [9] is connected to the NH EHR. It relies on a guideline-based knowledge base. The second CDSS [10] is a web-based application. Four information needs were identified from focus groups (guidance regarding resident assessment, communication with providers, care planning, and urine culture interpretation) and encoded in the knowledge base of the system (also including clinical practice guidelines). Both CDSSs provided educational recommendations. Both CDSS were considered useful for symptom tracking, visual information, facility of data entry, and ease of use.

4. Discussion and conclusion

Health information technology tools such as EHRs and CDSSs have proven to improve the quality of care in hospital settings. However, our literature review showed that these tools are not yet widely used in NHs despite a great number of residents and insufficient staff and resources, e.g., lack of doctors. On the last decade, only 15 papers describing the NH use of 10 different CDSSs have been retrieved. Most of the CDSSs were stand alone systems (six out of 10), this lack of interoperability being reported as being an issue in previous studies. Systems were poorly described in the retrieved papers and it was difficult to understand how they were developed (data processing, user's interfaces, etc.). For instance, we could not assess whether factors such as requiring practitioners to provide reasons when over-riding or providing advice concurrently to patients and practitioners, known to be winning factors to improve guideline compliance and care quality [3], were implemented. Only a few studies were RCTs (3 out of 15), evidencing positive clinical outcomes (significant reduction in the prevalence of malnourished residents and pressure ulcers incidence), and most of CDSSs were judged as satisfactory (ease of use, time saving, team working) even if some critics were also reported (alert fatigue). The number of health conditions addressed is currently quite limited although there is, undoubtedly, a great potential to expand CDSS applications, for instance to the management of osteoporosis or to fall

prevention. However, since elderly are more likely to experience adverse drug reactions, many studies were focused on drug prescription improvement.

Whether they are linked or not to an EHR, used by physicians, nurses, or pharmacists, generating alerts at the point of care or not, this review suggests CDSSs can be effective in NHs to improve nurses' daily practice and residents' clinical outcomes in several domains. However, more research is still needed for implementing effective CDSSs in NHs.

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