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Decision support systems in healthcare -
Literature review

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Decision support systems in health care – Literature review

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The purpose of this literature review was to determine which factors promote and support the use of the decision support system in nursing and what experience professionals in decision-making support have in using the system, and whether there are general factors that promote or inhibit the use of the system.

Literature searches were conducted on the following electronic databases: Finna (Finnish database), PubMed (international database) and Cochrane (international research network). Initially, the searches sought material published in 2010–2018. The search was later expanded to include two meta-analyses published in 2005. The review material consists of four meta-analyses of decision-making support in health (meeting a total of 362 articles) that met the admission criteria, as well as one dissertation study published in 2014.

Analyzes of the data in the review contained similar results. Decision support could potentially reduce prescription errors and incidents. It also appears to reduce medical errors and thus improve the quality and effectiveness of treatment. User experiences varied greatly and were influenced by many factors. However, according to the analyzes, no economic impact could be demonstrated.

The studies analyzed were mainly focused on healthcare providers. A few studies also include healthcare clients.

1	BACKGROUND.....	4
2	DECISION SUPPORT SYSTEMS.....	5
2.1	Computer assisted decision support.....	5
2.2	Implementation, application and functions of decision support.....	6
2.3	Decision support concepts	8
3	PURPOSE OF THE LITERATURE REVIEW AND RESEARCH QUESTIONS ..	10
4	LITERATURE REVIEW AS A METHOD.....	10
4.1	Systematic literature review.....	11
4.2	Integrated literature review	11
4.3	Article search	12
4.4	Article selecting	15
4.5	Evaluation of the quality of the selected material.....	16
4.6	Data and analysis of the review	17
4.7	Interpretation and presentation of results.....	18
5	RESULTS OF ANALYSIS.....	18
5.1	Factors contributing to and supporting the use of decision - making.....	18
5.2	Professionals experience with decision support	21
5.3	General factors contributing to the use and development of decision support.	22
6	DISCUSSION	23
6.1	Reflection on the results of the literature review	23
6.2	Ethics and reliability	26
6.3	Further research topics and importance of literature review	28
7	CONCLUSIONS.....	30
	REFERENCE.....	31
	APPENDIX	35

1 BACKGROUND

Healthcare has a variety of operational processes and a large number of information systems developed to support these functions. The patient care process does not proceed in an accurate, predictable manner, which poses its own challenges to health information system development. Patient information is stored at many stages of the treatment process and there is a wealth of medical knowledge available to the practitioner. Increasing medical knowledge and a wealth of patient information have made it difficult for healthcare professionals to manage information. Finding relevant information is more difficult in any given decision-making situation. There is a need in the healthcare industry to support decision-making in the treatment process by ensuring access to information relevant to the treatment situation. In the context of a healthcare information system, the goal of a decision support system is to collect and present information that is relevant to the individual care situation. (Miettinen 2006, 5)

The Counseling Patient Report is a healthcare method that transmits evidence-based patient-specific information to healthcare professionals. Patient-specific advice is transmitted to the professional computer screen when using a patient information system with a clinical decision support system attached. There is not much previous research on the use of the method in Finland. According to international studies, advice on individual treatment recommendations and preventive care improves the treatment process. More research is needed on the wider application of counseling to patient care in the context of primary care. (Kortteisto 2014, 11)

Kortteisto (2014) stated that research on clinical decision support systems in Finland is reasonably new. Scientific research on the topic in Finland is still scarce (2019) and mainly focuses on a small group of researchers. Decision support for healthcare systems has been the subject of international research for several decades. Generally, research on decision support systems has been conducted worldwide since the 1970s (Shim 2002, 112; Nykänen 2000, 33).

This review is timely because all healthcare providers are facing the same problem of information management. Decision support systems are an integral part of the future. Operating practices and work content will change radically. Consideration should be given to the deployment and usability of decision-support systems to ensure the best integration possible.

The topic is also important because it touches on all levels of healthcare, from patient to management. The need to do the work also stemmed from the researcher's own desire for information on the topic. The researcher works as a welfare analyst at Satasairaala hospital. The job description could also be described by the word "Data nurse". The work includes e.g. highlighting information flow issues, data recovery bottlenecks, and finding solutions. The researcher wanted to see if decision support systems could contribute to solving these problems.

The method chosen for the review was an integrated literature review of the supervisor's proposal and the researcher's own interest and desire to gain experience with this method. In addition, the selection was influenced by a brief literature review on the same subject made earlier by the researcher.

2 DECISION SUPPORT SYSTEMS

2.1 Computer assisted decision support

Although it is not possible to give a clear definition of decision support, there are many different versions of it from different sources. Common to these definitions is that the purpose of decision support is to maintain quality, efficiency and safety when making treatment decisions.

Electronic decision support systems (EDSS) refer to health care systems that provide patient-specific guidance to the caregiver and aim to improve practice or prevent maladministration. For an individual physician, decision support is a tool that serves as a memory aid and helps flood the information. Patient reports are often extensive, and an electronic reporting system as such may not be helpful in managing information and finding the information that is needed. Decision support enables the patient to highlight the most relevant information about the background and laboratory findings. Decision support can also contribute to the doctor's experiential learning and simplify work processes. Automatically retrieving treatment recommendations, treatment chains, and patient instructions related to a patient's problems into links to the patient history view increases their use. (Varonen, Kaila, Kunnamo, Komulainen & Mäntyranta 2006)

2.2 Implementation, application and functions of decision support

The decision support system can be implemented as a stand-alone application running on the side of the system, or it can be programmed inside the actual system, whereby its function is already included in the system's internal operating model. In most cases, these types of support systems are entities developed for a specific target area and around a particular decision-making problem. These one-to-one decision-making support system can support the user by automating routine data analysis. Based on the analysis, appropriate measures can be proposed to the user, which the user may or may not accept. It is the interactivity of the system that distinguishes the decision support system from other data reporting applications; is not only provided passively but is sought to be combined and provided to the user in such a way as to provide new insights into decision making. (Miettinen & Korhonen 2005)

Lipping (2018) writes that decision support systems are generally integrated with the healthcare information system, often commercially developed, and maintained. Information analytical decision support can be applied to different areas of health care. In its simplest form, decision-making can be provided, for example, through interactive forms, where, based on information retrieved from an electronic medical record, certain fields are pre-filled or the information to be filled can be limited to a specific range of values or values. At the other end of the scale are top-notch applications that, for example, generate intensive care alarms based on sophisticated data analysis and machine learning algorithms.

Most commonly, however, these systems refer to software designed to help physicians treat patients. These systems are often referred to as Computer Based Service Provider Input System (CPOE). The Finnish Duodecim EBMeDS system falls into this category (see [www. Eb-meds.org/](http://www.Eb-meds.org/)). (Lipping 2018)

According to Lipping (2018) the general functions offered by the CPOE include providing reference information, such as instructions or drug specifications, and anticipating needs (for example, when ordering certain medications, associated laboratory results can be displayed). Also offering order sets (listing all orders that are usually made for a specific diagnosis to avoid mistakenly omitting some orders) as well as providing feedback and calculations (such as dose of medication).

Reponen et al. (2018) classified support systems into three main types and four levels of integration. *The main categories* of decision support systems are: **1. Diagnosis support**; such as Health gate, Abnormal lab font or blood pressure diagram, or Duodecim's EBMeDS. **2. Drug interaction system.** **3. Support for treatment path protocols** (e.g. regional treatment path protocols or reminders of test results or referral, or intelligent system to support treatment progress).

At low levels of integration, support system information is available to individuals who are seeking it individually. As the degree of integration deepens, the additional information provided by the support system is provided more and more automatically and is more and more closely linked to health care processes, in this case patient encounter.

The degrees of integration are in ascending order: **1. A database separate from the reporting system on the desktop**, or as a bookmark or as a link on the browser home page. **2. A database accessible by navigation from the reporting system** **3. Automatic descriptors included in the Patient Reporting System**, such as memos (e.g. completed test results), alarms (e.g. abnormal laboratory value with color font), or automated administrative reminders (e.g. arrival of referral) **4. Automatic integration of narrative data and database data**, where the information system combines patient data with a evidence-based treatment database and produces the resultant programmable sentences, or scripts, that the user sees on the terminal screen as a short sentence. These include, for example, pointing out a lack of medication based on current treatment and diagnosis.

The most commonly used decision support system in Finland is EBMeDS. It is a clinical decision support service that combines patient status information stored in an electronic patient record with medical information, providing patient-specific, patient-specific instructions. The name EBMeDS comes from the term "Evidence-Based Medicine Electronic Decision Support".

The EBMEDS service provides structured information about the patient from the patient report and provides users with reminders, treatment suggestions, and recommended treatment links for diagnoses. It also gathers relevant data into electronic forms and counters. It is developed by Kustannus Oy Duodecim (www.ebmeds.org) and owned by the Finnish Medical Association Duodecim.

2.3 Decision support concepts

According to Varonen et al. (2006), decision support requires a system capable of combining patient data (e.g., laboratory values, diagnosis, medication or procedure data) with evidence-based information. The integration is done by means of programmed sentences or scripts that are programmed into the information system. The development of decision support has brought with it new concepts, the most important of which are summarized in Table 1.

Table 1. Concepts related to decision support.

Term	Explanation
Script description	An explanation of a script that describes the background of the advice to the user: what treatment recommendations and patient-specific information this script combines and how the advice is based
Script	A computer-readable instruction that guides the collection, processing, and display of data
Decision Support Script	A script that generates active prompts for its user to act on a treatment recommendation or to alert you to a demanding issue such as allergies
Control Script	A script that collects and organizes information on screen or documents (e.g., consultation requests or testimonies) and triggers actions
Auxiliary Database	A standalone database used by an electronic decision support system, such as a cross-allergy database or a synergy database
Reminder	Advisory message generated by the computer, for example, suggestion for further study or starting medication
Warning	A computer generated warning message about the potential risk of a treatment decision, such as drug interactions
Barring list (patient-specific or user-specific)	A menu that allows the user to block specific recurring reminders for a single patient or to prevent all specific reminders from being displayed

The most important scripts are decision support scripts and control scripts. Support scripts give the user suggestions or reminders about a particular action. Control scripts collect and organize information to be displayed to the user and to documents, such as solicitation requests or certificates, and trigger functions. From the decision support scripts, the user only sees the end product: a short message appearing on the computer screen suggesting a specific action in this case.

3 PURPOSE OF THE LITERATURE REVIEW AND RESEARCH QUESTIONS

The purpose of this literature review was to find out which factors are found to promote and support the use of decision support, and what experiences the decision support professionals had in using the system. It was also intended to compare previous studies on decision support and to identify challenges, experiences and potential common denominators through a literature review that could help develop these systems in the future. The aim of the review was to bring more insights into the experiences of using decision support and to bring new perspectives for future research.

Research questions for this study are:

1. Based on previous analyzes, what factors are known to promote and support the use of decision support?
2. How have professionals experienced the use of decision support?
3. Are there any general factors in the information that promote or block the use of decision support and could serve as a basis for future development of the system?

4 LITERATURE REVIEW AS A METHOD

The literature review as a method and research technique is already exploring existing studies. A prerequisite for the literature review is that there is at least some research on the topic. The aim is to compile the results of existing research, which will serve as a basis for new research. (Salminen 2011, 4; Leino-Kilpi 2007, 2.)

4.1 Systematic literature review

According to Salminen (2011), a systematic literature review serves as a summary of the content of previous research on a particular topic and aims to present the results of previous research in a concise form. This literature review includes meta-analyses that have already summarized the results of hundreds of studies. The purpose of this review was to further compare them.

Before you start looking for information in the literature review, you should think about what kind of information you are looking for, where you need it, and how you want to find reliable information. When conducting a test sample, the sources of information must be reliable. (Tähtinen 2007, 12.) Before starting this review, the author had already familiarized himself with the subject through a more concise review. Indeed, the review included articles in prestigious magazines that had undergone rigorous quality assurance.

4.2 Integrated literature review

An integrated literature review was chosen as the method for this thesis. It allows you to include studies and articles made by different methods. (Whittemore & Knalf 2005) In this literature review, we particularly wanted to include meta-analyses. An integrated literature review as a method made this choice well.

Prior to the actual literature review, a research plan was prepared to guide the research process. The research design had at least two tasks: it served as a basis for discussions between the supervisor and the researcher and guided the process in a systematic way from the choice of topic to publication of the final result. Research questions, on the other hand, delimited and defined what the literature review aims to answer.

According to Salminen (2011), the integrated literature review is used to describe the phenomena under investigation in as diverse a manner as possible. Compared to a systematic review, an integrative review gives a much broader view of the subject. Therefore, the integrative review is less selective and does not mimic the research material as systematically as it does. In this way, it is possible to collect a much larger sample of the subject being studied. The integrative approach

allows the use of studies based on different methodological criteria as a basis for analysis. The type of literature and the perspectives included in it can be significantly different in research material and more extensive than in systematic review.

Typical of an integrative review is its process-like nature. This type of analysis is demanding, but usually provides a fairly broad and in-depth understanding of the concept or topic being studied. (Whittemore & Knafl 2005)

An integrative literature review of a mature topic addresses the need for a review, critique, and the potential reconceptualization of the expanding and more diversified knowledge base of the topic as it continues to develop. Early in the article, the author should explain why a literature review is the research method of choice to address the problem or issue. The need for the review article should be supported by discussing the importance of the problem or topic to be examined and by justifying why an integrative literature review is an appropriate way to address the problem. The notion of a *need* for a literature review of a topic derives from a condition or situation in which something is required or wanted. On the other hand, the author may be *interested* in learning more about phenomenon *x*, and thus, undertake a review of the literature on this phenomenon. (Torraco 2005)

In the design phase of the review, the author became acquainted with the integrated systematic literature review as a research method by reading methodological literature, and master theses, and by discussing with the supervisor. The researcher had already familiarized himself with the topic under study in the form of a narrower literature review and was now deeper into defining keywords and research questions.

4.3 Article search

Initially, the search was for material published in 2010–2018 in Finnish and English. The search was later expanded to include articles published in 2005. The search was expanded because the initial search did not produce enough articles that met the criteria and the author was aware that high quality articles would be available among slightly older material. Your search returned 4874 articles matching your search terms. Selections were made by the author alone and selected according to the inclusion and exclusion criteria.

The aim of the literature search is to identify and find all the material relevant to the research question. The material is usually original articles. (Whittemore & Knalf 2005). However, this literature review wanted to focus on meta-analyzes.

According to Niela-Vilen and Hamar (2016), appropriate search terms and search queries are required for database searches. It is up to the researcher to define the key concepts that can be used as search terms for his subject. the selection strategy for inclusion and exclusion criteria is central to the search strategy. They ensure that the review stays in focus. For example by limiting or including the year of publication, studies written in a particular language can control the size of the material.

Despite carefully designed search queries, database searches result in a large number of unsuitable studies. The inclusion and exclusion criteria guide the selection of the study first at the title level, then at the abstract level, and finally at the full texts. The Literature Review is the most time consuming part of the review, as you may need to edit and refine your search several times. It also takes time and effort to process the final material found in the application process. The application process is never perfect and is also dependent on the resources available. The strengths and weaknesses of search strategy and literary search implementation should be highlighted and considered in the review (Niela-Vilen & Hamari 2016)

The **inclusion criteria** for this literature review were:

- The title or abstract must contain one of the keywords (Decision support systems, health care, success factors, literature review)
- Finnish or English literature
- Scientific literature published between 2005 and 2018.
- Extensive prior meta-analyzes on the subject
- Dissertation research in Finland
- Cost free literature
- High quality and reliable information (literature has already undergone rigorous quality evaluation prior to publication)

The **exclusion criteria** were:

- The title or abstract does not contain any of the keywords (Decision support systems, health care, success factors, literature review)
- Non-Finnish or English literature
- Scientific literature published outside the period 2005–2018
- Other than previous meta-analyzes on the subject
- Paid literature
- Lack of high quality and unreliable information (the literature has not been rigorously evaluated before publication)

Initially, the author made preliminary searches alone and later also used the computer scientist of the Satasairaala science library. The keywords in each database were the same, but the search strategies in each database were determined by their own search instructions. The data searches were conducted between November 2018 and January 2019.

Literature searches were conducted on the following electronic databases:

- Finna (Finnish database) (582 hits)
- PubMed (International Database) (177 hits)
- Cochrane (International Research Network) (4115 hits)

The following keywords were used:

"Decision support systems", "Clinical decision support system", "Decision support systems in health care" (Figure 1.)

Figure 1.

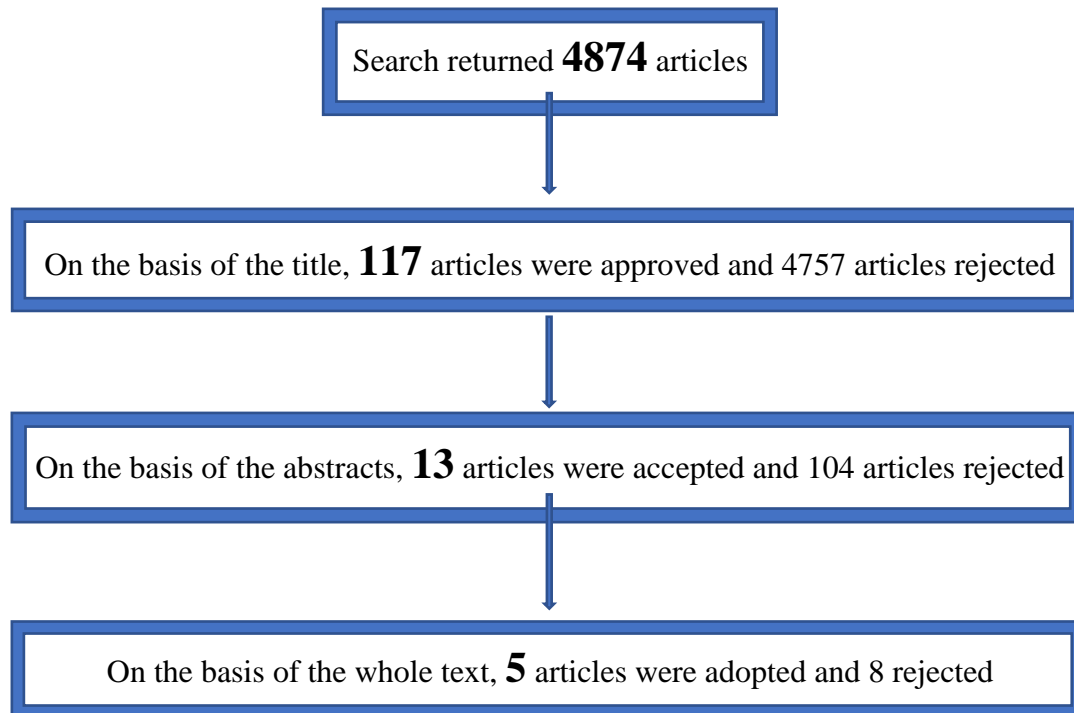
Keyword	Databases	Limitations	Hits	Approved
"Decision support systems", "Clinical decision support systems", "Decision support systems in health care"	Databases	Finnish or English, published 2005-2018	582	1 Kortteisto (2014)
	Finna		582	1 Kortteisto (2014)
	PubMed		177	4 Gard (2005) Kawamoto (2005) Roshanov (2013) Van de Velde (2018)
	Cochrane		4115	0

4.4 Article selecting

Article selection began with reading the headlines. On the basis of the title, 117 articles were approved and 4757 articles rejected. The reason for the rejection was that the article was not about healthcare decision support systems or the articles were from the same original research but published in different databases. Already at this point, attention was drawn to the fact that research and publications on this topic were concentrated on a reasonably small research team. Next, the abstract was read, leading to 13 articles being rejected and 104 articles being rejected. The reasons for the rejection were that the content of the article did not meet the inclusion or exclusion criteria, did not answer the research questions, or was not reasonably available. Finally, the entire texts were read. Five articles were rejected and eight rejected. The number of articles selected for the literature

review was five, of which four are comprehensive meta-analyzes and one is a dissertation study. (Figure 2.)

Figure 2. Article selection



4.5 Evaluation of the quality of the selected material

The material selected for the literature review is described and the quality of the source evaluated. According to Evans (2008), criteria and checklists can be used wherever possible. However, checklist tools may not always be applicable to an integrated literature review. Integrating a literature review does not always mean analyzing the results of a study by different methods, but may be aimed, for example, at analyzing the definition of a concept in previous studies. However, it is necessary to report on the sources used in the review and how.

The evaluation of materials used in this study is based, wherever possible, on the Joanna Briggs Institute checklist, which contains 11 evaluation criteria for methodological quality evaluation (JBI 2017). This literature review used only articles published in reputable scientific journals as they have already undergone rigorous quality evaluation prior to publication and can therefore be considered as a reliable source material.

4.6 Data and analysis of the review

The review material consists of 4 meta-analyzes on decision support in health care (selected from a total of 362 articles) and one dissertation study, selected according to inclusion and exclusion criteria. The choices were also influenced by a narrower literature review by the author of this work, who had previously included the same background material. The articles were analyzed with the help of the Satanic Hospital Scientific Library. The articles were read several times, analyzed, and their purposes and results were compared. The analysis was guided by research questions.

According to Niela-Vilen and Hamar (2016), the purpose of the analysis is to organize, classify, search for similarities and differences, and to summarize selected studies results. The method of analysis depends on the choice of the verification method chosen. It is also the intention to write and interpret the results so that they form a complete understanding.

The analysis of the material is considered to be the least developed part of the integrated systematic literature review. Compressing and analyzing data is the most difficult step and prone to various errors. (Whittemore & Knalf 2005.)

The steps of the analysis are as follows (Sulosaari & Kajander-Unkuri 2016):

1. Collection, classification and reduction of data
2. Presentation of information
3. Comparison of data
4. Conclusion
5. Comparison of conclusions

4.7 Interpretation and presentation of results

According to Sulosaari & Kajander-Unkuri (2016), the most important part of the integrated literature review is the interpretation and presentation of the results. A published literature review will increase the scientific community's knowledge capital and thus contribute to the scientific debate.

The material selected for the literature review is described and the quality of the source material evaluated. Assessment criteria and checklists are used whenever possible. However, checklist tools are not always applicable to the integrated literature review. The aim of an integrated literature review is not always to analyze and synthesize the results of studies conducted by various methods, but may, for example, aim to analyze the definition of a concept in previous studies. However, it is essential to report on the sources used and how. (Sulosaari & Kajander – Unkuri 2016)

In this literature review, the results of meta-analyses and dissertation research were compared and mirrored with research questions. The presentation of the results sought to answer these questions on the basis of articles. Each selected article was given a similar weight. Checklist tools could have been used to evaluate the source material, but it would have been very challenging, especially for meta-analyses. The aim of this literature review was rather to bring together and compare the factors that could influence the future development and successful integration of decision-making systems.

5 RESULTS OF ANALYSIS

5.1 Factors contributing to and supporting the use of decision - making

There is still relatively little scientific evidence as to why successful or unsuccessful decision-making systems are being used. Many researchers have sought to identify the factors and features that could promote the clinical use of the systems. The effects of different factors may vary depending on how and in what environment the research was conducted.

Garg et al. (2005) found that computer assisted decision support improved treatment practices in 64% of studies. Decision support was especially effective when reminders were given automatically. According to the review, poor usability or integration into the professional workflow were the major contributors to the decision-making failure. Its use was further promoted by asking users to automatically use the system for better performance compared to requiring users to actively start the system manually. The use was also facilitated by allowing users to participate in system development and integration. Possible reasons include the developer's motivation effect, the creation of more usable and integrated software, the increased availability of technical support and training. On-site training and customization to the unit's needs also increased the use.

According to Kawamoto et al. (2005), decision support was impressive in 68% of the included studies. Four factors contributed to the effectiveness of decision support: (1) making decision support part of normal daily work; (2) providing clear guidance and not just knowledge and estimates; (3) providing support right at the time of the decision;

Clinical decision support systems have demonstrated the potential to reduce medical errors and improve patient care. Such systems do not always lead to improved clinical practice for reasons that are not always clear. The common theme of all four features is that they facilitate access to decision support.

Roshanov et al. (2013) found that 58% of the studies had visible improvements in treatment processes or treatment outcomes. However, they came to the conclusion that advisory systems in e-health systems were far less likely to improve treatment or outcomes than stand-alone programs. Providing advice to professionals and patients alike, and providing users with explanations of excessive counseling, are two factors that can independently improve success. Unlike previous studies, providing automatic support in a professional workflow or during treatment did not predict success.

While this finding may seem paradoxical, it is likely that individual prompts will lose their ability to change service provider behavior when presented alongside several other alarms. When it is possible to integrate an institution's electronic health record alerts and add more alarms, practitioners may be overwhelmed and start ignoring prompts. This "warning fatigue" phenomenon could prevent a change in behavior. Studies estimate that up to 96% of alarms have been exceeded and suggest that the alarm threshold is too low (i.e., alarms are sensitive but not specific). Fatigue

from alarms that were either insignificant, non-serious, or repeatedly triggered is the most common cause of excess.

A summary of how the system is used by professionals could also better support deployment and improve compliance with guidelines and advice. This could support the training of professionals and act as an internal audit.

Roshanov (2013), Kawamoto (2005) and Van de Velde (2018) and their research team all focused on how the provision of decision-making directly to patients affects the success of treatment. According to Roshanov et al. (2013), treatment results, in particular for the chronically ill, improved slightly. This may be partly because they enable patients to actively participate in their own treatment or because they provide practical advice in addition to clinical encounter.

According to Kawamoto et al. (2005), systems that provide only patient evaluation (such as "patients at high risk for coronary heart disease") fail slightly more often than systems that also provide treatment recommendations (such as "patients at high risk for coronary heart disease, recommend starting XXX").)

Kortteisto (2014) study highlighted the fact that the content of the advisory and the operational reliability of the system can be the only factor contributing to the implementation, which can only be the result of cooperation between users and a reliable developer. System features must be easy to use, simple, and flexible to deploy. Automated patient-specific advice should be clear and concise in content and should facilitate and not hinder the work of professionals.

The new system should not require a lot of user training, but it should be provided at the workstations as professionals need it. Problems with the use of existing patient information systems were identified as barriers to deployment. The interviewees considered the usable systems to be inadequate. The integration of an automated decision support system into these patient information systems and network environments was considered almost impossible.

5.2 Professionals experience with decision support

The experiences of professionals were studied in several articles. Garg et al. (2005) and Roshanov et al. (2013) highlighted issues such as: compatibility with previous systems, which gave users a better response to the new system. Users also saw the maturity of the software and the availability of updates as an important factor in their use. Of great importance was the experience users had with previous implementations. Also, how well the system responds to local needs influences the use of the system.

Interviewed users were somewhat concerned about how the use of the system affects in particular the ability of younger users to make independent decisions.

According to Roshanov et al. (2013), users experienced “warning fatigue” because the system issued alarms too often or too easily. This meant that the warnings were no longer taken seriously and were ignored without action. This was slightly reduced if an explanation was required to bypass the warning. However, these demanding alarms easily led to their acceptance in order to avoid giving reasons. However, this can be dangerous. For example, patients may be misdiagnosed and the system will accept the prescription or the physician may contact the pharmacy directly to avoid the computer's notice.

Users also pointed out (Roshanov et al. 2013) that they were likely to follow advice that was easy to follow. For example, one-touch recommendations or instructions. Doctors also work better according to the recommendations given if they are based on research or clinical practice guidelines. Doctors may also be more likely to use the system if they do not need to enter data and the program will extract the data. This eliminates the need for time to search for information from various sources.

The interviews conducted by Kortteisto (2014) also highlighted general opposition to a change in operating practices. Especially the right decision support the structured recording of patient information required by the operation was seen as a slower factor in the work of the physician. Invalidity of unrecorded or unstructured information was also considered a problem.

The introduction of decision support also means for the user a change in the habits of work that are sometimes difficult to abandon. The use of even a small amount of additional time in connection with the Patient Information System was considered an obstacle to implementation in interviews.

The increased use of time with the computer was seen as detrimental to the doctor-patient interaction.

A threat to the deployment was also seen as a threat to a new information system that over-drives the physician's decision-making, thereby weakening autonomy and impairing clinical problem solving.

5.3 General factors contributing to the use and development of decision support

There are many factors that promote or hinder the use of decision support. It is noteworthy that almost all analyzes had taken the view that decision support developers had been involved in the research. This was considered to have an effect on the results of the study in that they show slightly more positive results or leave undesirable results unpublished. There is clearly still demand for independent third party research.

There are very different and different levels of decision support systems in place. Thus, comparing their usability and effectiveness is difficult. Most of the systems included in the articles are already obsolete and did not have the full functionality of existing systems. On the other hand, even today, the systems are different and may have a subsystem in place. Often this is based on the cost of the systems and their compatibility with current patient information systems. The complexity of this system's interfaces and the busy nature of the work affect its use. That the system would provide support and advice to others for professionals other than physicians, reduces physician work pressure and potentially expedites patient care.

Van de Velde et al. (2018) also highlighted the importance of stakeholders. Stakeholders should also be informed about how best to use decision support in ways that improve (1) health care, (2) health outcomes, (3) cost control and (4) patient and provider satisfaction. It is important that stakeholders understand the implementation of effective decision support.

According to Garg et al. (2005), implementation, development and testing of systems has been slow and challenging. However, there have been changes in recent years. Healthcare has woken up to the fact that we are no longer able to control the masses of knowledge and make quality care decisions. The technical performance and usability of the systems has improved and the quality has increased.

Roshanov (2013) also argues that obtaining and implementing effective and smooth decision-making systems requires a large amount of skilled labor. This also requires the creation of new types of professions such as IT experts and analysts and new job roles within the units.

Kortteisto's (2014) doctoral dissertation study described and measured the impact of an advisory patient's report on the work of a professional and the care of patients in primary health care. The empirical part of the study was implemented during the development phase of the clinical decision support system, EBMeDS (Medical Evidence Based Electronic Decision Support), in 2006-2008 and during its first deployment process in 2009-2011. The dissertation was part of this research project. The study sought answers to the questions of whether a counseling patient report is useful and effective in practical situations.

Based on their research, Kortteisto believes that computer-aided decision support is useful in the context of primary care, but that the impact on patient care can only be realized once it is well established, when the method works structurally without technical problems and advice tailored to the needs of professionals. . The cost of using electronic patient information systems was also seen as a barrier to the introduction of new IT applications.

6 DISCUSSION

6.1 Reflection on the results of the literature review

The purpose of this literature review was to determine which factors promote and support the use of the system in nursing and what experience professionals in decision-making support use the system have, and whether there are general factors that promote or discourage system use.

Based on the results, further decision support should be explored in the future, as long as user experiences in different health care environments are growing in Finland as well. The potential disadvantages of new technology also need to be explored. The introduction of decision support is supported by the ability to develop treatment practices and prevent treatment errors. User feedback

and user experience should be systematically collected and systematically developed. The introduction of decision support also often entails a change in the habits of the user, which are sometimes difficult to abandon. More recently, more attention has been paid to the usability of the systems. Healthcare professionals still do not require the systems they use to be practical and usable.

It is also noteworthy that the term “decision-making support” itself is not necessarily familiar to healthcare professionals but requires opening and familiarization. Only then can the use of the system itself be explored and the opportunities it brings. Professionals may also, on the basis of past experience, believe that support for decision-making does not add anything new to their work, and thus failure to implement. Previous experiences of inappropriate, unreliable and hard-to-use systems are driving the enthusiasm for introducing new systems.

Based on the meta-analyses reviewed, decision support is most often effective in improving treatment practices and reducing treatment errors. The research findings to date are limited by the focus of many studies on individual diseases or treatments.

There are advantages and disadvantages to all technical systems. The system itself sometimes produces errors and false alarms. The cause of the problems may be a human error, a computer problem, an incorrect entry in the patient record or a lack of information. Some of the problems may be due to misuse. Indeed, good user education is crucial to the success of decision support. (Koppel et al. 2005)

According to Varonen et al. (2006), new research data, which is constantly being prepared, requires updates and corrections to the background system used by decision support. False and outdated background information can be harmful in the same way as other obsolete clinical information. The use of decision support can also lead to a false sense of security, and it is therefore important to remember that it is only one part of the decision making process of the treatment. The system does not make decisions for the professional. The clinician already makes the treatment decisions on the basis of the law, and the decision-making does not support the situation.

The question is how much the program gives to guide its own decision-making and how it responds to the guidance and advice it provides. What is important, however, is that the professional retains decision-making power not only in the implementation of decisions but also to what extent and when he wants to use decision support.

Human factors must also be taken into account when making treatment decisions.

Recommendations and guidelines cannot always be used to treat a patient. Individual needs and resources must be taken into account. Although data collected from a patient should lead to a specific treatment plan, guided by decision support, the situation requires human knowledge and context. They pose different challenges the effects of decision support on the interaction itself. This topic was covered in articles quite a bit.

The intention is that decision support saves time and does not waste it. According to the articles, the challenge was wasting time on inappropriate patient advice and a large number of warnings that were too easy to trigger. Users found it important to be reminded only of decisions that are important to the treatment and the treatment guidelines relevant to each treatment situation.

Reminders that are triggered too easily can cause annoyance, and even critical messages may be ignored without reading and justifying. Warnings and reminders should be those that really require attention and action. Indeed, in their analysis, Roshanov et al. (2013) suggest that the system would have a feature that requires the professional to record the reason for ignoring advice.

The purpose of decision support is to facilitate data processing and not to automate the care process. The issue of unstructured data also arises as a problem. Decision support requires information stored according to a particular structure. This means that each unit that produces data should produce and store the information in the same way. Although recent efforts have been made on structured recording, there is still a long way to go, even nationally. Thus, it is difficult to assess whether the information produced by the decision support system is reliable when we cannot be sure of the form of the original data it uses.

In clinical decision-making, current patient information varies and treatment depends on the patient's situation. The decision is always unique and contains a great deal of experience. Decision support systems are not intended to replace human decision-making, but to support it by utilizing a variety of end-use technologies. The ultimate goal is to enable best practice and high-quality care to be provided to patients, and this can only be achieved through successful integration.

The support provided by the system focuses on one situation at a time and on the combination of information on which possible treatment measures are decided. The system should take into account current treatment recommendations and regional treatment guidelines. Could it be possible in the future to also take into account symptoms, medical and family history and genetic information?

Decision support systems are consistent and accurate. They are able to process huge amounts of data quickly and have no prejudices or assumptions like human. They also serve as a memory support. Today, we put many things on a sticky note so we can manage the flood of information and feel a sense of security in nursing conditions. However, decision-making systems never replace professional experience, intuitive knowledge, and interpersonal interactions that can play a crucial role in treatment situations.

Computer-aided clinical decision-making support can, with some limitations, improve decision-making and help manage information in a flood. It is an integral part of the modern health care system. There is no doubt about it. However, the analysis did not fully elucidate the reasons why its impact varies and which factors would ultimately make decision support more effective. Hopefully, future studies will provide answers to these questions.

6.2 Ethics and reliability

It is a good idea to define the exact criteria and timetable for the literature review from the start. Finding and analyzing the road to doo took more time than originally planned. The design phase took into account e.g.. own resources, experience, time available and material available. The credibility of the study may be affected by the fact that the author did not yet have much experience in making such an extensive literature review when he started. However, the author has over 15 years of experience as a research nurse. Previous studies had also dealt with the literature review. Seminars, previous theses, teachers' skills and the services of a scientific library were also used. With the help of the tutor, the research questions also found their correct form.

While subject-specific information was available, most of the time it focused on a single illness or problem, but I intended to address it from a broader perspective. There was a relatively small amount of extensive research in Finland, mainly focusing on a small group of researchers. Most of the meta-analyzes were selected to include as much material as possible on the topic. The handling of the meta-analyzes was very demanding. From the outset, the problem was to limit the theoretical part. Perhaps the fact that there would have been two contributors to the review would have increased the reliability and the analysis would have been more extensive. The author was aware of this, but for personal scheduling reasons, however, it was decided to do this individually.

Due to limited language skills, only Finnish and English sources were included in this literature review. Other language sources could have been included, but the author did not want to use translation programs because of the possible error translations they provided. Due to financial reasons, the actual translation services were not available.

The quality of the literature review can also be judged on the basis that each article receives the same weight. According to the author, this was well implemented in this work.

The quality evaluation was based on the Quality assessment criteria, published by Joanna Briggs Institute (JBI) and used a critical evaluation checklist for a systematic review (Appendix 1). The quality score for the original studies was 11 points for the JBI critical assessment checklist. The minimum quality score for the original studies was set at eight. This was done to ensure that studies of sufficient quality were selected for the review. All five studies initially selected received high scores (9-11 points) (Appendix 2).

According to the articles, it is important for users to understand how to implement effective decision support to succeed. The results of this literature review indicate that several factors may influence this issue. Results can be more effective when advice is given automatically and displayed on the screen and when suggestions are patient-specific. Lobach et al. (2012) introduce other factors that lead to the success of decision support, such as justifying advice on a research screen and providing advice not only to professionals but also to patients.

Patient care is always based on the clinical knowledge of the professional, which consists of evidence-based information, clinical assessment, and patient desires and behaviors. Evidence-based information alone is not enough unless it can be translated into practical work. Counseling Patient Report is a healthcare method that automatically brings patient-based evidence-based information to professionals when making decisions.

The problem with many articles seems to be that they only address decision support for a single variable or illness. There has been very little research into counseling decision support that combines patient information with recommendations. Many usage studies also focused on foreign patient information systems that are different in structure, function, and utilization than Finnish systems and therefore cannot be directly compared with one another.

Analyzes have shown that diagnostic decision support has worked in some cases but rarely helps in situations where there are many differential diagnostic options or the patient has multiple illnesses

at the same time. Decision support could help reduce prescription errors and hazards. It might also be easier for physicians to switch to prescribing medication if treatment recommendations were readily available on a patient-by-patient basis. At this point, it is the sole responsibility of the physician to read and act on the treatment recommendations.

“An efficient decision support system minimizes the user's efforts to find relevant information and use decision support. Studies have shown that decision support systems reduce medical errors and thus improve the quality of care”

(Kawamoto etc. 2005, 765, 771).

The financial and satisfaction results in these articles were so poor that conclusions could not be drawn from them.

6.3 Further research topics and importance of literature review

The amount of data collected from patients has made it difficult for healthcare professionals to manage their knowledge. Increasing medical knowledge is also challenging old therapies. Finding relevant information has become more difficult in any given decision-making situation. There is a need in the healthcare sector to support decision-making in the care process by ensuring access to information relevant to the care situation. Decision support systems respond to this need.

Many studies and surveys related to these systems often focus on only one variable or are otherwise conducted in very limited environments. There have been very few independent studies on the subject in Finland. Systems developers are often involved as researchers, which is understandable from the point of view of developing their own systems.

In the future, it would be good to have more information on independent research, especially in Finland. In the current tightening economic situation, it would also be necessary to obtain purely cost-effectiveness studies. However, this is particularly challenging in the healthcare sector.

The significance of this literature review can also be seen from the perspective that in the future, changing roles and professions are inevitably ahead and we need to adapt to it. We also need to deploy a wide range of systems to provide high quality and effective care to patients. In such a case, Mei must be able to rely on these systems without being overwhelmed.

7 CONCLUSIONS

The following conclusions can be drawn from this literature review:

1. Good usability and integration are factors that promote and support the use of decision support systems. This can be influenced by e.g. involving users in systems development. The system should be part of normal daily work. Use is also facilitated if the system is needs-based and can be customized to fit the application. Instructions and advice should be clear and available at the right time. Avoiding unnecessary reminders and remarks. Providing decision support also to patients can improve treatment.
2. According to the experience of professionals, the most important factors are the compatibility and usability of decision support with existing systems without technical problems. For example, previous bad experiences with deployment and so-called "bad guys" were identified as detrimental factors. "Warning fatigue". The introduction and use of systems in daily work requires a change in working methods. Concerns were also raised that the possibility of independent decision-making would be reduced.
3. There are many general factors that influence the use of decision support. Decision support systems, like health care systems, are different and varying in level. However, the performance and quality of the systems has improved. With decision support, the work pressure of physicians could be shared with other health professionals. A well-implemented system will require a skilled workforce and possibly a change of job roles in health care units. Cost may also be an obstacle to the acquisition and introduction of new systems. Obtaining independent research information about systems can be difficult, as systems developers are often involved in research.

REFERENCE

Evans, D.2008. Intergrative reviews of quantitative and qualitative research. Overview of Methods. In opus Webb,c. & Ross, B. (edit.) Reviewing research evidence for nursing practice: Systematis Reviews. Blackwell publishing. Oxford.

Garg,A., Adhikari,N., McDonald, H., Rosas-Arellano,M., Devereaux,P, Beyene,J., Sam,J., Haynes,R. Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: a systematic review. *JaMa* 2005; 293: 1223–38.

Kawamoto, K., Houlihan, C., Balas, E., Lobach, D. 2005. Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to success. *BMJ* 2005;330:765– 72.

Koppel, R., Metlay, JP, Cohen, A., Abaluck, B., Localio, AR., Kimmel, SE., Strom, BL. 2005. Role of computerized physician order entry systems in facilitating medication errors. *JaMa* 2005; 293:1197–203.

Kortteisto, T. 2014. Neuvova potilaskertomus - Käyttö ja vaikutus potilaan hoitoon. Akateeminen väitöskirja. Terveystieteiden yksikkö. Tampereen yliopisto. Tampere.

Kääriäinen, M. & Lahtinen M. 2006. Systemaattinen kirjallisuuskatsaus tutkimustiedon jäsentäjänä. *Hoitotiede* 18(1), 37–45.

Leino-Kilpi, H. 2007. Kirjallisuuskatsaus – tärkeää tiedon siirtoa. Teoksessa Johansson, K., Axelin, A., Stolt, M. & Ääri, R-L. (toim.) Systemaattinen kirjallisuuskatsaus ja sen tekeminen. Turun Yliopisto. Hoitotieteen laitoksen julkaisuja. Tutkimuksia ja raportteja. A:51/2007. Turku.

Lipping, T. 2018. Data analytics for Decision support in healthcare.

<https://media.sitra.fi/2018/11/28145403/from-big-data-to-myhealth.pdf>. Luettu 1.12.2019

Lobach, D., Sanders, G.D., Bright, T.J., Wong, A., Dhurjati, R., Bristow, E., Bastian, L., Coeytaux, R., Samsa, G., Hasselblad, V., Williams, J.W., Wing, L., Musty, M., Kendrick, A.S. 2012. Enabling health care decision making through clinical decision support and knowledge management. *Evid Rep Technol Assess (Full Rep)*, 1- 784.

Miettinen, M., Korhonen, M. 2005. Käypä hoito – suositukset ja päätöksenteon tuki terveydenhuollon prosessissa. http://portal.savonia.fi/img/amk/sisalto/_tki-ja-palvelut/julkaisutoiminta/pdf/KH.pdf. Luettu 20.8.2019

Miettinen, M. 2006. Päätöksenteon tukijärjestelmä terveydenhuollon tietojärjestelmäkontekstissa. Tietojärjestelmätieteen kandidaatintutkielma. Jyväskylän yliopisto Tietojenkäsittelytieteiden laitos. Jyväskylä

Niela-Vilen, H., Hamari, L. 2016. Kirjallisuuskatsauksen vaiheet. Teoksessa Stolt, M., Axelin, A., Suhonen, R. (toim.) Kirjallisuuskatsaus hoitotieteessä. Turun yliopisto. Hoitotieteen laitoksen julkaisuja. Tutkimuksia ja raportteja. A:73/2016. Turku

Nykänen P. 2000. Decision support systems from a health informatics perspective. Tampereen yliopisto, Tietojenkäsittelytieteiden laitos, Raporttisarja A, Tampereen Yliopistopaino, Tampere.

Reponen, J., Kangas, M., Hämäläinen, P., Keränen, N., Haverinen, J. 2018. Tieto- ja viestintäteknologian käyttö terveydenhuollossa vuonna 2017. Tilanne ja kehityksen suunta. Raportti 5/2018. Oulun yliopisto. Terveyden ja hyvinvoinnin laitos. Tampere.

https://www.julkari.fi/bitstream/handle/10024/136278/URN_ISBN_978-952-343-108-9.pdf?sequence=1&isAllowed=y. Luettu 6.1.2020.

Roshanov, P.S., Fernandes, N., Wilczynski, J.M., Hemens, B.J., You, J.J., Handler, S.M., Nieuwlaat, R., Souza, N.M., Beyene, J., Van Spall, H.G., Garg, A.X., Haynes, R.B. 2013. Features of effective computerised clinical decision support systems: meta- regression of 162 randomised trials. *Bmj*, 346, f657.

Salminen, A. 2011. Mikä kirjallisuuskatsaus? Johdatus kirjallisuuskatsauksen tyyppeihin ja hallintotieteellisiin sovelluksiin. Vaasan Yliopiston julkaisuja. Opetusjulkaisuja 62. Julkisjohtaminen 4. Vaasa: Vaasan Yliopisto.

Shim J., Warkentin M., Courtney J., Power D., Sharda R. & Carlsson C. 2002. Past, present and future of decision support technology. *Decision Support Systems* 33(2), 111-126

Sulosaari, V., Kajander-Unkuri, S. 2016. Integroitu kirjallisuuskatsaus. Teoksessa Stolt, M., Axelin, A., Suhonen, R. (toim.) Kirjallisuuskatsaus hoitotieteessä. Turun yliopisto. Hoitotieteen laitoksen julkaisuja. Tutkimuksia ja raportteja. A:73/2016. Turku

Torraco, R. 2005. Writing Integrative Literature Reviews: Guidelines and Examples. *Human Resource Development Review* Vol. 4, No. 3 September 2005 356-367.

https://pdfs.semanticscholar.org/2e73/3a173fa6e36b23e0648717fcb46701f49b15.pdf?_ga=2.204048976.1301827729.1578476095-1822380746.1578476095. Luettu 8.1.2020.

Tähtinen, H. 2007. Kirjallisuuskatsaus – tärkeää tiedon siirtoa. Teoksessa Johansson, K., Axelin, A., Stolt, M. & Ääri, R-L. (toim.) Systemaattinen kirjallisuuskatsaus ja sen tekeminen. Turun Yliopisto. Hoitotieteen laitoksen julkaisuja. Tutkimuksia ja raportteja. A:51/2007. Turku.

Van de Velde, S., Heselmans, A., Delvaux, N., Brandt, L., Marco-Ruiz, L., Spitaels, D., Cloetens, H., Kortteisto, T., Roshanov, P., Kunnamo, I., Aertgeerts, B., Vandvik, P., Flottorp, S. 2018. A systematic review of trials evaluating success factors of interventions with computerised clinical decision support. *Implementation Science* (2018) 13:114

Varonen, H. Kaila, M. Kunnamo, I. Komulainen, J. Mäntyranta, T. 2006. Tietokoneavusteisen päätöksentuen avulla kohti neuvovaa potilaskertomusta. <http://www.ebm-guidelines.com/xmedia/duo/duo95732.pdf>. *Duodecim* 2006; 122:1174–81. Luettu 1.11.2019

Whittemore, R., Knafl, K. 2005. The integrative review: updated methodology. *Journal of advanced nursing* 52 (5), 546-553.

Checklist for systematic reviews and research synthesis. 2017.
<http://joannabriggs.org/research/critical-appraisal-tools.html>

[www. Ebmeds.org/](http://www.Ebmeds.org/)

APPENDIX 1.

Appendix 1. JBI Critical appraisal checklist for systematic reviews



JBI Critical Appraisal Checklist for Systematic Reviews and Research Syntheses

Reviewer _____ Date _____

Author _____ Year _____ Record Number _____

	Yes	No	Unclear	Not applicable
1. Is the review question clearly and explicitly stated?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Were the inclusion criteria appropriate for the review question?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Was the search strategy appropriate?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Were the sources and resources used to search for studies adequate?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Were the criteria for appraising studies appropriate?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Was critical appraisal conducted by two or more reviewers independently?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Were there methods to minimize errors in data extraction?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Were the methods used to combine studies appropriate?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Was the likelihood of publication bias assessed?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Were recommendations for policy and/or practice supported by the reported data?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Were the specific directives for new research appropriate?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Overall appraisal: Include Exclude Seek further info

Comments (Including reason for exclusion)

APPENDIX 2

Appendix 2. Evaluation of quality of the original studies (JBI)

Study	Garg et all 2005	Kawamoto et all 2005	Kortteist 2014	Roshanov et all 2013	Van de Velde et all 2018
Q1	Y	Y	Y	Y	Y
Q2	Y	Y	Y	Y	Y
Q3	Y	Y	Y	Y	Y
Q4	Y	Y	Y	Y	Y
Q5	Y	Y	Y	Y	Y
Q6	Y	Y	Y	Y	Y
Q7	Y	Y	Y	Y	Y
Q8	Y	Y	Y	Y	Y
Q9	Y	Y	Y	Y	Y
Q10	Y	Y	Y	Y	NA
Q11	Y	Y	Y	Y	NA
Summary	.11/11	.11/11	.11/11	.11/11	.9/11

Y = YES

N = NO

NA = NOT APPLICABLE