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The Usability Aspects of Medication Related Decision Support Systems in an Inpatient Setting - A Systematic Review

Bram Knols[1], Mathijs Louws[2], Alec Hardenbol[1],

Jamshid Dehmeshki[3], Marjan Askari[2]

[1]Department of Information and Compuingr Sciences, Utrecht University, Utrecht, The Netherlands
[2]Erasmus School of Health Policy & Management, Erasmus University Rotterdam, The Netherlands
[3]Department of Information and Computer Sciences, School of Computer Science and Mathematics, Kingstone University, London, England
Corresponding author:
Bram Knols, Universiteit Utrecht, Department of Information and Computing Sciences
Buys Ballot building, office 583, Princetonplein 5, 3584 CC Utrecht, The Netherlands
Email: b.knols@uu.nl

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Importance Effort has been done in studying the effect of medication related clinical decision support systems (CDSS) in the inpatient setting, however there is not much known about the usability of these systems.
Objective To systematically review studies that focused on the usability aspects effectiveness, efficiency and satisfaction of clinical decision support systems in the inpatient setting.
Methods We systematically searched for articles in Scopus, Embase and Pubmed from 1 January 2000 to 1 Januari 2016. Articles were selected if they met the selection criteria of being medication related utilising computerized decision support in inpatient setting which, evaluated usability. Based on van Welie's model we categorized usability aspects in terms of usage indicators and means: effectiveness as safety, error, and memorability; efficiency as learnability and performance speed; and satisfaction. The syntheses of the results is done in each categories of ISO definition of usability: efficiency, effectiveness and satisfaction.
Findings Twenty-two articles were found that met our criteria. We found eleven articles studying effectiveness, nine on satisfaction and fifteen on efficiency. In general 81%, 33% and 60% of the articles respectively found

positive results regarding their aspect of usability. For effectiveness, the usage indicator errors and safety had positive results in 81% of the studies, and its most used means, warnings, scored positive results in 78% of the studies. Memorability was not studied. The mean feedback was studied two times, both being positive. Investigations on satisfactions found mixed results, and was only researched via the adaptability means, with only 33% positive. For efficiency, the usage indicator learnability was understudied and yielded mixed conclusions. Performance speed was studied and had 69% positive results. Its means, consistency and adaptability, drew positive results in respectively 50% and 71% of the studies.
Conclusions and Relevance Our results showed that evidence could mainly be found for effectiveness and efficiency and showed a high rate of positive results in the usage indicators errors and safety and performance speed. The means warnings and adaptability also had mostly positive results. To date, the effects satisfaction of CDS systems regarding medication prescription in the inpatient setting remains understudied. Usability aspects such as memorability, learnability, undo, task conformance, shortcuts and consistency require more attention. Studies are still needed to generate better insight in the user model as well as design a knowledge and better task model for these systems regarding medication prescription in the inpatient setting.

Keywords. Usability, decision support system, medication, inpatient

1 Introduction

Medication errors occur frequently in health care and are costly expenses, both economically and clinically.[1–4] Medication errors have impact on mortality, morbidity.[5] These errors could occur during various stages of the prescription process, however, it is known that most medication errors take place during the prescribing phase.[6] There is evidence that up to 9,1% of all prescriptions contain errors, but literature on the subject varies.[7] The consequences of medication errors can be severe; An estimated 7,000 deaths each year in the United States are attributed to medication errors.[1]

Electronic prescribing is an opportunity to reduce the amount of medication errors[8–10]. Electronic prescribing or e-prescribing refers to a computerized physician order entry (CPOE) with or without clinical decision support system (CDSS). We define CPOE as "a system that enables physicians or other medical personnel to enter medical orders in an electronic system", and clinical decision support system as "a system that supports physicians and other medical personnel in decision making". Clinical decision support is known to improve clinical practice.[11] A study done by Gartner for the Swedish Ministry of Health and Social Affairs estimates that 100,000 inpatient adverse drug events can be prevented yearly by the use of computerized order entry and clinical decision supports. According to this study, this would result in 700,000 saved bed-days and save almost €300 million[12].

Clinical decision support systems have been proven to have positive effects on clinical practice, with safety and quality benefits being among these effects[11,13,14].]. However, the effect of some of the aspects of CDS systems, such as usability, which is defined by the International Standards Organization (ISO) as 'the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use'[15] is not studied yet extensively. Since usability is one of the success criteria of implementing and utilizing CDS systems, it is important to study the consensus on this criteria. Previous studies, however showed that usability aspects of CDS systems and integration of these systems within e-prescribing systems still need improvement in different settings[16–18]. A list of 168 instances of usability flaws of medication-related alerting functions is previously generated. This list can act as a check-list for medication-related CDS systems during their design or evaluation process[16]. However, a systematic study of the usability of medication related CDS systems in the inpatient setting is missing which indicates what the current evidence is regarding the effectiveness, efficiency and satisfaction pillars of the usability.

This paper intends, therefore, to summarize all relevant literature on the usability of CDS systems. Only CDS systems that assist during the medication process in the inpatient setting are considered in this review.

2 Methods

2.1 Definitions

Usability is defined as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" by the ISO standard[19]. ISO has divided usability in three subcategories: effectiveness, efficiency, or satisfaction. For this study, the following definitions were used for each of these aspects as defined in ISO 9241-11:

- Effectiveness: 'the accuracy and completeness with which users achieved specified goals'.
- Efficiency: 'the resources expended in relation to the accuracy and completeness with which users achieve goals'.
- Satisfaction: 'freedom from discomfort, and positive attitude to the use of the product'.

In order to provide operationalized measures of usability van Welie[20] was used. The model consists of three related layers. The first one comprises the three aspects of usability, i.e. effectiveness, efficiency, and satisfaction used by the ISO[19]. The second layer relates usage indicators to these aspects. The third layer, provides means by which the usage indicators can be measured. Effectiveness has two usage indicators, errors and safety - defined as the rate of error - and memorability, defined as retention over time. Efficiency has two usage indicators as well: learnability and performance speed. They are defined as, respectively, the time to learn and the speed of performance. Satisfaction has only one usage indicator: satisfaction, defined as the user satisfaction.

We aim to summarize the results pertaining to the three aspects of usability, and to explore which of Van Welie's usage indicators need further exploration in CDSS evaluation research. The third layer, provides means by which the usage indicators can be measured. These include consistency, the availability of undo operations, and the presence of feedback. These usage indicators are then analyzed to discover which usability categories in the ISO standard need further investigation.

2.2 Data sources and in- and exclusion criteria

Articles were searched in Scopus®, Pubmed® and EMBASE®, published between 1 January 2000 and Januari 1^{st}, 2016. We filtered the results to exclude non-English languages, animals, non-medical disciplines, opinion papers, congress papers and letters. The final queries were executed on February 4, 2016. Figure 1 illustrates the search strategies that were applied for our literature search. The query we used was composed of four separate parts, with the first part (A) having keywords relating to electronic prescription and decision support, the second part (B) medication related keywords, the third part (C) the inpatient setting and the fourth part (D) usability. The four parts were combined using "and" statements resulting in the final query.

Articles were selected if they met the criteria of evaluating aspects of usability of clinical decision support systems related to medication prescription, in an inpatient setting. Studies that were patient-centered instead of clinician-centered, in an outpatient setting, studied cost-effectiveness or had an CPOE or e-prescribing system without CDSS were excluded from selection.

2.3 Data extraction and analysis

All article titles and abstracts were independently screened by two reviewers (BK, HA) to select those qualified for inclusion. Any discrepancy was resolved by consensus among the two reviewers, and if needed a third reviewer (MA) was consulted. We used structured spreadsheets to extract data from included articles (author, year, country and so on), in- and exclusion and demographic data. Studies were categorized based on their usability aspect (effectiveness, efficiency or satisfaction) and, if possible, further levels as defined by van Welie[20]. This was done in three steps: first the general usability aspect, followed by the usage indicator and last the means. In addition, all studies were divided in four categories according to a modified version of the hierarchy of study designs developed by the University of California San Francisco Stanford Evidence-Based Center as can be seen in Table 1. We also divided the results in outcome groups based on their type of effect. The types of effect that were possible were:

- positive: overall, the outcome improved;
- negative: overall, the outcome worsened;
- mixed: the outcome was both improved and worsened;
- no effect: the outcome was neither improved nor worsened.

3 Results

After running the final query a combined result of 3970 articles was acquired. Screening the titles and abstracts of these articles, a total of 162 articles was selected for full text review. Fifty-one articles were discarded as duplicates. The remaining 111 articles were thoroughly read and a total of 89 articles were excluded due to a lack of focus on clinical decision support (n=26), a lack of focus on usability (29), a lack of research results on usability/CDSS (n=24), or because the research was done in an outpatient setting (n=10). Twenty-two articles were classified as relevant and included in the final selection.

Out of the twenty-two studies, nine (41%) were done in North America, nine (41%) in Europa, two (9%) in Asia and two (9%) in Oceania. In total, twelve (54%) reported a positive usability of CDSS systems, while three (14%) concluded negative results, three (14%) found no effect at all and four

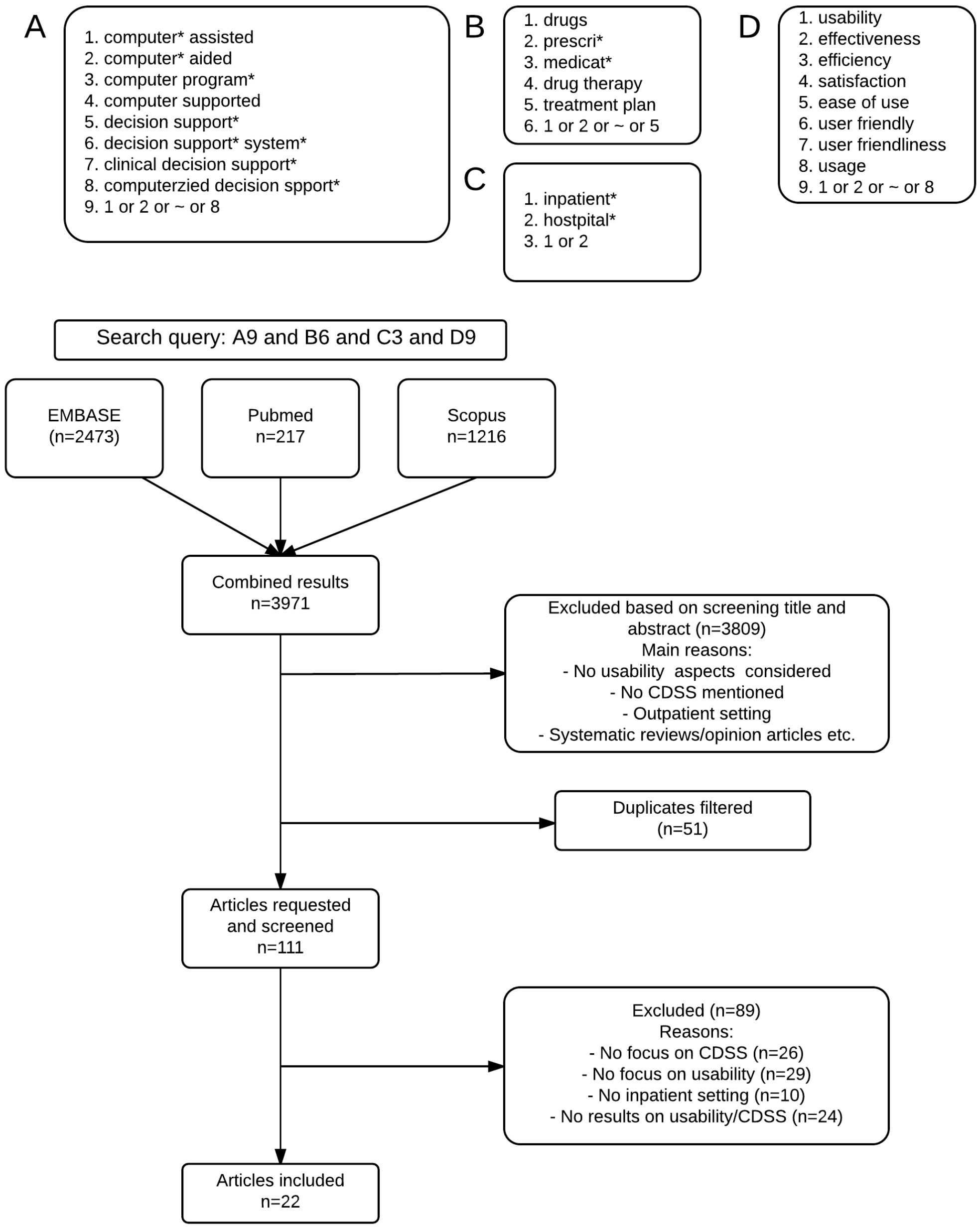

Figure 1: Flow chart of the search queries

Level	Study design	Description
1	Randomized Controlled Trials (RCT)	Studies in which people or groups of people are randomly assigned to an intervention group (or multiple intervention groups). With at least one comparison or control group.
2	Non-Randomized Controlled Trials (n-RCT)	Studies in which people or groups of people are assigned to an intervention group (or multiple intervention groups). With at least one comparison or control group. The assignment to a group is done by the researcher. These studies include before-after and interrupted time series studies
3	Observational studies with controls (OSWC)	Studies where people, or groups of people, are observed or outcomes measured. The researcher does not intervene and only observes how the systems are used. This way the outcomes can be measured and risk factors observed without forcing the users, resulting in practical use. Longitudinal studies (observing users in the intervention group for a specific time period) with controls and case control studies,comparing participants based on needed end result (DSS usage) with those control results (non-DSS usage).
4	Observational studies without controls (OSWoC)	Longitudinal studies and case series without controls

Table 1: Definitions used for categorizing studies

(18%) found mixed results. Ten articles (45%) were observational studies without controls, five (23%) were randomized controlled trials, four (18%) were observational studies with controls and three (14%) were non-randomized controlled trials. Two studies were done before 2005, and six before 2010. The rest of the studies were performed after 2010.

Each article was categorized, based on their outcome, in one of the main aspects of usability according to ISO definitions. These results are summarized in Table 2. A total of 11 studies could be categorized in effectiveness, 15 in efficiency and nine in satisfaction. On should note that some studies evaluated more than one specific area of usability, so the sum is higher than the total number of articles. This also causes certain studies to appear up to three times in the table, especially the three studies[21–23] that studied all three aspects and were positive in all three aspects. For a complete overview of each study and its categorization, please see appendix A. The different aspects of the usability of CDS systems in the inpatient setting related to medication will be discussed in the next sections.

Category	Total	Positive	No Effect	Negative	Mixed
Effectiveness	11[21–31]	9	2	0	0
Satisfaction	9[21–23,32–37]	3	1	3	2
Efficiency	15[21–23,29–31,34–42]	9	1	2	3
Total	35	21	4	5	5

Table 2: Categorizing of the studies

3.1 Effectiveness

Eleven (50%)[21–31] studies investigated the effectiveness of CDS systems, out of which three (27%)[21–23] studied all three aspects of usability and three (27%)[29–31] studied effectiveness and efficiency. Three (27%)[23,28,31] studies on effectiveness were observational studies without controls, one (9%)[29] was an observational study with controls, four[22,26,27] (36%) were randomized controlled trials and three (27%)[21,25,30] were non-randomized controlled trials. Nine (81%)[21–23,25,26,28–31] report an increase in effectiveness by using a CDS system regardless of the focus of their outcome, while two (18%)[24,27] find that the effectiveness does not change. Two studies (18%) report an increase in effectiveness after improving the CDS system with usability principles in mind, while the other nine (81%) look at the difference between no CDS and CDS. The latter group has no negative results but does have two articles that find no effect[24,27], the other seven are positive.

We analyzed the results based on van Welie. All effectiveness studies used the usage indicator errors/safety. The second usage indicator for effectiveness, memorability, was not studied. The articles focused mostly on the right dosing of medication (36%), detecting presrciption errors (36%) and helping physicians making better decisions (18%).

The means that belong to the usage indicator errors/safety are warnings and feedback. All the articles that studied effectiveness used warnings as their means, with two of them also using feedback in addition to the warnings. The studies two that investigated feedback and warnings[22,23] (9%) both reported positive results. The nine studies that looked at just warnings[21,24–31] got positive results in seven (78%) cases[21,25,26,28–31] cases and no results in two cases[24,27] (22%).

3.2 Satisfaction

A total of nine (41%)[21–23,32–37] studies looked at satisfaction, from which two (22%)[32,33] solely studied satisfaction. There were three (33%)[21–23] studies that looked at all aspects, and four (44%)[34–37] article took a look both satisfaction and efficiency. Six (66%)[23,32–36] of the studies studying satisfaction were observational studies without controls, two (22%)[22,37] were randomized

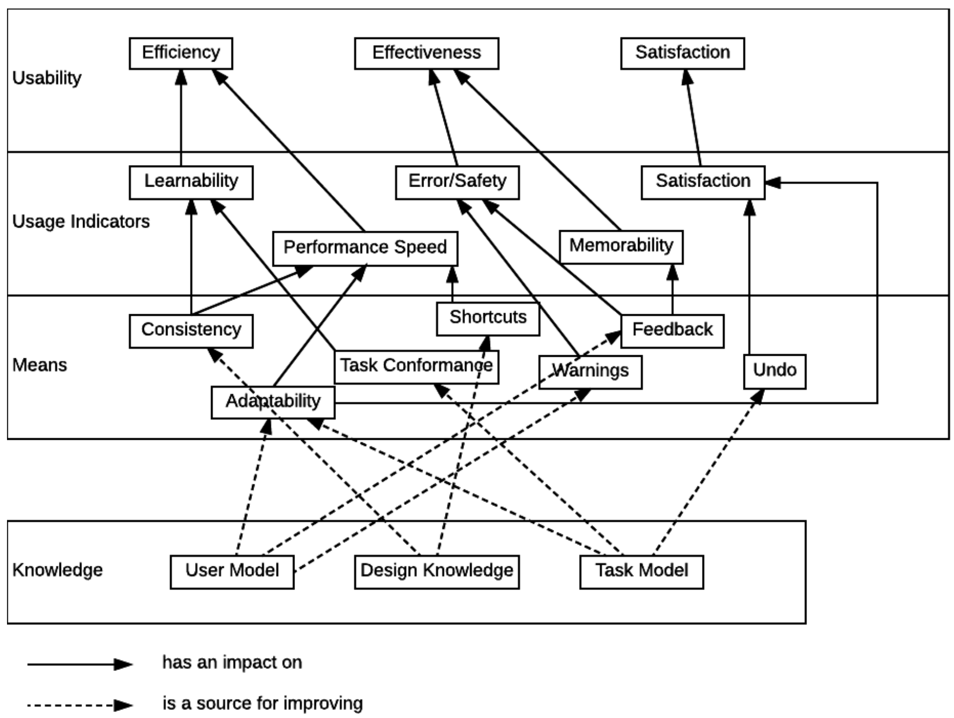

Figure 2: Layered model of usability as made by Van Welie[20]

controlled trials and one (11%)[21] was a non-randomized controlled trial. Three studies (33%) report a positive effect, while three (33%) others report a negative effect, two (22%) a mixed effect and one (11%) reports no effect at all. Six studies got their results via an interview or a usability survey (SUS, CSUQ and PSSUQ), while the three studies that took a look at all aspects used case scenarios or think-aloud. Four (44%) of the nine studies had quantitative results, while five (56%) had qualitative results.

Using Van Welie to further specify the usability aspects, we found that all articles used satisfaction as their usage indicator. The usage indicator satisfaction has two means: undo and adaptability. Undo as a mean was not studied, while all studies used adaptability as their mean.

3.3 Efficiency

Fifteen (68%)[21–23,29–31,34–42] articles were included that studied efficiency. Out of those articles, five (33%) studied efficiency solely, four (27%) both efficiency and satisfaction, three (20%) looked at efficiency and effectiveness and three (20%)[21–23] studied all three usability aspects. As for study designs, two (13%) were randomized controlled trials, two others (13%) non-randomized controlled trials, four (27%) were observational studies with controls and seven (47%) were observational studies without controls. A total of nine articles (60%) concluded that there was a positive effect on the efficiency, while one (7%) found no effect at all, two (13%) found a negative effect and three (20%) found mixed effects.

By using van Welie, we further analyzed the efficiency results. One of the fifteen studies[21] (7%) took a look at the workload of the physician, with a positive result. The same study, along with one other[35] (13%) studied the usage indicator learnability, with respectively one positive and one negative result. Learnability was measured by analyzing video footage[21] and reviewing prescription times and previous uses[35], and resulted in positive respectively negative results. The other usage indicator, performance speed, was studied by thirteen[21–23,29–31,35,36,38–42] studies. Nine[21–23,29–31,38,41,42](69%) found positive results, two[35,36](15%) found negative results and two[39,40] others (15%) found mixed results. Two studies used interviews and found a mixed effect[37] results and no effect[34].

The means regarding learnability and performance speed are consistency, task conformance and adaptability. Six studies included both consistency and adaptability[21–23,35–37] as their means, with three[21–23] (50%) being positive, two[35,36] (33%) with negative conclusions and finally one[37] with mixed results. Seven studies investigated just consistency[30,31,38–42]. They drew positive conclusions in five studies[30,31,38,41,42] (71%) and mixed results in the other two[39,40] cases. Last, two studies looked at only adaptability[29,34]. One[34] found no results whatsoever, while the other[29] found positive results. The mean task conformance was not studied.

4 Discussion

4.1 Main findings

Our systematic review analyzed the available literature on the different aspects of usability of clinical decision support systems in the inpatient setting related to medication prescription. The results of the review are mixed for satisfaction, but generally positive for effectiveness and efficiency. The satisfaction aspect was low, even when not considering the mixed results studies. Only 12 out of the 22 articles included studied only one aspect of usability.

The usability aspect in the effectiveness category was only studied by looking at van Welie's usage indicator errors/safety. This is remarkable, because the other usage indicator, memorability, was not studied at all. A large part (81%) of the research focusing on reducing errors and safety was positive, with the other 18% having no results. This indicates that the use of a CDS could have a positive impact on the errors and safety of the medication prescription which is in line with the previous research. Three of these results were obtained, however, with systems tailored to a very specific goal. Although all three of these studies had a positive effect, generalizing them is harder. The means by which effectiveness was studied was clearly focused on warnings. This is not surprising, given the type of system studied. The studies that also included feedback were positive but few. This implies that generating warnings is easier, while for feedback more insight knowledge on the situation is needed. Although giving feedback seems very valuable, it is harder to implement.

The studies on satisfaction almost all consisted of interviews or questionnaires. Think-aloud, case scenarios and other usability methods to measure satisfaction take a lot more time and are more difficult to perform, which might explain the absence of them. Another reason could be that satisfaction is always subjective and personal, making it harder to study in a quantitative way. Our findings showed that the results were mixed and no general trend can be identified. This might be caused by the lack of coherent techniques mentioned earlier. Furthermore, interestingly, only the mean adaptability was used in the nine studies on satisfaction. The other, undo, was not studied at all. This could indicate either a lack of interest or simply a lack of awareness with researchers in this area.

In the category efficiency, nine out of fifteen (64%) found positive results. Only one study investigated the mental workload of the physician. Two studies investigated learnability, but found different results. An explanation for the fact that so few studies investigated learnability and workload aspects could be the hardness to measure these phenomena than other aspects such as time spent using a system. Thirteen studies - including the ones that investigated learnability - studied performance speed, making it the most popular way to study efficiency by far.. Although most research (69%) reported an increase in efficiency, 15% report exactly the opposite: the physician was slowed down by CDS system usage. In addition, two studies conclude mixed results on efficiency. The general trend seems to be that despite most users experience a better efficiency, some view the system as time consuming and therefore a burden. Factor such as previous experience, amount of training time or having longer the experience to use that specific system could influence the efficiency results.

Another aspect to consider is the effect that a CPOE has on CDSS, since most of the studies we included (81%) studied a CDS systems in combination with a CPOE. Even if the CDS system is well designed, certain usability aspects may suffer if it is integrated in a poorly designed CPOE. Two systematic reviews done by Khajouei and Jaspers[43,44] on the usability and design of CPOE systems find that the design and configuration of CPOE systems are important. One[44] found that the configuration has an impact on the ease of use, task behaviour when ordering drugs, and the medication error rate. The other[43] notes that the design of a CPOE system is a two-edged sword because it can both be positive for the user and create problems with the usability, work flow and medication errors. We also found mixed results regarding this aspect.

The origin of the studies is also remarkable: 18 out of 22 articles were from either North America or Europa, giving our review a bias towards Western countries. This may cause our review to be of limited interest to people from a different culture, since they may have a different attitude towards medical systems or even implemented a different core system due to different work processes.

Although our review indicates that the effectiveness and efficiency aspects of the usability of CDS systems are generally positive, more research is needed regarding the different aspects of usability of these systems. Two studies[21,22] investigated investigated changes in an existing CDS according to usability principles and found better usability results after the change, suggesting that improving the usability of CDS systems does have an effect on user satisfaction.

4.2 Comparison with other literature

There have been several (systematic) reviews in the last fifteen years on clinical decision support[11,13,45–49]. Some[13,45,48,49] of them do study aspects of usability, but there is no review that fully reviews all the aspects for a certain setting. Furthermore, the most recent review is from 2012[45], while the others have been published eight or more years ago.

Bright[45] looks, among other things, at efficiency and workload, but does not fully study satisfaction and effectiveness. They did not specifically study the inpatient setting and not all systems are medication related. Their results showed that although there is evidence that demonstrates positive effects of CDS systems, it is "surprisingly sparse". In a study by Kaushal et alii[13] the same conclusion regarding error rates is taken: there is evidence, but it not convincing enough to draw conclusions. His review does not study any other aspects of usability though, and it dates from 2003. Wolfstadt[48] studied the effect of CDS systems on ADEs, but did not discuss general effectiveness or satisfaction and efficiency. She studied both inpatient and outpatient settings, but found most results in the inpatient setting. The authors concluded that more research is needed on this subject. Eslami et al[49] focuses on computerized physician medication order entry systems. The study is done in the inpatient setting, however, it is mostly about CPOE systems with only a small focus on the usability of these systems. He finds positive results for satisfaction and usability, but also suggests that more research is needed. Marcilly et alii[16] did a study to find usability flaws in medication-related alerting functions which were defined as the violations of usability design principles. In addition, they focused on alerting systems that supported the prescribing of medications, which were used in general hospitals or in primary care general practices. Aligned with their aim, they generated a list of flaws that were found in the literature, which could serve as a check-list for checking the usability of medication-related alerting functions during the design or evaluation process of such systems. In our study, we focused on the inpatient setting and studied the means that measure the usage indicators, which then lead to generating knowledge about the level of usability aspects (effectiveness, efficiency and satisfaction). We also investigated which measures and categories need to be given more attention in future studies, regarding the usability pillars of the ISO definition.

4.3 Limitations and strengths

To the best of our knowledge, this is the first systematic review that studied all aspects of usability of a CDS system in the inpatient setting in detail. Another strength is the fact that our review uses mostly recently conducted research, with 73% of our included articles originating from 2010 or later. We used structured data to extract data from these articles systematically.

Our review has also limitations. First: the lack of heterogeneous results of our articles made it impossible to do a meta analysis. Second, although we extensively searched for articles, it is plausible that we missed studies. Furthermore, we used a mix of the ISO definitions and van Welie's[20] usability model in order to cover usability aspects. . Had we used another definition or model, we might have found other aspects. Finally, it should be mentioned that the means from van Welie's mode were not the only possible means to achieve the improvement of the usage indicators, according to Van Welie et al. these were at the moment of the article a given set of appropriate means, and more means might be possible to define. These means were merely a grouping of the best means according to the authors.

5 Conclusion

In conclusion, our results revealed that evidence could mainly be found for effectiveness and efficiency and showed a high rate of positive results in errors/safety and speed performance. To date, the effects satisfaction of CDS systems regarding medication prescription in the inpatient setting remains understudied. Usability aspects such as memorability, learnability, shortcuts and undo require more attention. Studies are still needed to generate better insight in the user model as well task model for these systems regarding medication prescription in the inpatient setting.

Author's Contribution

MA, ML and BK conceived the study and study design. AH and BK carried out the search and data analysis under supervision of MA. MA, ML coordinated the study. BK drafted the manuscript. All authors participated in the interpretation of data and critically read and revised the manuscript.

Statement on conflicts of interest

All authors declare that there are no conflicts of interests.

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6 Appendix A

Author	Year	Design	Usability	Result	# of practitioners	Outcome measure	Usage Indicators	Means
Abramson E.L.[32]	2012	OwoC	Satisfaction	Mixed	19	Conclusions from interviews	Satisfaction, performance speed	Adaptability
Chen C.[29]	2010	OwC	Effectiveness, efficiency	Positive	Unspecified (200 patients)	Number of patients that reached a goal, time spent prescribing	Errors/safety, performance speed	Warnings, adaptability
Coleman, J.J.[42]	2015	OwoC	Efficiency	Positive	Unspecified	Time spent prescribing with or without a CDS alert	Performance speed	Consistency
Cresswell K.M.[40]	2014	OwoC	Efficiency	Mixed	Unspecified	Conclusions from interviews	Performance speed	Consistency
Devine E.B.[23]	2014	OwoC	All	Positive	10	Questionnaire on CDS system, heuristic evaluation	Errors/safety, performance speed, satisfaction	Warnings, feedback, consistency, adaptability
Georgiou A.[31]	2011	OwoC	Effectiveness, efficiency	Positive	Unspecified	Percentage of reports that include tests, time spent testing	Errors/safety, performance speed	Warnings, consistency
Glassman P.A.[36]	2002	OwoC	Satisfaction, efficiency	Negative	168	Percentage from interviews	Performance speed, satisfaction	Consistency, adaptability

Grossman J.M.[33]	2007	OwoC	Satisfaction	Negative	26	Conclusions from interviews	Satisfaction	Adaptability
Helmons P.J.[39]	2015	OwC	Efficiency	Mixed	Unspecified	Time spent prescribing	Performance speed	Consistency
Hwang H.G.[28]	2004	OwoC	Effectiveness	Positive	Unspecified	Conclusions from interviews	Errors/safety	Warnings
Maat B.A.[30]	2013	nRCT	Effectiveness, efficiency	Positive	7	Prescription accuracy, time spent prescribing	Errors/safety, performance speed	Warnings, feedback, consistency
Mannheimer[24]	2008	RCT	Effectiveness	No effect	Unspecified (150 patients)	Amount of relevant alerts given by CDS system	Errors/safety	Warnings
Russ A.L.[21]	2014	nRCT	All	Positive	20	General usability score, satisfaction score, workload score and number of prescribing errors	Errors/safety, performance speed, satisfaction	Warnings, adaptability, consistency
Scott G.P.[37]	2011	RCT	Satisfaction, efficiency	Mixed	24	Prescribing error rates, conclusions from interviews	Errors/safety, performance speed, satisfaction	Warnings, feedback, consistency, adaptability
Segal J.B.[41]	2015	OwoC	Efficiency	Positive	6	Conclusions from questionnaires, dosing accuracy	Performance speed	Consistency

Sheehan B.[34]	2009	OwoC	Satisfaction, efficiency	None	9	Conclusions from interviews	Performance speed, satisfaction	Adaptability
Strom, B.L.[27]	2010	RCT	Effectiveness	No effect	1963	Percentage of desired prescriptions	Errors/safety	Warnings
Tsopra R.A.[22]	2014	RCT	All	Positive	39	System Usability Score (SUS)	Errors/safety, performance speed, satisfaction	Warnings, feedback, consistency, adaptability
Vermeulen K.M.[38]	2014	OwC	Efficiency	Positive	Unspecified (592 patients)	Time investments per system	Performance speed	Consistency
Westbrook J.I.[25]	2012	nRCT	Effectiveness	Positive	Unspecified	Prescription error rates	Errors/safety	Warnings
Wu R.C.[35]	2006	OwoC	Satisfaction, efficiency	Negative	Unspecified	Case report about time consumption and learning times	Performance speed, learnability	Consistency, adaptability
Zamora A.[26]	2013	RCT	Effectiveness	Positive	10	Percentage of patients that reached a goal	Errors/safety	Unspecified

Table 3: All studies categorized