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Complex Medication Reconciliation in the Danish Medication System: Shared Medication Record for patients in transition of care across sectors

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Abstract

The purpose of Shared Medication (SMR) is to ensure medication reconciliation and thereby reduce the medication errors, thus increasing patient safety. However, medication errors concerning high-risk drugs as Warfarin remain a well-known issue in transitions of care. We examine if different ways of prescribing Warfarin in SMR affect patient safety in regard to transitions of care. We conducted a literature research and semi-structured interviews to investigate the objective. Data were analyzed based on the three analytical questions, and findings were synthesized. The findings indicate that implementing SMR has resulted in new errors. The medical order entry system allows for different manners to prescribe Warfarin which complicates reuse of information in primary sector. This can potentially jeopardize patient safety. Challenges using SMR in relation to the prescription of Warfarin creates workarounds which prevents a number of potential medication errors. But workarounds induce the risk of new undiscovered medication errors, which is why we argue for a higher degree of standardization in medication reconciliation of high risk drugs as Warfarin.

Keywords

Patient Safety, Medication Reconciliation, Medication Systems, Hospital, Medication Systems, Medication Errors, Medical Order Entry Systems, Shared Medication Record.

1 INTRODUCTION

Medication errors are a well-known problem internationally. In the Danish health service the most frequent form of adverse events reported by the Danish Patient Safety Database (DPSD) is medication errors. There are several causes of medication errors, and data from adverse events show that the errors occur in the entire medication process from prescription, dosage and administration to monitoring (Patientombudet, 2012).

High-risk medicine including the anticoagulant drug warfarin constitute a particularly increased risk of patient safety in case of errors in the medication process (Sundhedsstyrelsen, 2005, 2007). A medication error involving warfarin can cause serious consequences (Lægemiddelstyrelsen, 2011), e.g. haemorrhages and blood clots (Dansk Patientsikkerhedsdatabase, 2015). Due to the fact that the warfarin dosage often varies on a day to day basis and depends on effect monitoring, the prescription can be complex to administer (NSI, 2016), which particularly is seen during transitions of care between the secondary and the primary sector (Dansk patientsikkerhedsdatabase, 2016). The errors are often related to insufficient communication concerning the dosage, lack of control of International Normalised Ratio (INR), delivery of treatment responsibility during sector transition and mix-ups between dosage and number of tablets (Sundhedsstyrelsen, 2003). In the study, (Enheden for Brugerundersøgelser, 2006), *"The Patients Experiences in the Transitions Between the Primary and the Secondary*

Sector" from 2006, the patients express concern regarding the exchange of information between the hospital and the general practitioner as well as the co-operation between the hospital and the district nursing. This is stated as the reason for complications regarding medication (Enheden for Brugerundersøgelser, 2006). Doubt and uncertainty concerning medication in sector transitions can, according to McLeod (2013), result in medication error, delay, need of repetition, increased use of resources and it can reduce patient safety (McLeod, 2013). Since 2010 it has been possible to analyse the patient safety in Denmark in relation to adverse events across the health sector, and the number of reported incidents has been on the rise in recent years. Health care professionals at secondary sector have reported 262 incidents in 2015, where the incident occurred in the primary sector. Conversely the municipalities have reported 2.529 incidents, where the incident originated in secondary sector (Styrelsen for Patientsikkerhed, 2015). This indicates the occurrence of many errors in the sector transitions.

In Denmark, the Shared Medication Records (SMR) is developed to ensure a safe and trustworthy medication reconciliation by giving an overall picture of the individual patient's actual and current prescriptions. The solution is supposed to rectify medication errors resulting from sector transitions (National Sundheds-it and MedCom, 2011), and thereby contribute to a better coherence in patient courses across the health service, making the transitions between sectors on schedule, faster and safer (Statens Serum Institut and National sundheds it, 2014).

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The Audit Department, (In Danish: Rigsrevisionen) (2014), has pointed out some challenges concerning the SMR. In sector transitions where the medication responsibility changes, doctors and nurses find it difficult to get a clear picture of the patients' relevant medication, which can lead to medication errors. This indicates that the SMR does not ease medication procedures at sector transitions but instead create frustrations for both professionals as well as patients. The cross-sectorial cooperation is challenged and the job assignments have increased instead of decreased (Rigsrevisionen, 2014). A recent report by the Audit Department from 2016 shows that many patients continue to be discharged from hospitals without correct information on the relevant medication in the SMR (Rigsrevisionen, 2016).

While SMR seems to solve some of the current problems concerning accumulation, sharing and reconciliation, the SMR creates new problems as well.

The objective of this study is to explore if and how different ways of prescribing high-risk drugs as Warfarin in SMR affect patient safety in regards to transitions of care across sectors.

Materials and Methods

To investigate the objective we identified three relevant research themes with each having a specific research question:

1. **Patient Safety:** How is the patient safety affected by SMR?
2. **Medication Reconciliation:** How does primary sector use and reuse medication orders?
3. **Medication Errors:** Why is medication errors still present in the transitions of care when SMR is implemented in both primary and secondary sector, and how can they be prevented?

2 METHODS

In figure 1 the overview of the method is presented.

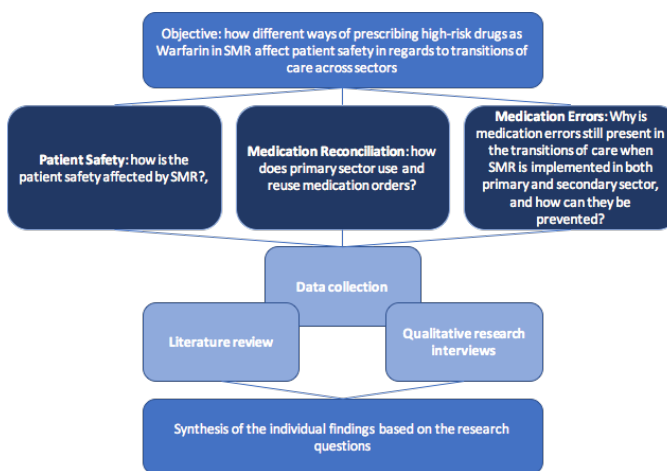


Figure 1 The method used to investigate the objective.

To answer the objective, we have been inspired in Hevner et al's (20) Information System Research Framework illustrated in figure 3. The framework is used to ensure a just evaluation of the developed SMR (the artifact).

According to Hevner et al. (2004) design science consists of factors from two different paradigms: design science and behavioural science. In the framework, there is given a premise for conducting evaluation in the area design of information system.

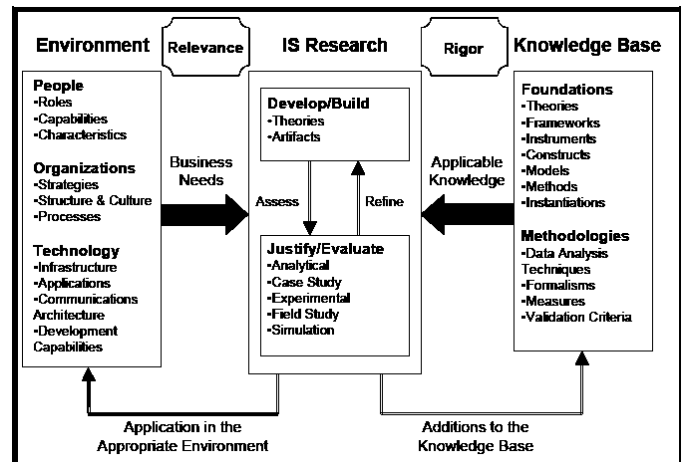


Figure 2 Hevner et al's Information System Research Framework (Hevner *et al.*, 2004).

If the artifact (SMR) is to be useful, there is a need for relevance between the artifact and the environment in which the artifact is to function. In order for the information technology to benefit the environment, it must be adapted to the real world (Hevner *et al.*, 2004). Therefore, we used the environment to structure our understanding of the clinical domain e.g. organization, the patients, district nurses, treatment and the ideal and actual medication process. In the knowledge base, we applied our data collection e.g. literature review and interviews. Both the environment base and the knowledge base are relevant to answer research questions One and two. Finally, to answer research question three, we evaluated the existing designed and developed SMR through an extreme case (warfarin treatment) with use of both knowledge base and environment base. This evaluation can lead to a suggestion on how to prevent medication errors across borders through re-design considerations relevant for preventing medication errors.

2.1 Literature review

The review of the research covered the period from 2000 to 2016. This period was considered adequate to cover most accurate elements in the literature in regards of the datafication of medication reconciliation. Research papers were sourced in three different ways. First, the most adequate electronic databases as PubMed and Embase were searched. Second, relevant cross-references from published literature were followed up and included if they met inclusion criteria. Third, additional 'gray' literature not identified in electronic searches were sourced. This third step included reports for government bodies. In table 1 our structured search is documented. To ensure that we have all relevant studies, we have created our search queries using PubMed's and Embase's underlying thesaurus (MeSH and Emtree) in collaboration with free text searches.

We found 627 articles. We excluded 605 articles based on their title, abstract or because they were doublets. Six of the authors reviewed the remaining articles and excluded an additional 15 articles due to exclusion criteria as focus on side-effects, focus on decision support system or focus on solemnly warfarin treatment. The included seven articles were checked for quality using CASP-UK 2016.

AND				
Informationssystemer	Medicinering	Sektorovergang	Patientsikkerhed	
"Medical Order Entry Systems" (MeSH + fri)	"Medication Reconciliation" (fri)	"Patient Transfer" (MeSH + fri)	"Patient Safety" (MeSH)	
"Computerized Physician Order Entry" (Fri)	"Medication Reconciliation" (MeSH + Fri)	"Sector Transition" (Fri)	"Patient Safe*" (fri)	
"Computerized Medical Record System" (MeSH + fri)	"Medication Prescribing" (fritekst)	"Health Care Transfer" (fri)	"Patient Security" (fri)	

Table 1 illustrates an extract of highly relevant search queries.

2.2 Qualitative research interview

We conducted three qualitative research interviews following a semi-structured interview guide. Our informants were all district nurses and met the following inclusion criteria:

- Employed in a locale municipality
- Using SMR on a day-to-day basis
- Minimum six months of experience working with SMR
- Experience on administrating warfarin medication orders

The data from the interviews were transcribed and coded in different themes.

3 FINDINGS

When analyzing the objective, it was found that in connection with the use of SMR the patient safety was at risk and new medication errors occurred, challenges arose around the medication reconciliation and the medication errors showed a need for standardized guidelines on complex prescriptions.

3.1 Research theme 1: Patient Safety

Both earlier studies and interviews from the present study point out problems regarding patient safety when implementing medical information systems as the SMR.

Studies by Turchin et al. (2011) and Steichen & Gregg (2015) indicates that information systems can facilitate new types of medication errors (Turchin, Shubina and Goldberg, 2011; Steichen and Gregg, 2015). Garrett & McCormack (2014) found fewer errors after the implementation of an information system, however the mistakes that did occur were judged to have severe consequences for patients (Garrett and McCormack, 2014). Interviews in this study indicate that medication information appears in several places, both electronically and in print, and it causes more complex workflows and potential risk situations in the medication process. The ideal medication process with warfarin is according to the

informants not consistent with the actual medication process. The ideal medication process involves three steps in communication perspective (Figure 3). The process is as following: First the hospital doctor updates the SMR (illustrated as database in the middle of figure 3) and a nurse announces discharge. Second the district nurse updates the patient's medication record in the local EHR-system with data from the SMR, and plans the first visit. Thirdly, the district nurse dispenses medication for the patient from the medication record in the SMR containing the patient's total, current medication information, including dosage and time of medication intake.

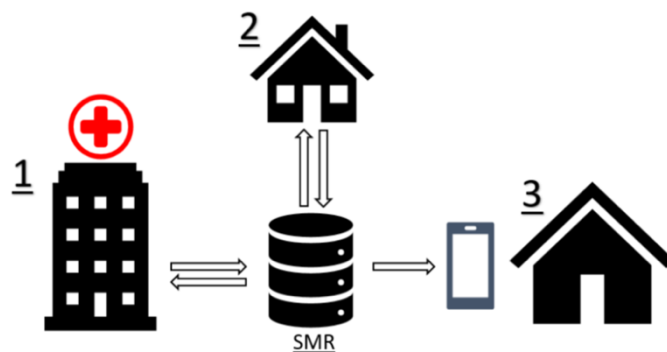


Figure 3 The ideal medication process.

The actual medication process at the time of discharge is contributing to several ambiguities and inconsistencies in the administration of the individual patient's medicine.

The actual medication process involves three steps in communication perspective (Figure 4). The process is as following: First the hospital doctor updates the SMR, and a nurse announces discharge. A printout of the patient's medication form from either the local EHR-system at the hospital or the SMR is given to the patient. Secondly, the district nurse reads discharge announcement where the dose and timing of intake of warfarin can be noted. The nurse updates the patient's medication form in the EHR-system using the current prescriptions of the SMR, and checks the dose and timing of warfarin, which is often omitted. Instead it says for example "see scheme", "after the written instruction", "0001" or "X". Thirdly, the district nurse compares the printed medication form to the current ordinations in the SMR, which often show inconsistencies and therefore the nurse has to obtain further information by contacting the prescribing department or the patient's doctor before dispensing the medication.

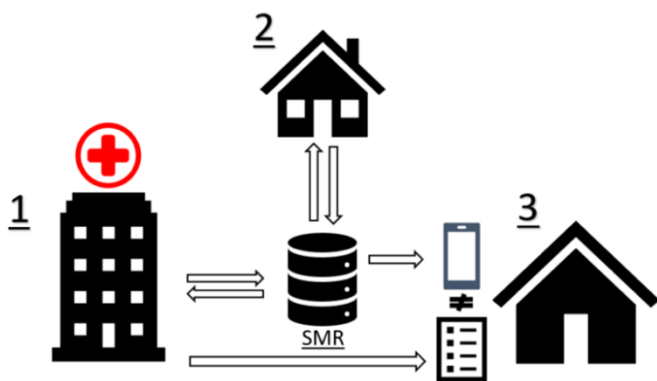


Figure 4 The actual medication process.

A study of Ash et al. (2007) finds that a failure between the information system and the clinician's workflow creates a number of problems that may be generated by the IT system's user interface not matching the clinician's workflow (Ash *et al.*, 2007). This is supported by the informants, who says that monitoring of the effect of warfarin can be overlooked after discharge, and cause either too high or too low a dose exposing the patient to serious complications.

"... and if people have been receiving warfarin before, then it is the old dose that is used. And if you don't think it through, you'll look at that [the former prescription]."

When a patient is discharged from the hospital with a prescription of warfarin, it requires special attention from the district nurses as they can be the intermediate link that discovers the errors or missing information in SMR.

3.2 Research theme 2: Medication Reconciliation

In transitions of care the use and reuse of data are dependent on how the local systems are utilized.

Warfarin is prescribed in different ways in the local medicine records at the hospital and there are indications that this affects the transfer of data when updating the SMR, where the district nurses get the medicine information. Both the local medicine records at the hospital and the SMR make it possible to store data in different ways, which complicates the reuse of data. If reuse of data is to be possible, it is a prerequisite that the it-system contains adequate XML-elements. Thus, XML-elements in the systems are crucial in determining whether district nurses can receive the information that is necessary to ensure correct administration of warfarin. In addition to this it is also a prerequisite that each local EHR-system is able to relocate and clearly present the information that is shared through XML-documents. If they cannot, information will be lost in the exchange of data with the SMR (NSI, 2016).

This is exemplified in the following, where one of the informants has found that in the prescription field in SMR times of dispensing are missing and instead it says "dosage according to written instructions", "as noted in the written instruction" or "see form":

"Then it says "dosage according to written instructions," and times of dispensing aren't noted. It may then be noted in the admission papers at start-up. Then we must put in

the dispensing times. Or we must call the ward and get them."

3.3 Research theme 3: Medication Errors

It seems medication errors are still present in the transitions of care because of the complexity involving human factors when developing information systems like the SMR.

The informants are not experiencing that SMR is contributing positively to their workflow as inadequate information causes prolonging of work processes and increases the risk of medication errors.

"... there are still errors, but as I said you can then write to the doctor or call the hospital like before and say: 'You know what? On the medication form she came home with, it says that she is to get two of it, but in SMR it only says one. What should we do?'"

According to Hevner, the different ways to prescribe warfarin may be related to a fault in the relevance between artifact (SMR) and the environment (the organization and the people using SMR) (Hevner *et al.*, 2004). It is well known that warfarin causes challenges to patient safety, and that technology, organizations and people affect each other, which begs the question why this was not taken into account in the development of the SMR. The different prescription procedures regarding warfarin also points to lack of standardization that has previously been identified as a contributing factor to errors and frustrations in the cross-sectorial communication (Sygehusapoteket Region Nordjylland, 2015). The district nurses, who administer warfarin to discharged patients, support the need for increased standardization.

"But that's why I think, that when it is so specific, there really should be only one way. There shouldn't be several different forms they can put it into (...) one big source of error!"

To prevent medication errors in information systems and increase patient safety Magrabi et al. (2013) suggests standardization and shared guidelines. It is described how initiatives in information systems in health services primarily focus on the software part of the information system (Magrabi *et al.*, 2013). This is problematic as technological science has a simplified view of the people and organizational contexts that information systems are to function in and this lowers the chance of success for the information systems (Hevner *et al.*, 2004).

4 DISCUSSION

It is well-known in national and international literature that there are challenges associated with the implementation of information systems such as the SMR (Turchin, Shubina and Goldberg, 2011; Steichen and Gregg, 2015). To better understand these challenges, a broader perspective is needed. Hevner et al. (2014) points out that there is an overriding focus on the importance of design science in the development and implementation of

information systems, and less so on behavioral science (Hevner *et al.*, 2004).

Berg (2001) describes the necessity of a sociotechnical approach, and points to the same challenges in regard to information systems as Hevner *et al.* (2004), i.e. technology and organizations inevitably change each other through an implementation process. Berg further emphasizes that, when planning the implementation of information system, account should be taken of the challenges that may arise in relation to the people who will use it and the organization to which the information system is to be implemented (Berg, 2001; Hevner *et al.*, 2004).

The findings in this study imply that managing the issues after implementing the SMR has not been successfully anticipated. This can be linked to a predominantly technical approach for the development and implementation of SMR. When implementing a new information system it is imperative that users accept it, and this requires coordination across organizations (Steichen and Gregg, 2015). An example is described in by Zwaanswijk *et al.* (2011), where health professionals resisted the implementation of a national information system. To address this, user-friendly guidelines should be developed so that application in daily practice can be ensured, and so fewer errors occur (Zwaanswijk *et al.*, 2011).

The district nurses point out that the SMR has the potential to facilitate their work and improve patient safety if used correctly and alike. The information in SMR is found to be inadequate, however, and the district nurse must disclose information from other sources than SMR. This practice can be described as a workaround.

Friedman (2014) describes workarounds as the result of a user's perceived limitations of an information system. This leads the user to explore ways to work around the perceived limitations. Friedman proposes a typology for different kinds of workarounds. Temporary workarounds are solutions to issues that occur when replacing one it-system with another. However, the temporary solutions may eventually develop into routine workarounds if they are accepted as a fixed part of the workflow (Friedman *et al.*, 2014). Obtaining missing information regarding warfarin ordination has evolved into a being part of the district nurses' workflow and can be considered a routine workaround that compensates for the lack of information exchange between the sectors. The district nurse has no alternative to retrieving the information, and the workaround is thus unavoidable. Whether this is a result of the system or the application of the system cannot be concluded.

It is possible to obtain knowledge about how complex prescriptions are managed in SMR and which effects the different prescription procedures have on the working procedures by conducting interviews of district nurses. This means that there is a risk of medication error, but a more exact description of how the patient safety is influenced require another study design. Consequently, it

indicates that the district nurses' critical approach to data in SMR prevents potential errors, that otherwise could reach the patient. The risks of this working procedure can be that the patient safety depends on the professional competences and vigilance of the individual district nurse.

The challenges of the documentation of warfarin at sector transition, is pointed out in a study by Day *et al.* (2016). The same challenges concerning sector transitions regarding the medication process with warfarin is identified in this study. Day *et al.* describes prescription errors, reduced compliance and insufficient monitoring as main reasons for medication errors and reduced patient safety. Furthermore, they find that there is a potential for implementing a decision support system for anticoagulants with five key elements, because it facilitates the cross-sectorial communication, forcing the responsible for the patient's medication from both sectors, to consider the patient's warfarin treatment at discharge. At the same time Day *et al.* have found that there are challenges in storing information, so they are available for both the discharging and receiving unit (Day *et al.*, 2016).

In addition, the study by Day *et al.* supports the findings in this study, where the standardization with the course of warfarin treatment at sector transitions could contribute with a positive effect on patient safety. Since SMR gives the possibility for healthcare professionals from both sectors to reach the same information, it is possible that a similar decision support system for anticoagulants could improve the communication, transmission of responsibility and in that way, ensure that the patient continuously receive the right treatment. Furthermore, the study by Day *et al.* can contribute with inspiration to some general guidelines to a decision support system with integration to the SMR (Day *et al.*, 2016). A decision support system and some general guidelines for prescription of warfarin can contribute to a correct and uniform use of SMR across the health sector, and according to Hevner *et al.* (2004) hereby contribute to be of relevance for the organization (Hevner *et al.*, 2004).

4.1 Conclusion

The findings of this study indicate that there are problems when dealing with complex prescriptions in SMR following current practice. It creates complicated working procedures and potentially risky situations when the ideal medication process with warfarin does not correspond to the actual medication process. Several of the utilized prescription procedures of warfarin in SMR does not allow for adequate reuse of data which causes the evolution of workarounds in working procedures of the district nurses. The managing of complex prescriptions thus depends upon the individual district nurse's ability to identify and compensate for the flaws of SMR, which leads to a need for a standardization that considers the reuse of data.

Future work: It can be relevant to research whether standardization of warfarin prescription or an individual decision support system for anticoagulants integrated into the SMR can ease the handling of complex prescriptions.

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