Towards a Socio-technically Resilient Collaborative Medication Process

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Abstract The fragmented character of healthcare produced by geographical, institutional and professional boundaries is well documented, as is the collaborative potential of information systems (IS) as a remedy. Empirical studies consistently document substantial socio-technical challenges related to realizing this potential. We study the case of collaborative, distributed medication (management) processes. Medication errors represent a significant health concern creating a strong interest in quality assurance. The principal question we discuss is: what are socio-technically viable and resilient mechanisms for safer collaborative medication processes? We contribute by *identifying* key quality assurance practices; we discuss their *role* or function in achieving improved quality, and propose information systems *design* related principles.

Keywords: collaborative medication management, socio-technical resilience, out-patient

1 Introduction

In 1999 the US Institute of Medicine report, *To Err is human,* estimated that medication error was the eighth leading cause of death in US hospitals [1]. This of course had major impact on the patient safety focus in health care in general. The traditional focus in the sector on training, rules and sanctions to reduce errors, is being extended by voluntary blame-free reporting (especially in hospitals) reflecting an increasing recognition that a systems approach to errors is necessary [2]. It seems however that technology are still viewed as tools, not systems, and causality of errors related to technology are still commonly attributed to either the technology or the individual user [6]. Technology in the medication management process is by now both seen as a means of reducing errors, as well as contributing to new and different types of errors [3-5]. Empirical studies however demonstrate socio-technical obstacles to collaborative use of such technologies [3, 4, 7-9], with possibly serious implications for patient safety [9]. Two problems seem particularly challenging [3]; (1) current automation technologies build on an underlying assumption of sequential clinical workflows

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where task performance is a well-defined step wise process, and (2); they have been designed primarily with the tasks and responsibilities of individual professional groups in mind. This begs of course attention to how collaborative medication processes actually unfolds *in practice* [10].

A characteristic trait of collaboration in health care, also related to the medication process, is the way it evolves around the patient trajectory. Against a backdrop of situated contingencies, in the face of uncertainties and deliberations of risk and coping with ever-present imperfection in the information [3], a collectively negotiated trajectory is managed in such a way that "what to do next" is worked out. The healthcare *services* for patients are fragmented and thus undermining ambitions towards more collaborative, process-oriented modes of working [11]. Despite the obvious potential of information systems to facilitate more collaborative modes of delivering health care, empirical studies have demonstrated socio-technically stubborn obstacles to their use that have severely hampered collaboration in practice [3, 12]. Tight integration of information across geographical and institutional boundaries has pointed to differences in perspectives and interests, generating quite distinct perceptions about what constitute high-quality information [13]. In collaboration crossing professional boundaries issues of conflict, power, trust and commitment are also discussed [14]. Key challenges with collaborative medication (management) processes are related to the information generated, communicated and updated along the process being incomplete, outdated, inaccessible and/or inconsistent. What information should I trust? Who can I consult with? What is a robust solution for appropriate medication for the patient? Against a theoretical understanding of collaboration as socio-technical [12], and practice-oriented [15], we document and discuss extensive and elaborate collaborative micro-practices in distributed medication management processes. The aim of the paper is: (i) to *identify* key quality assurance practices at the boundaries, (ii) to discuss their *role* or function in achieving improved quality and (iii) to propose information systems *design* related guidelines or principles for robust and resilient quality assurance for collaborative medication (management) processes. Empirically, we study medication management in an out-patient setting, across different municipal health providers.

2 Methods

This qualitative interpretative study took place in a mid-sized Norwegian city with a population of about 170.000, where about 2000 individuals living in private homes receive medication use assistance from the municipal home care service. Our research context involves numerous institutions with multiple, distributed stakeholders, and we strived to be sensitive to the differences of views, opinions and concerns of the stakeholders [16]. Observations were conducted in 2007 and 2010 by the first author, and include nurses in two home care units, health secretaries in one general practice, and pharmacists and pharmacy technicians in one pharmacy. Interviews were conducted with the health manager in each of the observed units.

Through a bottom-up categorization informed deductively by Leape et al.'s [17] focus on functions of quality assurance practices we developed the interpretative template shown in Table 1.

Table 1. Our interpretative template derived through a combination of bottom-up, open coding and classification of data with deductive elements, notably from [17].

Construct	Evidence, example
Establishing trust	*"Is this an intended change, or did we get this wrong from the beginning?"*
Filling the gaps	*"This has to go into a pill dispenser... this is quite simply wrong. Albyl-E is in here and he shouldn't have that."*
Passing on the token	*"Have we already bothered him a lot today? Should we just leave a note?"*

3 Case

In 2006 the city council in CityN introduced multi-dose drug dispensing in home care. The goal was to reduce the risk of medication errors, but also to save time in home care. Multi-dose drug dispensing (MDD) means that drugs are machine-dispensed into units of disposable bag, where each unit contains all drugs the patient should take at a given time of intake. Each MDD delivery contains a fortnight's supply of drugs. After a two year pilot, the MDD system was in 2008 declared the standard mode of drug delivery in home care. As part of the effort to improve safety and collaboration across providers, the patients' family doctors were also made responsible for keeping a complete and current drug list for these patients and fax this to the pharmacy to update or initiate a new MDD order. The pharmacy, which was contracted by the municipality through a bid for tender process, delivers all MDD drugs. Pharmacy staff transcribes the order into their MDD supplier's electronic ordering system, and the resulting MDD packages are distributed to the home care units, via the pharmacy, while home care further distributes them to the patients' homes. For some patients, the multi-dose routine can go on for months and even years, only interrupted by the pharmacy once a year requesting an updated MDD prescription from the family doctor. However, these patients are typically the elderly with complex health problems that often need assistance from a range of health service providers in the municipality. The challenge of coordinating and keeping track of the at all times correct and complete drug list increases correspondingly. We focus in the following on the collaborative aspects at the boundaries between the involved health providers, and organize the results according to the categories presented in Table 1.

3.1 Establishing Trust

When receiving input from other health providers in the medication management process this involves evaluating and comparing it to locally available information, knowledge and expertise. Our observations indicate that this reconciliation work also involves establishing trust in whether the new information is actually the most current

available and that it is complete. The observed routine of going through an updated multi-dose order received from a family doctor at the pharmacy illustrates well how trust is achieved in practice: *As the pharmacist goes through the list, she reaches 'Cipramil 20 mg, 1½ tablet, (i.e. 30mg x1)' (Figure 3, to the left) on the family doctor list and gets confused. She finds the equivalent drug: 'Citalopram 10mg' in the electronic MDD order, but the dose doesn't match. After some scrolling up and down the electronic record she finally notices another entry further down (Figure 3, to the right) where it says 'Citalopram 20mg' […] these pills can't be divided – that's why we need to order two different [doses]."* When patients are entitled to a reduced price on medication, the pharmacy is required by law to deliver the cheapest equivalent drug in order to receive the entitled reimbursement from the authorities. Unless explicitly indicated otherwise by the family doctor, the pharmacy staff accordingly changes the order and routinely faxes a copy to the family doctor. When the family doctor resends an updated order, more often than not, the new order does not reflect this change initiated at the pharmacy. Accordingly, this involves some additional consideration at the pharmacy to whether this is intended or not on the part of the family doctor.

As the observed pharmacy technician proceeds down the list, getting an overview of the new order, she makes further comments on issues in need of clarification: *"This [reimbursement] code [pointing] cannot be used for this type of drug. These are antidepressants, but this code is only accepted for pain-relievers for terminal cancer patients. […] I have to change this and inform the doctor"*. Further down, by the drug Haldol the family doctor order indicates: "1 tabl. Vesp" while the previous electronic multi-dose order says "1 tabl." in the column for 08.00 a.m. she wonders, *"Is this intended change, or did we get this wrong from the beginning? I will have to call him to ask about this."*

The pharmacy needs to establish trust in that the multi-dose prescription from the family doctor is correct. When the two lists do not match, the pharmacist must establish whether this is due to intended changes or not as most family doctors do not indicate on the new order what has changed since the previous list. Activities geared towards establishing trust to new input were observed at all sites in our study, though in different forms. In home care, a frequent concern is whether the new inputs is based on the most current and complete knowledge as they are closest to the patient, and accordingly quite often have access to the most recent information.

3.2 Filling the Gaps

Filling the gaps includes compensating for missing, incomplete and/or inaccurate information or drugs, based on professional competence or locally available knowledge and resources. In the home care service such corrective measures often follow from having confirmed a suspicion that something is missing or recent events are not reflected in the new input. The following extract is from the pilot phase in 2007:

The loose-leaf binder containing printouts from the patients' local medication charts in home care sits next to the nurse on the desk as she goes through the new MDD delivery, comparing its content to the local drug charts. She has established

that all but three MDD packages this week need some attention. She starts to transfer the content of one MDD package into a regular week-pill dispenser. The patient's medications have changed; one drug has been discontinued and another one added since the MDD order was executed. The small disposable bags of the multi-dose are ripped open and the pills are dropped successively into the compartment corresponding to the time of intake in the 7x4 matrix pill dispenser.

The nature of corrective measures needed vary greatly in home care with many nurses on duty, many clients involved and many potential contingencies arising during a busy work day. On one occasion we observe an evening shift where the only trained nurse scheduled for duty is absent on short notice. The most experienced enrolled nurse takes over the responsibility of coordinating the work this evening. During this shift another enrolled nurse finds a multi-dose unit bag in a patient's home – intact but – empty. "*He has been taking these sleeping pills for 20 years; he will be out wandering about to night if he doesn't get them",* she tells the responsible nurse on the phone. They discuss back and forth, unsure of how to solve the situation. As only trained nurses have access to the medicine room at the home care unit, their options are limited. Clearly troubled, the responsible on duty tries, without success, to call both of the two nurses who were on duty this morning. In desperation she exclaims, *"We are really not allowed to do this, but I don't have the keys to the medicine room, and there's not really much else I can do..."* and proceeds to borrow a sleeping pill from another patient.

Corrective measures, albeit not as elaborate, are taken also at the pharmacy and the general practice. Usually, this involves a phone call to clarify inconsistent information or to request missing information.

3.3 Passing on the Token

The collaborative aspect of the medication management process requires strategies for making sure the next in line is made aware of required action, easily overlooked during a busy work day. Initiating and updating the multi-dose order, the family doctors office have a set of illustrating challenges in handling changes to an already running order, here illustrated through observations in one general practice's reception area:

Calls to the general practice's "secret" number are not silent, as are all other incoming calls. This number is used by home care and the pharmacy to allow some priority over other calls. In principle these calls should be put through directly to the family doctor. However, one of the doctors hasn't answered the phone for a while and the two health secretaries discuss: "Is he particularly busy today, or is he out of the office? Have we already bothered him a lot today?" – They discuss whether they should call him themselves or just take a message, reveling yet another 'level' of access. They decide to leave a message (a hand-written note) in the doctor's mail trays – the "lunch-tray"- for messages a bit more urgent than regular postal mail.

When changes to a patient's medications are initiated by other physicians, for instance at the hospital, the family doctor might sometimes receive the official discharge letter no sooner than four weeks later (ref. observations in 2007). As home care nurses usually get the paper prescriptions following the patient, they are supposed to inform the family doctor. These messages are usually passed on over the phone, and if the doctor is not available, the health secretaries function as mediators.

At the pharmacy, they await the faxed multi-dose prescription from the doctor to initiate any changes, and in home care they are sometimes not alerted of changes until the pharmacy includes a copy of the updated MDD order in the subsequent delivery. Despite the fact that both pharmacists and nurses in theory have direct access to family doctors on the phone *"doctors are usually very hard to get a hold of"* (Nurse1 2007) and a lot of time is spent trying to get the doctor on the phone.

While all of the above described practices are components of the routine process, their significant importance as quality assurance mechanisms become particularly evident when there are breaches in the otherwise every-day routine practice. The number of contingencies arising also increases, along with the complexity of strategies to compensate, as the abstract doctor's order materializes into drugs throughout the process.

4 Discussion and Conclusion

A principal source for the socio-technical challenges of making automation technologies work in practice is the lack of flexibility or "system rigidity" [p. 95, 18]. This socio-technical rigidity – an inability to work outside the plan [19], with inaccuracies [12] and coping with uncertainties [3] – amount to lacking socio-technical resilience [20]. What, then, are important principles or guidelines for the design of information systems support of medication?

4.1 The Productive Role of Redundancy

A traditional and highly appraised design principle in information systems is to avoid redundancies as they are seen as leading to inconsistencies and lack of data integrity. Socio-technical analysis, however, challenge this deep-seated design principle. Empirical studies document the relative modest level of problems actually caused by redundancy. A rich network of artifacts and routines perform the 'invisible' work, i.e. fill in the gaps and glitches [21]. Users are highly competent in bridging these gaps. Suchman [p. 119, 19] underscores how collaborative work draws on multiple rather than singular information sources as 'work in operations makes artful use not only of computer technologies, but of a range of other communications and display technologies as well'. Hutchins [p. 223, 22], pressing this further, argues for a productive role played by redundancy as a principal reason for the resilience in collaborative systems because if 'one… component fails for lack of knowledge, the whole system does not grind to halt'. Different health professions have their own documentation, partly overlapping with that of the others, which they refer to in their spoken performances [p. 91, 21]. Combining information from multiple, independent, sources of information permits quality assurance as it serves to check, control or extend information from different non-integrated sources [p. 35, 22]. To illustrate from our case, the routine of cross checking multiple information sources when establishing trust to the doctors order at the pharmacy functions as a quality check of the order.

The important information systems design related implication of recognizing also productive forms of redundancies is to allow looser integration between the 'silos' along the medication process; users are good at 'integrating' manually. Automation

efforts assume high, if not absolute, levels of consistency, accuracy and completeness of the information sources. Obtaining, not to mention maintaining this over time, is often socio-technically unsustainably [12], risking also known problematic issues related to tight integration of information across boundaries. More realistic, we propose, is design supporting 'reasonable' levels of redundancies.

4.2 A Learning Perspective

An emphasis on a learning perspective in facilitating socio-technical robustness or resilience is related but different from the above focus on redundancy. Socio-technical resilience presupposes competent ('empowered', if you want) health workers [20]; detailed specification of every circumstance is theoretically and practically prohibitive [19]. Organizational learning is essentially about facilitating mechanisms for collective reflections on your own work practices [23]. In line with this, [17] argue for the need to search for the Third-order Whys; 1st) what was the error, 2nd) why did the error occur, and 3rd) what was the underlying system failure? The health care sector, the medication process very much included, still offers few forms for collective learning. While for instance hospitals are reported to increasingly implement voluntary error reporting systems, they rarely go beyond communicating information about the errors to health care providers [p. 816, 2]. This is in stark contrast to so-called high-reliability organizations (HRO) such as aviation, nuclear plants and oil industry [24]. Key here is recognizing (near-) errors as a resource for collective learning and subsequent organizational chance. Again, to illustrate from our case, when drugs are dispensed within home care, a dose and identity check performed by another nurse is required. When inexperienced nurses are performing this routine, they need to recognize the tablets. The uneven availability of experienced and competent staff reinforces the need for a learning perspective. E.g. the night and weekend shifts at the home care services are typically filled by inexperienced hands. Thus the need for explicit instructions and information vary. A learning perspective is at odds with (overly ambitious) automation efforts within the medication process. The lack of central traits of organizational learning - forums to reflect (on incidents including those we report), time and resources – in healthcare is striking. Also, it is necessary to extend the system error approach and subsequent learning to involve also technology [6]. In the hierarchies and task division of the well-established traditional manual medication ordering many error prevention mechanisms are built in, often informally [12]. This way errors made early in the process are regularly picked up by handlers later in the process. By introducing automation technologies into these established routines it should be expected that the sorts of problems that arise in the process and the way professionals detect, understand and correct errors will change, and accordingly the vulnerabilities of the system will change [25]. Our learning perspective is not an argument against automation per se, but a call for selective and socio-technical sensible aspects to automate.

4.3 Conclusion

Resilience is an essential feature for many collaborative solutions in healthcare, including but not confined to medication, that are characterized by distributed, at times

incomplete, inaccurate and/or not updated information *and* where errors have potentially devastating effects. Many proposed information systems aimed at automating selected or relatively comprehensive steps in the process of medication however seem to assume that errors are eliminated altogether. Resilience, on the other hand, represents a perspective where errors are inherent - but possible to tame. Socio-technically viable resilience is a feature or quality of information systems design that has to be actively catered for. The two broad design related guidelines emerging from our analysis, acknowledging and facilitating productive modes of redundancy and collective, reflexive learning, represent a point of departure for further research.

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