

EHR improvement using incident reports

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Abstract. This paper discusses reactive improvement of clinical software using methods for incident analysis. We used the “Five Whys” method because we had only descriptive data and depended on a domain expert for the analysis. The analysis showed that there are two major root causes for EHR software failure, and that they are related to human and organizational errors. A main identified improvement is allocating more resources to system maintenance and user training.

Keywords: Clinical software; Software Maintenance; Failure analysis; Five Whys

1. Introduction

This paper discusses reactive improvement of Electronic Health Record systems (EHR) viewed as part of a socio-technical system. Proactivity is the ideal for system designers and organizations: Striving to avoid incidents and design flaws instead of fixing or learning not to repeat them. However, systems are more or less flawed, not fulfilling the needs of changing organizations. Thus, our topic is pinpointing and prioritizing improvement in use, design and implementation of an operational EHR system. We describe detected and reported accidents, mishaps, errors or near misses as “incidents”, thus not judging or ascribing any reason. “Reactive improvement” means that incidents are analysed to find causes and eliminating them. This way of improving a complex, socio-technical system has been used with success in, e.g., the aviation industry, and it should be used more in healthcare [1]. Many methods support reactive improvement, but we will only employ “Five Whys”. Our data consists of error reports from an EHR help-desk in a hospital trust. Note that this work is an initial and independent analysis, not in any way commissioned or expected by the healthcare trust or a software provider. No actions have been taken to inform them about these preliminary results, but we intend to do so in the near future.

The following sections discuss related work, error analysis methods, empirical help-desk data, data analysis, results and finally conclude with recommendations for reactive improvement in practice.

2. Related work

The EHR fulfils many diverse, complex, partially conflicting requirements. In contrast to non-clinical information systems used in healthcare, the EHR ecosystem provide a very rich context of study. Three areas of research are related to our work: Introduction of IT in healthcare practice and corresponding evaluation of effects in quality, work

practice, patient safety [1]; Sociotechnical aspects of Information Systems [2]; Software and user interface design [3]. Surprisingly little research has focussed on methods for improving design or maintenance of existing systems. It is perhaps revealing that the term “e-iatrogenesis” [4] has been coined to describe adverse effects to the patient because of using clinical software. However, as a means to control and record quality, all specialist healthcare in Norway have implemented systems for recording, reporting and tracking issues related to adverse events [5]. *This paper proposes to take a next evolutionary step: From awareness and systematic recording of deficiencies, causes and effects, to directed improvement and maintenance of systems critical for patient care, i.e. Reactive Improvement.*

3. Reactive improvement

Reactive improvement is different from incremental, iterative or agile development. ‘Reactive’ implies that the information system is not in (agile) development or in design, it is considered to be fully deployed, fully operational and in use by the customer organization. The improvement may effect system design, function and use.

What kind of events during operation should trigger improvement? We have chosen to disregard IT-related, e-iatrogenic adverse events, as reported in the separate health quality reporting systems mandated in Norwegian specialist healthcare. This study *only* takes into consideration improvement triggers as reported to the IT helpdesk. In order to make this study useful from a patient and clinical perspective, it could be extended by aligning incidents with related, identifiable health adverse events. However, in this study, we have neither had access to clinical data, nor the analytical methods that would allow us to relate helpdesk event to clinical outcome.

Reactive improvement, based on helpdesk reports, relies on insight into both organization and system design in order to isolate root causes, and propose possible remedies. The EHR interconnects user interface components/devices/subsystems - used in organizational processes - by actors with certain patient responsibilities. In general, we have found it convenient to categorize errors along four independent dimensions:

1. Apparent **situation** of discovery/organizational context
2. **Type** of system malfunction or error
3. Apparent system **location**: a function or module
4. **Seriousness or risk** of patient harm

In the incident reports we have used for this paper, all these dimensions appear. Some, eg. 4, are reported as criticality, while others, eg. 1, must be deducted from the incident report. See incident report sample in section 5. The following sections describe an analysis method, review findings and explain how the data can be applied for ranking and specifying reactive system improvement.

4. Data analysis method

We did only have access to textual data and a purpose to extract knowledge, or more precisely, causes for problems with clinical software. Since this is a quite common data analysis problem, many analysis methods are available. We have chosen “Five Whys” due to its simplicity. The method was first described by T. Ohno [6] and is an important part of Toyota’s production improvement process. Our approach follows

Bulsuk [7]. “Five Whys” has been given little research attention, but there exist a large number of blogs reporting practical experiences. Several papers related to health care quality refer to the use of “Five Whys” [8, 9]. The main idea of “Five Whys” is simple – identify the problem, ask experts why the problem did occur and keep on asking “why” five times. The process is as follows:

1. Identify the problem – what are we trying to achieve. Spend some time here. It is important to focus on the root cause and not the symptom.
2. “Why did this happen?” Identify all the causes you can think of.
3. For each of the causes identified in step 2 ask “Why did this happen?”
4. Repeat steps 2 and 3 five times. By this stage, we should have identified all relevant root causes.
5. Identify solutions and countermeasures to the causes identified in steps 2 and 3

The method will run into difficulties if the experts disagree. However, having more than one answer to a why-questions is not a problem. There are two ways to resolve such situations: Either (1) choose one of the alternatives and document why it was chosen or (2) build a tree-structure and select the best alternative later. We can also reason that all remaining root causes eventually will be tackled. Following the five steps described above, the whole process can be documented using a table. When we have reached the last step in the table, we need to suggest actions that will remove or reduce the problem. Without this last step, the whole process is a waste of time.

Subjectivity is the main problem both with “Five Whys” and all other methods of analysis where people try to identify causes. This holds for methods such as Ishikawa diagram – also known as Fishbone diagrams, Fault Trees and Cause – Consequence diagrams.

5. The data used

The data used in this paper are collected from a helpdesk system used by Sykehuspartner – the IT service provider owned by the South East Norway Health Regional Authority. All system users in government hospitals of the trust report errors related to clinical ICT to Sykehuspartner, who is responsible for finding causes and solving the problems within an agreed period of time. At the helpdesk, reports are categorized along two dimensions¹, according to criticality (1: threat of life, 2: major/lasting service impact, 3: temporal service impact) and scope/quality (A: Whole wards, sections, patient groups, major loss of efficacy or work effort, B: Smaller groups, C: Individual, but workarounds possible, D: substandard service quality).

This study gathered more than 13000 reports with criticality 1B (i.e. errors that affect a small group of users and that might lead to a situation threatening patient life or being critical to hospital operation) related to different clinical applications, for the period from January 2013 to July 2014. Manual inspection of 13000 reports was not possible, so we narrowed the scope to analysis of 1618 reports related to the EHR. The specific EHR system has wide national coverage, so was of particular interest. Incidents originate from nine hospitals in the South-East Health Region. Incidents can have many immediate reasons: system down; malfunction under operation; user error; intra-system communication; data loss; data input failure; retrieval failure etc.

¹ With different responses. Very simplified for the purpose of this presentation

We did a grouping based on the similarity in manifestation of the incidents reported. This was done to avoid redundancy and gain insight into the problem. A representative sample of 26 incidents from each group have been selected and analysed by using the five whys analysis method. A sample incident report from the logging system and the corresponding Five Whys analysis is shown underneath:

Hospital: YY
Title: Scheduled contact did not appear in the record window
Description: Scheduled contact does not appear in the medical record registration window. Clinicians cannot register contact diagnosis. This happens intermittently and the clinicians want to know why it happens and how it can be avoided.
Solution: Contacted Dr XX by phone and informed that the clinicians must select/tick the current patient so that the scheduled contact will be visible in the registration window.

Table 2: Example of “Five Whys” analysis

Step	Reason	Why?
1	Clinicians couldn't register diagnosis	Why couldn't clinicians register?
2	Scheduled contact (window) did not appear	Why didn't scheduled contact appear?
3	The clinicians didn't tick the current patient	Why didn't the clinicians tick?
4	The clinicians did not know that ticking was required for registering diagnosis	Why didn't the clinicians know?
5	(New) clinicians didn't get detailed training	Why didn't clinicians get training??
Root cause	<i>This registration module is not part of the training program for new clinicians.</i>	

6. Results

In order to classify our resulting problems into categories, we applied the following algorithm:

1. Go through all the root causes and look for frequently used terms
2. Join terms that have the same or close meanings.
3. Repeat step 2 as long as we find categories that may be merged.
4. Select a unifying term for each class

Applying this process to the 26 selected incidents gave the six failure categories shown in table 3 below. Other category sets could have been used but as far as we can see, this would not change the main conclusions.

Table 3: Problem categories

Problem category	Failures	Relative volume
Wrong manual procedures	9	35%
Configuration problems	6	23%
Lack of resources, e.g., for training	5	19%
Deficiencies in (use of) the system monitoring services and brokers	3	11%
Unknown cause	2	7%
Long delays in a specific external register	1	5%
Sum	26	100%

We see that the main problem categories are not technical, but related to human users (both clinical and IT) and their organizations. Wrong manual procedures, configuration problems and lack of resources for training and monitoring.

7. Conclusions and implications

One broad conclusion that can be drawn based on our results is that Norwegian specialist healthcare may be unprepared for the challenges of continuous implementation of new information technology. Two categories of reasons stand out:

1. Too few resources are allocated for training the users and for using and responding to issues related to the service control/monitoring system.
2. Manual procedures are not well tested and validated.

Both of these problems are solvable, but require that the hospital administration understand them and give them priority. An additional challenge is that inferior log data quality makes many reported incidents impossible to analyse. The hospitals and their staff waste important improvement opportunities. In our opinion, the incident data quality will improve when the persons involved see that it is used for something important – namely to improve their systems and the service that they provide. On a higher level, in order to improve the quality of service offered to users and patients, it is necessary, but challenging, to analyse the relationship between EHR incidents and health outcomes. EHR malfunction does impact outcome [11], sometimes by improving quality at the cost of lowering efficiency. Our perspective on reactive improvement hunts the “why” of causality in the IT system. Hunting “whys” in the clinical work process is beyond our methods, but should nevertheless have high priority.

Both hospitals and software development companies should look at all problems and failure reports as an opportunity to improve their processes. This requires good reporting, an open communication and the necessary resources. All problems should be analysed using e.g. “Five Whys” and the identified root causes should be understood, resolved or at least remedied so as not increase patient risk.

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