Process Mining in Healthcare: A Contribution to Change the Culture of Blame

Silvana Quaglini

Department of Computers and System Science, University of Pavia,
Via Ferrata 1, 27100 Pavia, Italy
silvana.quaglini@unipv.it

Abstract. Statistics on medical errors and their consequences has astonished, during last years, both healthcare professionals and ordinary people. This work illustrates the possible error causes and, for some of them, it suggests solutions based on information and communication technology. In particular, process mining techniques are proposed as a mean to discover not only individuals' error, but also chains of responsibilities. Both supervised and unsupervised process mining will be addressed. The former compares real processes with a known process model (e.g. a clinical practice guideline), while the latter mines processes from rough data, without imposing any model. Potentiality of these techniques is illustrated by means of examples from stroke patient management.

Keywords: Process mining, clinical practice guidelines, stroke, medical errors.

1 Introduction

Something is changing in the medical culture. Historically, medical errors have been a kind of "professional secret", something to hide for preserving the institution's image and the individual's credibility. During the last years, however, healthcare organisations are changing their view, probably for two concomitant causes: on one hand, people is more and more *informed* due to the explosion of communication means (mainly the internet), so that it becomes difficult to hide errors, or to confine the story to a limited environment; on the other hand, healthcare organisations understood that reducing errors is *convenient*, not only for the population's health, but also for reducing healthcare costs, so improving efficiency. Thus, while both scientific literature and mass media are more and more sensitive to the problem [1], "risk management" is becoming a must in every healthcare organisation.

We are still far from a definite solution because, as stated within an interesting discussion in the literauture [2,3], "changing the culture of blame requires a revolution". Nevertheless, as medical informatics researchers, we can foster this process, and this work shows how Information and Communication Technology (ICT) may be applied to risk management. In order to tackle the problem and propose methodologies and technologies for reducing medical errors, we must go from the level of statistics and generic complaint to the individual level, to understand how and why errors happen. This is not for blaming an individual, but for reconstructing the pattern of actions that led up to the error. Opposite to the first impression, often this

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procedure relieves the individual, by discovering a chain of responsibilities. In the next sections, nature of medical errors is discussed, and some solutions are proposed.

2 Medical Errors and Need for Documentation

Everybody is concerned with medical errors. Patients are more and more informed and ask for medical excellence; healthcare personnel is more and more worried about increasing complaints; healthcare administrators are worried about waste of resources and increasing insurance fees. Insurances themselves have started modulating their fees according to the error prevention actions of their clients. This means that safety-oriented process re-engineering is becoming a must in healthcare organisations.

In order to propose ICT-based solutions, it is necessary to understand the nature and the cause of errors, and to clarify what the word "error" means. There are events that everybody should define "errors", e.g.: administering a wrong drug, confounded by similar drug boxes; wrong interpretation of bad-calligraphy prescription; misunderstanding a diagnostic test. These errors are caused by distraction, mental fatigue, ignorance, superficiality, and they are (often) easily recognised because they cause a specific adverse event. But there is a more subtle definition of *error*, referring to non-compliances with guidelines (GL) and protocols: can they be considered as errors? Of course every patient is a specific case, and some need to be treated as an exception with respect to a GL. However, there can be scientific studies [4] showing that GL compliance improves the outcome. If so, even if it is not straightforward that a non-compliance is an error, it should be worth to pretend a reason for it. In this way, documentation becomes both a justification and a basis for further statistics: outcomes (health, economic, etc.) must be monitored and correlated to processes, in order to show, by means of objective measures, that some processes are better than others. These statistics, that must be collected continuously, as part of the clinical routine, are also useful to understand “where” to concentrate error prevention efforts: if transcription errors are a problem, this will foster adoption of electronic clinical charts; if failure to perform a clinical task is common, this will foster adoption of GLs and protocols, and so on. All these activities require adequate technology.

3 Discovering What Is Wrong in a Process

There are different ways of collecting information on medical errors. The most common lies on voluntary provided information: questionnaires are administered to physicians and nurses in anonymous form to elicitate their “feeling of risk”. We think that more objective measures are necessary and they can be obtained by analyzing real processes. The term “process mining” refers to a set of techniques able to infer process models from rough data, namely the “event logs” [5], which may originate from running systems, such as electronic clinical chart, decision support systems, etc. recording sequential actions. It is useful to distinguish between supervised and process mining, depending on the knowledge underlying processes. In fact, that are processes that are (should be) driven by clinical practice GLs and/or protocols, where knowledge about “what to do” is explicit. Here, practice can be compared with theory and we can reason about compliance/non-compliance. Other processes are instead driven by “tradition”, medical school, consolidated routine, etc. Here, knowledge about “what to do” is tacit and the process cannot be compared with a gold standard.

3.1 Supervised Process Mining

As an example, the system implemented at the Stroke Unit of the Mondino Hospital in Pavia is described. It is a Careflow management system (CfMS), based on recommendations of the Italian stroke management GL. It manages the execution of the care process for each patient, verifying the GL rules, generating specific recommendations, and communicating recommendations to the opportune role (physician, nurse, etc). One important ancillary tool is RoMA (Reasoning on Medical Actions), triggered by the patient’s discharge. It analyses the care process of a patient, discovering non-compliance with GL. In practice, it matches the patient’s data with the formal GL rules. The physician may insert the motivation for non-compliance, choosing from a taxonomy. This allows creating a “community of practice”: once non-compliances have been labelled according to the taxonomy, reports are produced and sent to persons, hopefully able to tackle the problem: a recurrent “out of work” of an instrument will be notified to the clinical engineer; frequently missed data will be notified to the EDP department; frequent errors could call for an educational initiative from the hospital direction, an so on. More interesting, frequent disagreement on a recommendation is communicated to the scientific board that is maintaining the GL, for the further GL revisions: probably that recommendation is not suitable for the specific site, or there is evidence that makes the recommendation obsolete.

3.2 Unsupervised Process Mining

Process mining algorithms allow do discover several aspects of a workflow from event logs, capturing patients and physicians’ behavior previously unknown. It is possible to learn social networks, individuate bottlenecks and pitfalls, create Petri nets for simulation purposes, and reconstruct process flow. We use ProM [6], a tool developed at the TU Eindhoven University, to mine from data collected during a study on stroke management in four Italian hospitals.

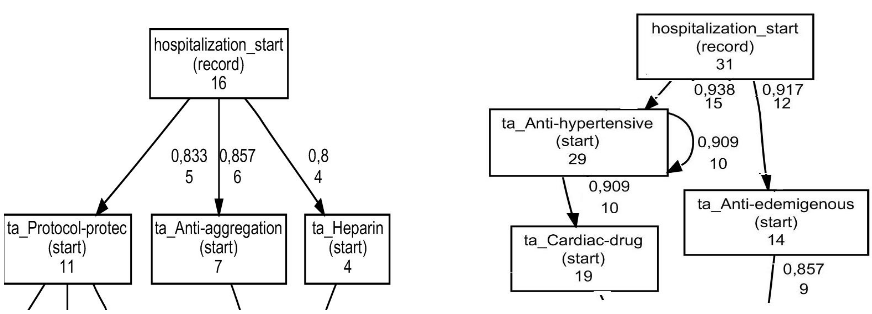

Fig. 1. Different stroke management processes mined for two hospitals. Numbers on the arcs represent the strength of the link found between two actions.

As an example of the results obtained, Figure 1 shows the first part (the first actions after the patients' admission) of the processes mined for two different Italian hospitals. It is very clear that the two hospitals adopt different strategies: on the left, immediately after the admission, specific treatments for stroke are administered, while, on the right, physicians prefer to start with treatment of stroke complications rather than stroke causes (that will be treated later, not shown in the figure). Different "schools" have been discovered, that underlie the treatment of similar patients. Of course, different processes could lead to different outcomes, and comparisons may be produced to the medical community for further reasoning.

4 Conclusion

Medical informatics community must promote careflow and process mining techniques, showing their potential to manage the clinical risk: this will foster healthcare administrators to adopt them and physicians to use them. Still remain some obstacles to the full exploitation of such techniques: one big problem is to manage interconnected healthcare systems (e.g. emergency room, acute ward, rehabilitation units), because this requires an agreement among different institutions, often difficult to be achieved.

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