

Methodology for Health Care Process Modelling:

Bringing the Health Care Complexity into Health IT System Development

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Abstract

Health Information Technology is recognized as a solution to manage health care and improve the quality of care. However, health IT has only proven its full potential and benefits in specific fields. The aim of this paper is to propose a methodology to comprehensively model health care processes in order to define health IT system requirements. The proposed methodology was successfully implemented in a University Hospital in Norway. By applying the suggested three-stage methodology, it was possible to identify the cause for elective surgery cancellations at this hospital. Additionally, the preoperative planning process was modelled, and its complexity described. Based on the conducted work, it is concluded that the design of health IT systems should not be done by computer scientist alone. An interdisciplinary team is required to tackle the idiosyncrasies of care processes.

Keywords:

Methodology, Interdisciplinary Studies, Health Information Systems, Workflow, Physicians, Nurses, Secretaries

Introduction

Surgical departments are simultaneously the major source of investment, and the greatest source of revenue for most hospitals [1, 2]. However, the cancellation rate of elective surgeries is high, especially in the public sector [3, 4]. It is reported that between 10 and 40 % of elective surgeries are cancelled [1, 5-7]. Surgery cancellations increase costs, reduce productivity and efficiency, increase waiting lists, and directly affect the patients [5, 8, 9].

In order to reduce cancellations of elective surgeries, hospital managers make a considerable investment on operating theatres and on having surgeons and theatre staff available on the agreed schedule [1, 10]. At the department level, health care workers make huge efforts in planning and scheduling surgeries to allocate the necessary resources. However, studies show that up to 20 % of elective surgeries are cancelled on the day of surgery [9, 11, 12]. Furthermore, it has been shown that 50 % of these cancellations might be avoided [1, 3, 13].

Health Information Technology (IT) is recognized as a solution to manage health care and improve the quality of care. In the national strategy plan for electronic collaboration in health and care services, the Norwegian Ministry of Health and Care Services identified IT as a cornerstone to improve the quality of health care [14]. However, health IT has only proven its full potential and benefits in specific fields [15-19]. A contributing factor for the slow diffusion of health IT may be found on its

focus on improving individual tasks, rather than supporting value added care processes. In this paper it is argued that this is replicating the individualistic work patterns inherent to paper based care processes, as observed in the case study.

Health IT orientation to individual tasks reflects the focus of health care itself. The majority of clinical departments behaves as discrete and independent sets of physicians, nurses, and other health personnel instead of a single team. [20]. Partly due to the autonomy of most clinical departments, few health care processes have been modelled comprehensively enough to provide a basis for specifying system requirements to health IT designers. Alternatively, health IT system developers have focused on supporting the work of individual care team members by taking existing paper-based tools, as their models. The result is that most health IT does little to support care teams [21].

The causes for elective surgery cancellation are classified in two major categories, according to who took the underlying decision to cancel [22]: (a) hospital, and (b) patient related reasons. Hospital related reasons can be further divided in planning and medical causes. At our site of research, the University Hospital of North Norway (UNN), the causes for elective surgery cancellations are mainly related to the hospital category, as demonstrated in Figure 1, in the results section. The hospital has reported that more than 50 % of all cancellations at UNN are related to inadequate pre-operative planning [23]. However, the planning tool on the surgical module in the EHR system has been recognized as an unused resource by FIKS (from the Norwegian *Felles innføring kliniske systemer*, translating as *Common Introduction of Clinical Systems*; a project initiated by the Northern Norway Regional Health Authority (Helse-Nord), who invested € 62.5 million to develop the electronic health record for the future) [24]. The same conclusion was also drawn by the Lean Project which was initiated by the management at UNN as an internal project to reduce the cancellations rate. For further reference on the Lean process refer to [22].

In this paper, the elective surgery cancellation problem, in a University Hospital in Norway, is addressed. Foremost, the reasons for cancellations at UNN were explored. The workflow was observed and modelled at different departments. Based on the modelling results one department was chosen for an in-depth study. In-depth and semi-structured interviews with different health care workers involved in the process were conducted. The preoperative process was modelled taking into consideration the perspectives from the physicians, nurses and secretaries involved in the preoperative planning process.

The aim of the work presented herein, is to propose a method on how to comprehensively model care processes to establish a basis to health IT requirements. It is argued the necessity of

health IT designers to understand the complexity of care processes, and their dynamic relation with the environment in which it is accomplished. Given the idiosyncrasy of care processes, it is recognized that this cannot be a solo work, an interdisciplinary team is required.

This paper is divided in four sections. In the first section, the approached problem is introduced, and the case study is described. Data collection methodologies, with which the results were obtained, are presented and explained in the second section. The results are disclosed and interpreted in sections three and four. In the last section conclusions about the results are drawn, and some indicators of future work in the area foreseen.

Materials and Methods

The data presented in this paper was collected based on a three stages methodology, as follows:

- Stage 1 - Analyses of historical data on the number of cancellations and the reported reason, provided by the Lean project at the hospital;
- Stage 2 - Fieldwork, including observation and interviews with health care workers at the hospital;
- Stage 3 - In-depth interviews with health care workers at a specific department.

In Stage 1, the number of cancellations and their reported reason by department, shown in Table 1, indicated that there is a great discrepancy in the number of cancellations between different departments. However, the data did not evidence a clear pattern for cancellations within the different departments. Thus, the need to obtain further knowledge on the preoperative planning workflow at each department was identified.

In order to obtain this knowledge, three weeks of fieldwork at the Surgery and Intensive care clinic was carried out as Stage 2, conducting observations and unstructured interviews while following an anaesthesiologist and an anaesthetist nurse – which provide care services at all surgical departments – in their daily work. In addition, thirteen structured interviews with physicians, nurses and administrative personnel were conducted.

Based on the fieldwork, the preoperative planning workflow was modelled at the different departments. From the initial results it was concluded that the discrepancy in the number of cancellations are related to the heterogeneity of work patterns observed. It also raised the hypothesis that the variations in the number of cancellations may not be related to structural, or organizational, differences at the department level. It may rather be related to the fact that, in order to complete the daily schedule, health care workers need to use empirical and personal knowledge. To be able to get an in-depth understanding, on what are the real needs of health care workers in the preoperative planning process, the fieldwork observations were narrowed to a single department in Stage 3.

During the observations, and the interviews, two departments at the hospital were described to be more efficient. However, the departments still evidenced a representative number of cancellations. From these, one department was chosen to proceed with the in-depth study. The choice was based on the need to gather knowledge about the preoperative planning process and reduce local, contextual and department specific complexity, without losing the general challenges in the process. The chosen department is not revealed due to ethical reasons.

In Stage 3, physicians, nurses and secretaries, at the chosen department, were interviewed. The interviews were semi structured, done at the workplace and lasted between one to two hours.

Results

In this section, the results from each stage of the methodology proposed in the Materials and Methods section are reported. In Stage 1, the historical data on the number and causes for elective surgery cancellations (Table 1), was analysed. From the analysis it is evident that the decisions to cancel elective surgeries are mainly taken based on reasons related to the hospital, as shown in Figure 1.

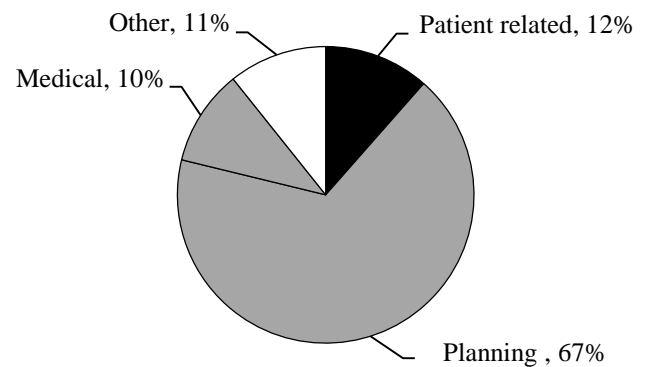


Figure 1- Fractional number distribution of the reasons for day of surgery cancellation at UNN.

■ Patient related reasons ■ Hospital related reasons.

The historical data also indicated that there is a great discrepancy in the number of cancellations between different departments, as shown in Figure 2. The results obtained from the analysis of the historical data were used to define the requirements for Stage 2.

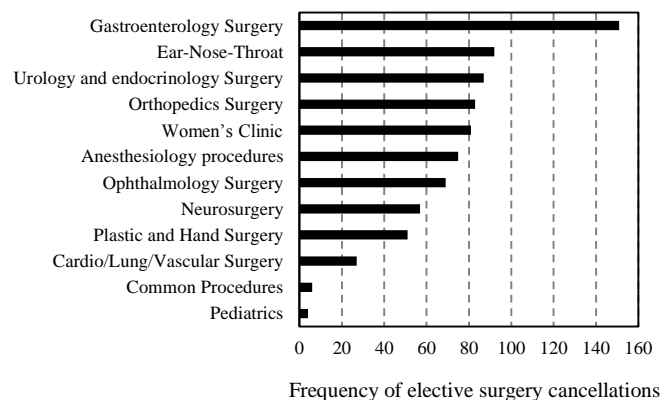


Figure 2 – Number of elective surgery cancellations by department.

In Stage 2, the preoperative planning workflow at the different departments was investigated and modelled. The workflow models revealed heterogeneous work patterns. The sequence of the activities required to complete the preoperative planning process was not consistent among the different departments. Furthermore, the preoperative planning process for different patients had different professionals executing the same activity. Additionally, the professional responsible for the activity varied. Based on these results, as well as the empirical nature of the daily running at the departments, it was recognized the need to narrow the fieldwork to a single department. The focus on a single department should facilitate the identification of the real needs of health care workers in the preoperative planning process, in Stage 3.

Table 1 - Number of cancellations and their reported reason by department.

Reason for cancellation Department	Other acute medical condition	Lack of capacity - Anesthesia nurse	Lack of capacity - Anesthesiologist	Lack of capacity - Surgeon	Lack of capacity - Surgery nurse	Lack of capacity - Intensive care	Lack of capacity - Recovery	Lack of capacity - Ward beds	Missing equipment	Insufficient surgery indications	Overbooking	Patient no-show	Incomplete study	Patient will	Emergency surgery	Higher duration of previous surgeries	Unknown/Other	Total
	Anesthesiology procedures	4								2	22	3	21	2	4	1		16
Gastroenterology Surgery	10	3		2	22				2	16	34	10	6	1	11	28	6	151
Cardio/Lung/Vascular Surgery	3	2			2		1			3			3	2	7	3	1	27
Urology and endocrinology Surgery	8	5			8				3	13	19	4	8	1	4	7	7	87
Pediatrics	1									1		1	1					4
Felles koder	2									3		1						6
Women's Clinic	5	4		1	19					7	13	4	3	3	4	12	6	81
Neurosurgery	2	6		1	7	1	2			4	3		1	1	12	10	7	57
Orthopedics Surgery	14	1		4	18		2	5	1	10	1	7	2	3	4	3	8	83
Plastic and Hand Surgery	1	5		5	9		1		1	6		1	2	2	5	7	6	51
Ear-Nose-Throat	20	3	1	1	10				2	15		7	5	3	2	13	10	92
Ophthalmology Surgery	12	1	1	1	1				1	16	1	8	2	6	2		17	69
Total	82	30	2	15	96	1	6	5	12	116	74	64	35	26	52	83	84	783

In Stage 3, the interviews with physicians, nurses and secretaries showed that the diversity of work patterns is also evident on the professional group level. An example of such heterogeneity is evident right in the beginning of the process, when the surgery referral is received by the hospital. The physicians have a holistic overview of this part of the process. The administrative activities on how the referral is handled, and the patients' pathway prior to surgery are not always clear to physicians. Nurses are more focused on practical activities and the daily running of the department. This part of the process is not of their responsibility, hence, they are not aware of the details on how referrals are processed. Secretaries work patterns evidenced a clear focus on avoiding elective surgery cancellations. They perform most of the operational planning work. Being the only professional group transversal to the preoperative planning process, they make a huge effort to make the patient move forward in the process and avoid cancellations. This might also be explained by the fact that they are the first line of communication with the patient.

It is our understanding that, in the preoperative planning process, the professionals that reveal more engagement in avoiding cancellations are nurses and secretaries. However, the information required for the patient to proceed in the process is generated by the physicians. In the next section, will be discussed on how this in-depth knowledge of the process is of great importance when defining the requirements for health IT system design.

Discussion

The preoperative planning is a complicated process that takes place in a dynamic environment, where numerous pieces of information are generated in multiple sources, shared by providers, and reviewed by various health care workers. The heterogeneity of work patterns influences the IT systems' usefulness in healthcare. This is exemplified by the low usage of the existing planning tool on the surgical module at the hospital, as communicated in the Introduction section. This was underlined, by a nurse, during one of the conducted interviews: *"I prefer the system on paper. The information is too dispersed and it takes too long to track it, and it is more difficult to take notes."*

An IT system should, in principle, only support one care process at a time. It is not efficient or functional to have different versions of an IT system for different departments, and surely not for different individuals. To define the requirements for health IT systems, IT system designers need to work with a standard process. The problem must be object of a thorough analysis to identify its real cause. The holistic overview that is supporting health IT system design until now is not always sufficient to reveal underlying causes of the problem. Moreover, there might exist more than one cause to the problem. Stage 1 of the proposed methodology allows the characterization of the problem and its causes according to their nature, and relate it to the structure of the organization.

To be able to define the requirements for health IT systems, designers need to be fully acquainted with: the purpose of the care process; the activities required to accomplish the process; who performs the activities; and who is responsible for them. This was the aim of Stage 2. Not all these objectives were accomplished during the fieldwork. However, from a methodological perspective this stage should not be eliminated as it revealed the complexity and the multiplicity of care processes at the department level.

The knowledge gathered during Stage 2 was not sufficient to answer the questions required for IT system development. Therefore, the study was extended through Stage 3 where in-

depth knowledge on the care process was acquired. In this stage the required resources for each activity, and who is responsible for the activity, were identified. However, it was evident that the different professionals that are involved in preoperative planning have distinct views of the process.

The three stages methodology enabled the modelling of the complexity and multiplicity in the health care process. This was only possible since the fieldwork, and the analysis of the care processes, was done by an interdisciplinary team, composed of a computer scientist, a social scientist and health care workers.

Conclusion

The implementation of the proposed three-stage methodology permitted the modelling of the preoperative planning process, and to describe its complexity. Furthermore, the proposed methodology made it possible to identify the cause for elective surgery cancellations at UNN. This will facilitate the development of a standard preoperative planning process, as future work. Processes that are re-engineered having a full understanding of: what they are meant to do; how resources act on it, e.g. their responsibilities and competences; how information is generated and required; and how they interact with other processes, provide the necessary knowledge for health IT to reduce inefficiencies and manage complexity.

Process re-engineering may require new activities and reorganization of the existing activities. This is a sensitive job that has impact on the whole organization. It is concluded that the design of health IT systems should not be a solo work done by software engineers or technical personnel. It is necessary to engage with the health care sector as an empirical field, and an interdisciplinary team is required to tackle the idiosyncrasies of health care processes.

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References

- [1] Schofield WN, Rubin GL, Piza M, Lai YY, Sindhusake D, Fearnside MR, *et al.* Cancellation of operations on the day of intended surgery at a major Australian referral hospital. *Medical Journal of Australia*, 2005: 182: 612-15.
- [2] Denton B, Viapiano J, and Vogl A. Optimization of surgery sequencing and scheduling decisions under uncertainty. *Health Care Manag Sci*, 2007: 10: 13-24.
- [3] Trentman TL, Mueller JT, Fassett SL, Dormer CL, and Weinmeister KP. Day of surgery cancellations in a tertiary care hospital: A one year review. *Journal of Anesthesia & Clinical Research*, 2010: 1:
- [4] Ferschl MB, Tung A, Sweitzer B, Huo D, and Glick DB. Preoperative clinic visits reduce operating room cancellations and delays. *Anesthesiology*, 2005: 103: 855-9.
- [5] Audit Commission for Local Authorities the National Health Service in England Wales, "Operating theatres: Review of national findings," London, 2003.
- [6] Lacqua MJ and Evans JT. Canceled elective surgery: An evaluation. *American Surgeon*, 1994: 60: 809-11.

- [7] Ivarsson B, Kimblad PO, Sjöberg T, and Larsson S. Patient reactions to cancelled or postponed heart operations. *J Nurs Manag*, 2002; 10: 75-81.
- [8] Cima RR, Brown MJ, Hebl JR, Moore R, Rogers JC, Kollengode A, *et al.* Use of lean and six sigma methodology to improve operating room efficiency in a high-volume tertiary-care academic medical center. *Journal of the American College of Surgeons*, 2011; 213: 83-92.
- [9] Yoon SZ, Lees SI, Lee HW, Lim HJ, Yoon SM, and Chang SH, *The effect of increasing operating room capacity on day-of-surgery cancellation* vol. 37. Edgecliff, AUSTRALIE: Anaesthesia Society of Anaesthetists, 2009.
- [10] Haana V, Sethuraman K, Stephens L, Rosen H, and Meara JG. Case cancellations on the day of surgery: An investigation in an australian paediatric hospital. *ANZ Journal of Surgery*, 2009; 79: 636-40.
- [11] Aaserud M, Trommald M, and J. B. Elektiv kirurgi - strykninger, skjerming og effektivitet. *Tidsskr Nor Lægeforen* 2001; 21: 2516-19.
- [12] González-Arévalo A, Gómez-Arnau JI, DelaCruz FJ, Marzal JM, Ramírez S, Corral EM, *et al.* Causes for cancellation of elective surgical procedures in a spanish general hospital. *Anaesthesia*, 2009; 64: 487-93.
- [13] Sanjay P, Dodds A, Miller E, Arumugam PJ, and Woodward A. Cancelled elective operations: An observational study from a district general hospital. *J Health Organ Manag*, 2007; 21: 54-8.
- [14] Helsedirektoratet, "Samspill 2.0 - nasjonal strategi for elektronisk samhandling i helse- og omsorgssektoren 2008 – 2013 (in norwegian)," ed. Oslo: Helse- og omsorgsdepartementet, 2008.
- [15] Simborg DW. Promoting electronic health record adoption. Is it the correct focus? *J Am Med Inform Assoc*, 2008; 15: 127-9.
- [16] DesRoches CM, Campbell EG, Rao SR, Donelan K, Ferris TG, Jha A, *et al.* Electronic health records in ambulatory care--a national survey of physicians. *N Engl J Med*, 2008; 359: 50-60.
- [17] Furukawa MF, Raghu TS, Spaulding TJ, and Vinze A. Adoption of health information technology for medication safety in u.S. Hospitals, 2006. *Health Aff (Millwood)*, 2008; 27: 865-75.
- [18] Pedersen CA and Gumpfer KF. Ashp national survey on informatics: Assessment of the adoption and use of pharmacy informatics in u.S. Hospitals--2007. *Am J Health Syst Pharm*, 2008; 65: 2244-64.
- [19] Jha AK, DesRoches CM, Campbell EG, Donelan K, Rao SR, Ferris TG, *et al.* Use of electronic health records in u.S. Hospitals. *N Engl J Med*, 2009; 360: 1628-38.
- [20] Knox GE and Simpson KR. Teamwork: The fundamental building block of high-reliability organizations and patient safety. *Patient safety handbook*, 2004: 379-414.
- [21] Poggio FL. End-to-end medication management. A game of 20 questions can show whether your hospital is ready for the project. *Healthc Inform*, 2004; 21: 30-1.
- [22] Granja C, Dyb K, Bolle SR, and Hartvingsen G, "Reduced elective surgery cancellations through patient involvement in pre-operative planning in norway," in *eTELEMED 2014, The Sixth International Conference on eHealth, Telemedicine, and Social Medicine*, 2014, pp. 164-69.
- [23] Busund R, "Rapport fra prosjekt: Optimal ressursutnyttelse av operasjonskapasiteten i unn," Norway, 2008.
- [24] Helse-Nord. (2012, 4 November 2013). *Dette er de nye systemene*. Available: <http://www.helse-nord.no/helse-nord-nytt/dette-er-de-nye-systemene-article90645-1526.html>

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