Surgical disruption: Information quality perspective

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Abstract. This paper emphasises that most surgical errors can be prevented or intercepted by reducing preventable disruptions inside the operating rooms. It uses information quality concepts and identifies information elements cause disruptions. The paper report initial results from 27 observed surgeries conducted in operating rooms of two Australian hospitals. This research employs an 'object-centred' strategy in which the object is the surgeon conducting the surgery and records the time during which a surgeon has to wait unnecessarily is recorded. The research indicates that disruptions may force surgeons to unnecessary wait more than 19% of the surgical time. However, the paper stresses that the results from the limited number of observations may not provides comprehensive list of disruptions.

Keywords: Disruption, information quality, governance information, surgery.

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1. Introduction

Literature shows a strong relationship between disruptions within operating rooms and medical surgical errors (Wiegmann, et al. 2007). Reducing disruption improves patient flow and reduces possible medical errors. The literature stresses that most disruptions within operating rooms are not the result of controllable variables within the system, process and conditions (Reason, 2001; Etchells 2003; Khon et al. 2000; Wiegmann, et al. 2007). Disruption resulting from controllable variables is referred to as 'preventive disruption'. Faulty systems, processes and conditions are sources of disruption. It follows that most surgical errors can be prevented or intercepted by reducing preventable disruptions inside the operating rooms.

This research deals with preventable disruption within the operating rooms. It employs the concepts of information quality (IQ) and applies the approach developed by Al-Hakim (2008) for mapping information flow and identifying information elements that govern activities within a process. Twenty-seven surgeries conducted within operating rooms of two hospitals were observed. Disruptions within the observed surgeries were recorded and discussed with the relevant surgeons. This research provides some insight into observed disruptions within the operating rooms and highlights the importance of considering the dimensions of information quality in dealing with information elements that cause disruptions. The paper is a research-in-progress work. It provides initial results for a larger study dealing with the disruption in operating rooms. It is important to note also that the number of observed surgeries recorded in this study is limited and does not necessarily reflect the actual situation or provides comprehensive list of disruptions.

The next section of this paper provides a brief summary of literature related to disruptions within operating theatre. Two concepts of IQ are then discussed; the elements of governance information and dimensions of IQ. The paper outlines the research methodology used to record disruptions in operating rooms of two Australian hospitals. The paper presents some statistical results and provides some insight relating to the role of IQ dimensions and elements of information flow on surgical disruption.

2. Literature review

In a surgical setting, disruption is any action or event that alters the planned surgical flow and forces surgeons to either wait or perform surgery inefficiently. Disruptions prolong surgery session time, increase costs (Couch 1981) and cause delay. We define delay as any action which prevents the planned flow of a patient to the operating rooms. Wiegmann, et al. (2007) conclude that lack of mental readiness and inability to maintain focus, are rated by surgeons as the most important factors causing errors and affecting surgery outcomes. Disruptions may comprise minor events. The accumulation of these events, however, creates stress and fatigue and, as a result, predisposes the surgical team to errors (Reason, 2001; Etchells 2003). An error is the failure of a planned action to be completed as intended (error of execution) or the use of a wrong plan to achieve an aim (error of planning) (Reason 1990; Khon et al. 2000; Etchells et al. 2003). However, Sexton et al. (2000) conclude that error is difficult to discuss in medicine and that medical staff are more likely to deny the effects of stress and fatigue. Some medical errors could lead to adverse events. An adverse event is defined as an injury caused by medical management rather than the underlying condition of the patient (McFadden et al. 2006). An adverse event attributable to error is a preventable adverse event (Kohn et al. 2000).

The time surgeons have to wait reduces quality of performance (Wiegmann et al. 2007). In addition, disruption to surgical flow for one patient delays the next surgery and forces the next patient to wait. The time patients have to wait directly affects patient satisfaction and forms a measure of healthcare service quality (Eitel et al. 2007). Several studies have focused on reducing surgeon's waiting time by reducing disruption during turnaround (turnover) times (Adams et al. 2004). Other studies attempt the same goal by reducing disruption during nonoperative time. Turnover time is the time from departure of the previous patient from an operating room to the entrance of the next patient into the operating rooms. Nonoperative time is the time between when surgical activity ends and the next patient is ready for surgical prep. It includes turnover time, plus anaesthesia induction and emergency time (post-anaesthesia period). Despite the present study focusing on disruptions in surgical flow as a source of preventable adverse events, there has been no research adequately dealing with interdependencies between disruptions and actions outside operating rooms. This proposal addresses this gap in the literature. In addition, this study goes a step further by considering disruptions during operative time as well as nonoperative time.

3. Information quality concepts

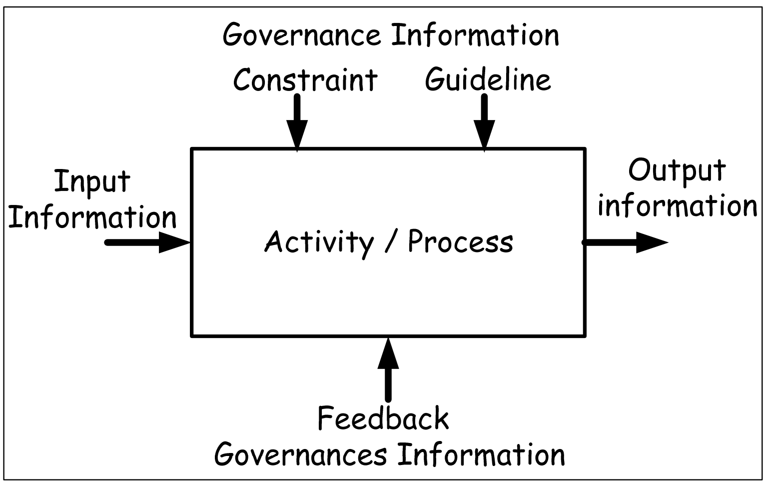
In this section we briefly discuss two related information quality (IQ) concepts; governance information and IQ dimensions.

3.1 Governance information

Lillrank (2003) suggests that the primary problem in healthcare is not the quality of the actual performance of a process, such as surgery, but the quality of information that regulates or constrains the implementation of the process. Al-Hakim (2008) refers to information that governs, regulates or constrains the activities of a process as ‘governance information’. Al-Hakim emphasises that identifying the elements of governance information for surgical activities and their interdependencies is the first step towards improving the quality of information flow within surgical activities and, as a result, reducing disruptions inside operating rooms.

Governance information has three sets of information elements other than input and output. These are ‘guidance’, ‘constraint’ and ‘feedback’. Guidance is made up of the policies, procedures and rules governing the implementation of the activity. The constraint comprises information from prior activities which influences or adjusts the implementation of a current activity or adjusts guidance information. A clinical test which resulted from a previous activity may affect the way in which a subsequent activity is performed. Feedback for an activity comprises information received from a subsequent activity that may require changes in the implementation of the activity. For example, bed availability in the recovery area may affect admission of patients to the operating room. Input information, output information, constraint and feedback represent information created during the implementation of the surgery process while the guidance is information created prior to the start of the process (Al-Hakim). Figure 1 illustrates the five elements of information; input, output, constraint, guidance and feedback.

Figure 1. Elements of information controlling an activity.



Source: Adapted from Al-Hakim (2007, 2008)

Information mapping is a process of tracing the relationships (interdependencies) between information elements governing the process activities. Though the quality of information flow for all elements is crucial for achieving quality healthcare, the constraints and feedback directly related to disruptions inside operating rooms. Improving IQ of constraints and feedback elements are crucial for reducing disruptions and ultimately reducing the preventable medical errors and adverse events. Identifying the related IQ dimensions of is the first step towards improving the quality of information. The next section provides brief description of IQ dimensions.

3.2 Dimensions of information quality

Individuals have different ways of considering the quality of information because they have different wants and needs and, hence, different quality standards which lead to a user-based quality perspective (Evans & Lindsay, 2005). This perspective is based on the Juran definition of quality which defines quality as 'fitness for intended use' (Juran & Godfrey, 1999). Thus, information and data can be regarded as being of high quality if they are fit for their intended use in operations, decision making and planning (Redman, 2004). While this perspective captures the essence of information quality, it is very broad definition and is difficult to use in the measurement of quality (Al-Hakim 2007). Several researchers have attempted to identify the IQ dimensions (Wand and Wang 1996; Wang, Story, and Fifth 1995; Wang and Strong 1996). Table 1 defines the most common IQ dimensions.

Table 1. Definitions of the common IQ dimensions used in literature. (Adapted from several research works).

Dimension	**Definition**
Accessibility	The degree to which information is available, easily obtainable or quickly retrievable when needed. Accessibility depends on the customer's circumstances.
Accuracy	The degree to which information represents the real world state.
Amount of Information	This dimension measures the appropriateness of the volume of information to the user or task at hand
Believability	This dimension measures the user assessment of trueness and credibility of information.
Coherency	This measures how information "hangs together" and provides one meaning to different users.
Compatibility	The level to which information can be combined with other information to form certain knowledge.
Completeness	The degree to which information is sufficient enough to depict every state of the task at hand or the represented system, that is, assesses the degree of missing information.
Conciseness of representation	The compactness of information representation.
Consistency of representation	The degree of similarity and compatibility of formats used to represent information by different systems/users.
Ease of manipulation	The applicability of information to different tasks.
Ease of understanding	The degree of user's comprehension of information.
Free-of-error	The degree to which information is correct. This dimension

	measures the number, percent or ratio of incorrect or unreliable information.
Interpretability	The appropriateness and clarity of information, language and symbols to the user.
Objectivity	This dimension measures the information impartiality including whether information is unbiased and unprejudiced.
Relevancy	Relevancy indicates whether information addresses the customer's needs. It reflects the level of appropriateness of information to the task under consideration.
Reputation	The degree of respect and admiration for both information source and information content.
Security	The level of either restriction on access to information or appropriateness of information back-up - protecting information from disasters.
Timeliness	This dimension measures how up-to-date information is with respect to customer's needs or the task at hand. It reflects also how fast the information system is updated.

4. Research methodology

The study was conducted in two hospitals, one from a rural area and one from a metropolitan area. The research methodology comprises two phases. The first phase introduces the project to hospital executives and arranges meetings with surgeons, anaesthetists and nurses. It also involves acquiring an understanding of the current situation at each hospital including study and analysis of existing processes for managing operating rooms, preparing surgery requirements, pre-operative activities, activities inside operating rooms, and possible disruptions. The second stage involves observations inside operating rooms. This research employs an 'object-centred' strategy in which the object is the surgeon conducting the surgery. The time during which a surgeon has to wait unnecessarily is recorded. This includes avoidable disruption times during operating room setup, anaesthesia inducement or emergency time. A liaison officer assigned by the hospital accompanies the observers. The officer introduces the observers to the surgical team and arranges meetings with surgeons after surgery sessions to comprehend reasons for recorded disruptions and the effect of disruptions on surgery performance and time.

5. Results

Two observers involved in this study; the author and a Master student. A sample of twenty seven surgery operations was observed over a four month period (May-August 2008). All operations were chosen randomly from elective day surgery lists. Surgery time for the observed surgeries ranges from approximately ¾ an hour to almost three hours with total time for all observed surgery operations equals to 37.88 hours and average time for surgery is 1.40 hours (about 84 minutes). The surgery time is the time between when a patient enters the anaesthetic bay of an operating room to the time when the patient is moved out of the room. The following events were not considered - surgery cancellation, patient condition, unanticipated complication in anaesthesia preparation and delays in elective surgery resulting from priority given to emergency cases. The effect of these disruptions on actual surgery performance was not recorded also. It is very important to note that the number of observed surgery operations is limited and the related results may not reflect the actual situation. However, this study provides some insight relating to the role of information flow and information quality on surgical disruption.

Table 2. Disruptions and their percent effect relative to total time for surgery sessions.

No.	Disruption	Occurrence	Effect %
1	Theatre staff not available for patient transport (in/out OR)	23	4.05%
2	Anaehestist unavailable/ not ready	4	0.79%
3	Surgeon unavailable / not ready	2	0.30%
4	Change order of list during surgery session	3	0.35%
5	Wrong consent form	2	0.57%
6	Incomplete consent form	7	0.84%
7	Unavailability (not enough) of required instruments or material	11	1.54%
8	Wrong / unsuitable instruments or material	12	2.95%
9	Unsuitable attachment for patient positioning	5	1.19%
10	Wrong patient positioning	6	1.27%
11	Recovery bed unavailable (preparation)	3	0.58%
12	Awaiting ICU bed (preparation)	1	0.17%
13	Document not readily available	3	0.75%
14	Awaiting pathology results	2	0.62%
15	Radiographer unavailable	3	0.63%
16	X-ray machine unavailable	1	0.39%
17	Patient lost way to pre-operative area	3	0.97
18	Unsuitable trolley to move a patient	2	0.48%
19	Surgeon moves around surgery table	2	0.09%
20	Instruments and material are scattered	19	0.35%
21	Searching for instrument	16	0.57
22	Telephone disruption	39	0.30%
	Total	**169**	**19.75%**

Table 2 shows statistics relating to type, and effect of disruption (in term of percentage relative to total surgical time). A total of 169 disruptions were observed with an effect of about 20% of the total surgery time. It should be noted that though some disruptions such as disruptions numbers 18-21 has relatively low effect on surgeon waiting time but the probability these disruptions cause medical errors and may lead to adverse events is very high. Such disruption should receive significant attention. Meetings were arranged with several surgeons to discuss reasons for disruptions and the main information elements (constraints and feedback) that controlling the disruptions. Discussions with surgeons also clarified the IQ dimensions required to be considered when dealing with quality of information required to reduce disruptions. Constraints and feed back provides better understanding of disruption reasons and make action required more feasible and realistic. Table 3 illustrates type of disruptions, information elements govern disruptions, related IQ dimensions and action required to reduce disruptions. It can be noticed that most recommended actions can be easily performed without significant costs or resources. One may wonder why such actions were not implemented before. The author background on industrial engineering helps establishing links between identified information elements and industrial engineering techniques such as time and motion economy and workstation design. Though literature on operating room techniques emphasises time and motion economy concepts, (see for example Phillips 2004), the high number of observations in which instruments were scattered on the patient's drape, around and sometimes within anatomic area is but one example for the need for training the scrub nurses on work and motion economy techniques.

One may argue that this research provides a simplistic approach to a very complicated issue. However, the research looks to disruption from new, novel perspective and it worth it to consider.

6. Conclusion

Disruption is the main source of preventable medical errors and adverse events. The present study dealt with disruption from IQ perspective. This is part of a comprehensive research program aiming at reduction of disruption and medical errors with the operating rooms in Australian hospitals. Twenty-seven surgeries were observed with 169 disruptions categorised into 22 types. Results demonstrated that disruption caused an increase in surgical time and forced surgeons to unnecessarily wait for more than 19% of the normal surgery time. Such additional time could be used to deal with other surgeries and consequently reduces the waiting list and save money. It can also ease the pressure of emergency cases and on the admission of elective surgery patients. The paper suggests several actions to be taken among which training surgeon team on time and motion economy is considered as the most effective.

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Table 3. Disruptions and related IQ dimensions and elements of governance information.

Disruption	Information Element		IQ dimension	Reason	Required Action
	Constraint	Feedback			
Theatre staff not available for patient transport	Timing of initiating the call	Requiring extra minutes to arrive	Timeliness	Delay in initiating the call	Call staff before the anaesthesia period).
	Location & room number		Completeness	Failure to allocate the operating room (OR)	Information in the cal OR number. Confirm recommended to insta OR.
Anaehestist unavailable	Timing of calling	Requiring further time	Timeliness	OR supervisor fails to inform anaesthetist in time	Communication betw supervisor should be
Surgeon unavailable	Timing of calling	Requiring further time	Timeliness	OR supervisor fails to inform the surgeon in time	Communication betw supervisor should be
Change order of list during surgery session	Similarity of patients' positioning	Inform pre-recovery	Timeliness, coherency , compatibility	Surgeon failure to recognise positioning similarity before the day of surgery	Surgeon should verif amend the list before pre-operative area sho day before the day of
		Inform patient	Timeliness, accessibility	Failure to inform patients about the change	
Wrong consent form	Selecting correct form	Reprepare	Accuracy	Using wrong consent form	Having different cons prevents such disrupt
	Verify data	Amend data	Accuracy, free-of-error, relevancy	Consent form contains wrong information related to surgery	It is advisable that a c information is prepare consultation with surg
			Accuracy, free-of-error	Ticking 'yes' incorrectly	Add field requiring e suggestion makes sta 'yes' field
	Verify patient name	Select patient's form	Accuracy	Consent form is belong to another patient	Develop consent form (digital form)
Incomplete consent form	Verify fields	Complete the form	Completeness	Failure to enter data in all related fields	Missing data and unfi by developing conser digitised.
Unavailability of required instruments or material	Check availability	Confirm availability	Accessibility, Timeliness	Failure to confirm instruments unavailability	Facilitate direct infor office and store / inve
Wrong / unsuitable instruments or material	Specification	Confirm availability	Compatibility, relevancy	Receiving instrument with incompatible or wrong specification	Use coding system to instruments and mate
			completeness	Surgeon fails to record complete specifications	Same as above. Inver query about the speci
Unsuitable attachment for patient positioning	Positioning & Specification		Compatibility, relevancy	Receiving wrong or unsuitable attachment	Use coding system to attachments – prefera
			Completeness	Surgeon fails to record complete specifications	
Wrong patient positioning	Surgeon's Requirements	Repeat / adjust positioning	Ease of understanding	Failure to follow the surgeon's requirements	Positioning staff may
			Completeness, amount of information	Incomplete description	Coding positions –us considering patient sh
Recovery bed unavailable	Patient readiness	Number of available beds	Timeliness, accessibility	Failure to confirm bed availability within adequate time	Pre-operative area sho bed availability & mo
Awaiting ICU bed	Patient health status	Number of available beds	Timeliness, accessibility	Failure to confirm bed availability within adequate time	Pre-operative area sho bed availability & mo area
Document not readily available	Search		Accessibility	Searching takes considerable time	Certain documents sh colour signs.
	Search	Not found	Accessibility	Failure to allocate the	This is very vital mat

				medication chart (ECT operation)	should be in recognis attached to top of the
Awaiting pathology results	Test sample	Result not available	Timeliness, coherency	Failure to have the test before the surgery day	Checklist for each cat be used to remind sur
			Accessibility, timeliness	Failure to obtain the results before the surgery	Direct communicatio maintained. Tests car urgency.
Radiographer unavailable	Availability	No instant response. Requiring extra time	Timeliness, accessibility, ease of manipulation	Failure to inform radiographer in advance.	Schedule the availabi consistency with the s
X-ray machine unavailable	Availability	Not available	Timeliness, accessibility, ease of manipulation	Failure to bring the machine in time	Schedule the availabi radiographers in cons schedule.
Patient lost way to pre-operative area	Patient Mobility	Patient booked at reception	Relevancy	Failure to recognise patient's inability to move freely – using wheelchair	All relevant informat should be identified. operative and recepti guided by a porter to
	Arrival time	Patient booked at reception	Ease of understanding, interpretability	Patient arrive late and lost way to pre-operative	Coordination betwee required. Recommen directing patients tow Allow to use staff lift
Unsuitable trolley to move a patient	Patient weight		Relevancy, accessibility	Failure to bring trolley that suit overweighted patient.	Patient weight, age a information that may transportation should accessible to the rele
Surgeon moves around surgery table	Positioning	Adjust positioning	Relevancy, coherency	Positioning prevents surgeon to comfortably observe the anatomic area	Lack of knowledge o study, and motion ec required
	Table height	Lower surgery table	Relevancy, coherency	The height of the table prevents surgeon works comfortably	Anatomic area shoul the surgeon. Lack of on methods and moti required
Instruments and material are scattered	Handling instruments and sponges		Relevancy, coherency, ease of manipulation	Sharp instruments and used sponges are scattered randomly around anatomic area	Use mayo table. Dev disruption. Lack of k motion economy. Ins within the grasp rang be required.
Searching for instrument	Handling Instrument	Search	Relevancy, coherency	Failure to locate the position of instruments	Lack of knowledge o on workstation desig within the grasp rang be required.
	Handling instruments	Missing	Relevancy, coherency	Instruments slipped under surgery drape	The use Mayo Table hospital policy (guid time and motion econ workstation design. T
Telephone disruption	Handled by circulating nurse	Answering call	Relevancy	Surgeon dictates the answers	Most calls can be ans Calls can be received