Preventable Variation within Operating Rooms

Information Quality Perspective

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***Abstract*− This paper uses the concepts of information quality to identify the preventable variation in terms of disruption and delay within the operating rooms. This paper has presented the results of 22 cases undertaken inside operating rooms of a public hospital in Australia. Results demonstrated that preventable variation resulted from poor information quality increases surgical time and forced surgeons and patients to endure an unnecessarily average delay of 25.68% (or about 26%) of the total surgery time. Such additional time could be utilised to deal with the pressure of emergency cases and to reduce the waiting lists for elective surgery.**

***Keywords-component*; Information flow, information quality, operating room, preventable variation, surgery.**

I. INTRODUCTION

Harders et al. [1] point out that improving the performance of operating rooms (ORs) is the key to improving services for patients. More efficient use of ORs will reduce waiting times in patient treatment and ultimately reduces waiting lists; however, process variation remains a major reason for poor performance within ORs. Process variation frequently arises from disruption and delay [2, 3]. These disruptions are often a result of lack of consistency between planned theatre session lists and the manner in which the task is actually carried out. Delays arise when procedures exceed scheduled time allocations, or when lists are altered to accommodate additional patients [4]. Literature indicates that delays and disruptions have substantial financial implications for hospitals, affects the quality of patient care, prolong waiting lists, and are recognised as a growing problem throughout the developed world [5, 6]. In addition, there is a strong relationship between disruptions within ORs and medical surgical errors [7]. Reducing disruption improves patient flow and reduces possible medical errors [1,4, 5-7].

The literature stresses that most process variations within ORs are the result of controllable variables within the system, process and conditions [7-12]. Variation resulting from controllable variables is referred to as 'preventive variation'. This paper stresses that managing the quality of information flow to and within the operating rooms will considerably reduces the preventable variation. This study uses the concepts of Information Quality (IQ) and identifies five information elements that govern the flow of information. These elements are input, output, guidance, constraint and feedback.

This research employs case study methodology in which the operating theatre suite of a regional public hospital was selected. A total of 22 surgery operations conducted inside ORs were observed and activities were recorded. The results show that more than 25% of the average surgery time is preventable variation. This paper is structured as follows. The next section reviews the literature for variation in ORs, IQ dimensions and the elements of information flow. Section III presents brief description of the selected case hospital and the procedure used to collect data. The results of observations for 22 case surgeries are presented in section IV. Section V concludes the paper.

II. 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. Delay is any action which prevents the planned flow of a patient to the operating rooms. Variation in terms of disruption and delays prolongs surgery session time, increase costs [13]. The time surgeons have to wait reduces quality of performance [7]. In addition, disruption to surgical flow for one patient delays the next surgery and forces the next patient to wait. Barlow [14] emphasises a direct relation between waiting time and patient dissatisfaction.

Variation may comprise minor events. The accumulation of these events, however, creates stress and fatigue and, as a result, predisposes the surgical team to errors [7, 8]. Wiegmann, et al. [7] conclude that lack of mental readiness and inability to maintain focus, are rated by surgeons as the most important factors causing errors. 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) [8, 9]. However, Sexton, Thomas and Helmreich [15] 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 [9].

Several studies have focused on reducing surgeon's waiting time by reducing variation during turnaround (turnover) times [16]. Other studies attempt the same goal by reducing variation 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 variation in surgical flow as a source of preventable adverse events, there has been no sufficient research adequately dealing with interdependencies between variation within ORs and actions conducted prior to the start of the surgery. This paper addresses this gap in the literature. In addition, this study goes a step further by considering the effect of variation on the actual performance of the surgeons.

A. Information Quality

In 1999, gate [17] states that "*How you can gather, manage and use information will determine whether you win or lose*". Gates' statement implies that there are some issues that traditional information management systems have not addressed. One critical issue in particular is the quality of information an organisation should gather, manage and use.

Information quality (IQ) is multidimensional. This means that organisations must use multiple dimensions to evaluate the quality of their information or data. Several researchers have attempted to identify the IQ dimensions. Table 1 defines the common related IQ dimensions[18-20].

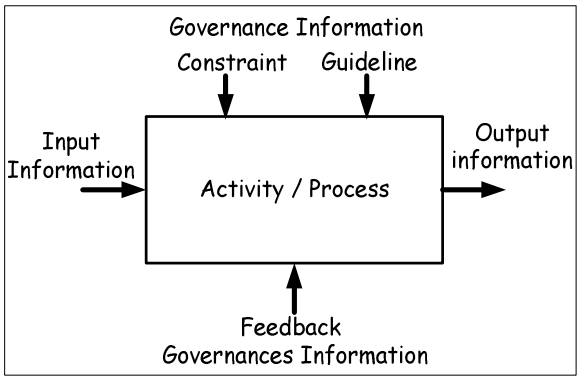
TABLE 1. DEFINITIONS OF THE COMMON IQ DIMENSIONS USED IN LITERATURE. (ADAPTED FROM SEVERAL RESEARCH WORKS).

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.

Lillrank [21] suggests that the primary problem in service operation is not the quality of the actual input-output conversation, but the quality of information that regulates or constrains the implementation of the process. Al-Hakim [3] refers to information that governs, regulates or constrains the activities of a process as 'governance information'.

B. Elements of Governance Information

Governance information has five sets of information elements. These are 'input', 'output', 'guidance', 'constraint' and 'feedback'. Input information is information in forms of documents or instruction that is related to the operation under consideration. The quality of input information is measured using IQ dimensions. Output information is information in form of documents and instructions created as a result of implementing the operation. 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. Feedback for an activity comprises information received from a subsequent activity that may require changes in the implementation of the activity. Figure 1 illustrates the five elements of information; input, output, constraint, guidance and feedback.



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

Figure 1. Elements of information controlling an activity.

Al-Hakim [3] 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.

III. THE SELECTED CASE HOSPITAL

The selected case hospital (the Hospital) is a public regional hospital. This Hospital is a major referral centre providing a comprehensive range of health care services to the region and surrounding rural areas. It is also a teaching hospital. The Hospital has a 261 bed facility, including 164 acute beds, 57 mental health beds and 40 day beds. It employs around 2000 staff and there are 13 departments in this hospital. The Surgical Department offers four types of services: surgical services, anaesthetic services, orthopaedic services and peri-operative services. The operating theatre suit of the Surgical Department includes six ORs. Four ORs are used for elective lists that are run for two sessions per day from 08:30 to 12:30 and again from 13:00 to 16:30 hours. The two other ORs are dedicated to 24 hours emergency surgery and to 24 hours caesarean section surgery. There are eight recovery wards catering to the theatre patients. Post-operative patients are closely monitored until patients are physiologically stable. Centrally located in the operating theatre suit, the sterile stock room is staffed by a registered nurse and an assistant in nursing. Reusable and disposable sterile supplies are stored in this area.

A. Data collection procedure

At the day of observation, the researcher arrived early enough so as to be able to change clothing because the observation is in a sterile area of the operating theatre suite. The liaison officer obtained a schedule of the surgeries that would be considered suitable for observation to generate data for the study. In the preoperative department, the liaison officer introduced the researchers to patients and staff and explained to them that the researchers were observing the surgery process and that information would be recorded with no identification of the names of individuals. The liaison officer obtained the consent of the surgery team before the start of observations. The researchers observed the activities, along with the liaison officer during the observations.

The research team followed patient's progress from pre-operative holding area until discharge. The researchers observed and recorded the timing of all events inside the OR. Variation resulted from the following information elements are observed [22]:

1. Input information: There are three types of input information that causes variation:

- incomplete, incorrect or not updated information of the patient record may cause variation as a result of the time required to adjust information. Information contained in consent form and surgery preference sheet are mainly considered in this project;
- lack of information that allows the medical professional to conduct activities in efficient way. This mainly resulted from lack of understanding the principles of productivity management techniques such as motion economy within the operating room [23]; and

- lack of technical information to perform the activities – this part of information is beyond the objective of this research.

2. Guidance information: The observer records variation results from the failure of following the operating room policies and regulation.

3. Constraint information: The constraint information resulted from the lack of adequately flow of information between professional and related staff prior to conducting the surgery. For instance, variation may occur as a result of inadequately following the surgeon preferences which prepared prior to having the patient in the operating theatre. This type of variation resulted mainly from lack of coordination.

4. Feedback: Lack of adequately flow of information from subsequent sections to operating theatre may create variation. For example, bed unavailability in the recovery area may delay the movement of a patient from the operating room or affect admission of patients to the operating room.

At the end of each observation, data were entered into an Excel data file and the summary reviewed. For each observation a narrative summary, including any notable features of the observed case and details of observed errors were recorded.

After completed observation of each surgery case, the researchers managed discussion meetings with liaison officer, surgeons and nurses for the purpose of review and revise the major non-value added activities and causes drafts recorded by researcher.

IV. Data Analysis

A total of 22 surgeries were observed. Table 2 presents descriptive statistics for the 22 surgeries. The table shows surgery session time, preventable variation time and percentage of preventable variation for each surgery. Surgery session time and variation and session time were measured in minutes. The longest session time in the cases observed was 192 minutes and the shortest was 10 minutes. Total session time for all the cases was 1496 minutes, with a mean of 68 minuted and standard deviation of 48.41 minutes. The average preventable variation time per surgery session is about 17.5 minute with standard deviation of 10.5 minutes. Results demonstrated that lack of managing information flow elements created preventable variation which caused an increase in surgical time and forced surgeons and patients to endure an unnecessarily average delay of 25.68% (or about 26%) of the total surgery time. Such additional time could be utilised to deal with the pressure of emergency cases and to reduce the waiting lists for elective surgery.

TABLE 2. DESCRIPTIVE STATISTICS OF THE PREVENTABLE DELAY IN VALUE ADDED AND NON-VALUE ADDED ACTIVITIES

Surgery No.	Total session time	Total variation time	% Preventable variation
1	36	25.6	71.11%
2	51	25	49.02%
3	107	27.4	25.61%
4	58	20.8	35.86%
5	110	22.2	20.18%
6	25	10.2	40.80%
7	80	13.2	16.50%
8	64	16.4	25.63%
9	162	41.8	25.80%
10	46	15.4	33.48%
11	29	11	37.93%
12	43	9.4	21.86%
13	55	12.2	22.18%
14	105	19.4	18.48%
15	17	8.2	48.24%
16	23	4.2	18.26%
17	46	7.2	15.65%
18	71	16	22.54%
19	134	30	22.39%
20	32	8.6	26.88%
21	192	38	19.79%
22	10	2	20.00%
Total	**1496**	**384.2**	**25.68%**
Average	**68.00**	**17.46**	
Standard Deviate	**48.41**	**10.53**	

Table 3 summarises the main causes for the preventable variation. The failure to adequately managing input information contributed about 51% of the total preventable variation being about 34.5% (about 9% of the total surgery time) resulted from the lack of information related to productivity management principles. Poor information quality in surgeon reference sheet contributed 12.8% of the total preventable variation while the poor information quality in consent form increased the preventable variation by about 13% (or in average of 3.4% of the total surgery time).

TABLE 3. MAIN CAUSES FOR THE PREVENTABLE VARIATION

	Preventable variation		% of session time
Information element	**minutes**	**%**	
Input information: Consent form	15.1	3.93%	**1.01%**
Input Information: Surgeon preference sheets	49.5	12.88%	**3.31%**
Input information: productivity management	132.0	34.36%	**8.82%**
Guidance information	18.9	4.92%	**1.26%**
Constraint information and feedback: Coordination	168.7	43.91%	**11.28%**
Total	384.2		**25.68%**

The results also indicates that the failure to adequately managing the constraint information and feedback disturbed the coordination with or within operating rooms and increases the presentable variation by about 44% or in average of 11% of the total surgery session time. Failure to follow exactly the guidance information (regulation and policy) contributed only 5% of the total preventable variation time (or about 1.3% of the total surgery session time).

V. Summary and conclusion

Variation can be seen as undesirable gap between an ideal and actual state that hinders a worker's ability to complete his or her tasks within the specified time. Variation in surgical setting frequently arises from disruption and delay. Variation affects the quality of patient care, prolong waiting lists, and result medical errors. Most variation within ORs are the result of controllable variables within the system, process and conditions. Variation resulting from controllable variables is referred to as 'preventive variation'. This research deals with preventable variation within ORs. This research uses the concepts of Information Quality (IQ) and employs case study methodology in which the operating theatre suite of a regional public hospital was selected. A total of 22 surgeries were observed and activities within operating rooms were recorded. Information elements affecting the surgery performance and creating variation were discussed with related professional after the surgery sessions. The total session time for all the 22 cases was 1496 minutes, with a mean of 68 minuted and standard deviation of 48.41 minutes. Results indicates that failure of managing information elements creates preventable variation ranged between 14.93% to 71.11% of the surgery session time and caused an average increase in surgical time of about 26% of the total surgery time. Such additional time could be utilised to deal with the pressure of emergency cases and to reduce the waiting lists for elective surgery.

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