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Operating Room Management and IT: Improving Efficiency and Safety with a Innovative Managerial Model

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The operating room suite (OR) represents one of the most critical hospital units, both in patient safety and financial terms. In this article, we present a theoretical model, called ORMS (Operating Room Management System), embedded in a business intelligence environment, that is able to provide useful and easy-to-use information by using medical literature indicators for the management of ORs. The ORMS model, which is based on a tracking system of relevant events within the surgical path, presents three profiles of information that cover information needs of different actors: managers, anaesthesiologists and surgeons. After two years of utilisation of this model at Forlì Hospital, Italy, the performance has increased both in terms of efficiency and patient safety, proving that improvements in performance are possible by implementing innovative managerial models even in an era of constrained resources.

Step One: Tracking the Surgical Path

This study was developed in house by the Forlì Local Health Authority (Forlì, Italy) within the Morgagni-Pierantoni Hospital. The purpose was to improve the level of efficiency and patient safety within the OR, and to ensure a fair distribution of hospital resources among healthcare professionals. The research team of the hospital performed two experiments for the data gathering. The aim of the first experimentation was to develop a system called 'data recording system' (DRS) to track the relevant steps of the surgical path process. Initially the research team set out simply to define appropriate timeframe that would be useful in measuring the efficiency of the OR (Table 1 column A), in line with scientific literature.

Personal Digital Assistants (PDA) were selected as hardware to support data entry activity. The PDA software was entirely developed by hospital engineers. The results of the first experimentation phase showed that our surgical path tracking approach was generally implementable; although the additional workload for operators was acceptable, there was potential for reducing it. The PDA software required re-engineering to adapt it more effectively to OR requirements. It also became evident that system improvement potential would be higher if the quantity of time tracking stamps was increased and entire tracks were registered without data lacks or interruptions. With the results of the first experimentation in mind, the aims of the second experimentation consisted of tracking the whole 16 surgical path process steps proposed by Rotondi et al (Table 1 column B) and increasing the quantity and quality (reducing incompleteness in tracking) of data concerning the surgical process.

To overcome the data quality problems the hospital research team introduced a series of improvements. The nurse anaesthetist was identified as the appropriate operator to track the different surgical path timeframes. The PDA software was redesigned to enable a closer alignment of time tracking with the logistic path of the patient. The adapted version of the software was aligned closer to OR logistics and suggests following time registration steps to the operator.

Table 1: First and second trial: timings of the surgical path process

A	B	C
1	ward exit	ward exit
2	entrance ORB	entrance ORB
3		identification by nurse anaesthetist
4		entrance anaesthesia room
5	start anaesthesia	start anaesthesia
6		end anaesthesia
7	entrance OR	entrance OR
8	start surgical procedure	start surgical procedure
9	end surgical procedure	end surgical procedure
10	exit OR	exit OR
11		entrance RR
12		exit RR
13		identification by healthcare assistant
14		transport ICU
15		exit ORB
16		ward re-entry

ORB: operating room block OR: operating room RR: recovery room ICU: intensive care unit

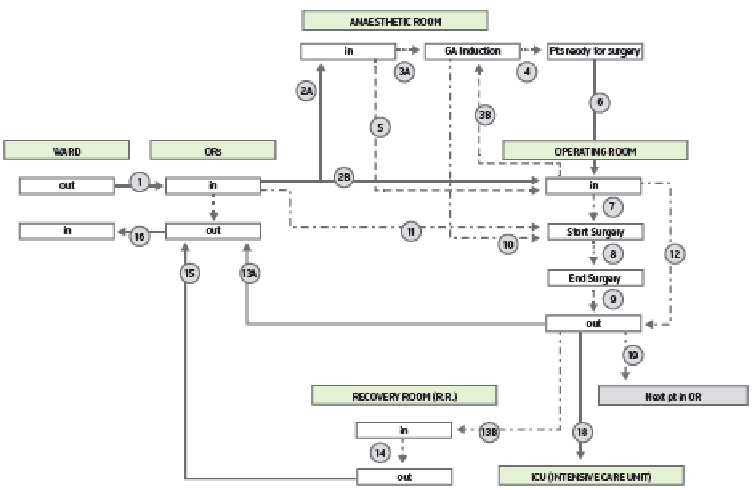
The barcode reading system was identified as the simplest and fastest way to gather data using PDA, and led to a reduction in data entry errors as well as minimised obstacles to clinical activities. The PDA usage was extended with the introduction and development of a barcode reading system, enabling the scanning not only of patient bracelets, but also of cards which operators used to access software and register room entering/exiting. Data was recorded by DRS as a simple output made up of a series of 12 to 16 steps along the pathway from the ward to the operating room. The number of outputs depends on the route the patient follows during the surgical pathway (Figure 1) and data is sent to ORMS as a series of outputs. DRS is able to read every step of the surgical path and all the delta-times between every step and the next.

Table 2: Categories and subcategories of data analysis

Window	Subject	Level	Type of data
M1	Facility	Global	Quantitative
M2	Productivity units	Comparison	Quantitative
M3	Productivity unit	Comparison	Performance
M4	Facility	Efficient indicators	Performance
M5	Surgical procedure		Qualitative
A1	Facility		Performance
A2	ORB	Pathway	Quantitative
A3	Surgical procedure		Qualitative
A4	Pathway	Timing	Quantitative
S1	Facility	Global	Performance
S2	Productivity unit	Comparison	Quantitative
S3	Surgical procedure		Qualitative
S4	DRG		Quantitative

M: Manager A: Anaesthesiologist S: Surgeon ORB: Operating Room Block DRG: Diagnosis Related Groups

Figure 1: Surgical path: from the ward to operating room and back to the ward



Out: patient is leaving In: patient is entering ORs: operating rooms or surgical block
GA: general anaesthesia Pt/s: patient/s R.R.: recovery room
ICU: intensive care unit A or B: different solution from the same position

Step Two: The ORMS Model

ORMS can be regarded as practical model implemented in an analysis tool embedded in a business intelligence environment, which processes data to simple and understandable performance tachometers and tables. The analysis of data is based on Macario and Dexter's studies on ORB efficiency and our experience and analysis of tracked data. Data recorded by DRS is sent immediately via wi-fi connection to a central hospital server, which works as an interim storage. Systematically data is sent to the ORMS system where it is processed and added to previous data analyses.

Data quality is guaranteed by the introduction of two data quality rules. These data quality rules overcome basic data introduction problems by excluding non-reliable data before their analysis. The ORMS login (with password) is layered and every user has access to data depending on his/her professional The system is divided in three main profile types (Figure 2) M (manager), A (anaesthesiologist) or S (surgeon); each profile type can access required information in the profile content. Every profile includes a few subcategories where operators can access more detailed data analyses (Table 2). The first data output screen shows general information and guides the user towards more detailed data analysis as precise surgical procedure time of every single surgical unit. The hierarchy inside the software enables the user to have a complete insight of data regarding his/her profile in a very simple and “user-friendly way”. The manager’s profile is aimed at hospital managers and presents data concerning the entity of operations. Within the surgeonsprofile the model works out data that is important for surgeons and anaesthesiologists alike.

The manager’s profile comprises five different data analysis subcategories. The first output screen (M1) is a global vision of the entire surgical activity in terms of total number of procedures, number of scheduled/unscheduled procedures, raw utilisation (total hours of cases performed ÷ total hours of OR time allocated), and a description of all surgical units’ workload. M2 is a comparison of the productivity of each surgical unit. Variables used to describe the workload are: number of surgical procedures, number of procedures together with duration, and logistic pathway (induction area, ward, recovery room or intensive care unit- ICU). M3 gives a view on surgical units in terms of number of procedures, surgical time average and logistic patient flow analysis (ward, recovery room or ICU admission). M4 displays the efficiency indicators and expressed as key performance indicators (6 dashboards that use the red-yellow-green traffic light-like scale of colours). M5 represents the Transport-Induction-Surgery-Awakening (TISA) graph. This graph maps the time it takes to bring the patient from the ward to ORB, the induction time, the surgery procedure time and the awakening time. Each time interval is referred to the surgical procedure chosen by the operator, so the TISA graph represents the total amount of time, expressed as average time and standard deviation required to perform a specific procedure.

Implementing and Using the ORMS Model: Results

From January 2009 to December 2011, on an average year the DRS enabled the registration of about 5,000 surgical operations covering 97.7% of actual procedures. The total number of surgical procedures has increased from 4,892 in 2009 to 5,616 in 2010 and decreased to 5,120 in 2011. The DRS systemhas improved the efficiency of the operating room process and patient safety.

Raw utilisation has increased from 44% in 2009 to 56% in 2010 and decreased to 52% in 2011 with the same OR block time and hours of allocated block time.

The number of high complexity surgical procedures (≥120 minutes) has increased in 2011 compared to 2010 and 2009 for General Surgical unit, ENT surgical unit, Urology surgical unit and Orthopedic-Traumatology surgical units.

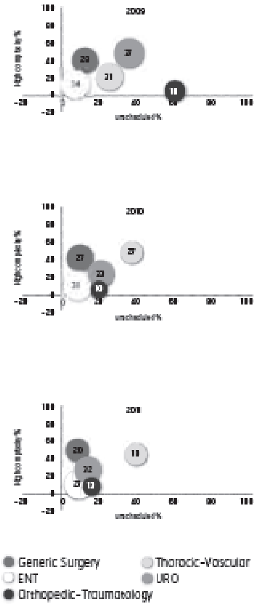
The number of unscheduled procedures performed has been reduced while maintaining the same percentage of surgical procedures. The number of overtime events decreased in 2010 and in 2011 compared to 2009 and the delays expressed in minutes are almost the same.

A direct link was found between the complexity of surgical procedures, the number of unscheduled procedures and overtime (cause-effect relationship). Figure 3 shows this link: the x axis represents the percentage of high complexity procedures and the y axis represents the percentage of unscheduled procedures. Bubble diameter represents the percentage of over time procedures.The graph shows the relation between the three variables; from 2009 to 2011 the bubbles go up or remain at the same height and move closer towards the y axis as the percentage of unscheduled procedures decreases. Therefore, despite a consistency in the complexity of procedures, surgical groups have been successful in reducing the number of unscheduled procedures and overtime.

No serious adverse events occurred in three years compared to the 2007-2008 period, when one event of wrong site surgery and 2 near misses of one WSS and of one wrong person surgery occurred.

For the above mentioned reasons, the model has proved to be successful and has been awarded as finalist at the European Public Sector Award of 2011 by European Institute for Public Administration.

Figure 3:
Three years correlation: complexity - unscheduled procedures - over time



Conclusion

The ORMS model represents a successful experiment of the introduction of managerial innovation in a public hospital in Italy, a country that is considered one of the laggards in terms of introduction of effective managerial models within its public sector. But it contains interesting insights even for more advanced countries. In fact, it is interesting to note that although the project was developed by healthcare professionals, it aims to align managerial and professional goals. This is an important step forward, when compared to solutions typically based on a "trade-off" between efficiency (managerial side) and effectiveness (professional side).

Provides solutions for patient safety and risk management. The results of this project are producing a "domino effect" not only on surgical or anaesthesiological or nursing activities, but also on how we understand the process as a whole. James Harrington states that we can’t improve what we can’t measure; we have improved and strive to improve even further so that our daily work benefits from efficiency, cost reductions and work comprehension. It is our belief that a secondary effect of our system is the forging of a new way of thinking among team members.

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