

## ENHANCING CARDIAC OPERATION THEATRE EFFICIENCY BY USING QUALITY CONTROL TOOLS IN CARDIAC SURGERY

Farrah Pervaiz, Imtiaz Ahmed Chaudhry, Ali Gohar Zamir, Afsheen Iqbal

Armed Forces Institute of Cardiology/National Institute of Heart Diseases Rawalpindi

### ABSTRACT

**Objectives:** To identify delays in the operative process in the cardiac surgery theatres. To understand the reasons of delay noted in different phases.

**Study Design:** Descriptive cross sectional.

**Place and Duration of Study:** AFIC/NIHD Rawalpindi from Dec 2015 to Jan 2015.

**Patients and Methods:** A descriptive cross sectional study was conducted to analyze the cardiac surgery procedures, in terms of seven delays during three phases of operation theatre time utilization.

**Results:** A total of 70 cases were analyzed. The mean time for anaesthesia induction and knife to skin time were estimated to be 29 min and 59 min respectively. All the time intervals are within the control limits. Maximum number of delays occurred during surgical procedure and sifting of the patient to the intensive care unit once the procedure ends, and is mainly attributable to shortage of experienced theatre staff and defective equipment.

**Conclusion:** This study was performed in a tertiary cardiac care hospital and the time intervals of three phases of OT time utilization ranged within acceptable limits. The preparation of the equipment and required material for the OT cases must be done well in advance. It is essential that the anaesthetists and surgeons perform their work proficiently avoid undue delays, and supervise the proceedings as the OT managers. The QC tools can be aptly applied to all phases of operation theatre.

**Keywords:** Cardiac surgery, operation theatre, quality tools

### INTRODUCTION

The perioperative system involves both the operating room and the entire system that supports it. For the purpose of this paper, the perioperative portion of a patient's surgical care begins once a decision has been made for a patient to undergo surgery. During the preoperative phase, the surgeon and hospital prepare the patient and the resources required to deliver the surgical care. This is followed by the operative phase, when surgery is performed in the operating room. The postoperative phase is the period after surgery is completed, and includes patient recovery and discharge from hospital.

The operating theatre is an integral component of the elective journey. They are usually the largest revenue generator, but also the largest cost centre for an organization. The extent to which operating theatres are managed efficiently and effectively is a key issue in the

overall use of hospital resources<sup>5,6</sup>.

Cardiac surgical procedures are time consuming (4-5 hrs) and only 2-3 procedures can be performed in a theatre in one day. Loss of single operation slot in this scenario has dire implications on the waiting lists and also prolong hospital admission times. Procedural delays and consequent cancellations of surgical procedures are arguably an issue of health care quality as well as a major cause of waste of health resources<sup>7,8</sup>. As a consequence, they prolong the duration of hospitalization causing anxiety and inconvenience to patients and their families, quite apart from increasing the cost in terms of working days lost and disruption to daily life. The most common causes of cancellation are the patient being unfit for surgery and suboptimal utilization of theatre time, with the latter leading to case delays<sup>9-11</sup>.

Procedural delays (for example delay in the availability of equipment, implants, staff or instruments) are most often due to incomplete or inaccurate communication. The time that it takes to transfer patients, the time it takes to obtain extra equipment, or the time patients spend waiting at various points can be

---

**Correspondence:** Dr Farrah Pervaiz, Director  
R&D Department AFIC/NIHD, Rawalpindi  
Email: farrahpervaiz@yahoo.com

modified by process-control software using real data. Systems can then be reconfigured (in terms of which operating lists are used when, and which theatres and staff are used for which functions, for example) to become more efficient<sup>12</sup>.

A range of strategies have been proposed to identify and address operating theatre delays, including preoperative checklists, post-delay audits and staff education. These strategies provide a useful starting point in addressing delay, but their effectiveness can be increased through more detailed consideration of sources of surgical delay<sup>13,2</sup>.

The available information and reliable data on the efficiency of use of operating time and the reasons for suboptimal utilization are minimal in Pakistan. What we need are useful techniques and tools to help in determining where to begin our efforts to improve. Thus, we cannot conclude anything with certainty by comparing two numbers unless we understand the stability of the processes that produced them. This insight was obtained in industry many years ago by Walter A. Shewhart, and his methodology for measuring processes was later developed by W. Edwards Deming and others<sup>14</sup>.

Statistical Process Control (SPC) aims to control quality characteristics on the methods, machine, products, equipments both for the company and operators with magnificent seven. Statistical process control (SPC) is one of the important tools in quality control (QC)<sup>15</sup>. The purpose of this study was to determine the root cause of operating room delays in a standardized manner to help improve overall operating room efficiency.

## METHODOLOGY

This descriptive cross sectional study was conducted after the approval of Institutional Ethics Review Board of AFIC&NIHD ref.no IERB-AFIC 191107. The anonymity and confidentiality of the data was assured. During a 2-month period from 1st Dec, 2014 to 7th Jan.2015, we prospectively collected data after developing and pretesting the data collection tool.

The data was collected according to the type of OT, type of session whether elective,

**Table-1: Descriptive Statistics.**

	Variables	n=70 Cases	Frequency (%)
1	Operation Theatre		
		OT 1	31(44%)
		OT 2	29(41%)
		OT 3	10(14%)
2	Procedure		
		CABG	54(77%)
		MVR	2(2.9%)
		AVR	6(2.9%)
		DVR	2(2.9%)
		ASD	2(2.9%)
3	Operating session	First	54(97%)
		Second	16(2.3%)
		Third	
4	Type of operation	Elective	68(97%)
		Emergency	2(2.9%)
5	Operating hours	Office Hours	69(98%)
		Out of office hours	1(1.4%)
6	Anaesthesia induction time (mins)	Mean =29(min), Median=29(min), SD=11.00	
7	Knife to skin	Mean=59 (min), SD=14.5	
8	Cross Clamp Time (mins)	Mean=64 (min), SD=36.5	
9	Bypass Time (mins)	Mean=99(min), SD=45.6	
11	Total procedure time	CABG	4 hrs
12	Length of stay in OT	CABG	5 hrs

emergency and unscheduled and type of procedure and timing of operating session. The predetermined types of cardiac surgery procedures were Coronary Artery Bypass grafting (CABG), Mitral Valve Replacement and Mitral valve repair (MVR), Aortic valve Replacement (AVR), double valve replacement

(DVR) and atrial septal defect (ASD) closure. These types of operations were selected on the basis of variability of duration or severity and the degree of patient’s vulnerability to perioperative complications.

The inclusion criteria involved the exclusive fit to one of the five operations included in the study protocol. For the purpose

different time intervals estimated during this study, the average time for anaesthesia induction was 29(min) SD+11.00 and knife to skin time was 59(min) SD+14.5 respectively. The average cross clamp time and bypass time were 64 (min) SD+36.5 and 99(min) SD+45 as shown in Table-1. The bypass and cross clamp times are influenced by the type of the procedure, the

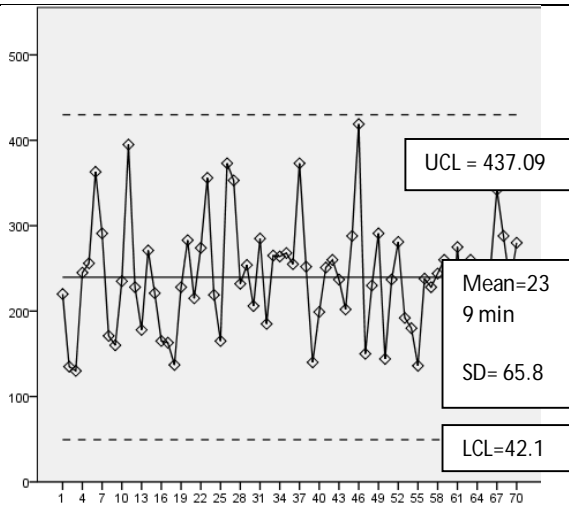


Figure-2: Control Chart for Total procedure time CABG.

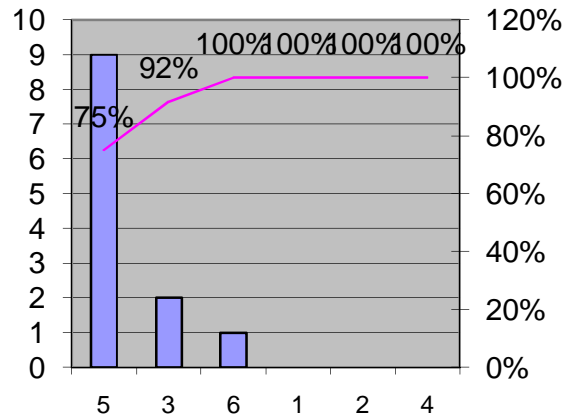


Figure-3: Pareto chart of Delays in OT.

1.Delays by the surgeon, 2.Delays by the anesthetist, 3.Theatre staff shortage, 4.Equipment malfunctioning, 5.Shortage of material, 5.Procedural Complications

of this study the per operative period was divided into three phases.

Patient wheeled in to start of procedure duration (Phase 1), surgical procedure duration (Phase 2) and completion to shifting from OT (Phase 3). Statistical analysis was done in SPSS 21 version and the quality control tools were applied in Word Excel.

**Conceptual process flow chart:**

A conceptual flow chart regarding flow of events, time intervals and procedural delays<sup>16-18</sup> was, prepared from analyzing data as shown in Fig-1.

**RESULTS**

The present study helped us to better understand different types of procedural delays in operation theatre during cardiac surgery. Data was analyzed from a total of 70 cases operated over a period of one month. Majority of the procedures conducted were CABG 54(77%). Of all the cases performed emergency procedures constitutes 2(2.9%) Regarding

complexity of the procedure the number of grafts, number of valves to be replaced and intraoperative complications.

The mean total time of procedure for CABG was 239.0 min (3.98 hrs) SD=65.8 and 3 sigma deviation revealed that the process is within control limits.

Maximum delays occurred during third phase of per operative period. This observation was further reinforced with the help of Pareto chart that showed that greater number of delays (75%) could be attributed to shortage of material and theatre staff.

**DISCUSSION**

This study helped us to better understand various factors associated with different delays in operative process. Our data showed that time intervals of three phases of operation theatre time utilization for cardiac surgery ranged within acceptable limits. Delays due to suboptimal utilization are a common occurrence throughout the world but at the

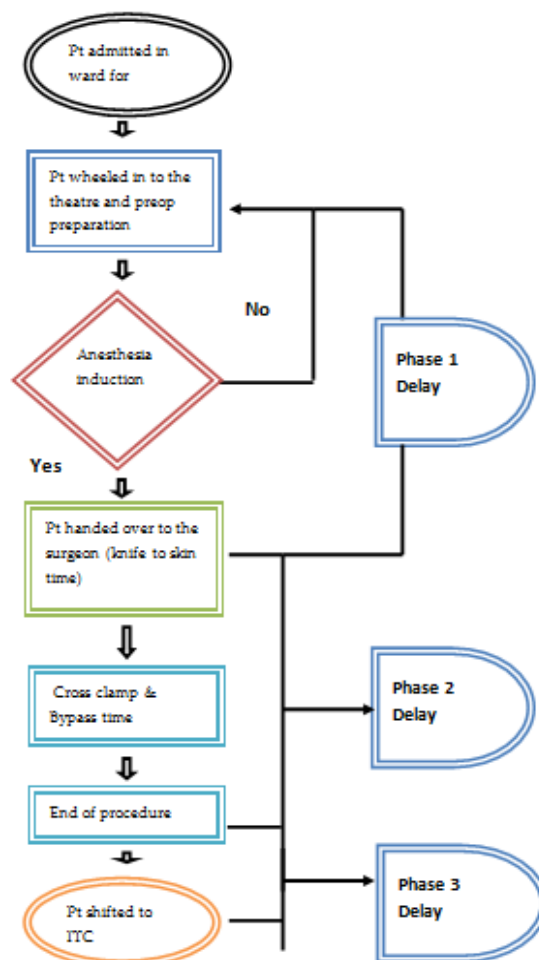
same time identifying the reasons for delay and developing strategies for accurate estimation of time needed for surgical interventions, could help us to optimize the efficient use of the operation theatre time.

In our present study minority of delays during phase 1 were attributed to the delays by anesthetist. In an effort to estimate anesthesia induction time according to, Koenig et al<sup>20,21</sup> the duration of anesthesia induction time are in line with our results i.e 29 minutes. Complex techniques involving placement of central venous catheter for cardiac anesthesia are likely to be more time consuming and sometimes difficult as well and could lead to a delay. Even for experienced anesthetists, it is often difficult to predict the duration of anesthesia induction for a specific case. In some cases process time might be influenced by the performance level of the individual anesthetist, or by other specific factors such as shortage of instruments or of staff<sup>20</sup>. Once the patient is wheeled into the theatre the mean knife to skin time was 59 minutes which is in accordance with the study by J. Mazzei<sup>22</sup>, suggesting that surgical incision was made after 21 to 49 min, once the patient is brought into the theatre, due to variable amount of time required for anesthesia induction and surgical preparation and draping. In most of the teaching hospitals the presence of residents and trainees was found to prolong the duration of surgery by up to 70% and the teaching of an anaesthesia resident may delay the anaesthesia procedure by 2-3 minutes<sup>23,24</sup>. Our institution is a teaching hospital and besides an inadequate number of registrars, the duration of operations might be influenced by the need to train.

This study suggested that most of the delays occurring during phase 2& 3 are mainly due to shortage of experienced theatre staff and inadequate number of human resource per operation theatre<sup>25,26</sup>. Most of the experienced staff has been posted out and the new theatre nursing staffs is in the learning curve and need some time to be proficient in assisting cardiac surgeries.

Another important factor contributing toward prolonged theatre time was technical

errors like equipment efficiency e.g availability of adequately functioning saws, head lights, source lights and surgical instruments. Finally, delay in transportation of patient from OT to ITC leads to considerable waste of operation



**Figure-1: Process flow chart for process flow in OT.**

theatre utilization time between operations. Saha et al<sup>27</sup> extrapolate their results to a typical 4 h operating theatre session consisting of three to four procedures, reporting up to 60 min of the surgeons' time being lost while waiting between cases.

The present study has few limitations. Firstly, the sample size is limited to 70 cardiac operations, though it enhances the reliability but it weakens the generalizability of our findings. Secondly, there is lack of an

established classification of the system delays, which limits the comparison of our study findings to those from similar clinical settings.

## CONCLUSION

This study was performed in a tertiary cardiac care hospital. The time intervals of three phases of OT time utilization ranged within acceptable limits, being comparable to the time estimates of published. The preparation of the equipment and required material for the OT cases must be done well in advance. Utilization of newer technology enables timely booking and scheduling of cases. Improved inter-departmental coordination and compliance with pre-anesthetic instructions needs to be ensured. It is essential that the anaesthetists and surgeons perform their work promptly, well in time and supervise the proceedings as the OT managers. The basic QC tools can be aptly applied to all phases of operation theatre. Plotting data over time and using control chart techniques will tell us whether the variation in a surgical process is stable and predictable or whether variation signals a significant change in the process.

Efficient operating theatres are crucial to high-quality care. To meet and sustain targets, theatres must continuously find areas for improvement and invest in the right people and systems. Procedural delays (for example delay in the availability of equipment, implants, staff or instruments) are most often due to incomplete or inaccurate communication. Short preoperative briefings using a standardized format have been shown to reduce unexpected delays and decrease the frequency of communication breakdowns.

The time that it takes to transfer patients, the time it takes to obtain extra equipment or the time patients spend waiting at various points can be modified by process-control software using real data. Systems can then be reconfigured (in terms of which operating lists are used when, and which theatres and staff are used for which functions, for example) to become more efficient.

## Acknowledgement

The author wishes to express profound gratitude and deep regard to Adult Cardiac Anaesthesia Department AFIC&NIHD particularly Maj Gen S.M Shahab Naqvi HI(M), Brig Safdar Abbas, Brig Safdar Ali Khan and Brig Muhammad Buksh for their exemplary guidance and assistance in carrying out this study. I would also like to give my sincere gratitude to all the members of data collection team, for their immense help throughout this research project.

## Conflict of Interest

This study has no conflict of interest to declare by any author.

## REFERENCES

1. World health organization, monitoring the building blocks of health system, a hand book of indicators and their measurement strategies: 2010
2. Quality standards for health and social care, UK 2006
3. Enhancing surgical unit care in BC. Improving perioperative quality, efficiency and access.
4. Noyez L, Kievit P, Verkroost M, van Wetten H, Verhagen A, van Swieten H. Evaluation of quality in adult cardiac surgery: let us speak the same language. *Netherlands Heart Journal*. 2010;18(7):365-9.
5. Boyer KK, Pronovost P. 2010. What medicine can teach operations: what operations can teach medicine. *Journal of Operations Management* 28:367-71.
6. Cardoen B, Demeulemeester E, Belein J. 2010. Operating room planning and scheduling: A literature review. *Journal of Operational Research* 201:921-32.
7. J. J. Pandit and A. Tavare, "Using mean duration and variation of procedure times to plan a list of surgical operations to fit into the scheduled list time," *European Journal of Anaesthesiology*, vol. 28, no. 7, pp. 493-501, 2011.
8. M. Schuster, C. Neumann, K. Neumann et al., "The effect of hospital size and surgical service on case cancellation in elective surgery: results from a prospective multicenter study," *Anesthesia and Analgesia*, vol. 113, no. 3, pp. 578-585, 2011.
9. A. R. Tait, T. Voepel-Lewis, H. M. Munro, H. B. Gutstein, and P. I. Reynolds, "Cancellation of pediatric outpatient surgery: economic and emotional implications for patients and their families," *Journal of Clinical Anesthesia*, vol. 9, no. 3, pp. 213-219, 1997.
10. S. Venkataraman and K. Sriram, "Cancelled elective surgery: study in an Indian Corporate Hospital," *Indian Journal of Surgery*, vol. 59, pp. 372-376, 1997.
11. J. J. Pandit and A. Carey, "Estimating the duration of common elective operations: implications for operating list management," *Anaesthesia*, vol. 61, no. 8, pp. 768-776, 2006.
12. Strategy 4: improving elective productivity and quality through improved theatre scheduling and management.
13. Higgins VJ, Bryant MJ, Villanueva EV, Kitto SC. Managing and avoiding delay in operating theatres: a qualitative, observational study. *Journal of evaluation in clinical practice*. 2013;19(1):162-6.
14. Levett JM, Carey RG. Measuring for improvement: from Toyota to thoracic surgery. *Ann Thorac Surg*. 1999 Aug;68(2):353-8; discussion 374-6.
15. Srinivasu R, reddy GS, Rikkula SR. Utility of quality control tools and statistical process control to improve the productivity and quality in an industry. *International Journal of Reviews in Computing*. 2009-2011.
16. Nancy R. Tague. *The Quality Toolbox*, Second Edition, ASQ Quality Press, 2004, page 17. Nancy R. Tague. *The Quality Toolbox*, Second Edition, ASQ Quality Press, 2004, pages 255-257.
17. Nancy R. Tague. *The Quality Toolbox*, Second Edition, ASQ Quality Press, 2004, pages 247-249.

18. Nancy R. Tague. The Quality Toolbox, Second Edition, ASQ Quality Press, 2004, pages 141-142.
  19. Excerpted from Nancy R. Tague's. The Quality Toolbox, Second Edition, ASQ Quality Press, 2004, pages 155-158.
  20. T. Koenig, C. Neumann, T. Ocker, S. Kramer, C. Spies, and M. Schuster, "Estimating the time needed for induction of anaesthesia and its importance in balancing anaesthetists' and surgeons' waiting times around the start of surgery," *Anaesthesia*, vol. 66, no. 7, pp. 556-562, 2011.
  21. W. J. Mazzei, "Operating room start times and turnover times in a University Hospital," *Journal of Clinical Anesthesia*, vol. 6, no. 5, pp. 405-408, 1994.
  22. T. J. Babineau, J. Becker, G. Gibbons, et al., "The "cost" of operative training for surgical residents," *Archives of Surgery*, vol. 139, no. 4, pp. 366-369, 2004.
  23. R. Marjamaa, A. Vakkuri, and O. Kirvelä, "Operating room management: why, how and by whom?" *Acta Anaesthesiologica Scandinavica*, vol. 52, no. 5, pp. 596-600, 2008.
  24. J. J. Pandit, T. Abbott, M. Pandit, A. Kapila, and R. Abraham, "Is "starting on time" useful (or useless) as a surrogate measure for 'surgical theatre efficiency'?" *Anaesthesia*, vol. 67, no. 8, pp. 823-832, 2012.
  25. M. Schuster, C. Neumann, K. Neumann et al., "The effect of hospital size and surgical service on case cancellation in elective surgery: results from a prospective multicenter study," *Anesthesia and Analgesia*, vol. 113, no. 3, pp. 578-585, 2011.
  26. P. Saha, A. Pinjani, N. Al-Shabibi, S. Madari, J. Ruston, and A. Magos, "Why we are wasting time in the operating theatre?" *International Journal of Health Planning and Management*, vol. 24, no. 3, pp. 225-232, 2009.
- .....