

POSTPONEMENT OF SCHEDULED GENERAL SURGERIES IN A TERTIARY CARE HOSPITAL - A TIME SERIES FORECASTING AND REGRESSION ANALYSIS

Momia Yashpal¹, Talati Shweta², Bhagat Hemant³, Koushal Vipin⁴

Department of Hospital Administration
Post-Graduation, Institute of Medical Research and Education
Chandigarh, India

Abstract—Introduction: Postponement of elective scheduled operations results in inefficient use of operating room (OR) time on the day of surgery. Inconvenience to patients and families also caused by postponements. Moreover, day of surgery (DOS) postponement creates logistic and financial burden associated with extended hospital stay and repetitions of pre-operative preparations to an extent of repetition of investigations in some cases causing escalated costs, wastage of time and reduced income. **Methodology:** A cross sectional study was done in the operation theaters of a tertiary care hospital in which total ten operation theaters of General Surgery Data of scheduled, performed and postponed surgeries were collected from all the operation theater with effect from march 1st to September 30th 2018. A questionnaire was developed to find out the reasons for the postponement for all hospital's stakeholders (Surgeons, Anesthetist, Nursing officer) and they were further evaluated Time series analysis of scheduling of Operation Theater for Moving average Technique. **Results:** total 2,466 surgeries were scheduled and 1,980 surgeries were performed and 486 surgeries were postponed in the general surgery department during the study period. Month wise postponement forecast was in accordance with the performed surgeries and on regression analysis postponed surgeries were in perfect linear relationship with the postponement Rate.

Index Terms— Regression Analysis, ARIMA, Advance Pediatric center, TIME SERIES Forecasting.

I. INTRODUCTION

Efficiency of Operation Theater depends on the constant flow of the patients to fulfill its capacity. Throughput of the theater is declined due to the delay in postponement of surgery resulting in wastage of resources. Level and reason of postponement can be established through a study. Implementation strategy (action plan) to minimize the postponement of surgery may be formulated through this information. Late postponement is a waste of, material, money, time and Human resources hence is burden to the Nation.

Patients and their families face economic and emotional implications for postponement if the case is cancelled. When the cases are postponed more than half of family members of patients miss at least 1 day at work. Operating room utilization is defined as the measure of the use of an operating room that is properly staffed with people needed to successfully deliver a surgical procedure to a patient. Many postponements are often due to non-medical problems such as a full ICU, surgeon unavailability, or bad weather and postponement rates can be monitored statistically. Elective surgery cancellations always lead to insufficient utilization of manpower and hospital resources and can also lead to an increase in patients treatment expenses due to prolonged hospital stay and in many cases, repetitions of pre-operative preparations and management¹. The delays and postponements specifically lower the morale among the staff, patients and relatives and may reflect as a decreased productivity in their workplaces.⁴ There is a need for the health care teams to encourage cost-effectiveness in every aspect of patient care. Therefore, avoidance of unnecessary cancellation of elective surgery should lead to reduction in the overall cost of the treatment.⁷ Cancellation is a major problem in most hospitals.⁸ It is an inconvenience, which has a significant ripple effect.¹⁵ Cancellation of cases on the scheduled day of surgery leads to inefficient utilization of manpower and scarce resources.²¹ Cancellation of elective operations is a parameter to assess quality of patient care and quality of management system.¹⁸ Hence, this is one criteria for evaluating the efficiency of surgical service which has low rate of cancellation of operations, which compels the hospital management to demonstrate the good performance

II. RESEARCH METHODOLOGY

A. RESEARCH SETTING:

The study of postponement of scheduled surgeries was done in Main OT located at Nehru Hospital, Cardiac OT located in Advance cardiac center (ACC), Pediatric Operation

Theater complex located in Advance Pediatric center (APC), and in Eye Operation theater located in Advance Eye Center (AEC). Bed compliment of Nehru hospital is 949, Advance Pediatric Centre is 243 and Advance Cardiac Centre is 208, and advance eye center is 101 respectively. Main Operation theatre complex situated on 4th and 5th floor of Nehru Hospital, Pediatric, Cardiac operation theater complex and Eye OT. General Surgery department has 25 Senior Resident Doctors and 9 consultant surgeons.

B. RESEARCH DESIGN:

This study was conducted between March1st to September 30th 2017. It was a cross sectional study. Study tools: Questionnaire/opinion sheet was used. It included a semi-structured Performa by which information and data was obtained through the communication with the Doctors and Nursing officer.

C. SAMPLING TECHNIQUE DATA COLLECTION:

Observation was done only for the scheduled cases enlisted for specific day. The List of surgeries was generated before 8 pm on previous day. Data for scheduled, performed and postponed surgeries were collected for seven months. The observation was not made on holidays, as routine cases were not scheduled on those days. A universal sampling technique was adopted to select the one surgical specialty for each day since there are ten surgical specialties (twelve working days for each department thus data from the various stake holder was taken for total 120 days). The opinion regarding the postponement was taken from various stakeholders (anesthetist, surgeon and staff nurse) was done by using a questionnaire/ opinion sheet ,after obtaining the informed consent In case of different opinion regarding the postponement of same case, consensus was arrived by the discussion among surgeon, anesthetist, staff nurse and Hospital administrator and final opinion was entered in annexure B. Postponement rate was calculated by dividing total number of surgeries postponed on day of surgery by the total no. of scheduled surgeries on that day multiplied by hundred. Data was compiled into two major groups that is Hospital related and patient related causes of postponement and they were further classified into avoidable and non-avoidable causes of postponement. Statistical analysis was done with the help of SPSS version 22, and stat pus application.

D. EXCLUSION CRITERIA:

All the cases posted as unlisted cases or emergency cases.

E. DATA ANALYSIS TECHNIQUE:

The data collected was analyzed by using, descriptive statistical method to describe sample characteristics in terms of frequency, mode, and percentage, moving average, exponential smoothing, Regression analysis and modeling techniques were used to interpret the data.

F. ETHICAL JUSTIFICATION

This was a cross sectional study to study the causes of postponement of scheduled surgeries. The confidentiality of any patient or the institution was not be breached evolving any ethical issue. Treatment did not be altered delayed deprived when the study was undertaken. Study did not affect the procedure, process and outcome of the ongoing treatment of the patient. Study in no way involves and experimentation on human no intervention procedure was carried out as apart of study. The ethical issues in the study had been paid due attention to and study did not delay any patient of required investigation or treatment. Freedom of expression and un-indentured use of information generated victimization of participants and threats were taken care with special attention and due regards as per recommendation during the approval from Institutional Ethics committee.

III. OBSERVATION AND RESULTS

Postponement cause study for the scheduled surgeries was conducted in the operation theaters of PGIMER Chandigarh. Data from the operation theaters was collected w.e.f 1st March to 30 September 2017. During this period there were total 174 working days and total ten surgical departments hence 1740 observations were recorded for scheduled performed and postponed surgeries.. During this period 26,662 surgeries were scheduled 21,805 surgeries were performed and 4837 surgeries were postponed and postponement Rate was 18.22% allover the institute. However total 2,466 surgeries were scheduled and 1,980 surgeries were performed and 486 surgeries were postponed with postponement rate of 19.71 % in general surgery department. Postponement rate was calculated by using the formula as under.

$$\text{Postponement Rate} = \frac{\text{Postponed Surgeries}}{\text{Scheduled Surgeries}} * 100$$

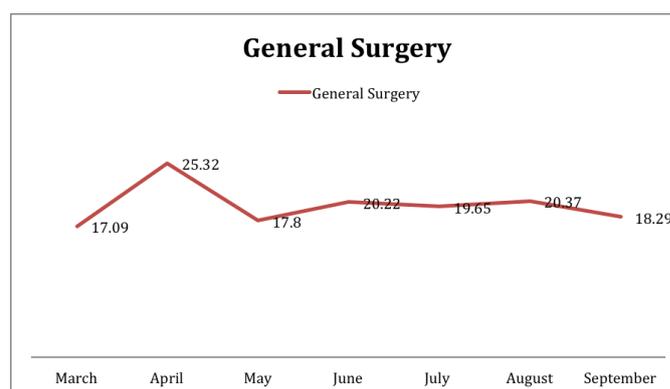


Fig.1

Month wise postponement rate of scheduled surgeries in General surgeries Department is graphically reperesented on

time trend in Fig 1. Postponement rate increases from 17.09 % to 25.32 % from the month of March to April 2017 then declined to 17.8 % in the month of May further increases to 20.22 % in the month of June. Postponement rate was 19.65% ,20.37% and 18.29 % during the month of July, August and September 2017 respectively.

Forecasting of postponement and postponement rate was done in the time series analysis through the moving average technique and results are illustrated in Figure 2 and Figure 3 respectively. Postponed surgeries were 61, 78, 68, 73, 67, 77, and 62 from the month March to September respectively. On the ground of data for the month of March, April, May and June the forecasted value for the postponed surgery during the month of July was 69.333, for the August it was 72.333, and for the September 68.666. However actual surgeries were 67, 77 and 62 during the months of July, August and September which were in the synchronicity of actual one.

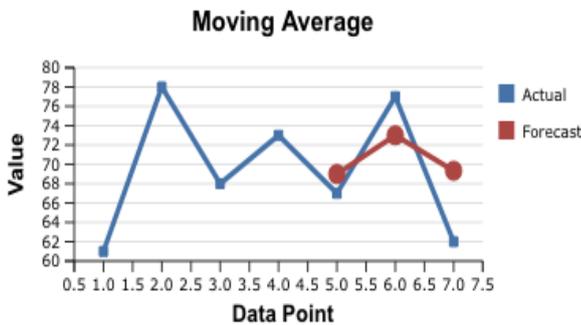


Fig. 2

Increase in the postponement of surgeries for the month of July to August and decrease in the number of postponed surgeries from August to September was forecasted from the previous data as illustrated in the figure 2 which significantly gave an insight to think upon the fixed behaviour of the surgical suite since actual trend followed the forecasted values.

Similarly on the application of moving average forecasting techniques of the postponement rate on the basis of data of March, April, May and June forecasted values of postponement rate for the month of July, August and September showed that the actual values follow the forecasted values that is synchronized increase in the forecasted postponement rates with actual postponement rate from the month July to August then synchronized decrease in postponement rate of both actual and forecasted from August to September.

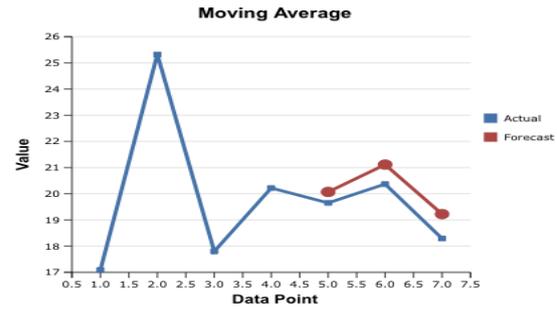


Fig. 3

Table 1 shows the statistical results of postponement forecasting of the General Surgery Operation theater Suite.

Table 1

Moving Average	Prior	Forecast	Standard Error
Variable	Postpon. GS	NaN	NaN
Length	3	NaN	NaN
Standard errors			
Denominator	3	69	NaN
		73	NaN
		69.33333	1.46566
		72.33333	3.01232
		68.66667	4.88763

- Input Indicator - Scheduled Surgeries
- Output Indicator - Performed Surgery

Postponement = Scheduled – Performed surgeries

Postponement Rate = (Postponed / Scheduled) * 100

- Throughput Indicators
 - Postponed surgeries (Independent Variable)
 - Postponement Rate (Dependable Variable)

To test the throughput, postponement Rate is plotted against Postponed surgeries for perfect linear relationship in simple linear regression Technique.

- Hypothesis: Postponement Rate has perfect Linear Relationship with the postponed surgeries.
- Null Hypothesis (H0): Postponement Rate does not have perfect linear relationship with the postponed Surgeries

Figure 3 shows the scatter diagram of postponed surgeries (X axis) independent variable with the postponement rate of seven months from March to September 2017 (Y Axis) i.e. dependable variable.

Table 2

Regression Statistics of General surgery department

d.f.	1	5	6
SS	29.43301	15.18259	44.6156
MS	29.43301	3.03652	
F VALUE	9.69302		
p-level	0.02645	H0 (5%)	Rejected

Scatter Diagram (Predicted Y, Postponment Rate GS vs. Postponment GS)

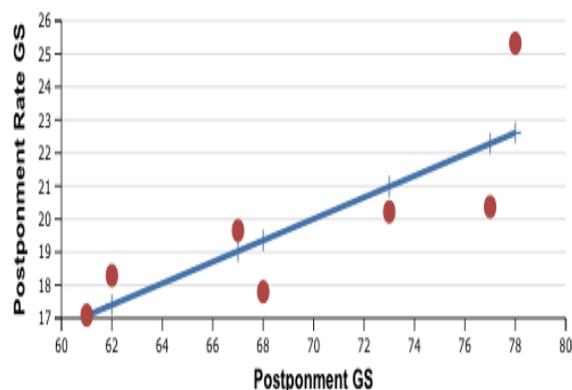


Fig 3

In table 3 regression statistics shows the p-Value 0.02645 which is less than 0.05 hence we successfully rejected the null hypothesis that is Postponment Rate does not have perfect linear relationship with the postponed Surgeries. We can say that throughput is responsible for the postponement.

IV. DISCUSSION

Postponement of scheduled surgeries results in increased consumption of various tangible resources like Financial Resources, Organizational Resources, Physical Resources, Technological Resources, The organization’s borrowing capacity, ability to generate internal funds, formal reporting structure and its formal planning, controlling, and coordinating systems. In addition to this Sophistication and location of a hospital’s plant and equipment, Access to raw materials; Stock of technology; such as patents; trademarks; copyrights, and trade secrets; take a toll. The postponement not only impact tangible resources but also to intangible resources like Human resources, Innovation, Knowledge, Trust, Managerial capabilities, Organizational routines, Ideas, Scientific capabilities; Capacity to innovate; Reputation with beneficiaries; Brand name, Perceptions of quality; durability and reliability; Reputation with stakeholder for

efficient; effective; supportive; and mutually beneficial interactions which causes depreciation of institute. These factors seem unnecessary in public sector hospital however corporate hospitals have deemed necessity for formulating different strategies to minimize postponement in constrained recourse in developing nations. During analysis of postponement causes it appears that in 80% postponements of scheduled surgeries were due to delay in previous surgery, changing patient health state, not contactable, failure to arrive, scheduling Emergency operation, were responsible. It was also observed that among the postponed surgeries 63.67 % cases were due to avoidable reasons as also suggested by Hanna et al that elective procedure were potentially avoidable and may be prevented using quality improvement techniques. Maximum postponements rates are observed during the month of April and May that may be due to the vacation of the faculty.

V. CONCLUSION

- It was evident from our study that surgical postponement rate is relatively lower than other studies conducted in India and abroad.
- Our study also concluded that only four reasons are responsible for the 80% postponement of scheduled surgeries.
- Among all postponement of scheduled surgical cases, sixty three percent was avoidable.

VI. RECOMMENDATION

- General surgery, Urology, Plastic and pediatric surgery Operation theater has predictable postponements rate and they can be further well optimized by taking appropriate operation research techniques like Linear Programming, Discrete event simulation modeling with Network Analysis.
- **Auto Regression Integrated With Moving Average (ARIMA)** models are also very useful to eliminate the residue by streamlining internal processes after the process flow analysis of each department.
- **Value Stream Mapping** (flow chart) of the processes of different surgical department. **Time Value analysis** will further helpful to identify the bottlenecks and waste can be eliminated accordingly.

REFERENCES

[1] Chalya PL, Gilyoma JM, Mabula JB, Simbila S, Ngayomela IH, Chandika AB, Mahalu W. Incidence, causes and pattern of cancellation of elective surgical operations in a university teaching hospital in the Lake Zone, Tanzania. Afr Health Sci. 2011; 11:438–43Oguntola AS, Agodrin S.O. Cancellation Of Elective Surgical Gases In A Teaching Hospital, South-Western Nigeria The Tropical Journal Of Health Sciences

- 2009; 16(1): 39-43.
- [2] González-Arévalo A, Gómez-Arnau JI, Delacruz FJ, Marzal JM, Ramírez S, Corral EM. Causes for cancellation of elective surgical procedures in a Spanish general hospital. *Anaesthesia*. 2009;64(5):487-93.
- [3] Jonnalagadda R, Walrond ER, Hariharan S, Walrond M, Prasad C. Evaluation of the reasons for cancellations and delays of surgical procedures in a developing country. *Int J Clin Pract*. 2005;59(6):716-20.
- [4] Garg R, Bhalotra AR, Bhadoria P, Gupta N, Anand R. Reasons for cancellation of cases on the day of surgery-a prospective study. *Indian J Anaesth [Internet]*. 2009;53(1):35-9.
- [5] Boker A. Causes of Last Minute Cancellation of Operative Procedures at King Abdulaziz University Hospital. *Journal of King Abdulaziz University-Medical Sciences*. 2008;15(4):31-9.
- [6] Kolawole I, Bolaji B. Reasons for cancellation of elective surgery in Ilorin [Internet]. Vol. 4, *Nigerian Journal of Surgical Research*. 2002. p. 28 a 33.
- [7] Mesmar M, Shatnawi NJ, Faori I, Khader YS. Reasons for cancellation of elective operations at a major teaching referral hospital in Jordan. *East Mediterr Heal J [Internet]*. 2011;17(8):651-5.
- [8] McIntosh B, Cookson G, Jones S. Cancelled Surgeries and Payment by Results in the English National Health Service. *Journal of Health Services Research & Policy*. 2012;17(2):79-86.
- [9] Jokhio AJ, Hussain S. Reasons for cancellation of elective surgical procedures at Chandka Medical college hospital, Larkana, Pakistan" *Rawai medical journal* 2014, 39(1); 61.
- [10] Dawlaty E, Turkistani A, Reasons Of Cancellation Of Elective Surgery In A Teaching Hospital. *The Internet Journal of Anesthesiology*. 2008;15(2).
- [11] Mahmood M, Akhter N, Cancellations of elective operations—causes in pediatric patient, *Rawal Medical Journal* 2011; 36(3).
- [12] Hovlid E, Bukve O, A new pathway for elective surgery to reduce cancellation rate *BMC Health Services Research* 2012;(12): 154.
- [13] Zafar A, Mufti TS, Griffin S, Ahmed S, Ansari JA. Cancelled elective general surgical operations in Ayub Teaching Hospital. *J Ayub Med Coll Abbottabad*. 2007;19(3):64-6.
- [14] Lopez PN, Jowett S, Mark S. The reasons for cancellation of urological surgery: A retrospective analysis. *NZ Med J*. 2012; 124:1339
- [15] Caesar U, Karlsson J, Olsson LE, Samuelsson K, Hansson-Olofsson E. Incidence and root causes of cancellations for elective orthopaedic procedures: A single center experience of 17,625 consecutive cases. *Patient Saf Surg*. 2014;8(1):1-7.
- [16] Keller A, Ashrafi A, Ali A. Causes of elective surgery cancellation and theatre throughput efficiency in an Australian urology unit. *F1000Research [Internet]*. 2014;3(0):197.
- [17] Kumar R, Gandhi R. Reasons for cancellation of operation on the day of intended surgery in a multidisciplinary 500 bedded hospital. *Journal of Anaesthesiology Clinical Pharmacology*. 2012;28(1):66.
- [18] Sultan N, Rashid A, Abbas SM. Reasons for cancellation of elective cardiac surgery at Prince Sultan Cardiac Centre, Saudi Arabia. *Journal of the Saudi Heart Association*. 2012;24(1):29-34.
- [19] Ebirim LN, Buowari DY, WI Causes of cancellation of elective surgical operations at a University Teaching Hospital *Journal of Medicine and Medical Sciences* 2012;3(5):297-301.
- [20] Hewawasam GC, Maduwanthi A. Cancellation of elective surgical procedures in the Genito-Urinary section of National Hospital of Sri Lanka – can we do better? *Sri Lankan Journal of Anaesthesiology*. 2013;21(2):68.
- [21] Schofield WN, Rubin GL, Piza M, Lai YY, Sindhusake D, Fearnside MR. Cancellation of operations on the day of intended surgery at a major Australian referral hospital. *Med J Aust*. 2005;182(12):612-5.
- [22] Jiménez A, Artigas C, Cancellations In Ambulatory Day Surgery: An Observational Study 2005;3.
- [23] Chiu CH, Lee A, Chui PT. Cancellation of elective operations on the day of intended surgery in a Hong Kong hospital: Point prevalence and reasons. *Hong Kong Med J*. 2012;18(1):5-10.
- [24] Trentman TL, Mueller JT, Fassett SL, Dormer CL, Weinmeister KP. Day of Surgery Cancellations in a Tertiary Care Hospital: A One Year Review. *J Anesth Clin Res*. 2010;1(3):1-4.
- [25] Afzal F, Asad N, Ali K. Causes of postponement of elective surgery in Mayo Hospital Lahore *Biomédica*. 2010;26:148-51.
- [26] Sung W-C, Chou A-H, Liao C-C, Yang M-W, Chang C-J. Operation cancellation at Chang Gung Memorial Hospital. *Chang Gung Med J [Internet]*. 2010;33(5):568-75.
- [27] Dadaş S, Eti-Aslan F. The causes and consequences of cancellations in planned orthopedic surgery: the reactions of patients and their families. *Journal of Orthopedic Nursing*. 2004;8(1):11-9.
- [28] Xue W, Yan Z, Barnett R, Lee F, Liu R. Different dynamics of elective case cancellation for inpatient and outpatient in an academic center. *J Anesth Clin Res*. 2013;4(5).
- [29] Talati S, Gupta A, Malhotra S, Jain A. An analysis of time utilization and cancellations of scheduled cases in the main operation theater complex of a tertiary care teaching institute of North India. *Journal of Postgraduate Medicine*. 2017;61(1):3-8.
- [30] Dawlaty A, Turkistani A, Aldohayan A, Zubaidi A. Reasons Of Cancellation Of Elective Surgery In A Teaching Hospital. *he Internet Journal of Anesthesiology*. 2007;15(2):1-5.
- [31] Haana V, Sethuraman K, Stephens L, Rosen H, Meara J. Case cancellations on the day of surgery: an investigation in an Australian paediatric hospital. *ANZ Journal of Surgery*. 2009;79(9):636-640.
- [32] Mesmar M, Satnavi N, Faori I, Khader Y. Reasons for cancellation of elective operations at a major teaching referral hospital in Jordan. *EMHJ*. 2011;17(8).
- [33] Kaddoum R, Fadlallah R, Hitti E, EL-Jardali F, El Eid G. Causes of cancellations on the day of surgery at a Tertiary Teaching Hospital. *BMC Health Services*. 2016;16(259).

- [34] Moataza M, Wahab A, Nagwa Y, El-Enein A. Statistical Process Control for Cancelled Operations at the Paediatric Surgery Department of a University Hospital in Alexandria. Egypt Public Health Assoc. 2009;84 (5&6).
- [35] Bento Vaz C. Methodology to reduce cancellations of scheduled surgeries [Internet]. 1st ed. Portugal: School of Technology and Management, Polytechnic Institute of Bragança; [cited 18 November 2016]. Available from: <http://apolo.dps.uminho.pt/icqem/2014/abstracts/D2.2.pdf>.
- [36] Schofield W, L Rubin G, Piza, M, Lai Y, Sindhusake D, R Fearnside M et al. Cancellation of operations on the day of intended surgery at a major Australian referral hospital. MJA 2005. 2005;182(12):612–615.
- [37] González-Arévalo A, Gómez-Arnau J, delaCruz F, Marzal J, Ramírez S, Corral E et al. Causes for cancellation of elective surgical procedures in a Spanish general hospital. Anaesthesia. 2009;64(5):487-493.
- [38] Keller A, Ashrafi A, Ali A. Causes of elective surgery cancellation and theatre throughput efficiency in an Australian urology unit. F1000Research. 2014;3(197):1-1.
- [39] Ebrahimipour H, Shirdel A, Rahimi M, Meraji M, Hooshmand E, Pourtaleb A et al. A Study on the Frequency and the Reasons for Cancellation of Surgical Operations in Khatam Hospital (Mashhad, Iran) in 2013. Patient Safety And Quality Improvement. 2014;2(4):156-159.
- [40] Elrahman A, A Hamza A, A El-Haj M. Cancellation of Elective General Surgical Operations at the Day of Intended Surgery. Global Journals Inc (USA). 2014;14(3).
- [41] Ehrenfeld, J, Dexter F, Adrienne B, Rothman M, Johnson M, H. Epstein R. Case Cancellation Rates Measured by Surgical Service Differ Whether Based on the Number of Cases or the Number of Minutes Cancelled. 2013;117(3).
- [42] Ebirim L, Buowari D, Ezike H. Causes of cancellation of elective surgical operations at a University Teaching Hospital. Journal of Medicine and Medical Sciences. 2017;3(5):297-301.
- [43] Trentman T, Mueller J, Fassett S, Dormer C, Weinmeister K. Day of Surgery Cancellations in a Tertiary Care Hospital: A One Year Review. Journal of Anesthesia & Clinical Research. 2010;1(3).
- [44] Kim K, Lee J. Reasons for cancellation of elective surgery in a 500-bed teaching hospital: a prospective study. Korean Journal of Anesthesiology. 2014;67(1):66.
- [45] Epstein R, Dexter F. Management Implications for the Perioperative Surgical Home Related to Inpatient Case Cancellations and Add-On Case Scheduling on the Day of Surgery. Anesthesia & Analgesia. 2015;121(1):206-218.
- [46] Rohini R, Mallikarjun J. Six Sigma: Improving the Quality of Operation Theatre. Procedia Social and Behavioural Sciences. 2011; 25:273 – 280.
- [47] Jones SS, Thomas A, Evans RS, Welch SJ, Haug PJ, Snow GL. Forecasting daily patient volumes in the emergency department. Academic Emergency Medicine. 2008 Feb; 15(2): 159-170.
- [48] G. Eason, B. Noble, and I. N. Sneddon, "On certain integrals of Lipschitz-Hankel type involving products of Bessel functions," Phil. Trans. Roy. Soc. London, vol. A247, pp. 529–551, April 1955. (*references*)
- [49] J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.
- [50] I. S. Jacobs and C. P. Bean, "Fine particles, thin films and exchange anisotropy," in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.
- [51] K. Elissa, "Title of paper if known," unpublished.
- [52] R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.
- [53] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetism Japan, p. 301, 1982].
- [54] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.