## Original article
## Effect of implication of time management principles on efficiency parameters in the cardiac catheterization laboratory

Kamal Sharma [1], Anchal Jindal[2].

[1] Associate Professor (Cardiology), UNMICRC, B.J. Medical College, Senior Interventional Cardiologist at Apollo Hospital, Ahmedabad, Gujarat.
Former consultant Intervention Cardiologist at Life Care Hospital, Ahmedabad, Gujarat.
[2]III year resident, Department of Dermatology, Smt. S.C.L Hospital, Ahmedabad,
Correspondance to  Dr. Kamal H. Sharma, E mail ID : kamalsharma1975@gmail.com

**Abstract:**

**Context:** With the increasing incidence of Coronary Artery disease in developing countries and availability of fewer resources and manpower, optimal Operating Room management is the key factor for patient care.

**Aims:** To evaluate the effect of time management principles on efficiency parameters in the cardiac cath-lab.

**Methods and Material**: Prospective interventional study was carried out on patients admitted for procedures at the cath lab amongst eight cardiologists during April 2009 to June 2009. The control period was from January 2009 to March 2009. Parameters like start time tardiness, case cancellation rate, turn over time, waiting time of the operator in the waiting area of the cath-lab and patients' waiting since hospitalization for operative slot was evaluated after the implementation of time management steps and compared with control group. Unpaired t-test was used for statistical analysis. P< 0.05 was considered as statistically significant.

**Results:** Total number of the patients were 430 (Mean $\pm$ SD, 73.75$\pm$83.63) and 590 (75$\pm$52.59) for study group and for control group respectively. Implementation of operating room (OR) management principles resulted in improvement of OR efficiency parameters reaching statistically significant reduction in start-time tardiness (P=0.023), case cancellation rate (P=0.031), turnover time (P=0.0113) and patient waiting time (P=0.025) while reduction in cardiologist waiting time did not reach statistically significant level (P=0.15).

**Conclusion:** Implementation of OR management principles in cath-lab resulted in improvement of most of the efficiency parameters in patient management.

**Key-words:** OR Efficiency parameters, Time management

### Introduction:

Coronary heart disease is a leading cause of mortality in the world, accounting for almost 17 million deaths annually. Nearly 80% of this global mortality and disease burden occurs in developing countries[1] and projections show that this will still be the case in 2025.[2] Optimal resource utilisation to tackle this huge burden is a key area. Operating room (OR) management is a new subset of hospital management and entails not only optimal utilization of OR resources but also of time slots by various operators. The same holds true for Catheterization Laboratory (cath-lab) for cardiology since "Time is muscle". However, fewer cath labs and especially fewer trained operators mark the importance of time management, with efforts directed towards maximizing resource efficiencies. Mismanagement in the cath-lab not only results in time delays of both the doctor and patient care but also lead to frustration amongst the patients and operators involved, apart from under utilization of resources.
Personal time management skills like **Goal setting, Prioritization**, **Managing**

**Interruptions, Procrastination and Scheduling** are essential tools for effective utilization of Resources. Various efficiency parameters[3] were predefined, based on other time efficiency parameter studies [3,4,5]. In this study, following parameters were used for quantitative assessment for time management in cath-lab:

1. Start-time tardiness: Mean tardiness of start times for elective cases per OR per day i.e. the time delay between scheduled time and actual beginning of the procedure.

2. Case cancellation rates (overnight case cancellation): Cancellation rates vary among facilities, depending partly on the types of patients receiving care. Monitoring the cancellations correctly is calculated by taking the ratio of the number of cancellations to the number of scheduled cases.

3. Turnover time: It is the time from when one patient exits an OR until the next patient enters the same OR. Turnover times include cleanup times and setup times, and not delays between cases.

4. Patient waiting time[4] : Time from hospitalization to shifting to an OR.

5. Cardiologist waiting time: Time from operator's arrival to OR to his getting washed up in OR for that case.

For timely intervention and treatment, the effect of various time management principles in cath-lab has been analyzed in this study, considering it as important marker of patient management.

**Subjects and Methods:**

This interventional single centre study was carried out at a private hospital of Ahmedabad city for three consecutive months (April 2009 to June 2009). All the patients undergoing procedure in cath-lab during this period were recruited in the study (study group). All eight Cardiologists working in this cath lab centre during this

period were included in the study. Apart from this cath lab centre, all cardiologists use to operate at atleast one more cath lab centre, which influenced OR utilization efficiently. Three of the eight cardiologists also had their OPD consultation in the same premises and it tended to run simultaneously with procedures in cath lab. Practice pattern in this part of India is determined by "patient and referral doctor preferred cardiologist" approach instead of divided emergency scheduling of cases. Hence the numbers amongst the operators were uneven.

Based on the principles of time and OR management, following steps were taken with effect from 1st of April 2009 in terms of cath-lab (Operating Room) management policy :-

1. 1. Assigning duty of cath-lab manager[5] to an assistant doctor and a senior cath-lab technician. They were assigned to coordinate for the slots and timings amongst all the operators based on their schedule by calling all the cardiologist in the morning for scheduling their respective cases based on the operator and cath lab availability. This did not incurr any additional cost. Similar methods are being employed by some but not all the corporate hospitals in the city. However there are no published data about the OR management from India to our knowledge and to our knowledge this study is first of its kind to implement OR management principles in cath lab.

2. All operators were briefed about tentative cath-lab schedule of planned cases.

3. Shorter duration cases and diagnostic procedures (like angiography) were given priority over planned longer and therapeutic procedures (like angioplasty).

4. Early start rather than late start strategy was preferred for optimal utilization of available resources.

Cath lab tended to start for planned cases at 1000 hrs or so before implementing the policy but during the study period certain cardiologist, who found it suitable, started their cases around 0800 hrs or so.

5. Procedural route selection i.e. Radial or femoral route was left to operators experience and judgment and lesser on the demands of the patients to optimize time management.

6. If the time anticipated for making a decision for an "ad hoc interventional procedure" (like angioplasty) was more after a diagnostic procedure (like angiography) by relatives , then that time was utilised for another diagnostic procedure (angiography) or short operation, thus utilizing the OR for the same time.

Five efficiency parameters: start time tardiness, case cancellation time, turn over time, waiting time of the operator in the waiting area of the cath-lab and patient waiting time since hospitalization for operative slot were evaluated after the implementation of time management steps. The control period was from January 2009 to March 2009 and all the patients ("all-comers") operated during this duration by the same eight cardiologists in this cath-lab were included in the control group, for which data was collected on retrospective basis for the same parameters . Comparison was done to evaluate the effect of application of time management principles.

Data thus collected was entered in the master chart and statistically analysed using unpaired t-test to evaluate the effect of time management principles in our hospital settings. Statistical analysis was done by using software epi-info version 6.0. P< 0.05 was considered as statistically significant.

**Results:**

In the present study, total number of the patients were 430 (Mean$\pm$ SD, 73.75 $\pm$ 83.63) and 590 (75 $\pm$ 52.59) for study group and for control group respectively amongst eight operators (Table 1). Following are the results of various efficiency parameters that were evaluated:

1. Start time tardiness: For control group, Mean=22.8. Standard Deviation (SD) = 9.73 .For intervention study group, Mean = 13.7.SD = 2.23. After implementation of management principles, statistically significant reduction was found in start-time tardiness (P=0.023). (Table 2)

Table 1: Personal characteristics:

| | Control study period (Jan 2009 - March 2009) | Intervention study period (April 2009 - June 2009 ) |
|---|---|---|
| Total number of operators | 8 | 8 |
| Total number of patients | 590 | 430 |

2. Turnover time: For Control group, Mean = 24.2. SD = 10.8. For intervention study group, Mean = 12.0. SD = 1.53. Statistically significant reduction was found in turn over time (P=0.0113). (Table 3)

3. Patient waiting time: For control group, Mean = 184. SD = 77.2. For intervention study group, Mean = 115. SD = 10.7. Statistically significant reduction was found in patient waiting time after application of management principles (P=0.025). (Table 4)

**Table 2: Start Time Tardiness (with mean value) in Control and Intervention study group:**

| Operators | Control group | | Intervention study group | |
|---|---|---|---|---|
| | Total STT(min) | Mean STT per patient | Total STT(min) | Mean STT per patient |
| A | 6368 | 24.21 | 1675 | 11.3 |
| B | 1622 | 21.91 | 1122 | 9.59 |
| C | 1653 | 27.09 | 508 | 13.4 |
| D | 624 | 27.13 | 413 | 14.8 |
| E | 162 | 32.4 | 63 | 15.8 |
| F | 2321 | 26.07 | 503 | 14.8 |
| G | 0 | 0 | 32 | 16 |
| H | 1764 | 23.52 | 805 | 13.6 |
| Gross Total | 14514 | 22.8 | 5121 | 13.7 |

**Table 3: Turnover Time (with mean values) in Control and Intervention study group:**

| Operators | Control group | | Case group | |
|---|---|---|---|---|
| | TOT (min) | Mean value | TOT(min) | Mean value |
| A | 6937 | 26.37 | 1732 | 11.7 |
| B | 1678 | 22.67 | 1279 | 10.93 |
| C | 1741 | 28.54 | 401 | 10.55 |
| D | 724 | 31.47 | 312 | 11.14 |
| E | 178 | 35.6 | 49 | 12.25 |
| F | 2411 | 27.09 | 403 | 11.85 |
| G | 0 | 0 | 31 | 15.5 |
| H | 1612 | 21.49 | 706 | 11.96 |
| Gross Total | 15281 | 25.9 | 4913 | 11.42 |

**Table 4: Patient waiting time (with mean value) in control and Intervention study group:**

| Operators | Control group | | Intervention study group | |
|---|---|---|---|---|
| | PWT(min) | Mean value | PWT(min) | Mean value |
| A | 59793 | 227.35 | 19741 | 133.38 |
| B | 14889 | 201.2 | 13007 | 111.17 |
| C | 13242 | 217.08 | 4352 | 114.52 |
| D | 4425 | 192.39 | 3218 | 114.92 |
| E | 1186 | 237.2 | 421 | 105.25 |
| F | 19934 | 223.98 | 4120 | 121.17 |
| G | 0 | 0 | 245 | 122.5 |
| H | 13121 | 174.95 | 5821 | 98.66 |
| Gross Total | 126590 | 214.56 | 50925 | 118.43 |

**Table 5: Cardiologist waiting time (with mean value) in Control and Intervention study group:**

| Operators | Control group | | Intervention study group | |
|---|---|---|---|---|
| | CWT(min) | Mean value | CWT(min) | Mean value |
| A | 7028 | 26.72 | 3403 | 22.99 |
| B | 2479 | 33.5 | 2412 | 20.61 |
| C | 1812 | 29.70 | 768 | 20.21 |
| D | 877 | 38.13 | 576 | 20.57 |
| E | 165 | 33 | 83 | 20.75 |
| F | 2687 | 30.19 | 701 | 20.61 |
| G | 0 | 0 | 43 | 21.5 |
| H | 2003 | 26.70 | 1212 | 20.54 |
| Gross Total | 17051 | 28.3 | 9198 | 21.39 |

**Table 6: Case cancellation rate (%) in Control and Intervention study group:**

| Operators | Control group | | Intervention study group | |
|---|---|---|---|---|
| | CCR (%) | Mean value | CCR (%) | Mean value |
| A | 9 | 3.42 | 2 | 1.35 |
| B | 2 | 2.70 | 1 | 0.85 |
| C | 2 | 3.27 | 0 | 0 |
| D | 1 | 4.34 | 0 | 0 |
| E | 0 | 0 | 0 | 0 |
| F | 3 | 3.37 | 1 | 2.94 |
| G | 0 | 0 | 0 | 0 |
| H | 1 | 1.33 | 0 | 0 |
| Gross Total | 18 | 3.05 | 4 | 0.93 |

**Table 7:  Measurement of  Efficiency  Parameters:**

| Efficiency Parameters | Control (n=590) | | | | Cases(n=430) | | | | P* value |
|---|---|---|---|---|---|---|---|---|---|
| | Gross Total | Mean value | SD of mean | 95% CI value for mean | Gross Total | Mean Value | SD of mean | 95% CI value for mean | |
| Start-time tardiness | 14514 min. | 22.8 min | 9.73 | 17.44$\pm$28.15 | 5121 min. | 13.7 min | 2.23 | 8.29$\pm$19.01 | 0.023 |
| Case cancellation rate | 18 | 2.31 % | 1.66 | 1.25$\pm$3.36 | 4 | 0.643 % | 1.06 | -0.412$\pm$1.64 | 0.031 |
| Turnover Time | 15281 min. | 24.2 min | 10.8 | 18.33$\pm$29.98 | 4913 min. | 12.0 min | 1.53 | 6.161$\pm$17.81 | 0.0113 |
| Patient waiting time | 126590 min | 184 min | 77.2 | 142.5$\pm$226.1 | 50925 min. | 115 min | 10.8 | 73.41$\pm$157.0 | 0.025 |
| Cardiologist waiting time | 17051 min. | 27.2 min | 11.6 | 20.99$\pm$33.50 | 9198 min. | 21.0 min | 0.894 | 14.72$\pm$27.23 | 0.15 |

*P value <0.05 is considered as statistically significant.

4. Cardiologists' waiting time: For control group, Mean = 27.2. SD = 11.6. For intervention study group, Mean = 21. SD = 0.894. The reduction in cardiologists waiting time was statistically not significant. (P=0.15). (Table 5)

5. Case cancellation rate: For control group, Mean = 2.31. SD = 1.66. For intervention study group, Mean = 0.643. SD = 1.06. Statistically significant reduction was found in case cancellation rate (P=0.031). (Table 6)

Measurement of efficiency parameters with P value are shown in Table 7. Overall 9393 minutes of start time tardiness, 75665 min of patient waiting time and 10368 min of patient turn over time were saved in intervention phase. This saved time can be utilized for improving patient care and OR management. Also there was reduction of cancellation rate from 3.05% to 0.95 % in the intervention period as compared to pre intervention period. There was also trend towards reduction in cardiologist waiting time with reduction of 7853 min but this did not reach statistically significant level. (Above results were obtained by subtracting gross total time of study group from that of control group for each parameter – Table 7).

**Discussion:**

Operating Room Management is the science of how to run an Operating Room Suite. Operational Operating Room Management focuses on maximizing operational efficiency at the facility, i.e. to maximize the number of surgical cases that can be done on a given day while minimizing the number required resources and related costs. This study was envisaged to extend these principles for cath-lab management.

In the present study, there were more number of cases in January to March, 2009 (pre interventional period/ control period) as compared to April to June 2009 (Interventional period/ study period). This variability may be due to seasonal factors and marriage season in second half in India and more leaves utilized by the cardiologist during the same period.

In present study, early start of the procedure helped in reduction of start time tardiness. Assigning the duty to an assistant doctor or senior cath-lab technician as cath-lab manager improved the cath-lab efficiency in terms of reduction in start time tardiness and patient waiting time. Knowledge of schedule also resulted in the improvement in case cancellation rate and turn over time[6, 7]. Prioritizing short procedure over longer, improved on-time performance and decreased staff member overtime expense and turn over time.[8]

Application of OR management principles in cath-lab improved most of the efficiency parameters. Though waiting time of cardiologist reduced but, still remained below the statistically significant level in the current study. Further studies need to be conducted, applying various management principles and eventually it may lead to reduction in this parameter as well to a level of significance. As elucidated in the study, application of OR management principles is easy and inexpensive. Also it can be adopted by other cath labs as well as other sub specialities like advanced imaging modalities which are underutilized due to scarcity of resources. The total number of procedures along with operating room utilization can be increased more markedly in terms of time as well as cases[9].

Other OR management principles like bin packing algorithms, parallel processing and resource management can also be studied to analyze further impact on patient care and management with improvement in efficiency parameters. To conclude, time

management in cath-lab has proved to be an effective tool to increase the efficiency of patient management and resource utilization under this study. Improvement in OR efficiency can reduce duration of hospital stay and fasten the diagnostic or therapeutic procedure schedule of the patient. Application of OR management principles as adopted in this study can help in more efficient utilization of resources in populous nations and areas where patients outnumber the available resources.

**Acknowledgement:**

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