



OPERATING-ROOM SCHEDULING  
AT TUCSON MEDICAL CENTER,  
TUCSON, ARIZONA

APPROVED BY THE U. S. ARMY MEDICAL FIELD SERVICE SCHOOL:

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Director of the Program

A Problem Solving Thesis  
Submitted to the Faculty of  
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APPROVED BY THE PROJECT COMMITTEE:

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Requirements for the Degree  
of

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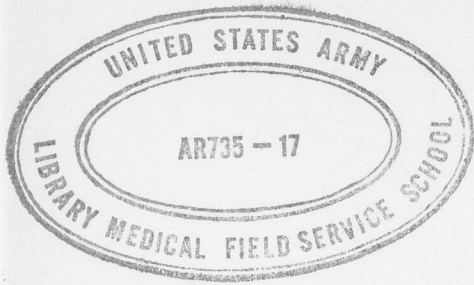


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In an effort to accommodate this increasing surgical workload, elective operating room time was extended into the evening shift.

Although this extension of elective surgery schedule appeared to give an immediate relief to the problem, the surgical staff has now

requested the construction of additional operating rooms in order that

the elective surgery be extended into the evening shift. Prior to approving construction of additional operating

### Statement of the problem

The problem is to determine a scheduling system which will maximize utilization of the current operating rooms at Tucson Medical Center. Utilization of the present operating rooms would eliminate the need for

### Conditions which prompted the study

The Tucson Medical Center is a modern 555 bed general hospital located on the outskirts of present day Tucson. The hospital was originally built in 1927 as a privately-owned desert sanatorium to accommodate patients suffering from lung diseases and arthritis. Subsequent to World War II, the sanatorium was deeded to the community for the purpose of converting it into a community hospital. At the present time Tucson Medical Center serves a community of over 325,000 people and is one of three hospitals within the community providing non-governmental health care.<sup>1</sup>

The following terms are used in this report in the sense that they are defined below:

#### 2. Anesthetist

A nurse who administers anesthetics under the supervision of an anesthesiologist.

The total number of hospital beds has increased since 1959 from 472 to its present capacity of 555 of which 232 are surgical beds. During this same period the number of surgical cases performed has increased from 500 to over 800 per month, with no increase in the number of operating rooms available.

Other equipment necessary for the next surgical case.

4. Day In an effort to accommodate this increasing surgical workload, elective operating room time was extended into the evening shift.

Although this extension of the elective surgery schedule appeared to give an immediate relief to the problem, the surgical staff has now requested the construction of additional operating rooms in order that the elective surgery schedule does not have to be extended into the evening shift. Prior to approving construction of additional operating rooms, the hospital administrator wants to know to what extent the present operating rooms are being utilized and whether better utilization of the present operating rooms would eliminate the need for additional operating rooms.

#### Definitions

The following terms are used in this report in the sense that they are defined below:

##### 1. Anesthesiologist

A physician who limits his practice to the administration of anesthetics.

##### 2. Anesthetist

A nurse who administers anesthetics under the supervision of an anesthesiologist.

##### 3. Cleanup and setup time

The time it takes to clean the operating room after completion of a surgical case plus the time it takes to setup the instruments and other equipment necessary for the next surgical case.

4. Day shift

The hours from 7:30 A.M. to 3:30 P.M.

12. Operating-room time5. Evening shift

The hours from 3:30 P.M. to 11:30 P.M.

6. Finish anesthesia

The time the anesthesiologist or anesthetist has discontinued the administration of an anesthetic agent and the patient is ready to leave the operating room.

14. Start anesthesia7. Incision time

The time the surgical procedure begins after the area of incision has been prepared and the patient draped.

8. Night shift

The hours from 11:30 P.M. to 7:30 A.M. in the surgical suite

9. Operating-room schedule

A daily log maintained by the operating room department which contains the patient's name, age, identification number, surgeon, and operating room number of the surgical cases to be performed.

10. Operating-room secretary

An employee who, under the supervision of the operating-room supervisor, is in charge of scheduling surgical procedures to be performed in the operating rooms.

11. Operating-room supervisor

A registered nurse in charge of the management of the

surgical suit.

12. Operating-room time

The time from the start of anesthesia to the finish of anesthesia.

13. Patient arrival

The time at which the patient arrives in the operating room suite.

14. Start anesthesia

The time when any anesthesiologist or anesthesiologist performs any procedure in the operating-room which is necessary for the administration of an anesthetic agent.

15. Surgeon arrival

The time at which the surgeon arrives in the surgical suite ready to scrub.

16. Operative procedure

In this study is used synonymously with the term surgical case and includes all surgery performed on a patient.

Criteria

The following criteria were established for the study to allow consistency and, consequently, meaningful observations and data:

1. A room must be capable of supporting the full gamut of general surgical operations to be considered an operating room.

2. Any definitive procedure performed in an operating-room, by choice or common practice, is to be counted as an operation.

3. Any operative procedure, regardless of its nature, is to be accepted as an emergency if so scheduled by the surgeon.

4. Any procedure not termed an emergency by the surgeon is to be considered elective surgery, whether or not it is accomplished during the normal daytime schedule.

5. An operating-room which is being cleaned or setup for an operation is to be considered in use even though no patient is present.

6. An empty operating-room is to be regarded as unused when it is ready to receive a patient.

7. Operating-room disuse due to delays, cancellations, or non-scheduling is to be recorded as nonutilized time during the day shift and the evening shift in those rooms designated for scheduled surgery.

8. The main criterion for judging the effectiveness of utilization of the operating room is to be the percentage of the total available scheduled hours utilized.

#### Assumptions

This study is based on the following assumptions:

1. That the surgical workload will continue at, or near, its current rate.

2. That there are no immediate plans to build additional beds at Tucson Medical Center or make additional surgical beds available by any other means.

3. That the type of patients currently admitted and the types of surgical procedures currently being performed will not change significantly.

4. That an adequate number of nursing service personnel will remain available to staff the operating rooms.

#### Limitations

This study will be limited to the six general operating rooms and will not include the cystoscopy, cast, special procedures or minor surgery rooms. These rooms do not present a problem in utilization, since only specific type procedures can be performed in them and they cannot substitute for general surgery rooms except in an emergency.

#### Review of the Literature

To determine operating-room utilization, it is necessary to determine what portion of time of the total daily period available for surgery is unused. Operating-room time is considered unused only when a room is fully prepared for surgery. Used time, on the other hand, includes periods when a room is being cleaned or being setup for the next case, as well as when it is occupied by a patient undergoing anesthesia, preparation, surgery, or resuscitation. The biggest losses of operating-room time are nonscheduled periods, cancellations, and delayed starts.<sup>2</sup> Scheduling by allotting certain operating-rooms or certain days to each of the various surgical specialty services contributes to unused time. When one service fails to use its time, it is often not made available to others soon enough to schedule their cases.<sup>3</sup>

Central scheduling has been offered as a way to control the variability between available and utilized operating-room time.<sup>4</sup> In this method, all services and surgeons have equal daily access to all operating rooms through a single scheduling agency.

There is a tendency for operating-rooms to function mostly in the mornings and not fully utilize the afternoons.<sup>5</sup> A better balance and more surgery are possible by scheduling throughout the day and utilizing Saturdays for scheduled surgery.

Other considerations in operating-room utilization must include the time required for cleanup and setup, the patient's arrival time to the operating room from the hospital ward, and the surgeon's arrival time.<sup>6</sup>

Inefficient scheduling is the most common cause of poor operating-room utilization. For the patient's interest, which is paramount, the surgeon, once he begins an operation, should not feel pressured by the schedule, but should take the time necessary to perform the surgery properly. The core of the problem then is to accurately estimate the length of time required for each case.<sup>7</sup>

#### Problem-Solving Methodology

The approach to the problem was to initially observe the present method of operation and management of the surgical suite and interview selected personnel. The personnel interviewed included the assistant administrator in charge of the operating-rooms, the operating-room secretary, the chief of anesthesiology and other anesthesiologists, and members of the surgical staff.

The operating-rooms were then observed specifically to determine the causes of unutilized operating-room time.

Data was collected from the hospital's operation reports to represent a twelve week period and included the months of July, September, and November 1970. The effective operating-room utilization time was determined by recording the total time required for each operation. The time was from the start of anesthesia to the finish of anesthesia. Twenty minutes was allocated for cleanup and setup time after each operation. The total amount of utilized operating time was determined for both the day and evening shifts. The amount of time utilized for both scheduled and emergency surgery was determined for both weekdays and Saturdays.

The operation reports were then analyzed to obtain the thirty-five most commonly performed operations. An estimate for the time required to perform each of these operations was obtained by determining the most optimistic time, denoted by " $t_o$ ," which was the shortest time in which the operation was performed; the pessimistic time designated by " $t_p$ ," which was the maximum time required to perform the operation; and then the most likely time, designated by " $t_m$ ," which represented the median of the times the operation took to perform. Using these three times, an expected time for the completion of an operation was obtained. The expected time can be thought of as an average for the probability distribution of completion times. An approximation for the expected value of this distribution is:

$$t_e = \frac{t_o + 4 t_m + t_p}{6}$$

This approximation can be thought of as a weighted average of the three values with more than four times as much emphasis placed on the most likely value than on the pessimistic or optimistic values.<sup>8</sup> These estimated times can then be used as a guide to scheduling of surgical cases.

#### Footnotes

<sup>1</sup>Carolyn B. Durbin, History of Tucson Medical Center (Tucson Arizona: By the author, 5031 East Grand Rd., 1965), Chapter 1.

<sup>2</sup>Wilson L. Williams, "Improved Utilization of the Surgical Suite," Hospitals, XLV (March, 1971), 93.

<sup>3</sup>Otto C. Zimmerman, "Utilizing Operating-Room Time," Hospital Topics, XLI (February, 1963), 102.

<sup>4</sup>Gordon J. Davis and Ruddell Reed, Jr., "Variability Control is the Key to Maximum Operating Room Utilization," The Modern Hospital, CII (April, 1964), 116.

<sup>5</sup>Alice R. Clark, "Challenging New Study Made of Traditional O.R. Practices," Hospital Topics, XXXVIII (March, 1960), 86.

<sup>6</sup>Morris London, "Know Your O.R. Vacancy Rate to Improve Surgical Scheduling," The Modern Hospital, CIII (October, 1964), 113.

<sup>7</sup>Ernest T. Sheen, "A Realistic Surgery Schedule Based on Surgeon's Own Estimates," Hospitals, XXXVII (November, 1963), 50.

<sup>8</sup>Robert E. Schellenberger, Managerial Analysis (Homewood, Illinois. Richard D. Irwin, 1969), Chapter 17.

## CHAPTER II

### DISCUSSION

#### Present System

On weekdays the six general operating-rooms are used for scheduled surgery during the day shift and two operating rooms are staffed for scheduled surgery during the evening shift, plus one room for emergency cases. During the night shift only emergency surgery is performed. On Saturdays, four general surgery rooms are used for scheduled surgery during the day shift and one room is used for scheduled surgery on the evening shift, plus one room for emergency surgery.

Surgical cases are scheduled by the operating-room secretary. If the request is made by the surgeon's secretary, the operating-room secretary will estimate the time required for the case to be completed. If the surgeon schedules the case, the operating-room secretary will ask the surgeon how much time he will need to perform the case. Only fifteen surgical admissions per day are authorized since surgical beds are now being used at maximum capacity. Surgery cannot be scheduled when this limit has been reached, unless the patient to be scheduled is already a patient in the hospital. Pediatric patients are considered medical bed admissions. At the present time there is a three week waiting time to schedule elective surgery.

The surgical staff are all private physicians who maintain their offices outside the hospital and perform surgery at either one or more hospitals, although most of them perform most of their surgery at one hospital. The anesthesiologists and anesthesiologists belong to a private group who maintain an office outside the hospital but do almost all of their work at Tucson Medical Center. No other anesthesiologists or anesthesiologists provide services at Tucson Medical Center.

#### Causes of Unutilized Time

The following observations were made relating to operating-room utilization time:

1. No excessive delay existed in cleanup and setup time between cases with an average time of fifteen minutes observed.
2. Adequate coverage of the operating-rooms was rendered by the anesthesia service, and there were no apparent delays caused by this service. From the time the patient entered the operating-room and anesthesia started averaged five minutes.
3. No delays in the patient arrival time to the operating-room suite from the hospital wards were apparent.
4. No attempt was made to begin cases scheduled for 7:30 A.M. on time, although the operating-rooms were setup and staffed. Surgeons scheduled to begin surgery at 7:30 A.M. usually arrived at 7:30 A.M. or later and the surgical procedure was usually begun near 8:00 A.M. This appeared to be accepted practice by all concerned.

5. A lack of understanding or concern seemingly existed as to whether a case scheduled for a specific time, such as 10:00 A.M., was meant to start at 10:00 A.M., or the surgeon was to arrive at this time. When questioned, almost everyone concerned indicated that the scheduled time meant incision time but none expected this to be the case. Few incisions were observed being made prior to, or at, the scheduled time; and the usual observation was that the patient was just being brought into the operating-room at the time for which the operation was scheduled to begin.

6. The most obvious cause for lack of utilization of operating-room time was the method of scheduling cases. There was an excessive estimate of the time an operation would take to be performed, and thirty minutes was added to each estimate for cleanup and setup time. After the first case was scheduled for the day each succeeding surgeon was given an exact time his case would start based on these estimates. This method of excessive estimation of operating time and cleanup and setup time was a conscious effort to avoid any conflicts in starting times. Although this method caused unutilized operating-room time of thirty to sixty minutes between cases in many instances, there was little to no effort made to adjust the schedule during the day to eliminate this unutilized time.

7. A common practice of scheduling a case for a specific time of the day with an earlier time still open was observed. An example was a case scheduled for 11:00 A.M. with the rest of the morning schedule still open. This resulted in the remainder of the schedule being adjusted around this one case and meant unutilized operating-room

time to assure that the room was available at 11:00 A.M.

8. Also observed was the scheduling of cases for 8:00 A.M. because the surgeon did not want to begin at 7:30 A.M. This resulted in thirty minutes of unutilized operating-room time. There was also preference given to senior and "favorite" surgeons in scheduling room time.

9. Surgery was scheduled for the evening schedule, at the request of the surgeon, before the day schedule was filled. This practice encourages the use of the evening shift for elective surgery instead of attempting to perform all elective surgery during the day shift.

10. There appeared to be a conscious effort to avoid the hours of noon to 1:00 P.M. in scheduling, and at least one or two rooms were usually not being utilized during this period.

11. The majority of scheduled surgery during the evening shift is not elective surgery, but urgent surgery; and is scheduled within the previous twenty-four hours.

12. The neurosurgery and cardiovascular surgery services account for most of the scheduled night surgery and this usually consists of long cases which were started late in the day shift.

#### Presentation of Data

Operation reports were reviewed for a twelve week period, including the periods of July, September, and November 1970. Holidays and Sundays were excluded. Added to the time required for each case was twenty minutes for cleanup and setup time. The following data was obtained:

1. The six general surgery rooms are utilized at 77.0 per cent effectiveness during the day shift on weekdays. There is a range of utilization from 59.4 to 100.0 per cent (Table 1).

TABLE 1

UTILIZATION OF OPERATING-ROOM TIME DURING DAY SHIFT ON WEEKDAYS FOR TWELVE WEEK PERIOD

Total Hours Available	Hours Utilized	Hours Not Utilized	Percent Utilization
2,880	2,237.6	652.4	77.0

Non-utilized hours averaged 8.7 hours a day with a range from 0 to 16.5 hours. These figures include all surgery performed during the day shift and include cleanup and setup times.

2. During the evening shift the two rooms used for scheduled surgery on the weekdays were utilized at 41.0 per cent effectiveness with a range of 0 to 100.0 per cent (Table 2).

TABLE 2

UTILIZATION OF OPERATING-ROOM TIME DURING EVENING SHIFT ON WEEKDAYS FOR TWELVE WEEK PERIOD (SCHEDULED SURGERY)

Total Hours Available	Hours Utilized	Hours Not Utilized	Percent Utilization
960	393.75	566.25	41.0

There was an average of 6.6 hours a day of surgery scheduled during the evening shift with a range of 0 to 16.5 hours.

3. The four general surgery rooms used during the day shift on Saturdays were utilized at 73.4 per cent effectiveness with a range of 51.6 to 85.2 per cent (Table 3).

TABLE 3

UTILIZATION OF OPERATING-ROOM TIME DURING  
DAY SHIFT ON SATURDAYS FOR TWELVE  
WEEK PERIOD

Total Hours Available	Hours Utilized	Hours Not Utilized	Percent Utilization
384	282	102	73.4

The one room used for scheduled surgery during the evening shift on Saturdays was utilized at 31.6 per cent effectiveness with a range of 0 to 75.0 per cent (Table 4)

TABLE 4

UTILIZATION OF OPERATING-ROOM TIME DURING  
EVENING SHIFT ON SATURDAYS FOR TWELVE  
WEEK PERIOD (SCHEDULED SURGERY)

Total Hours Available	Hours Utilized	Hours Not Utilized	Percent Utilization
96	30.4	65.6	31.6

There was an average of 2.5 hours utilized a day with a range of 0 to 6 hours on this shift.

4. There was a 65.5 per cent utilization of the one room reserved for emergency surgery during the evening shift on weekdays (Table 5) and 62.0 per cent on Saturdays (Table 6).

TABLE 5

UTILIZATION OF OPERATING-ROOM TIME DURING EVENING SHIFT ON WEEKDAYS (EMERGENCY SURGERY) FOR TWELVE WEEK PERIOD

Total Hours Available	Hours Utilized	Hours Not Utilized	Percent Utilization
880	576	304	65.5

TABLE 6

UTILIZATION OF OPERATING ROOM TIME DURING EVENING SHIFT ON SATURDAYS (EMERGENCY SURGERY) FOR TWELVE WEEK PERIOD

Total Hours Available	Hours Utilized	Hours Not Utilized	Percent Utilization
96	59.35	36.65	62.0

The amount of emergency surgery performed during the evening shift ranged from 0 to 12 hours an evening.

5. The estimated times required to perform the 35 most commonly performed operations are shown in Table 7.

\*Estimated time is rounded to next highest 0.25 of an hour.

TABLE 7

ESTIMATED TIME REQUIRED TO PERFORM THE  
THIRTY-FIVE MOST COMMONLY PERFORMED  
OPERATIONS (HOURS)

Operation	Shortest Time (to)	Longest Time (tp)	Most Likely Time (tm)	*Estimated Time (te)
Abdominal-perineal resection	3.0	7.0	3.5	4.0
Aneurysmectomy, abdominal	2.0	5.0	2.25	2.75
Breast biopsy	0.5	1.0	.75	.75
with simple mastectomy	1.25	2.5	2.0	2.0
with radical mastectomy	2.25	3.25	2.5	2.75
Bronchoscopy	0.25	0.75	0.5	0.5
Cholecystectomy	1.0	2.5	2.0	2.0
Common duct, operation on	1.5	3.0	2.5	2.5
Colectomy, partial or total	1.5	4.0	3.0	3.0
Colostomy closure	1.0	1.75	1.5	1.5
Dilatation and curettage	0.5	0.75	0.5	0.75
Endarterectomy, carotid	1.25	3.25	2.0	2.25
Eye surgery				
Cataract	0.75	1.5	1.0	1.25
Enucleation	1.0	1.75	2.25	2.0
Muscle resection	1.0	1.5	1.25	1.25
Gastrectomy, partial	1.5	3.5	2.5	2.5
Hemorrhoidectomy	0.5	1.0	0.75	0.75
Hip nailing	1.5	2.5	2.0	2.0
Hip prosthesis, insertion of	1.5	2.5	2.25	2.25
Herniorrhaphy, inguinal	0.75	2.0	1.0	1.25
Herniorrhaphy, pediatric	0.5	1.5	1.0	1.0
Hysterectomy, abdominal	1.25	3.0	2.0	2.25
Hysterectomy, vaginal	1.0	2.5	2.0	2.0
Menisectomy	0.75	2.0	1.0	1.25
Nephrectomy	2.25	3.0	3.0	3.0
Nerve transplant, ulnar	1.25	1.5	1.75	1.75
Pacemaker power pack replacement	0.75	1.25	1.0	1.0
Pulmonary resection	2.0	4.0	3.0	3.0
Salpingo-oophorectomy, abdominal	0.75	1.5	1.0	1.25
Salpingo-oophorectomy, vaginal	0.75	1.25	1.0	1.0
Sigmoidoscopy	0.4	0.5	0.5	0.5
Sympathectomy, lumbar	0.75	1.0	1.5	1.25
Tonsillectomy	0.5	1.0	0.75	1.0
Thyroidectomy	1.5	3.0	1.75	2.0
Vagotomy and pyloroplasty	1.75	2.25	2.0	2.0

\*Estimated time is rounded to next highest 0.25 of an hour.

will still be performed after the elective surgery schedule for that day, which in most cases would be performed during the evening shift.

A three to four week wait for elective surgery is reasonable since most patients desire at least this amount of time to arrange their personal affairs.

### CHAPTER III

### CONCLUSION

#### Conclusions

The findings led to the conclusions that utilization of the general surgery operating-rooms can be improved by a more efficiently organized scheduling system. Scheduled surgery performed during the evening shift can be performed during the day shift if urgent surgery is classified as emergency surgery. At the present time the majority of scheduled surgery during the evening shift is not elective surgery, but is urgent surgery which has been scheduled within the previous twenty-four hours. With this new classification two operating-rooms an evening would be needed for emergency surgery but no room would be needed for elective surgery. The two rooms reserved for emergency surgery would be able to handle any overlap from the day schedule and there would be one less room used during the evening shift. There is also no indication for elective surgery being performed during the evening shift on Saturdays.

There is no indication for additional operating rooms. Additional operating rooms would only shorten the present three to four week waiting time for elective surgery and would not solve the problem of the large amount of urgent surgery which is performed. This surgery must be performed within twenty-four hours of admission and

will still be performed after the elective surgery schedule for that day, which in most cases would be performed during the evening shift. A three to four week waiting time for elective surgery is reasonable since most patients desire at least this amount of time to arrange their personal affairs.<sup>1</sup>

#### Recommendations

It is recommended that:

1. The chief of surgery should insure that the elective surgery schedule begin at 7:30 A.M. in all rooms and all other cases be scheduled to follow with no specific starting times given. The surgeon would be informed of the number and types of cases he is scheduled to follow. Based on an accurate and timely estimate by the operating-room supervisor as the cases progress during the day, she should be able to exactly estimate the starting time of the next case in ample time for the surgeon to arrive from his office or from other duties he may be performing within the hospital. With elective surgery being scheduled three to four weeks in advance, the surgeon should be able to plan his day to be available and, also, be able to conform to a reasonable adjustment of the starting time.
2. The chief of surgery should insure that there is a clear understanding by the operating-room personnel and the professional staff as to what the starting time of surgery means and the unutilized time at the beginning of the day should be eliminated by having the patient ready for the incision and the incision made at 7:30 A.M.
3. The operating-room supervisor should insure full utilization of the operating-rooms during the hours from noon to 1:00 P.M.

by adequate staffing and staging of personnel going to lunch.

4. The operating-room supervisor should utilize all six operating-rooms during the day shift on Saturdays for elective surgery.

5. The operating-room supervisor should insure that scheduling preferences are not given to "favorite" or senior surgeons.

6. The operating-room secretary should be held responsible by the operating-room supervisor for scheduling surgery. She should be responsible for using all available time during the day shift prior to scheduling any surgery for the evening shift. Fifteen to twenty minutes should be allowed between cases for cleanup and setup time, depending on the type of surgery being performed.

7. The operating-room secretary should insure that long cases are scheduled to begin at a time that will allow their completion during the day shift.

8. The estimated time to perform the most commonly performed operations, as outlined in Table 7, should be used as a guide by the operating-room secretary for scheduling.

9. On the day of surgery, the operating-room supervisor should be responsible for making adjustments in the operating-room schedule to effectively utilize operating-room time. She should be responsible for keeping the surgeons informed of their starting times based on accurate and periodic estimates of the time required to complete each case as it progresses.

10. After these recommendations have been implemented a similar evaluation such as the one developed in this Problem Solving Thesis be conducted in six months to insure more effective scheduling system and

maximum utilization of the operating rooms.

### Footnotes

<sup>1</sup>Community Systems Foundation, "Surgery Data Profile Study at Tucson Medical Center," Ann Arbor, Michigan, March 28, 1969.

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ABSTRACT

OPERATING-ROOM SCHEDULING AT TUCSON MEDICAL CENTER,  
TUCSON, ARIZONA

A Problem Solving Thesis Submitted to the Faculty of Baylor University  
in Partial Fulfillment of the Requirements for the Degree of  
Master of Hospital Administration

by

Lieutenant Colonel James M. Feltis, Jr., MC

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This thesis was a study of the utilization of the operating-rooms at Tucson Medical Center. Operating-room statistics were collected and on-site observations and interviews were carried out. Inefficient scheduling was found to be the major reason for lack of maximum operating-room utilization.

Recommendations to improve operating-room scheduling included:  
(1) better estimation of the time required to perform surgical procedures;  
(2) a more effective scheduling method; (3) better staffing and assignment of operating room personnel; (4) enforcement of operating room policies and regulations as relating to starting time and surgeon's arrival time; and (5) utilization of operating rooms on Saturdays.