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THE USE OF A SIMULATION MODEL FOR PLANNING AMBULATORY SURGERY

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ABSTRACT

A computer simulation model of a hospital operating room and a freestanding center with planned expansion was used to assist planners in analysis of a joint venture among surgeons, the hospital and the center. Methods used for projecting ambulatory surgery demand are described. A general overview of the model, the model inputs, outputs and use in decision-making is discussed.

INTRODUCTION

Ambulatory surgery has increased by over 75 percent in the past five years in the United States. While ambulatory surgery in recent years accounted for 18 percent of all surgery, some authors are predicting this to increase to 40 percent by 1990, and as high as 50-60 percent thereafter.(1) Several reasons for this growth have been cited: customer and physician preferences, third-party reimbursement incentives, advances in pharmaceuticals, and new, more advanced laser and endoscopic technology.(2)

Concurrent with this growth, hospitals are facing increased competition for their ambulatory surgery patients from freestanding surgicenters. In 1983, there were 240 freestanding outpatient surgery centers in operation in the United States. This is projected to grow to over 500 by 1988.(3) Many of these surgicenters are owned and operated by for-profit chains which are growing by establishing new centers through physician partnerships and hospital joint ventures.

In December, 1984, a 175-bed general acute care hospital in central Washington was confronted with the potential loss of 80 percent of its ambulatory surgery volume to a competing freestanding center. Ambulatory surgery at the hospital was performed within the general operating rooms and shared the recovery room space with inpatient surgery. The hospital was in the process of building 10 pre- and post-operative ambulatory surgery beds, and opening two additional general operating rooms. The freestanding center had plans to expand from 2 to 4 ambulatory surgery operating rooms. Major questions faced by the planners were: (1) How many outpatient surgeries would be performed in the community; (2) Could these be accommodated by the hospital; and, (3) What advantages would be offered by the freestanding center?

This paper describes the use of a computer simulation model in planning for ambulatory surgery in this community. The method used to project demand for ambulatory surgery is described. The paper presents a general overview of the model of the hospital facility and the freestanding facility, the model results, and the use in decision-making.

BACKGROUND

In December, 1984, a 175-bed general acute care hospital in Washington was faced with the potential loss of a large portion of their ambulatory surgery volume to a freestanding surgery center. This center evolved when a nearby specialty hospital announced closure of its inpatient beds and conversion and expansion of its two operating room suite into a dedicated ambulatory surgery center.

The success of the freestanding ambulatory surgery center depended on assumptions of growth of outpatient surgery and on cooperation of surgeons from the community's large multi-specialty clinic. The multi-specialty clinic had been using the hospital for both inpatient and ambulatory surgery.

The surgeons at the multi-specialty clinic were dissatisfied with the existing ambulatory surgery program at the hospital. They foresaw tremendous growth in ambulatory surgery and were concerned about the lack of a dedicated schedule or room(s) for ambulatory surgery, the lack of pre- and post-op holding areas, and the lack of competitive packaged pricing. At the same time, many surgeons preferred to keep much of their outpatient surgery at the hospital for convenience and patient safety.

The three parties involved, the hospital, the surgeons from the clinic, and the freestanding center decided to consider a joint venture in ambulatory surgery. A study was initiated to address several questions:

- o Given the existing and proposed operating rooms at the hospital, was there adequate capacity to accommodate both inpatient and ambulatory future surgery demand?

A procedure time was determined for that case dependent on the subspecialty and the distribution of procedure times observed in the hospital data base. The case was then placed into the next available operating room without delay.

Approximately 5,000 cases per year were randomly generated to arrive as elective inpatient or ambulatory patients. About 36 percent of these (or 29.2 percent of the total) are expected to be ambulatory patients. With both of these patient groups, a subspecialty block was assigned to represent the appropriate mix of subspecialties. With this information, a procedure time was sampled from a distribution derived from the historical data.

The elective cases were placed on the elective schedule, which was a modified block schedule. This is where surgeons and patients might encounter a delay (called booking delay) to get on the schedule. The modeling logic for representing a blocked system is described elsewhere.(4)

The model schedules elective cases to arrive in the operating room according to the block schedule. Both the current block schedule and proposed improved schedules were tested to account for any possible scheduling inefficiencies.

Figure 1 shows five operating rooms. This model input was varied to examine the effect of 5, 6, or 7 operating rooms at the hospital. The model also dedicated 0, 1, or 2 of the rooms for ambulatory surgery. Note that ambulatory patients are routed through a special room of ambulatory beds before and after their operation.

The model kept track of delays to get on the block schedule, the ambulatory bed utilization, the number of operating rooms in use, and the overtime incurred on any given day.

Figure 2 shows a similar representation of the freestanding center. There were fewer cases at the center, and they were divided into specific procedures as well as subspecialties. In addition, this center was capable of receiving some of the ambulatory patients from the hospital. The number of cases that shifted from the hospital to the center was an important variable in the scenarios analyzed and, subsequently, greatly affected utilization and delays of both facilities. As in the hospital model, the number of operating rooms was varied, in this case from 2 to 4. Similar statistics were observed.

Both models were programmed in the SLAM network simulation language(5) and were run for an initial start up period, and then a sample 1-month observation period for each scenario.

The following sections discuss the data that was used to develop the model inputs, the method for projecting ambulatory surgery demand, and the results of the model runs.

DATA COLLECTION

Data on surgical cases performed over the preceding three years came from a variety of sources. The following sources were helpful:

- Hospital's computerized operating room data base.
  A 2 1/2-year sample of surgical cases, including detailed procedure information: CPT code, code description, surgeon name, specialty, date, time in to operating, time out of operating room, scheduling category, admitting category, and type of anesthesia.

- Hospital's 1-week concurrent study.
  A 1-week concurrent study which documented average case set-up and clean-up time (turnaround time) and reasons for delays.

- Freestanding surgery center's computerized operating room procedure list.
  A 3-year list of surgical cases performed at the freestanding center (former hospital) including CPT code, code description and total number of procedures performed per year.

- Historical and projected utilization.
  Historical population and forecasts developed by the State of Washington, Office of Financial Management.

- Interviews.
  Surgeons representatives of each specialty at the hospital and freestanding surgery center were interviewed. The surgeons were shown yearly procedure use rate trends for the sample period and asked to comment on local or national factors which might influence those trends in the future. For each procedure they were also shown trends in shifts from inpatient and ambulatory surgery and asked for their projections on the percentage which will be performed on an ambulatory basis in the future.

PROJECTING THE DEMAND FOR AMBULATORY SURGERY

To project the number and type of ambulatory procedures expected to be performed, the following steps were taken:

1. A list of potential ambulatory surgery procedures was obtained by examining Medicare approved lists, Blue Cross of Washington approved lists, and other Washington-based ambulatory surgery centers' procedure lists.

2. Physicians were interviewed from each surgical specialty to:

   - Verify the list of potential ambulatory surgery procedures and identify a minimum and maximum range of procedures they felt they would perform on an ambulatory basis.

   - Identify local trends in physician practice which would influence ambulatory surgery trends.

3. For each procedure on the list of potential procedures, the actual number of cases performed in the community in the past three years was obtained by examining the hospital and freestanding clinic records.

- If there was adequate capacity at the hospital, how might the schedule be structured to accommodate both inpatient and ambulatory surgery demand?

- What would be the utilization of both the hospital and the center, given projected demand and proposed expansion of each facility?

- How long would it take to get on the schedule at either facility under different assumptions of demand and construction?

To help answer these questions, a computer simulation model of the hospital facility and the freestanding center was developed. Projections of demand for ambulatory surgery were developed and input to the model. Outputs included facility utilization and delays to access the schedule.

Multiple scenarios were examined to evaluate improved scheduling methods and the effect of increasing the number of operating rooms at either the hospital or the center.

System Description and Model Overview

The system modeled is described with reference to Figures 1 and 2. Figure 1 represents the requests for surgery at the hospital and flow of patients through that facility. There are approximately 850 cases per year that are emergent. These were generated to arrive in a random fashion. The term "assign block" means the model designated the arriving patient as belonging to one of the subspecialty blocks according to the percentage of emergent cases for each specialty (data abstracted from the hospital data base).

FIGURE 1
A COMPUTER SIMULATION MODEL
OF THE HOSPITAL OPERATING ROOMS

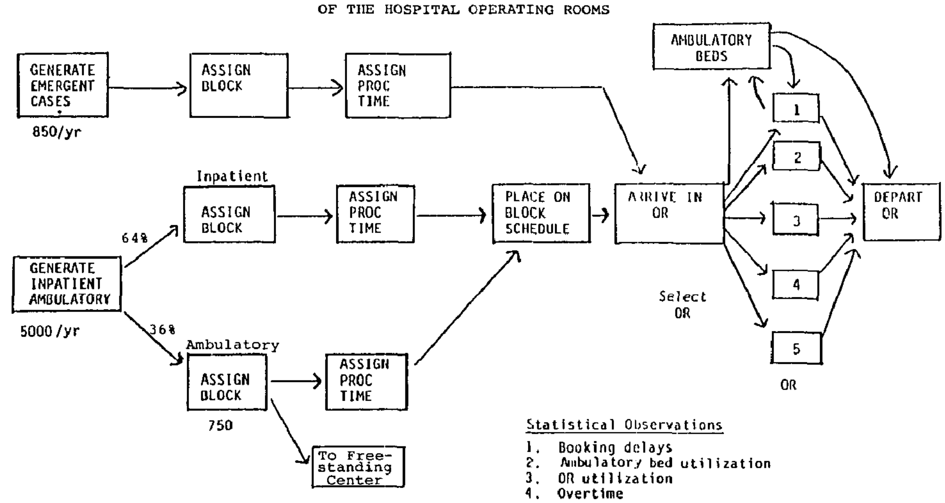
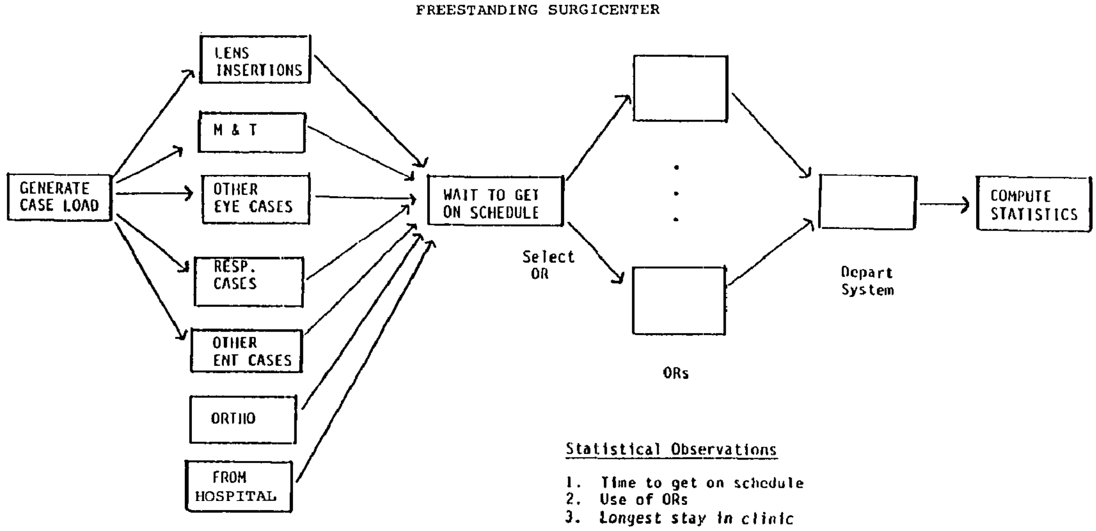


FIGURE 2
FREESTANDING SURGICENTER



In this way, it was determined which procedures and how many of each could be expected to be performed as an outpatient.

Of note, there were less than 10 high volume procedures which were similar in kind to those of other hospitals. These include arthroscopies, dilatation and curettage, herniorrhaphies, tonsillectomies, laparoscopies, myringotomies, cystoscopies, carpal tunnel repairs and cataract repairs.

The next task was to determine how the number of each procedure would grow over the next five years. To do this, population trends and surgical use rates were employed. Use rates for a given procedure are defined as the number of times that a procedure is performed for every 1,000 population in a given community. Use rates were determined by examining the surgical data in relation to the population of the community. Most surgeons interviews felt that the end year (1984) use rate would be appropriate for the projection of future demand. The historical increase in surgical use in the community was anticipated to stablize due to the expected decline in inpatient use resulting from prospective payment.

Population trends were obtained from available census data. By multiplying population projections and surgical use rates for each ambulatory procedure, estimates of future caseload were obtained. All major specialties were expected to experience a growth in ambulatory surgery, as shown in Figure 3. Total procedures (inpatient plus outpatient) was estimated to remain fairly constant. Hence, this growth actually represented a shift from inpatient to outpatient surgery.

In this manner, projections of ambulatory surgery were obtained that included the requirements of major health care payors (Medicare, Blue Cross, etc.), the practice patterns of the community's physicians, and the growth of the community's population.

MODEL INPUTS

This section describes the inputs to the previously described model in further detail. These inputs included:

- Projected number of total surgical cases.
- Inpatient/ambulatory surgery mix.
- Specialty case mix.
- Procedure times by specialty.
- Number of pre/post-op ambulatory surgery beds at the hospital.
- Number of general operating rooms at the hospital.
- Number of operating rooms at the freestanding center.
- Scheduling practices at the hospital and the clinic.

Projected Number of Surgical Patients

The total number of surgical cases projected for hospital was roughly 6,000 total cases. From the ambulatory projections described above, 1,800 cases (30 percent) were anticipated to be ambulatory surgery cases. The freestanding center was projected to have approximately 1,200 ambulatory surgery cases by 1990.

Specialty Case Mix

While all specialties were expected to experience growth, the largest hospital increase was projected for orthopedic surgery and otolaryngology.

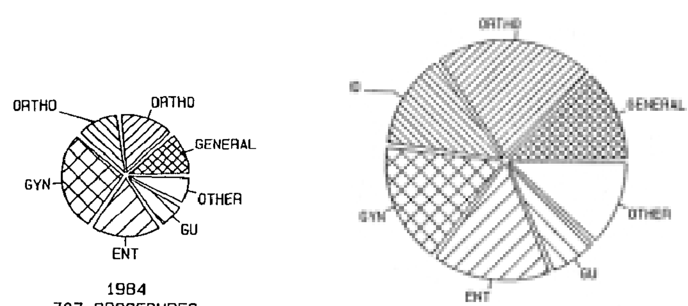
A detailed analysis of the case mix for the freestanding surgery center revealed that four major categories of procedures accounted for 85 percent of all ambulatory surgeries: lens insertion, tympanostomy, respiratory, other eye procedures.

Procedure Time by Specialty

Procedure times by specialty for inpatient and ambulatory surgical cases were included in the hospital operating room data base. These data

FIGURE 3

GROWTH OF AMBULATORY SURGERY



1984
707 PROCEDURES

PROJECTED FOR 1990
1757 PROCEDURES

were summarized in histograms and statistical distribution were used to describe procedure times.

As more of the inpatient cases shift to ambulatory surgery, the average procedure length times for ambulatory surgery are expected to increase. Additionally, many of the microscopic surgeries performed in orthopedics are taking longer to perform, but can be safely performed in an ambulatory setting. For this reason, the 1984 procedure length times had to be modified. In general, the average case length times for ambulatory surgery increased. The average inpatient case times also increase slightly. It is anticipated that after a shift to ambulatory surgery, the inpatient cases remaining are the longer, more complicated cases. Both of these increases were calculated from the percentage of cases shifting from inpatient to outpatient cases, and from current average procedure time.

Average Turnaround Time

The 1-week concurrent study performed by the hospital found the average inpatient turnaround time to be 20 minutes and the average ambulatory surgery turnaround time to be 15 minutes.

Inpatient/Ambulatory Surgery Mix

Based on the results of surgeon interviews, the percentage of cases performed on an ambulatory basis at the hospital was projected to increase from 14.2 percent in 1984 to 29.8 percent in 1986, and remain constant through 1990. For the two facilities combined, this percentage was projected to increase from 28.1 percent in 1984 to 41.1 percent in 1986, and to remain constant until 1990.

Number of Pre- and Post-Op Ambulatory Surgery Beds

The hospital had begun construction on a 10-bed pre- and post-op ambulatory surgery holding area. The number of beds in this area was used as an input to the model to evaluate the adequacy of this capacity for the anticipated growth.

Operating Room and Demand Shift Combinations

Representatives from the hospital, the freestanding center, and the multi-specialty clinic were asked to participate in the selection of scenarios to be evaluated by the simulation model. The purpose of this modeling was to evaluate the capacity of the existing two operating rooms at the freestanding center, and the effect of shifting patients away from the hospital.

A total of 11 room and demand shift scenarios were used as inputs to the simulation model. All scenarios assume 1990 demand for surgical procedures, some combination of rooms, and 50-80 percent of the ambulatory surgery cases shifting to the freestanding center (Table 1).

Scenarios A through G have the same areawide capacity of nine general operating rooms, with each scenario varying the number at each facility, and the amount of ambulatory surgery shifted to the specialty clinic. The remaining scenarios add from 1-2 rooms of additional capacity to the entire system.

TABLE 1

SIMULATION MODEL RESULTS

SCENARIO											
% Shift to Freestanding	Base	50%	80%	50%	80%	50%	80%	50%	80%	50%	80%
Hospital Inpatient OR's	5	5	5	5	5	4	4	5	5	5	5
Hospital Outpatient OR's	2	2	2	1	1	1	1	2	2	2	2
Freestanding Center OR's	2	2	2	3	3	4	4	3	3	4	4
Model Input	A	B	C	D	E	F	G	H	I	J	K
HOSPITAL:											
Utilization (inpatient)	56%	56%	56%	56%	56%	70%	70%	56%	56%	56%	56%
Avg. booking delay (days):											
Total	1.2	1.0	1.0	1.4	<1	1.0	.9	<1	<1	<1	<1
Day	1.6	1.0	1.0	2.4	<1	1.2	.8	<1	<1	<1	<1
Rooms in use at 3:30 pm	.3	.3	.3	.3	.3	.6	.6	.3	.3	.3	.3
4:00 pm	.1	.1	.1	.1	.1	.4	.4	.1	.1	.1	.1
5:30 pm	0	0	0	0	0	.1	.1	0	0	0	0
Util. of outpatient rooms*	87%	50%	30%	96%	26%	100%	30%	50%	13%	50%	13%
Max. ambulatory beds in use	8	6	3	4	3	5	3	6	3	6	3
Percent day patients leaving after 3:30 p.m.	3%	3%	None	6%	None	14%	None	2%	None	2%	None
Average late stay	4:45pm	4:00pm	--	5:00pm	--	5:00pm	--	4:15pm	--	4:15pm	--
FREESTANDING CENTER:											
Utilization (5-day week, 8-hour shift)	32%	62%	84%	39%	55%	31%	42%	39%	55%	29%	41%
Average booking delay (days)	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1
Maximum patient stay (hours)	5	**	**	4	5.2	5.5	5	4	5.2	3.8	5

* This figure is based on a 6-hour shift for outpatient rooms.

** In both these scenarios, the model indicated patients may be leaving late. Exactly how late depends on the exact scheduling practices of the freestanding center.

RESULTS

The model outputs for each of the 11 scenarios evaluated include:

- o Operating room utilization.
- o Ambulatory surgery bed utilization.
- o Booking delays -- the delays encountered when the surgeon attempts to schedule a case.
- o The number of cases performed per shift.
- o Overtime -- the number of operating rooms kept open at the end of the day to accommodate surgical demand.
- o The maximum number of beds in use at one time.
- o The average late stay ambulatory surgery patients.

Table 1 summarizes these outputs for 11 scenarios. The first row of the table describes each scenario. The major characteristics for each scenario are the percentage of ambulatory surgery patients that go to the freestanding center, the number of inpatient and outpatient operating rooms maintained at the hospital, and the number of operating rooms maintained at the freestanding center.

The first scenario, labeled A, is the baseline condition with 5 inpatient, 2 outpatient rooms in the hospital and 2 rooms at the center. Scenario B represents 50 percent of the hospital's ambulatory surgery being diverted to the center with these number of operating rooms. Scenario C represents an 80 percent shift under the same conditions. The remaining scenarios analyze the same type of shift, but with different numbers of operating rooms maintained at either facility.

The outputs described above (i.e., utilization, overtime, booking delays, etc.), are given in the table for each scenario. For example, note that the inpatient utilization at the hospital remains at 56 percent in scenarios A, B and C. The shift of ambulatory surgery causes a fall-off in the use of outpatient rooms from 87 percent to 30 percent. The utilization at the center increases from 32 percent to 84 percent.

The booking delays of all the scenarios are acceptable, giving the surgeons reasonably good access to either facility.

The table aided the hospital and freestanding center planners in estimating the operational aspects of each of these scenarios. As long as proper scheduling was used, and as long as a total of seven rooms was available at the hospital if all the ambulatory surgery stayed there, then good service to the physicians and adequate facility utilization could be maintained. More than two rooms at the center did not seem necessary unless more than 80 percent of the surgery was transferred from the hospital.

The planners from the three different groups combined this operational information with other financial data and elected not to pursue a 3-way joint venture. As of this writing, the surgeons from the multi-specialty clinic decided to stay at the hospital as long as the increased number of operating rooms and improved scheduling were utilized. The freestanding center opted not to expand beyond its two rooms and continues in operation with its original subspecialty surgeons.

SUMMARY AND CONCLUSIONS

This paper described the use of a computer simulation model in the planning of ambulatory surgery. Methods used to predict the demand for ambulatory surgery were described. A model of a hospital facility and a freestanding center with proposed expansion was presented. The model inputs, outputs, and its use in decision-making in a joint venture were discussed. The use of computer simulation represents an approach worthy of consideration by others when evaluating the operational aspects of a proposed ambulatory surgery facility, either in a hospital or freestanding facility.

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