CALIFORNIA
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Improving Efficiency in the Safety Net: Management Engineering Practice and Cases

Prepared for
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About the Foundation

The **California HealthCare Foundation** is an independent philanthropy committed to improving the way health care is delivered and financed in California. By promoting innovations in care and broader access to information, our goal is to ensure that all Californians can get the care they need, when they need it, at a price they can afford. For more information, visit www.chcf.org.

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I. Introduction

California's safety-net hospitals — public, rural, critical access, and disproportionate share — are central to California's health care system because they serve populations that would not otherwise have access to care. This critical role demands continuous innovation to ensure patient safety, achieve excellent clinical outcomes, and maximize efficiencies.

In this paper, efforts are described to improve efficiency in safety-net hospitals through the application of management engineering, a systematic method for diagnosing and correcting problems in service delivery. Management engineering offers a way to improve care delivery through better efficiency, thereby increasing access to care and reducing, or at least controlling costs and patient wait times.

Management Engineering in Other Industries

Management engineering has transformed the quality and productivity of many complex industries, such as telecommunications, transportation, and manufacturing. These industries have used management engineering to optimize scheduling, staff at levels that match demand, and reduce waste in production processes. Management engineering improves efficiencies through systematic measurement and analysis of system performance, coupled with action plans that aim for continuous improvement.

The health care sector has been slow to embrace management engineering for both cultural and financial reasons. While management engineering can help a hospital reduce costs and improve service, it also requires investment, both in people and in systems to measure, monitor, and respond to performance. Safety-net hospitals in particular often lack the resources to make such investments. Just as important, health care clinicians and administrators are typically not trained in management engineering and operate in a regulatory environment that does not demand efficiency.

Despite these challenges, management engineering methods are becoming more widespread, through the efforts of the Institute for Healthcare Improvement to build multi-hospital collaboratives, as well as through the support of the California HealthCare Foundation (CHCF) and other organizations. Management engineering methods have been successfully used by clinicians, care teams, and administrators in large and small health care organizations in all steps of care delivery, including out-patient, emergency department, surgery, medical testing, bed assignment, and patient discharge.

The role of the management engineer is to be a change agent who helps hospitals quantify specific problems, design needed interventions, and recommend solutions. A management engineer works in partnership with administrators and clinicians in all of these steps and provides guidance in the implementation of change. However, successful management engineering cannot be viewed as a one-time process, but rather as a way to engage health care workers in continuous review and improvement, both raising their awareness of the problems experienced by patients and empowering them to make changes that improve care.

To stimulate the adoption of management engineering, the California HealthCare Foundation

commissioned the University of Southern California to complete a set of demonstration projects at California safety-net hospitals. The research and management engineering work were performed by faculty and students from the Viterbi School of Engineering in cooperation with hospital staff. This paper summarizes the research conducted at 12 safety-net hospitals and its main findings. More detailed case studies that build upon and complement the work presented here are summarized in the appendix.

II. Patient Flow and Management Engineering Basics

Patient flow is the process by which patients are served through multiple stages of care. Good patient flow is represented by short waits at registration, examination, diagnostic testing, surgery, placement in beds, and discharge. When patient flow is excellent, patients experience a shorter length of stay, because they are not waiting for these critical steps to occur. A shorter length of stay translates to increased capacity for serving more patients, making it possible to improve access to care.

Poor patient flow is a symptom of inefficiencies in care delivery, including a poor staffing plan, inability to use critical resources at maximum capacity, and a lack of synchronization between discharging and receiving departments. There are numerous instances of long patient waits coupled with under-utilization, which ought to be an obvious sign of inefficiency. Yet these inefficiencies only became apparent after the introduction of management engineering, which identified how inattention to work practices and unbalanced resources harmed productivity.

Management engineering can address inefficiencies through a cooperative approach that engages staff in a systematic process of continuous improvement. An individual management engineering project includes five basic steps: (1) problem identification, (2) measurement, (3) analysis, (4) design of solutions, and (5) intervention. However, it is also important to view a management engineering project as a teaching experience that builds a culture that motivates continuous improvement. Toward this end, the management engineer needs to be both a motivator and teacher, and needs to help develop systems that sustain change once he or she moves on to another project.

The management engineer brings a range of techniques from various disciplines including social science, physics, and mathematics. Many of the specific management engineering tools are listed in the Glossary.

The case studies that follow examine individual processes within surgery and diagnostic imaging departments. Keep in mind, however, that the biggest opportunities for improvement often come through systematic change spanning multiple departments, such as improved coordination between the emergency department, surgery, and care units. Emergency cases must have operating rooms available and surgery cases need inpatient beds or bottlenecks delay all areas.

III. How Management Engineering Can Benefit: Case Studies

A WIDE VARIETY OF HOSPITALS RESPONDED to the California HealthCare Foundation's request for proposals to apply management engineering methodologies to expand capacity. Out of 32 proposals received, 12 hospitals were selected, all with need for process improvement in their diagnostic imaging and surgery departments.

Radiology Case Studies

The diagnostic imaging services offered varied across the three hospitals, but the radiology departments had many problems in common: excessive wait times, low patient satisfaction, low staff satisfaction, low physician satisfaction, and underutilization of equipment. The goals of the effort were to improve hospital operations in a meaningful way, improve access and cost-effectiveness, and evaluate the results and use the experiences for demonstration and education at other hospitals. Radiology projects were launched in January 2007, with recommendations for change and improvement made in April and May. These projects were completed in July.

Sample improvements from the three hospitals chosen included:

- Radiology department patient visits were increased by up to 46 percent
- Percentages of patients rating their service as "excellent" were doubled and growing
- Productivity was improved by up to 29 percent
- No-show rates were reduced by up 20 percent

These results are being followed up at the individual institutions with new projects, continuing work by staff, more ambitious targets, and new implementations. See Table 1 on page 6. The case of Mendocino Coast County Hospital is also discussed in the Appendix.

ARROWHEAD REGIONAL MEDICAL CENTER

About the Hospital

Arrowhead Regional Medical Center, in Colton, California, is the county hospital for San Bernardino County, geographically the largest county in the United States. It has 373 beds and had 570,000 outpatient and ER visits in 2007.

Problems

In radiology, the hospital's mammography department has two exam rooms, both film based. Mammography was experiencing backlog, low patient volume, and poor productivity. The patient backlog was four months. The mammography department saw 19 patients per day, spending a total of 2.4 labor hours per patient.

The head of radiology had succeeded in making significant improvement in patient flow in most departments, but not in mammography. He felt that the productivity of the mammography department could be improved and had made recent changes toward that end, but these changes were not accompanied by improvement in patient volume.

Table 1. Radiology Projects, by Hospital

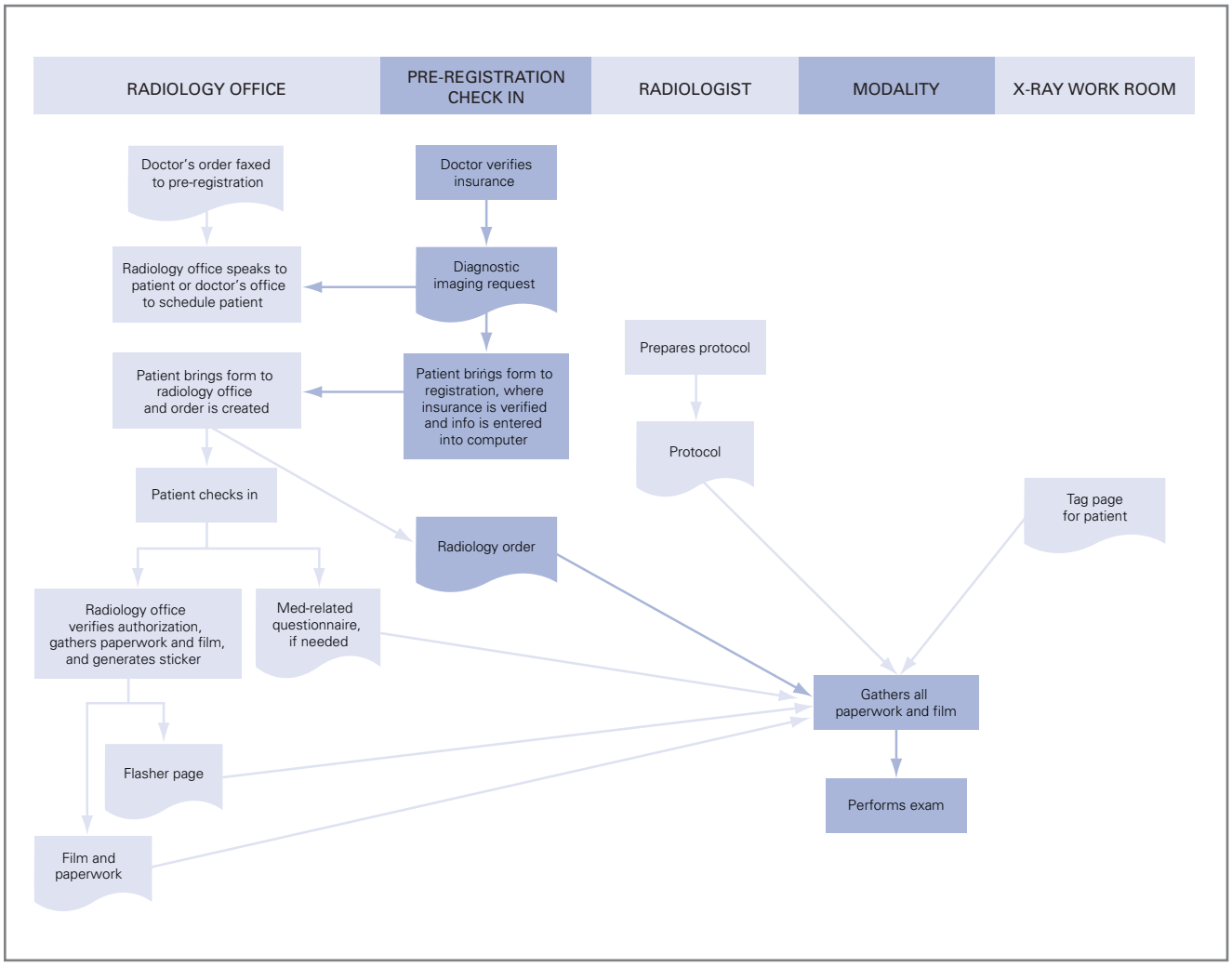
	ARROWHEAD REGIONAL HEALTH CENTER (MAMMOGRAPHY ONLY)	WHITE MEMORIAL MEDICAL CENTER	MENDOCINO COAST DISTRICT HOSPITAL
Hospital type	County, serving largest U.S. county, by area	Nonprofit, faith-based, urban hospital	Rural, Critical Access, Hospital District
Hospital size	354 beds	373 beds	25 beds
Department	Two mammography exam rooms	Full range of services: CT, MRI, etc.	Full range of services: CT, MRI, etc.
Problems addressed	Backlog, throughput, productivity	Patient satisfaction, productivity, operational data	Patient satisfaction, productivity, no-show rate, wait time
Measurable improvements	• Backlog reduced from four months to one month, • Patients per day increased from 19 to 30 • No-show rate reduced from 40 percent to 27 percent • Productivity raised from 2.4 hours per patient to 1.7 hours • Mammography cycle time reduced from 60 minutes to 40 minutes (no change in staffing or equipment)	• No-show rate reduced from 40 percent to 25 percent • Productivity raised from 1.8 hours per patient to 1.5 hours • Patients rating their service as "excellent" increased from 20 percent to 45 percent measured monthly	• Patients per day increased from 40 to 57 • Productivity raised from 1.8 hours per patient to 1.3 hours
Other improvements as a result of this project	• Developed daily benchmark targets, revised task assignment and patient flow • Revised scheduling policies • Simplified technician workflow	• Eliminated unnecessary data entry tasks • Developed cycle time data for scheduling • Developed and implemented a dashboard • Initiated a patient tracking system • Simplified workflow	• Developed cycle time data for scheduling • Designed and implemented patient satisfaction survey • Developed layout for use in new building • Developed and implemented dashboard

Intervention

After preparing flow charts and comparisons to performance benchmarks, the management engineers established targets for improvement, such as an increased number of exams completed per day. See Figure 1 as an example of a flow chart. Tasks were timed in detail to reengineer the jobs of the technicians so that they could complete each patient in a shorter cycle time. Through workflow analysis, the USC engineers identified process improvements and the elimination of unnecessary tasks, such as assisting patients with questionnaires and not having patients occupy exam rooms while films were being developed.

The management engineers next created a spaghetti diagram—a depiction of staff and patient walking paths—to show where certain steps should be changed. A list of recommended improvements was provided, including revision of standard appointment times, changes to daily targets, design of a dashboard report (a report of key indicators), calling patients earlier to remind them about their appointments, double-booking patients when there was a high probability of no-shows, relocating

Figure 1. Example Flow Chart



the patients' clothes changing area, having staff (non-tech) escort patients, changing break times and the lunch-hour policy, revising supervisor's responsibilities, providing staff recognition for productivity improvements, and creating new reports from the information system. Through focus group meetings, the staff agreed to changes and specific productivity improvement targets. A computerized simulation was created to identify bottlenecks and to confirm the expected throughput potential in patients seen per day.

Impact

Improvements were seen in capacity, backlog, and no-show rates. Other areas show promise and have inspired longer-term process improvement efforts. At start of year, Arrowhead's mammography department examined about 19 patients per day. By April, that number was 27 to 35 per day, a 42percent increase. The backlog was reduced from four months to one month. The noshow rate declined from 40 percent in February to 27 percent in April.

Changes

Initial changes included reassignment of patient flow tasks, such as having patients fill out their questionnaires before entering the exam room rather than during their exams, having patients change clothes outside the exam room, and double-booking exams when there was high probability of a no-show. A dashboard report was created for patient flow outcomes so that the staff had a sense of progress on the project.

Ongoing changes include revising work procedures, such as assigning more clerical tasks (e.g., mailing) to clerical staff rather than technicians, and a more logical mix of diagnostic and screening exams in the weekly schedule. The USC engineers continued to participate on a staff committee implementing additional changes.

Lessons

The staff's resistance to, and fear of, change was overcome when it was demonstrated that increased productivity, rather than reduced staffing, would be the result. Although the engineering team's research initially showed that the department was seeing half as many people as it could, the staff's impression was that they were extremely busy. The engineering students addressed those concerns in part by identifying unnecessary tasks that could be eliminated to increase productivity, rather than reduce staffing, and soliciting staff support and ideas through focus group discussions.

WHITE MEMORIAL MEDICAL CENTER

About the Hospital

White Memorial Medical Center is an urban, nonprofit, teaching hospital in Los Angeles with 354 beds, and 100,000 outpatient and ER visits in 2008. White Memorial provides a full range of inpatient, outpatient, emergency, and diagnostic services. It is part of Adventist Health, which operates health care facilities in California, Hawaii, Oregon, and Washington.

The hospital's diagnostic imaging department has a full range of modalities. Imaging is digitized and includes a separate registration and check-in.

Problems

A high rate of no-shows, underutilized equipment and staff, and unnecessarily long waiting times for patients after check-in persisted in the department. As a result, White Memorial suffered from low patient satisfaction, low productivity, and a shortage of operational data. The diagnostic imaging department, an important revenue source for the center, is in a new building with relatively new equipment. The expectation had been that these would automatically yield high patient satisfaction, but patient and physician satisfaction surveys told a different story.

The physical layout of the new building was a problem, as it was difficult to locate patients and staff in the convoluted set of corridors and rooms. There was no visibility between check-in, registration, dressing rooms, exam rooms, and waiting rooms. The department's patient tracking information system was of no help, as it was difficult to use.

Intervention

Based on flow charts and productivity measurement, it became apparent that changes to certain workflows, particularly administrative tasks in check-in, registration, and patient escorting, would improve productivity. The USC engineers recommended changes in workflow based on observation and analysis of both jobs in the department and patient flow. These included simplifying patient tracking, earlier availability of appointment data, earlier phoning of patients to remind them of appointments, development of a dashboard report, comparison to industry benchmarks, preparation of inpatients at units, research into no-show causes, reporting of exam start and end times by technicians, incorporating actual procedure time averages for patient scheduling, and a new patient tracking system. Process improvements eliminated registration tasks, such as data entry. The management engineers also developed benchmarks for a departmental dashboard—a report that includes key indicators for the department—that highlighted productivity targets for supervision. In addition, patient tracking system changes were identified.

Impact

As a result of the intervention, no-show rates, patient tracking, productivity, utilization, and scheduling improved. Patient satisfaction lagged, but began to trend up as additional changes were implemented.

No-show rate. Reduction in the no-show rate was accomplished by more frequently phoning patients in advance than had previously been the practice. By changing the paper flow, the department became able to call nearly all patients four days prior to appointment. The department tracks a "registration complete" percentage that records the percentage of appointments that are ready in time for phoning. This improved from about 20 percent to more than 90 percent.

Patient tracking. Tracking patients had been a problem in the radiology area because of a physical layout that made it difficult to observe patient flow, and because the patient tracking information system was extremely difficult for staff to use. At the USC engineers' suggestion, the system's corporate office canceled the use of its tracking system, which freed staff for other duties. The engineering team suggested radio frequency identification (RFID) technology, which automatically reports on the patient's location, much like a global location tracking device. The system was installed and has proven effective in reducing data entry tasks, improved accuracy of records, and reduced patient wait times. The system has been expanded to additional areas in the hospital.

Patient satisfaction. This figure started out very low, but climbed steadily. Initially, 5 to 15 percent of patients rated the department, on an independent survey, as "excellent," but after the changes about 45 percent of patients gave a rating of excellent.

Room utilization. With high utilization being a primary objective, all agreed the lack of utilization measures was hurting the hospital. The department took the difficult step of putting a measurement process in place. Room utilization rates were discovered to be 60 percent in computerized tomography (CT) and 70 percent in magnetic resonance imaging (MRI). The department's implementation committee began changes to achieve a target of 80 percent.

Productivity. Time per patient visit declined from 1.8 hours before the project to 1.5 hours.

Recording actual exam times for use in patient scheduling: The staff had recorded exam times previously, but not accurately. The supervisors and technicians made accuracy a priority, and began using

the information for tracking and better scheduling based on accurate cycle times.

Tracking room utilization as a measure of scheduling effectiveness. Department management lacked information on utilization. The management engineers worked with staff and the hospital's information technology department to create useful measures. They then set goals to improve the utilization of these expensive resources, which became part of the dashboard used to manage the department.

Ongoing changes. The implementation committee designed a dashboard, produced weekly. Specific functional staff areas are responsible to gather data for their area and a summary report is produced. Monthly meetings with managers and technicians are used to review trends in the report and plan improvements.

MENDOCINO COAST DISTRICT HOSPITAL

About the Hospital

Mendocino Coast District Hospital is located in Fort Bragg, California. It is a rural, critical-access hospital district with 25 beds and 25,000 annual outpatient visits. The diagnostic imaging department is very important to the viability of the hospital, which at the time of the project, was in the process of a financial turnaround. The 12-person diagnostic imaging department offers a full range of modalities, is film-based, and includes a separate check-in.

Hospital leadership was concerned about the department's productivity as well as poor physician and patient satisfaction with its services

Problems

The USC engineers initially identified low patient satisfaction, low productivity, a high no-show rate, and high wait times as key problems. Patient satisfaction was not measured prior to the management engineering project, but was believed to be poor. The department saw 40 patients per day, which the hospital believed was well below capacity. Although the no-show rate was not methodically measured, it was recognized as being too high. The productivity was 1.8 hours per patient.

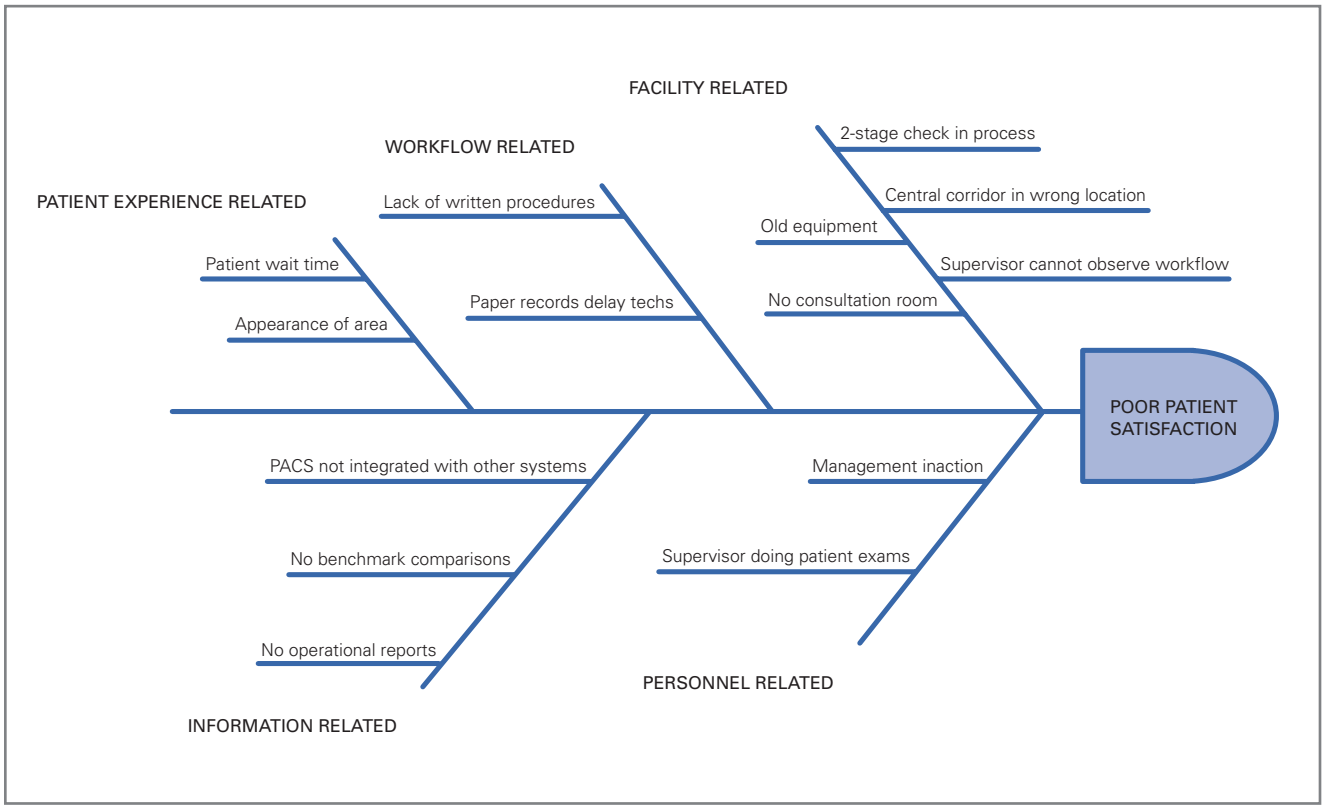
Mendocino felt it important to improve the patient experience as well as the cost-effectiveness of the department. Underlying issues included a problematic physical layout, mistrust of management by the staff, a relatively high level of staffing for the patient volume, and poor workflow.

The hospital collected limited operational data. It suspected low patient satisfaction rates, but did not have the data to measure or improve this measure. The physical layout of the department was also a problem; outpatients had to walk a relatively long distance from the hospital entrance to the department through a busy corridor that ran down the middle of the department with offices on either side. This layout complicated supervision and gave patients a poor impression.

Intervention

As in the other projects, flow charts and focus groups were key tools. The engineering students first developed a flow chart to analyze the processes for each of the radiology modalities in order to identify likely problems. See Figure 1. Several focus group meetings were held with the entire staff to gather input and enlist their support for future changes. The USC engineers discussed key issues with the staff and utilized a fishbone diagram to determine the causes of the problems. See Figure 2. A dashboard with key metrics was developed to show where patient flow could be improved. See Figure 3. Considering patient and staff walking patterns and time delays,

Figure 2. Example Fishbone Diagram



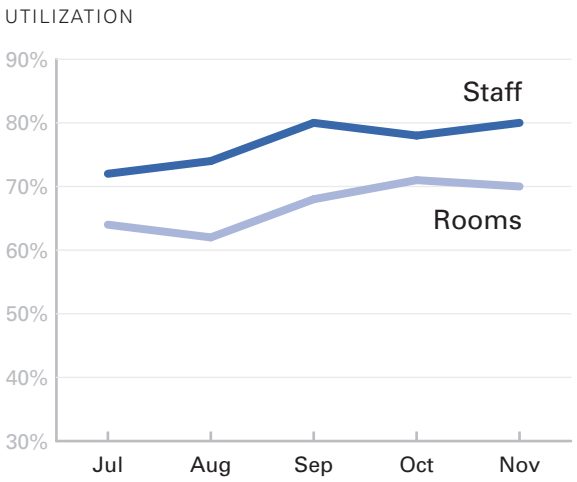
the layout of the building needed to be changed. The management engineers recommended changes in facility layout based on patient flow data.

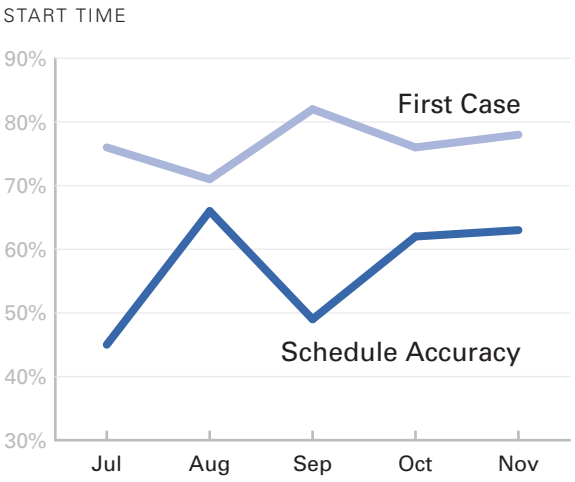
The first round of changes involved collecting information. The hospital commenced a patient satisfaction survey designed by the engineers to measure the perception of service and to let patients know that the hospital cares about their experience and wants to meet their needs. It also began capturing data about patient flow. Finally, a dashboard report was established that listed productivity indicators such as:

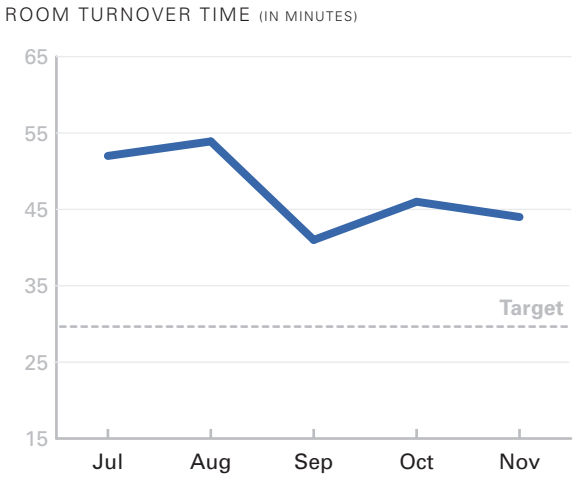
- Patients per day per room or exams done per day per room;
- Turnaround time in the various radiology departments (mammography, MRI, etc.);
- Room utilization (or room idle time) as a percentage of the available day;
- Patient wait time;
- Backlog;
- Patient satisfaction, as a percentage of patients rating service as "excellent"; and
- No-show rate, as a percentage of scheduled appointments.

The USC engineers uncovered waste with the department's paperwork flow. Radiology technicians, rather than clerical staff, were collecting the needed paperwork (chart and orders, for example) before they could conduct the exam, thereby causing a delay. The staff and management worked together to revise paperwork and film flow.

Figure 3. Surgery Dashboard







	LATE	TURNOVER (IN MINUTES) AVERAGE	BENCHMARK
General Surgery	10%	61.4	59.2
Gynecology	20%	46.4	44.2
Neurosurgery	50%	99.0	96.8
Ophthalmology	9%	N/A	N/A
Oral Surgery	N/A	60.5	58.3
Orthopedic Surgery	15%	54.4	52.2
Otolaryngology	0%	40.3	38.1
Plastic Surgery	11%	43.4	41.2
Urology	17%	43.0	40.8

Notes: "Utilization" refers to the percent of available time that a room is in use. "Room Turnover Time" refers to the average interval between patient occupancy. "Late" refers to a case starting more than 15 minutes behind schedule. "Benchmark" refers to an industry standard achieved by other hospitals. "N/A" stands for data not available.

Impact

Mendocino experienced improvement in the area of patient and physician satisfaction, patient volume, paperwork flow, productivity, and wait times.

Patient throughput. The department was seeing about 40 patients per day in February, and by June this increased to about 57 per day. This growth may be influenced by increased visits to the area during summer months but improved productivity meant the volume could be accommodated with existing staff.

Paperwork flow. The department was able to reduce waiting times by making sure that technicians had required paperwork before the start of each exam. Ideally, the department would be paperless, but given that this is not currently possible, the

hospital instead adjusted staff job descriptions so that assembling paperwork would not be the technician's responsibility.

Productivity. The staff hours per patient were about 1.8 hours, against a common benchmark of just under one hour per patient). Mendocino's productivity level indicated overstaffing by at least one-third. During the summer, staffing changes and increased patient volume reduced the apparent overstaffing by about 25 percent. Hours per patient dropped to 1.3.

Wait times. Mendocino lacked wait-time measurements, though long waits were recognized as a problem. A new computer report generates wait time and exam time for each modality. Having such timing data for each modality provides management with a tool to accurately identify bottlenecks and address problems.

Physical layout. The hospital recognized that the physical layout needs to be changed. In 2009, the hospital authorized the start of a separate diagnostic imaging building which incorporates suggestions from the management engineering project.

Lessons

At the beginning of the project, the USC engineers faced a department whose staff often had low morale. This was exacerbated by a sense that management had not fulfilled previous promises to improve the building space and buy new equipment. The engineering students found that the hospital did not have information about some of the most basic and essential measures of productivity, such as exam length, the frequency of no-shows, or utilization of exam equipment. These challenges were overcome or are being eliminated through the team's efforts.

Surgery Case Studies

Surgery projects were launched in late 2007 with recommendations for change, and improvement were made during subsequent years. The size of the departments varied but there were many common problems, including under-utilization of resources, lack of operational performance measurement, slow operating room turnaround, communications issues, and ineffective scheduling. The projects focused on improving patient flow so that capacity increased. Solutions included changes to patient flow, better scheduling, and changes to personnel assignments. A monthly surgery report card to track results was a useful tool for most hospitals. See an example in Figure 3. The engineering projects improved the frequency with which surgeries started on time and room turnover times were reduced.

Surgery Projects Summary

The issues and opportunities varied by hospital, some were common and others were unique. A brief summary of the surgery projects is provided below. Those marked with an asterisk (*) are described in greater detail in the Appendix.

CHILDRENS HOSPITAL LOS ANGELES*
(14 OPERATING ROOMS)

There were issues regarding case throughput and waiting time. Flow charts of surgery processes were developed as well as analysis of data on daily activity. Causes of delays were identified as well as operating room utilization problems. Scheduling guidelines and timing of patient movement were recommended. Changes included revising communications from pre-op to the operating room. A report card with performance benchmarks was designed and implemented.

MAMMOTH HOSPITAL
(2 OPERATING ROOMS)

There were issues about staff scheduling and room utilization. Workflow was observed, paper records were used to develop productivity measurement, and staffing was compared to industry benchmarks. Significant changes to nurse staffing and scheduling policies were recommended.

NATIVIDAD MEDICAL CENTER
(4 OPERATING ROOMS)

There were issues regarding pre-op processes, patient wait time, and throughput. Observation and comparison to benchmarks indicated a bottleneck in the check-in and pre-op steps. Analysis of data and comparison to best practices were used along with focus group discussions with the nursing staff to develop a consensus on changes. This resulted in improvements to patient flow procedures, reduced duplication of duties, and a better definition of responsibilities.

LOS ANGELES COUNTY – OLIVE VIEW/ UCLA MEDICAL CENTER (9 OPERATING ROOMS)

There were issues regarding patient throughput, operating room on-time starts, and turnover time. Analysis of patient flow data, focus group discussions, and observation of patient flow resulted in recommendations concerning revision to charge nurse responsibilities and other staff assignments, changes to scheduling practices, and a report card to track turnaround time and other metrics.

RIVERSIDE COUNTY REGIONAL MEDICAL CENTER*
(12 OPERATING ROOMS)

There were issues regarding throughput, delays, and the surgery information system. Specific problems identified included delays in movement of patients to pre-op, lack of communications in certain areas, scheduling of housekeeping and equipment, and lack of performance information. Changes were earlier movement of patients to the pre-op area, a report card on performance, walkie-talkies to coordinate flow, and scheduling of rooms and housekeeping. The hospital reported that the project resulted in 40 more surgeries per month and a 20 percent reduction in room turnover time.[1]

ST. FRANCIS MEDICAL CENTER
(8 OPERATING ROOMS)

The issues were low patient satisfaction, low throughput, and lack of performance information. Analysis included observation and flow-charting of workflow and of the physical layout, investigation of existing IT services, and analysis of available data. Changes included revising the registration area patient flow, new reports on performance, and better scheduling policies. These changes resulted in improved patient satisfaction scores, reduced patient wait times, and implementation of performance reports.

SAN FRANCISCO GENERAL HOSPITAL*
(10 OPERATING ROOMS)

The objective was to improve room turnover time and on-time starts of surgeries. The analysis included review of available digital surgery data, focus group discussions, and observation of workflow. Recommendations included layout changes, eliminating duplicate tasks, and a report card on monthly performance. Time was spent developing an organizational culture more focused on prompt patient flow and teamwork. Average turnaround time was reduced by about 20 percent, and the number of first cases of the day starting surgery on time doubled.

VALLEY PRESBYTERIAN HOSPITAL*
(9 OPERATING ROOMS)

The issues were about resource utilization and patient flow delays. Analysis of surgery data indicated utilization was about 60 percent against a common

benchmark of 85 percent for similar hospitals.[2] Communication in the OR was made difficult due to the physical layout and delays in room turnover occurred due to patients being moved to pre-op holding area late. Changes resulted in increasing room utilization from about 60 percent to over 80 percent and reducing turnover time between surgeries by about 20 percent.

VENTURA COUNTY MEDICAL CENTER*
(5 OPERATING ROOMS)

The issues were regarding delays in patient flow, a limited scheduling system, a lack of performance information, and attention to efficiency. Changes implemented included earlier patient movement from pre-op, better coordination of patient flow, and a report card, as well as recommended physical layout changes supported by a cost-benefit analysis.

Overall Conclusions

Safety-net hospitals can improve patient satisfaction, increase productivity and increase patient access through use of management engineering. Management engineering can launch a culture of innovation in tradition-bound departments by creating buy-in to the concept of improvement. Hospital staff in all of these case-study hospitals quickly adopted the concepts and the challenge, with the result that most now have ongoing process improvement groups that meet regularly and that are implementing and extending the initial recommendations and using the tools demonstrated.

The keys to a successful management engineering intervention are:

- **Problem identification.** Identify an area where the hospital must improve its performance. A clear and measurable objective is needed, such as increasing the number of daily exams completed and attaining the level of the industry norms.
- **Measurement.** Accurately measure operational attributes related to the problem both before and after changes. The hospital's information technology systems may provide reports but data may be limited to financial or clinical information, not operational information, so that new measures may be necessary.
- **Analysis.** Understand the system related to the problem by using a variety of management engineering tools. Often a model is created in order to consider alternative changes. The model may be a flow chart, a statistical analysis, or a simulation.
- **Solution.** Analyze alternatives in order to develop the most cost-effective change. In management engineering practice, brainstorming with hospital staff in a focus group setting is a good source of ideas. The management engineer can then analyze the expected effect of changes, select the preferred recommendations, and develop specific implementation plans.
- **Intervention.** Make the selected changes, and monitor and revise if necessary based on the operational measures developed in the measurement step. Continuous improvement may occur by repeating these steps.

Management support is critical in management engineering projects. The hospital cases all had strong management support, reflected by management's involvement in the California HealthCare Foundation's application and selection process. There is continuing interest in the projects, manifested differently at each of the institutions. At White, a committee consisting of supervisors, information technology personnel, and technicians meets regularly to review progress on the list of recommendations. At Mendocino, the chief executive

officer and chief compliance officer are quite involved in continuing the process improvement efforts. At Arrowhead, a group of clinicians, technicians and supervisors continues to monitor and implement change. CHLA and Riverside hired management engineers and others have initiated new management engineering projects.

The impact on patient flow can be quite great; at San Francisco General, for example, on-time operating room start times more than doubled and turnover time was reduced by 20 percent. At Valley Presbyterian, utilization of rooms increased from about 60 percent to over 80 percent. Turnaround time was reduced by about 20 percent. The management engineer, or those trained in management engineering techniques, is a resource to instigate change in hospitals. The engineer identifies changes and can remain focused on completing implementation. The need for change may be apparent, but internal organizational inertia or culture often prevents change from occurring.

Process and operations improvement projects are a way to disseminate innovation from one department to another. In the hospitals described in this report, the data-gathering procedures and report card formats developed for one hospital were transferred and used at other hospitals, reducing the time to perform this most time-consuming task.[3] This dissemination can apply as easily to departments as to facilities.

These projects demonstrate the use and impact of management engineering techniques in California's safety-net hospitals. Participation in management engineering projects can prepare staff in the basics of management engineering, understand its benefits and help build a long-term commitment to operational improvement within the hospital. Hospital leadership must provide a vision and promote operations improvement internally. Administration must show staff that process improvement is an opportunity to make their work more productive and rewarding and increase patient satisfaction and well-being.

Glossary

Balanced scorecard: Used to drive performance and accountability. Under this approach the organization develops performance measures in each of four categories:

- Financial (the traditional focus of performance)
- Customer (generally a patient): The present and future needs and expectations
- Business processes: The efficiency of the operations
- Learning and growth: Developing knowledge and expertise within the organization

Benchmarks: Operations indicators such as patient satisfaction or staff productivity, which may include standards, critical success factors, and metrics based on industry averages or best practices at comparable hospitals. Benchmarks allow a hospital to see how it is performing in comparison to others and what might reasonably be achieved.

Control chart: A graph that monitors variance in a process over time and alerts the organization to unexpected variance that may cause defects.

Dashboard: A periodic management report, primarily for administration but also for staff, that describes the performance of a functional area, such as surgery. Like a car dashboard, it provides the information needed to steer the department by displaying current, clear and graphic measurements that are easily and quickly understood. See Figure 3 on page 12.

Facility layout study: The process of studying the physical configuration of departments, staff workstations, service areas, material storage areas, offices and patient flow patterns in order to produce the best possible physical arrangement or building design. Minimizing travel distances, improving patient satisfaction and improving the quality of care are often the objectives. Similar tools can find the optimum location for a site, such as a clinic or a hospital.

Fishbone diagram: A graphic that shows the causes of an event such as a problem. It is useful to identify the range of multiple factors such as the reasons for delays in patient flow or the causes of a quality issue. Also known as a cause-and-effect diagram or an Ishikawa diagram. See Figure 2 on page 11.

Flow chart: A schematic representation of a process. It depicts inputs, outputs, and a sequence of activities. It can represent an entire process at a high level or describe detailed steps. The resulting flow chart may, for example, represent a patient visit or a radiology procedure. Similar graphic descriptions are called process charts or workflow diagrams. See Figure 1 on page 7.

Focus group: People gathered together to discuss their opinions about a topic such as service or process. Questions are asked in a group setting where participants are free to talk along with other group members. It is a useful way to get a prompt and candid picture of an issue when multiple people and organizational units are involved.

Inventory and supply chain management: Methods to minimize inventory levels, minimize shortages, and control supplies, including systems to order, move, and store materials.

Lean method: An approach to operations improvement originally developed at Toyota but successfully utilized in health care. Emphasis is on reducing waste, developing smooth workflow, and creating a culture responsive to customer needs.[4]

Pareto diagram: A graphic that focuses on efforts or problems that have the greatest potential for improvement by showing relative frequency and/or size in a descending bar graph. Based on the Pareto principle, 20 percent of sources cause 80 percent of problems.

Operations research and resource allocation: Mathematics to identify optimal solutions for problems such as nurse staffing and patient scheduling.

Patient satisfaction survey: A questionnaire that can be used to obtain ratings from patients about the degree to which services received from a health care provider meet their expectations, usually performed on a confidential basis. Such surveys can be used to measure physician or community satisfaction and offer clues as to where improvement is needed.

Process improvement: A systematic approach to making an activity better by reducing its cycle time, reducing its variability, improving its quality, or making it more effective or efficient.

Process modeling: Prescribes how things should happen in contrast to the process itself or what really happens. In hospitals, this reveals how patients are currently served, determines where inefficiencies exist, and prioritizes future changes. Process modeling can reveal unnecessary repetition, miscommunication, and inconsistency in methods.

Productivity measurement: The ratio of measured outputs over measured inputs, usually labor (i.e., patients served per staff hour or exams completed per technician hour).

Queuing models: Mathematical models used to study or forecast waiting lines for patients, staff, samples, records or supplies.

Simulation modeling: Using computer models to replicate almost any type of system, from a radiology department to a pharmacy, in order to understand the dynamics of such things as patient wait time, staff scheduling, and emergency room flow. It can be used to evaluate new processes, to understand and demonstrate the current causes of delay, and to forecast bottlenecks. Simulation models are used to test changes without disrupting the real system.

Six Sigma: An approach to operations and quality improvement with an emphasis on controlling variability, identifying causes for defects, and developing a set of trained change leaders. Originally developed for manufacturing, it has been successfully implemented in health care.

Statistics and quality control: Mathematical and graphical methods to quantify performance and use statistical models to identify problems and control variability.

Time study: Observation and detailed time measurement of repetitive tasks to understand work processes and improve them.

Work measurement and reengineering: Redesign, often radically, of how work is done by measurement and analysis of jobs, such as the time and sequence of individual tasks. It has been used to design work such as a radiology procedure, patient registration and surgery.

Appendix

Safety-net hospitals in California are under persistent pressure to meet rising patient demand despite ever-scarcer resources. In the face of tight budgets and no additional resources on the horizon, many hospitals are realizing that they simply have to get more capacity out of their existing systems. To achieve this, hospital leaders have looked at ways to improve operations so that more patients move through more efficiently to take advantage of scarce resources such as surgical suites and radiology equipment.

This appendix presents seven short case studies that highlight the use of management engineering in safety-net hospitals to improve patient throughput. Five of the cases took place in surgical departments and two took place in radiology. Each examined the impact of patient flow, asset utilization, communications, and changing roles and responsibilities on efficiency and throughput. The participating hospitals were diverse, ranging from 25 to 300 beds, but all are safety-net providers with a common desire to run more efficiently, increase patient satisfaction, improve staff morale, and increase capacity to serve more of their populations.

Management engineering offers a way to improve care delivery through better efficiency, thereby increasing access to care and reducing, or at least controlling, costs and patient wait times. It is a systematic process for diagnosing, quantifying, benchmarking, and addressing bottlenecks and inefficiencies in the delivery of care. Management engineering can improve care by increasing productivity, controlling costs, and reducing wait times for patients. It also offers clinical staff a different and objective way to look at patient flow. Management engineering challenges the status quo and encourages care providers to make efficiency a priority.

Readers can select relevant cases by choosing a type of problem, solution, or management engineering tool by using the matrices in Table 2 (see page 21) and Table 3 and (see page 35).

Several prominent themes emerged in these cases:

- **Generate commitment to change by developing a public scorecard for patient flow.** Every hospital that participated in these studies created and maintained the momentum for change through visible collection, analysis, and publication of the data. Posting operational performance data as a scorecard visible to everyone in the department creates a culture with incentives for people to improve efficiency.
- **Map patient movement to identify bottlenecks to improve patient flow.** Major causes of delays can be identified by mapping the patient's movement from admission to discharge and noting when there are waiting times, resource constraints (e.g., ORs not being ready or equipment being double-booked), or other gaps in service.
- **Trace miscommunications and change the mechanisms that create them.** Understand how and when people are supposed to communicate across and within departments, and where problems and miscommunications typically emerge. Almost always, there are chronic patterns of poor or untimely information exchange, and there is a way to change the actual vehicle, process, or person for improved communication.
- **Standardize procedures.** Instead of assuming that everyone knows what everyone else is

doing, have all staff and physicians use checklists and procedures that keep the patient moving efficiently through the system.

- **Create accountability for patient flow.** In many cases, it makes sense to put a single person in charge of patient flow rather than having responsibility spread across an entire department or many departments.
- **Clarify roles and responsibilities and dedicate staff where necessary.** One hospital had long-overdue open discussions on who was in charge of which decisions on patient flow. Another hospital recognized that surgical housekeeping is a specialized skill that requires dedicated staff. Using these dedicated resources, the hospital improved many aspects of the surgery department, from scheduling to surgeons' on-time rates.
- **Use technology to its full advantage.** This doesn't have to mean a massive IT investment; in some hospitals, providing cell phones, two way radios, or electronic OR whiteboards had a real impact on efficiency. In others, existing scheduling systems had capabilities that weren't being used because the proper data wasn't being entered in a timely manner. Making changes to data input and processing is relatively simple and can have a big impact on managing patient movement.

These cases are intended to give safety-net hospitals a new framework for thinking about their own challenges with patient flow, asset utilization, communications or staffing. Approaching these issues from a management engineering rather than clinical perspective can be enlightening. Taking advantage of a neutral third-party perspective and using data can break through political issues that may be hindering efficiency.

Each case provides some background on the challenges of the department, what specific problems were identified by the team of management engineers, solutions that were suggested and implemented, results from the study, and lessons for other hospitals.

Table 2. Surgery Projects, by Hospital

	CHILDRENS HOSPITAL L.A. (pages 13, 23)	VENTURA COUNTY (page 25)	VALLEY PRESBYTERIAN (page 28)	S.F. GENERAL (pages 14, 30)	RIVERSIDE COUNTY (pages 14, 34)
Problems					
Under-utilization of rooms or staff		✔	✔		
Patient flow delays	✔	✔		✔	✔
Room turnover time			✔	✔	
Communications	✔	✔			✔
Satisfaction of patients and staff			✔		
Scheduling	✔				✔
Management Engineering Tools					
Flow charts, maps, diagrams	✔		✔		✔
Collect data by observation		✔		✔	
Focus groups, brainstorming, Kaizen	✔			✔	
Facilities layout		✔	✔		
Data analysis and manipulation	✔			✔	✔
Benchmarking		✔		✔	
Staffing, scheduling allocation	✔				✔
Design of procedures, guidelines	✔				
Time study, reengineering				✔	
Solutions					
Implement report card, dashboard	✔	✔	✔	✔	
Better staff and room scheduling	✔				
Standardize procedures and checklists	✔			✔	
Redesign patient flow		✔	✔		✔
Better use of technology and information systems	✔				✔
Improve whiteboards		✔	✔		
Role definition and redesign	✔			✔	
Physical space redesign		✔	✔	✔	
New communications tools	✔				✔

Case Studies: Surgery Departments

Childrens Hospital Los Angeles

INCREASING SURGICAL CAPACITY BY IMPROVING PATIENT FLOW

Overview

In a busy hospital like Childrens Hospital Los Angeles (CHLA), where more than 13,900 pediatric surgeries are performed a year, chronic delays and bottlenecks can add up to tremendous systemic inefficiency. Cynde Sherman, the hospital's administrative director for the Department of Surgery, says, "We had a patient flow issue. Turnaround times for operating rooms and surgeons' on-time rates were very poor. We had the data, but we weren't reporting it or using it."

Recognizing these problems, the hospital leaped at the chance to participate in a management engineering study aimed at improving efficiency in the surgical department. Over the course of about four months, a team of management engineers from USC led by Dr. David Belson studied the flow of patients, communication and processes for sharing information, and roles and responsibilities of hospital staff and physicians to determine ways to improve efficiency.

Patient Flow

The USC team identified a bottleneck between the Admitting department and the pre-op area created by delays in recording patient status into the computer system. The team recommended that nurse practitioners in Admitting be required to enter completion status into the computer system in a timely manner.

In addition, there were significant problems in the scheduling process for surgeries. A number of recurring errors in advance scheduling produced an often inaccurate daily schedule: schedulers assumed 15 minutes for room turnover time (TOT), which underestimated the actual time it took to prepare the OR, and estimates of actual time required for specific procedures were frequently inaccurate as well. The management engineering team provided CHLA with specific guidelines to improve scheduling accuracy. The team also recommended changes in the process for scheduling surgical teams. They suggested assigning anesthesiologists earlier, three days in advance. This would make it possible to determine ICU bed requirements three days in advance to avoid the problem of bed shortages.

Finally, the study pointed out that CHLA's physical layout presents some real challenges to moving patients around efficiently. CHLA has consulted architects to physically bring pre-op and post-op closer to the ORs, although these types of changes will obviously take time to implement.

Communication/Exchange of Information

Overall, the management engineering team found that CHLA needed better communication across all the people involved in moving a patient through surgery. One way to ensure better communication is to centralize it; specifically, the team believed that the control desk was not sufficiently involved in patient movement for outpatients. They recommended that the hospital require operating rooms to request their next patient through the lead nurse at the control desk to centralize patient flow communications, but this suggestion met with some resistance from surgeons.[5] The hospital is still considering different ways to coordinate information.

Other areas of communication were more easily resolved. The study team recommended that housekeeping staff note when the OR is clean on the whiteboard by the control desk and that they post that information in pre-op as well. The team also recommended that the advance schedule show more

details regarding ICU bed requirements, and that the next computer system (which CHLA is planning) include scheduling input from clinics available online and integrated with the surgery scheduling office.

Perhaps the most significant improvement in communication came through the data tracking required for the study itself. Prior to this study, some relevant data on surgical efficiency was gathered, but there was no report card for tracking patient flow. The study recommended implementing and circulating a patient flow report card measuring turnover time, room utilization, schedule accuracy, and other metrics. According to Cynde Sherman, "This brought turnaround time to the forefront and made it a measurable goal. We're now tracking efficiency much more carefully."

Roles and Responsibilities

The engineers found that turnover time for operating rooms suffered when the housekeeping staff was slower than expected. The issue was that every department in the hospital utilized rotating members of a large team of housekeepers, not all of whom had the specific training and skills required to prepare an operating room. Following this study, the hospital decided to create a dedicated housekeeping staff for surgery to reduce the time it takes to turn over the room between patients. This helps with scheduling, since the dedicated staff is much more consistent and predictable. In addition, the hospital can now require surgeons to remain in the OR if they have two back-to-back patients (previously, they would often leave the floor rather than wait around for the housekeeping staff to finish).

Solutions and Results

At the start of the project there were no regularly measured patient flow statistics other than volume and first-case start percentage, and there had been a lot of ongoing debate about exactly how to measure efficiency (i.e., whether to include heart transplants and other exceptionally long, complex surgeries in the data alongside relatively straightforward procedures in ambulatory surgery). Depending on the data sources and which cases were included, results varied. The USC team estimated the average turnover time at about 53 minutes in December 2008, and at their recommendation the hospital began automating data collection for room utilization and other measures. One retrospective analysis seems to indicate an average turnover time of 34 minutes in November and December of 2007, down to 28 minutes in July 2008. Not all of the recommendations have been fully implemented, so improvements should continue. Meanwhile, the hospital makes use of its new tracking capabilities to motivate improvements.

Lessons for Safety-Net Hospitals

- **Small improvements can make a big difference.** New whiteboards and an audit of the scheduling parameters had a significant impact at CHLA.
- **Communication is key.** Creating systems to keep everyone informed about a patient's status and the readiness of each department goes a long way.
- **Automated data collection and publicized report cards about efficiency can be powerful motivators.**
- **Make sure the right people have the right roles and responsibilities.** Recognizing that surgical housekeeping is a specialized skill that requires dedicated staff has improved many aspects of the surgery department, from scheduling to surgeons' on-time rates.

- **Learn how the management engineering approach can stimulate improvement initiatives of all sizes.** Says Cynde Sherman, "This was an awesome opportunity for us to get a different look at things. The engineers are not focused on the clinical side, so working with them was fascinating. This gave us a big leg up, knowing all the things they look at. We can pick a small project, take the emotional process out of it, and look at it objectively."

About the Hospital

Childrens Hospital Los Angeles (CHLA) is a 318-bed pediatric trauma teaching hospital that performs more than 13,900 surgeries a year. There are two surgical areas: the main area on the second floor, with 14 operating rooms, and an ambulatory surgery center with four operating rooms on the fifth floor of the main hospital building.

Ventura County Medical Center

IMPROVING EFFICIENCY BY CHANGING THE TEAM'S MINDSET ON THE NEED FOR CHANGE

Overview

At the outset of this study, the surgical department at Ventura County Medical Center (VCMC) had turnover times that were slightly below national averages, but the people working there didn't think there was a problem. The hospital's Manager of Surgical Services, Brad Ditto, says, "There was a general lack of perception of what was going on in the surgery area. We were OK at what we did, but there were a lot of people—housekeeping, nurses, techs, and doctors—who wanted to stick to the same routine. We needed a mindset change."

The management engineering study was aimed at improving efficiency in the surgical department, by identifying and removing process-based delays and fostering a more efficiency-seeking culture within the surgical department. To that end, a team of management engineer students from USC led by Dr. David Belson studied facility issues, the flow of patients, communication and processes for sharing information, and roles and responsibilities of hospital staff and physicians to determine ways to improve efficiency.

Facility Issues

VCMC's surgery area had several advantages: there were only five operating rooms in a relatively compact space; the area has good visibility; the staff is a small enough group to foster teamwork; and the department manager, a nurse, has an office in the center of the flow so she can be constantly aware of all events.

However, the pre-op area—where patients wait for surgical rooms to be free—is distant from surgery. The distance contributed to poor communication and patient flow between pre-op and surgery. Further, the management engineers found that pre-op was often understaffed, so that all four pre-op beds could not be occupied. Finally, the hospital needed more transport staff to move patients from pre-op and inpatient beds. Some volunteer staff was available, but not on a consistent basis or when the demand was highest.

Patient Flow

Patients were delayed in pre-op and not sent to the pre-op holding area promptly enough, which caused a "starvation effect" in the operating rooms while the surgery teams waited for patients to be ready to be moved from pre-op holding into the ORs. As Ditto says, "Our efficiency problem had to do with the timing of when patients were moved." This timing was impacted by poor communications.

Patient flow issues were exacerbated by unscheduled surgeries. One-third of the hospital's

daily surgery volume is not scheduled in advance. These patients come from the emergency room or are referred by various physician offices.

Communication/Exchange of Information

A major challenge, both for assessing and solving patient flow issues and for data gathering and benchmarking, is that VCMC does not have a computerized scheduling system; scheduling is done with a manual paper system.[6] The scheduler records planned cases in a logbook. But for unplanned surgeries, cases are phoned in, the scheduler finds the best time and date and adds the case to the logbook, and, if needed, the scheduler updates the whiteboard. Before the day of surgery, the scheduler enters the planned surgeries into a computer record, but this system is used solely to keep a record of the daily OR activity, not to originate the schedule.

Information is also disseminated manually, with the charge nurse serving as the linchpin for all communication. There is a centrally located control desk where the charge nurse and room scheduler sit. From there, the charge nurse can see everyone going to and coming from the ORs, but not the actual ORs. The charge nurse speaks by telephone to the pre-op and holding areas regarding patient status and movement, and phones surgeons and anesthesiologists to alert them to upcoming cases. This charge nurse maintains a whiteboard to track patient flow. The nurses, surgeons, and anesthesiologists usually congregate near the whiteboard (it's also at the entrance to the break and change rooms for the staff) to discuss what is happening regarding the flow of cases.

Roles and Responsibilities

Most nurses in pre-op had worked in the county hospital for many years longer than people in other parts of the surgery area, and they had developed their own routines and opinions about how and when to process outpatients. There was a notable, significant difference in attitude toward change between the pre-op team and the rest of the surgery area. This silo-like departmental thinking contributed to pre-op's lack of coordination with the rest of the surgery team, especially with pre-op holding and the control desk. In addition, the physical layout might have also served as a factor in promoting this difference in the organization. Because of the pre-op area's isolation, it was not surprising to find that pre-op nurses had developed their own timing in processing the patients and were not well coordinated with pre-op holding processes.

Making changes in a team's culture, and especially shifting around specific responsibilities, can be sensitive. However, it can also have a tremendous impact. Brad Ditto says, "The charge nurse ran the show, but a couple of people had their hands in the mix. It was the charge nurse's job to improve communications with pre-op—she had to be put in charge. It didn't go over well initially, but people saw that it worked."

The key to success with this initiative was showing everyone at VCMC that making a few minor changes in workflow created tangible results. As Ditto says, "The big thing was awareness of the management engineering process, and people saying, 'Hey, this guy has some good ideas.' It didn't change anyone's day that much, so the staff saw that it wasn't going to have an impact on them, but it would improve efficiency."

Solutions and Results

A combination of standard operating procedures on patient flow, computerized scheduling, physical redesign and adding transport staff created efficiencies.

The USC team helped VCMC create patient flow operating procedures to standardize and manage processes and provide the staff with goals for improvement. The manual records made it difficult to accurately track turnover time and room utilization in comparison to other hospitals, and certainly a computerized scheduling system would be beneficial. In the interim, though, a monthly report card is now used to evaluate key metrics within the surgical department. With a centralized communication center, there is better information flow between pre-op and the OR.

The USC team also recommended some changes to the physical layout in the building (moving the pre-op area closer to the pre-op holding area and possibly sharing beds between pre-op holding and post-anesthesia care unit, or PACU) that are under consideration, but which obviously will take more time to implement. The USC team recommended adding a patient transport person, which could be a part-time or student worker, and provided the hospital a cost-benefit analysis to facilitate discussions with county administration.

Although not all of the changes that were recommended have been implemented, in November and December 2007 the average TOT was 45 minutes, and the TOT for July 2008 was estimated at an average of 34 minutes.[7]

Lessons for Safety-Net Hospitals

- **Culture makes a huge difference.** In many hospitals, there are departments that have long-established routines and "ways of doing things" that aren't efficient, and don't work well with other parts of the hospital. Finding ways — such as data sharing — to change people's mindset to embrace teamwork with other departments can be a challenge, but can also have enormous impact.
- **Centralize and delegate responsibility for communication.** Creating systems to keep everyone informed about a patient's hourly status and the readiness of each department to receive and manage a patient is essential.
- **Automate where possible.** Computerized scheduling systems make it much easier to accommodate a higher volume of patients, particularly when there are as many unscheduled surgeries as there are at VCMC.
- **Respect people's existing work flow.** Change can be disruptive, so it's worthwhile to make sure that people's normal workflow is not altered too much so they can embrace a slightly different way of doing things.
- **Have the right support staffing levels.** Highly skilled staffing is frequently in tight supply so ensure that support staff are appropriately scheduled to maximize these resources.

About the Hospital

Ventura County Medical Center (VCMC) is a full-service, acute-care hospital serving residents of Ventura County. VCMC has a satellite hospital in the Santa Clara Valley, Santa Paula Hospital: it is a 208-bed hospital with a 24-hour emergency and trauma center.

Valley Presbyterian Hospital

IMPROVING EFFICIENCY WITH A COMPREHENSIVE DASHBOARD

Overview

Management at Valley Presbyterian Hospital (VPH) knew that the surgery department had room for improvement but did not know exactly how much, because at the start of the project there was no overall patient flow report. Before any improvements could

be made, the surgery department had to know how it was performing. To kick off this management engineering study, Dr. David Belson and his team created a reporting tool based on paper records of patient movement, which enabled them to look at room turnover time (wheels in to wheels out), room utilization, percentage of first cases starting on time, schedule accuracy, how actual times vary from scheduled times, and distribution of these measures by time of day, day of week, room, service, surgeon, nurse, or anesthesiologist. They found that VPH was missing many key benchmarks for efficiency, most notably turnover time (hospitals turn surgery rooms over in an average of half an hour and often considerably less, and at VPH it averaged about 40 minutes) and room utilization (which was between 59 percent and 63 percent compared with a target of 85 percent).

To the people working at VPH, the frustration caused by chronic delays and inefficiency was taking its toll. Director of Surgical Services Roxanne Baden summed up the hospital's rationale for participating in a management engineering study by saying, "We knew we had a poor process and needed help. The staff was discouraged, patient satisfaction was low, and it wasn't anyone's mandate to make it better."

In order to improve patient turnover time and reduce frustration among the staff, a team of management engineer students from USC led by Dr. David Belson studied the flow of patients, communication and processes for sharing information, and roles and responsibilities of hospital staff and physicians to determine ways to improve efficiency.

Patient Flow

The management engineering team immediately identified one of the critical problems at VPH: patient transport. Roxanne Baden says, "What we found was that there was a long wait time for people who were already admitted. Part of that is the facility—there's a long walk—but the bigger issue was transportation. The admitting agent had to assign an orderly, and then we had to pace them. They were waiting until they had two or three patients to transport them. We decided to start our first batch of patients—our 7:30 starts—in the recovery room because it's closer to admitting. We improved from a 56 percent on-time rate to an 83.3 percent. It was phenomenal." In addition, the hospital adjusted staffing to ensure that there were enough orderlies available for patient transport to remove this bottleneck.

Communication/Exchange of Information

The lack of regular, standard reporting on patient flow metrics was making it difficult for management to understand where there were problems and delays in the process. There was also a lack of clear scheduling instructions and guidelines. In the absence of an IT solution, VPH created its own utilization report card using paper records and MediTech data as input. While an automated solution is preferable, the current system at least allows the team to identify and resolve problems in patient flow.

In a great example of how a simple technology solution can make a world of difference, VPH radically improved efficiency (and morale) just by providing everyone with phones. The staff and physicians had been frustrated by not being able to communicate with the surgery office, and the surgery office also had challenges in contacting the medical staff. Communications between admissions, same-day surgery, holding, the ORs, PACU, and clinical staff was a challenge and contributed to patient wait times. By giving everyone phones instead of relying on overhead speakers and pagers, all the delays

caused by not being able to reach people immediately disappeared.

Roles and Responsibilities

Some of the major delays at VPH were caused by patients waiting for orderlies to take them from one area of the hospital to another. The solution was to add transport staff. "We've invested in outside transportation," says Baden. "We have more transporters now. The problem wasn't just with us, it was with the whole hospital. Having dedicated surgical orderlies helped with the turnover process. We use more carts, we organize better, and there are more people."

One of the advantages of an outside perspective is that the management engineers can objectively assess a situation that, from the inside, may be colored by convention or habit. For instance, many hospital staff are accustomed to doing whatever it takes to keep doctors happy at all costs, which may conflict with an efficient schedule and enforcing rules concerning start time, etc. The management engineers created neutral, impartial decision rules and guidelines for the scheduling of cases, which streamlined the scheduling process and made it more accurate.

Solutions and Results

The surgery department now uses a dashboard to monitor turnover times, on-time starts, and other important metrics for efficiency. While there have been measurable improvements in many areas, the biggest change is less tangible: the staff, nurses, and doctors in surgery experience less daily frustration at unnecessary delays and miscommunication. Roxanne Baden was so impressed with the process that she has continued her education in management engineering, and has promoted this type of initiative throughout the hospital.

Lessons for Safety-Net Hospitals

- **Provide tools and education for continuous improvement.** As Baden says, "Give us the tools to do this on our own—start small, showing us how to map processes and look for obstacles."
- **Make sure management supports the improvement initiative.** "Initially the staff was skeptical, but one the CEO gave it his blessing it was like, 'ok, we're doing it.' It helped to have buy-in from the top down."
- **Spread the results of successful initiatives to the rest of the hospital.** "I think we should do more to promote the results throughout the hospital. We have so many initiatives in a big hospital like this that this one hasn't really stuck with the rest of the hospital."
- **Simple technological solutions can be enormously helpful.** As Baden says, "We gave everyone Nortel online phones, so that rather than paging and having overhead PA systems, you can just call and reach someone wherever they are in the hospital."
- **Use performance measures as a diagnostic tool as well as a way to publicize and promote the importance of efficient patient flow.**
- **Take advantage of a neutral third party perspective to break through political issues that may be hindering efficiency.**

About the Hospital

Valley Presbyterian Hospital (VPH) is the only not-for-profit, non-sectarian, independent, full-service, general, acute-care hospital in the San Fernando Valley, which has a population of 1.7 million. The 350-bed facility offers a wide range of services such as emergency, neonatal ICU, cardiac care, orthopedics, and critical care. The surgery area, on the first floor,

includes eight operating rooms, one of which was under construction during the course of this study.

San Francisco General Hospital

IMPROVING EFFICIENCY THROUGH PUBLIC METRICS AND EFFICIENCY-BASED PERFORMANCE STANDARDS

Overview

Dr. James Marks, chief of anesthesia at San Francisco General Hospital (SFGH), is a self-professed "efficiency nut." In talking about his decision to take part in a management engineering study with a team of students from USC, he says, "I wanted to increase operational efficiencies because it is the right thing to do, and because I think sometimes hospital leadership doesn't pay enough attention to throughput."

The primary goal of a management engineering study is to identify concrete ways to improve efficiency, but Dr. Marks also felt that it was important to use the analysis as a stimulus for culture change. It was common knowledge at SFGH that the OR was not run as efficiently as it could be, but there was some resistance to change. To address this, at the outset of the study, the USC team met with the entire surgical staff, explained that the hospital was facing severe financial challenges, and gave them an opportunity to ask questions and provide input. The USC team also explained that a management engineering study would help them make some necessary productivity improvements without adding more work to their days. The response was very positive. Management made it clear that they were sincere about the need for change, and the staff appreciated being included in the discussion from the beginning.

In addition to highlighting the importance of operational efficiency, the study gave the department's managers tools and analyses that would help them continue to improve in the future. "This was an opportunity to leverage outside expertise, get outside recommendations, and implement some changes," says Marks. "We had a good idea of what the results would be — there were no great surprises — but the process was interesting to see. We learned about how one goes about data gathering and finding bottlenecks. It was more comprehensive than we would have done on our own." A team of management engineers from USC led by Dr. David Belson studied the flow of patients, facilities utilization, communication and processes for sharing information, and roles and responsibilities of hospital staff and physicians to determine ways to improve efficiency.

Patient Flow

According to Dr. Marks, one of the bottlenecks identified was "a huge problem in the pre-op area." In particular, the nursing staff, surgeons, and anesthesiologists duplicated some tasks in patient interviewing. Although some duplication is needed for legal or clinical purposes, unnecessary redundancies needed to be identified and eliminated.

The management engineers also borrowed a concept from manufacturing and recommended that the OR use a "pull" rather than a "push" approach to patient flow (a so-called Toyota Production System approach). Nurses in the OR were instructed to be proactive in pulling in the next cases rather than waiting for pre-op or the OR charge nurse to push the next case to the room once the room was emptied. This requires a change in mentality as well as explicit definition of roles and expectations of staff.

Facility Utilization

Sometimes operational efficiency is limited by the physical constraints of a surgical department. As Dr. Marks says, "The problem in the pre-op area was largely due to space constraints." At SFGH, the

first set of patients use beds that are used for recovery later in the day. Thus, patients for the second and third surgeries in an operating room must be held in the hallway prior to surgery. Every day the USC team observed patient flow, this situation occurred. Also, the waiting area for families is extremely small relative to the size of the daily surgery volume. There is less than one chair for waiting family members per operating room. The USC team recommended creating a "block space" for anesthesiology pre-op, which would reduce OR time and increase throughput. Currently, the block procedure is often done in an operating room, which can take up to an hour. Some hospitals do this procedure before the patient enters the operating room. Since OR time is at a premium, a separate area or block room for such procedures could improve throughput.

The USC team was specifically asked by hospital management to make room turnover time (the time from when one patient wheels out until the next wheels in) a priority because they felt it was a problem. The data from three months of surgeries bore that out. Similar hospitals turn surgery rooms over in a half-hour on average, and often considerably less.[8] Room turnover time at SFGH was nearly a full hour.

The findings about room turnover time were no surprise to Dr. Marks, who says, "We had some known problems, but there were additional things identified that we didn't think of." An example of this is room utilization, which is the percentage of the day during which the operating rooms are in use. From an economic standpoint, utilization is important since the OR is a very valuable resource (SFGH estimates the value of the OR at $64 per minute). The USC team computed utilization as the time patients are in an OR during the regular weekday shift, plus an allowance for room turnover since a new patient cannot be moved in the instant one patient leaves. They found that room utilization was an average of 54 percent and staffed room averaged a utilization of 79 percent. Typically hospitals target about 85 percent utilization.

Communication/Exchange of Information

There seemed to be no clear pattern of how communications should occur, particularly regarding whiteboard changes, status of cases, and movement of patients. The paperwork from inpatient floors was sometimes incorrect or incomplete, causing delays in room turnover, and scheduling information was unclear (there was ambiguity about whether start time meant "wheels-in" or "cut-time" and over half of actual case times differed from scheduled times by more than 30 minutes). The department sorely needed an overhaul in the way patient throughput was communicated, including defining critical terms like "start time," and considering using electronic whiteboards and/or two-way radios to facilitate better communication.

Residents also appeared to be under-informed, so the USC team recommended publishing a set of standards for all services regarding resident responsibilities and responsibilities of attending surgeons, including explicit checklists and instructions for patient preparation and equipment requirements.

Most importantly, though, the management engineers recommended adopting a regular patient flow dashboard or report card to measure important variables, such as room utilization, turnover time, and scheduling metrics. The report card would also show trends and comparison to benchmarks.

Roles and Responsibilities

When there are as many moving parts in an organization as there are at SFGH, it is imperative that every role be clearly defined, and that everyone

know what he or she is responsible for. Dr. Marks agrees that, "A lack of leadership was identified." The USC team recommended increasing the authority of the charge nurse, since the people currently in this role seemed to be very capable, highly involved in assigning staff to rooms, and close to the department's activities. They also recommended explicitly tying the charge nurses' performance reviews to room utilization and turnover time.

Another problem with resource management was that equipment and supplies were not available when needed. Messages from the sterile processing department were handwritten on the paperwork on the case cart, and were often inaccurate. There were unclear lines of responsibility between sterile processing and the surgical staff.

Another area marked for improvement was surgical services. "We made significant progress on surgical services," says Dr. Marks. "There was a lot of disorganization. We assigned responsibility to one person, and then looked at the availability and responsiveness of housekeeping."

Solutions and Results

At the start of this project there was no overall regular patient flow report or scorecard. As Dr. Marks says, "We weren't collecting the data in the detail we needed to understand why there were problems." The USC team developed a report based on raw data provided from SFGH, and suggested using it as a template for ongoing reports. The hospital established a report card and circulated the resulting graphs to all staff, and now posts results at a central location in the OR corridor. Now, says Dr. Marks, "We're tracking these metrics and displaying them publicly. One reason is that we can show, Hey, you've cut our budgets, but we're doing the same number of cases by improving efficiency. It makes a business case for efficiency and puts heat on our leaders to pay attention to it."

Based on this new reporting system, in the three months following the study the hospital achieved a 40 percent reduction in turnaround time, from a baseline of 55 minutes to an average of less than 34 minutes for April 2009. Late first-case starts were cut in half, and there was a significant reduction in overtime costs. Surgery leadership, including the director of perioperative/critical care/specialty clinic nursing and the chief of anesthesia, made a concerted effort to publicize and promote efficiency as one of the key goals of the department. "I was very happy with the study," says Dr. Marks. "It confirmed some known things, identified some new things, and gave us an impetus for implementing change."

Lessons for Safety-Net Hospitals

- **Use visible dashboards.** Develop, implement, and widely circulate a report card or dashboard with room turnover time, utilization, scheduling performance, and start time information. Once people know that results are being measured and they can see how their performance compares to similar institutions, there is a strong incentive to improve.
- **Set up a "pull" mentality from the operating room.** By "pull" we mean that the staff (probably the circulating nurse for the incoming case) should be responsible for getting the room ready, working to ensure the incoming patient is ready, and moving the patient into the room as soon as possible—before the current case is done. A pull philosophy puts responsibility into the hands of the person who can best take action.
- **Use detailed checklists.** By creating clear expectations and checklists for each team (pre-op, anesthesia, etc.) everyone can begin to trust

that the other team has done their part instead of needing to double-check everything.

- **Make a financial case to improve buy-in.** SFGH estimates surgery minutes at $64. Based on their caseload, a reduction in average turnover time of just ten minutes, which appears quite feasible, represents a potential value of over $2 million per year. For anyone working in a safety-net hospital, the opportunity to squeeze more out of your resources will be compelling.
- **Promote results hospital-wide.** As an advocate for efficiency initiatives throughout the healthcare delivery system, Dr. Marks says, "Efficiency happens to be one of my big-ticket items. So I made sure to include this report in my annual report and give it public voice. It has been read by the CEO, CMO, et cetera. The project gave me an opportunity to spotlight the fact that a multi-disciplinary committee can be an effective body."

About the Hospital

San Francisco General Hospital Medical Center (SFGH) is an acute-care hospital owned and operated by the City and County of San Francisco. SFGH provides a full set of inpatient, outpatient, emergency, skilled nursing, diagnostic, mental health, and rehabilitation services for adults and children. It operates the only Level 1 trauma center for 1.5 million residents of San Francisco and northern San Mateo County. In terms of surgery, SFGH offers a complete set of specialties and is a teaching hospital for the University of California,t San Francisco Medical School. There are 10 operating rooms.

Riverside County Regional Medical Center

REALIGNING PATIENT FLOW ACCOUNTABILITY TO DRIVE OR EFFICIENCY

Overview

Louise O'Rourke, the OR nurse manager at Riverside County Regional Medical Center (RCRMC) is very matter-of-fact about her motivations for participating in a management engineering study. "We knew there was a problem. I thought we could streamline and improve flow, but some people here didn't want to hear it. It was extremely useful to have an outside group come in and say, 'your goals are reasonable, and here's how you get there.'"

O'Rourke's assessment turned out to be true; based on manual calculations using data from the hospital's information system, it was apparent that the average turnaround time was well above industry norms, and there were some clear areas for improvement. In order to improve efficiency in the OR, a team of management engineering students from USC led by Dr. David Belson studied the flow of patients, asset utilization, communication and processes for sharing information, and roles and responsibilities of hospital staff and physicians to determine ways to improve efficiency.

Patient Flow

The management engineers found that the pre-op holding area was a bottleneck; patients simply were not ready when needed. There was one holding bed available for each of the 11 OR beds, but typically only one or two holding beds were occupied. The management engineers suggesting increasing the average number of patients in the pre-op holding area so that during the day shift — especially the first half of the day — most of the beds are occupied. "We needed a lot more control over pre-op of patients," says O'Rourke, and this area of the department

became a major focus of the study, as well as an area for ongoing improvement.

Asset Utilization and Facility-Related Issues

The control desk where patient flow is monitored and posted on a whiteboard is located in an office with internal windows so that nurses can view the corridor where patients get wheeled into the OR area. The control desk is also located in an area with the offices of the anesthesiologists, OR manager, OR scheduler, and the anesthesia technicians. As a result, the area is often crowded, and the charge nurse cannot actually see all the ORs, so she relies on the telephone and intercom system to get notification about the status of each room. Since it isn't cost-effective to reconfigure this area, the team of management engineers suggested working around it by improving communications and using automation to help eliminate confusion.

The main surgical area has a total of 11 operating rooms, including one GI room and one dedicated trauma room. RCRMC assigns certain ORs by specialty because of certain essential equipment that is stationary (for example, eye surgeries must be done in Room 9 and neurosurgeries must be done in Room 8 because these surgeries require large microscopes that are too fragile and expensive to move among rooms). The study found that some delays were caused by scheduling procedures in rooms that did not have essential equipment, or by booking procedures at the same time that would require the same equipment. RCRMC has technology capable of managing rooms and equipment, but data was not entered into this computerized scheduling system. Since the study, the department has made a conscious effort to improve data entry so that the automated system can alert them to potential conflicts.

Communication/Exchange of Information

There was a lack of communication between staff in certain patient areas. The pre-op holding staff found it difficult to determine when a patient needed to be ready or transported, as they could not see the whiteboard and often were not contacted via intercom. The study recommended some changes in the way communications were handled. "We instituted a new pre-op checklist," says O'Rourke. "It was expanded to include the clinic and admitting department, and it made everyone more accountable for sending information on the patient when it was needed." The goal was to improve communication between admitting, pre-op, the charge nurse, transportation, and the surgeons so that everyone would be in the OR when needed. The management engineers also suggested that the department purchase two-way radios because the intercom system was inadequate.

At the outset of the USC study, there was no patient flow report card or regular statistics maintained on surgery patient flow. The engineers suggested implementing a patient flow report card that could be used to determine where improvement was needed and that could motivate staff.

Roles and Responsibilities

"We really needed a realignment of responsibilities," says O'Rourke. "Pre-op was under the clinic's management, not under OR. It needed to be controlled by us — the nurses need to be accountable for having patients ready for the surgeons on time." Following this study, the responsibility for pre-op shifted to surgery, along with the responsibility for tracking patients throughout their procedures and notifying the relevant parties when the patient was ready.

Another concern was the availability of housekeeping staff. When the OR was busy, there

sometimes were simply not enough people in housekeeping to handle the demand. As a result of this study, RCRMC has added two new housekeepers to the department to accommodate the busier periods for surgery.

Solutions and Results

Most of the recommendations made by Dr. Belson and his team have been implemented or are in the process of implementation. The OR has revised communications policies, procedures, and staffing to support better patient flow. Patients are arriving earlier into the pre-op holding area, and the average number of patients in pre-op holding has increased from one or two to three or four patients in beds, so there are fewer delays from patients not being ready for surgery in time. The hospital has also purchased cell phones for the techs so everyone can have direct access rather than relying on an intercom system. The department is now tracking patient flow using a modified report card.

Overall turnaround time has gone from about 50 minutes in late 2007 to about 40 minutes in early 2008.[9] This reduction of over 10 minutes adds a significant amount of capacity for surgeries. "There was a frustration level before," says O'Rourke. "It always felt like we weren't functioning fast enough. Now we have it down."

Lessons for Safety-Net Hospitals

- **Assign responsibility for patient tracking where it makes sense.** The pre-op area had been under another department's management, which meant that no one in the OR was accountable for getting patients ready for surgery in time.
- **Use checklists to improve throughput.** Rather than counting on people to remember that they are supposed to be sharing information, make a formal checklist that includes communications points along the way.
- **Assess staffing of non-clinical roles.** Housekeeping plays a very important role in room turnaround, and staffing shortages can cause serious delays in a busy OR.
- **Take advantage of technology.** At RCRMC, the scheduling system already had a function to check for equipment conflicts, but the relevant data wasn't being entered. Changing the data entry requirements is a quick, painless fix that will virtually eliminate these types of scheduling conflicts.
- **Give people the right tools to communicate.** The intercom system was central to the way people stayed informed at Riverside, and it simply wasn't an adequate system. Providing cell phones to key employees ensured that they could be immediately and directly contacted.
- **Use data tracking and scorecards to motivate people.** Publicly sharing information about patient flow and efficiency creates a powerful incentive for people to play their part in keeping the department running smoothly.

About the Hospital

Riverside County Regional Medical Center (RCRMC) is located in the city of Moreno Valley, serving residents in Riverside County. There are 362 licensed beds in the main acute-care hospital, and 77 licensed beds in a separate psychiatric facility. RCRMC has 12 operating rooms, a helipad adjacent to the trauma center, digital radiology services, and all single-bed rooms. There are also adult, pediatric, and neonatal intensive care units.

Table 3. Radiology Projects, by Hospital

	ARROWHEAD (page 5)	WHITE MEMORIAL (page 8)	MENDOCINO COAST (pages 10 and 38)	SANTA CLARA VALLEY MEDICAL CENTER (page 36)
Problems				
Under-utilization of resources	✔	✔		✔
Patient flow delays	✔		✔	
Communications		✔		✔
Clear definition of roles	✔			
Satisfaction of patients and staff			✔	
Staffing level		✔		
Scheduling				✔
Management Engineering Tools				
Flow charts, maps, diagrams	✔			✔
Collect data to stimulate change			✔	
Facilities layout			✔	
Data analysis and manipulation		✔		✔
Benchmarking	✔			
Staffing, scheduling allocation		✔		
Computer simulation	✔			✔
Focus groups, brainstorming, Kaizen			✔	
Design procedures, guidelines		✔		
Time study, reengineering	✔			
Solutions				
Implement report card, dashboard		✔		
Better staff and room scheduling	✔			✔
Standardize procedures and checklists	✔			✔
Redesign patient flow			✔	
Better use of technology and information systems		✔		
Role definition and redesign	✔			
Physical space redesign			✔	
New communications tools		✔		✔

Case Studies: Radiology Departments

Santa Clara Valley Medical Center

USING SIMULATIONS TO ASSESS THE IMPACT OF BOTTLENECKS IN COMPLEX SYSTEMS

(Note: The management engineering study conducted at Santa Clara Valley was conducted by a team from University of California, Berkeley, not University of Southern California.)

Overview

The Interventional Radiology (IR) department at Santa Clara Valley Medical Center (SCVMC) poses some unique challenges when it comes to operational efficiency. Dr. Young Kang, the chairman of the department, says, "IR is a complex discipline. We have a lot of emergency patients having invasive procedures, so it's literally a question of life or death to have the right capacity." Because of the invasive nature of many of the procedures performed there, the department has many of the facilities requirements of a surgical sub-specialty (such as sterile equipment and techniques, anesthetic drugs, and stringent patient safety requirements and precautions). On any given workday, the IR department at SCVMC consists of two radiologists, one resident, one physician assistant, one medical assistant, three to five registered nurses, three to five diagnostic imaging technologists, and one clerical employee. Patients are multicultural and sometimes non-compliant, and often have complex medical conditions. Referrals come from doctors in every other department, and are often urgent and unscheduled.

Although some of the challenges of IR are unique to this discipline, Dr. Kang describes the fundamental problem in terms that are familiar to anyone at a safety-net hospital. "We had quite a bit of dysfunction and lack of organization on top of increasing demand," he says. "We knew we could solve the problem by throwing more resources at it, but those resources weren't going to come from the County. We were very excited about this project. To be honest, some people probably hoped that the study would show that we are efficient and just need more resources, but we wanted the experts to come and look at the problem impartially." In fact, there are more resources on the way for Santa Clara — a third IR procedure room will be opening at SCVMC within a year — so one of the initial thoughts for the study was to establish what the new workflow would be like after capacity increased. Instead, though, the department chose to focus on opportunities to streamline processes to better accommodate the work it does with the space and equipment now available.

To that end, a project team led by Ravi Nemana and Dr. Jean Paul Jacob of CITRIS, James Ensign of the New Century Healthcare Institute, and Professor Max Shen of UC Berkeley, and including four senior industrial engineering and operations research students, analyzed the operations of the IR section of SCVMC's imaging department, with the goal of improving throughput and reducing overtime.

Patient Flow

One of the main causes of frustration cited by people in the department was delays.[10] More than two-thirds of the first procedures of the day started at 9:00 a.m. or later (even though nurses and IR techs start work at 7:30 a.m. and radiologists start at 8), and more than half of the last procedures of the day started at 4:30 p.m. or later, and sometimes as late as 8:00 p.m. However, no one could pinpoint the root causes for the delays — they just knew that their days were long and stressful.

The management engineers set out to understand what variables factored into delays, and how much impact each factor contributed. Dr. Kang says, "The analytical process they used was really interesting. [The management engineers] looked at workflow

each day, interviewed all the stakeholders, and ran the data. The question was: what is the rate-limiting step? Is it patient transportation? Environmental services? Patient prep? Late staff? What I found most useful was the Monte Carlo simulation. They found that some variables, even if reduced by 50 percent, would have no significant effect, but others would have a huge effect with even a 10 percent reduction."

Monte Carlo Simulation

Monte Carlo simulations are a set of algorithms that simulate physical systems with many inputs. The method relies on repeating calculations with randomly generated inputs to find the most likely pattern or result. Monte Carlo simulation methods are especially useful in studying systems with a large number of interrelated inputs that have significant uncertainty associated with them.

More specifically, the computer simulation mentioned by Dr. Kang demonstrated that a reduction in delay time by 50 percent would only provide a potential 5.2 percent gain in the number of procedures, whereas a 10 percent reduction in overall procedure time could provide an additional 9.9 percent gain in procedure numbers. In a concrete example, Dr. Kang says, "After a surgeon was done with an arterial puncture, the patient would stay there with someone holding the groin. If we could move the patient to another area for that, it would be a big improvement [in the in-room procedure time]."

Communication/Exchange of Information

The management engineering students and consultants interviewed more than 20 people at SCVMC during this study, and nearly all of them mentioned the need for better communication and coordination. One doctor pointed out, "the IR radiologists have met together about three times in five years," and another staff member said, "that meeting the other day was the first time the section has met together in more than a year." After the study concluded, Dr. Kang instituted a schedule of regular, more frequent management meetings, which he says has already improved communication within the department.

According to Dr. Kang, "data keeping and parameters were really off." More specifically, the data provided to the management engineers had a number of inaccuracies, including "end-of-procedure" times that were determined by the time the patient data was transferred to the Picture Archiving and Communications System (PACS), not the actual end of the procedure. Scheduling and tracking was done through an elaborate paper and whiteboard system that was inefficient and often inaccurate. Based on the recommendations of this study, the department is looking into a computerized scheduling system and better data collection practices for tracking patient flow.

Roles and Responsibilities

As one staff member put it, "we need someone to call the shots." Throughout the department there was a sense that no one was specifically in charge of optimizing patient flow, that staff optimized a department or a function. The management engineering team recommended designating one person to be a coordinator who understood the complex workings of the department. It was recommended that this person also be responsible for improvements in scheduling, such as formalizing a process for accepting add-ons so that the department's hours wouldn't stretch well into the night.

Solutions and Results

"A lot of these findings were intuitive," says Dr. Kang, "but the quantitative analysis showed us the real impact of inefficiencies. It acted as a stimulant, and people really learned from the process." As a result of this study, the department is more committed to improving its data collection process, scheduling, and delegation of responsibilities. Patient flow is now considered an important aspect of the department's performance. Dr. Kang says, "We weren't having regular management meetings, and it caused communication problems. We have started a regular schedule to review our performance together and make decisions about areas to improve."

Lessons for Safety-Net Hospitals

- **Explore ways to perform simulations and sensitivity analyses.** Even though it may seem that there is a single big factor causing delays and inefficiencies, a computer simulation can reveal what the real impact would be of improving performance at each step in the process. This can help you prioritize and focus your efforts to improve efficiency.
- **Put someone in charge of patient flow.** Establish a point person to coordinate patient tracking.
- **Automate manual systems.** In this case, the IR department needed an electronic replacement for its elaborate paper and whiteboard scheduling and tracking system.
- **Make time to meet and review performance.** Despite the difficulty of coordinating schedules in a busy department, it's worthwhile to schedule time to meet, improve communication, review performance, and solve problems.
- **Make sure you're keeping the right data.** Review and revise data element definition and collection.
- **Share best practices with other departments and hospitals.** Dr. Kang says, "Because we're a teaching hospital, one of the residents who was involved in this study wanted to write a paper about using a management engineering model and simulations in the IR suite. He submitted an abstract to the Society of Interventional Radiology and is hoping to present next March."

About the Hospital

Santa Clara Valley Medical Center (SCVMC) is a 524-bed hospital located in San Jose, California. It is a public hospital, owned and operated by the County of Santa Clara, and was first established in 1876. It cares for over 25,000 hospitalized patients and provides over 700,000 outpatient and emergency visits annually. The Interventional Radiology section at SCVMC provides services for many inpatients and outpatients through the region. In 2008, there were 2,327 IR procedures performed by five radiologists in two angiographic suites and other procedure rooms.

Mendocino Coast District Hospital

IMPROVING ASSET UTILIZATION WITH PHYSICAL REDESIGN, DATA SHARING AND JOB DEFINITION

Overview

Mendocino Coast District Hospital (MCDH) was going through substantial changes when the opportunity arose to take part in a management engineering study with the California HealthCare Foundation and the University of Southern California. The hospital's CEO, Ray Hino, explains, "We had downsized from a 49-bed to a 25-bed hospital, we had just converted to a critical-access hospital designation, and I had just arrived. Our OR

was smooth, but there were challenges in diagnostic imaging."

Since radiology is a critical financial resource for the hospital, Hino was concerned that the department was inefficient. Imaging is a very important revenue-producing department and a key resource that impacts patient satisfaction and operations across many hospital departments. MCDH appeared to suffer from a relatively poor reputation for imaging efficiency in the community. In addition to low patient satisfaction, Hino was aware that the physical layout of the area was problematic, there were strained relations between management and staff, and the department's overall workflow was suboptimal. It was clear to Hino that these were connected issues.

In order to improve efficiency in the diagnostic imaging department, a team of management engineering students from USC led by Dr. David Belson studied the flow of patients, asset utilization, communication and processes for sharing information, and roles and responsibilities of hospital staff and physicians to determine ways to improve efficiency.

Patient Flow

One major concern for MCDH was that patients were dissatisfied with delays and wait times in diagnostic imaging. This perception was widespread within the hospital, but there had been no formal assessment of the problem. Shortly after this study began, a patient satisfaction survey was conducted in March 2007, which confirmed relatively low patient satisfaction.

The management team at the hospital hypothesized that one problem was the physical layout of the department, which forced patients to move (or be moved) across several buildings. Ray Hino says, "There was a very poorly designed system for patients to access the imaging department. The department is hard to reach, not in a good location. Patients had to go through a multi-step process, through a maze to another building." There were two waiting rooms for patients (one for registration and one for radiology), check-in was nowhere near any of the actual imaging equipment, and a corridor through the center of the department interrupted workflow. Patients were simply moved around too much, asked to wait in too many different places, and given an overall impression of disorganization.

The scheduling process was another cause for concern. Scheduling was handled by the Radiology Department, which was physically and organizationally distant from the main patient registration area. This physical layout was inefficient from a patient flow perspective, and made communications between departments difficult. As a result, procedures per day per room were below industry norms, and scheduling was not being used to manage productivity or smooth Radiology's workload. Dr. Belson's team recommended that scheduling be redesigned to ensure there was always a patient available to pull into the next available time slot. They also suggested that the radiology department adopt more of a "pull" mentality, that is, that they develop the mindset that "I'm going to go get my patient," so that as soon as one patient is finishing a procedure, a tech from radiology will go get the next patient (this is different from a "push" mentality where an outside manager would be responsible for getting the patient into Radiology on schedule).

Asset Utilization and Facility-Related Issues

At the outset of this project, everyone at MCDH was aware that the physical layout of the imaging department had some major drawbacks. The MRI was in an outdoor trailer, which was inconvenient

and unpleasant for patients, especially when the weather was bad. Many of the work spaces and exam rooms were crowded and awkward, but it was difficult to make changes to the layout because there was special wiring and walls build to support the equipment of the department. Some of the key equipment (including x-ray) was outdated and often inoperable, which created unexpected waits and/or cancellations. It also took considerable pre-procedure time to assemble materials (e.g., collecting film for an upcoming exam, gathering paperwork, and making materials available for technicians). Of course, an all-digital system would substantially streamline this, but a more centralized process with fewer places to assemble materials would also be helpful.

Recognizing that facility improvements can be prohibitively expensive, Dr. Belson's team made a number of suggestions for incremental improvements within the existing physical plant. They suggested consolidating the waiting areas into one space in the outpatient building, improving the physical appearance of the radiology department, better utilizing currently wasted space (such as in the x-ray area), and moving the radiology manager into the center of the x-ray work area so she could better observe and influence patient flow.

These incremental improvements, however, did not address the hospital's core issue, so the hospital's management began looking at making some more radical changes. "We all recognized that there was a significant problem," says Dr. Hino, "but the team's initial approach was to try to redesign within the existing facility. The report took awareness to a whole new level." In particular, Dr. Belson's engineers suggested that Radiology could be relocated to the new, more appealing outpatient building. They pointed out that departments like accounting, IT, and HR (which were to be housed in the new building) didn't actually need to be close to the patient entrance, but Radiology did. While some services like CT would be expensive to move, others like mammography and ultrasound would be relatively inexpensive to move, and, as larger equipment was replaced, the new items could be relocated to a better area. If Radiology were located in the new building, the MRI trailer could be also moved closer, limiting patient movement outdoors.

Communication/Exchange of Information

The management engineers had a real challenge when it came to data analysis. The hospital could not produce reports from MediTech regarding daily details on patient throughput, such as a list of patients completed, radiology services used, or exam start and end times.[11] As a result, operating statistics were not monitored, benchmarked against industry norms, or compared to past performance. There was also no effective system for keeping track of patients' waiting status and location — not even a centralized whiteboard.

Dr. Belson's team unequivocally told MCDH that accurate and relevant operational data would be absolutely essential to making the department more efficient. The hospital's information system — MediTech — had limitations, but there were ways to better use this system to assess and measure performance. The engineers suggested developing a dashboard or productivity tracking system that would be visible to all staff. To minimize complexity, a few essential data points would be visible for all staff to see, such as room utilization, no-show rates, patient average wait time, and patient satisfaction survey results. Staff were encouraged to enter accurate start and end times for procedures in MediTech, and the hospital was encouraged to purchase software that could extract operational results from MediTech.

Dr. Hino says, "We never had a balanced scorecard dashboard report before. We created one

and are looking at tracking metrics, including patient wait time between calling to schedule and getting, for instance, an MRI."

Roles and Responsibilities

As the hospital's new CEO, Ray Hino was very aware of the importance of diagnostic imaging to the bottom line. However, one of his main motivations for participating in this study had less to do with revenue than with people. He says, "The impact of the inefficiencies was mainly employee dissatisfaction. Morale was low, people felt they were working in poor conditions, and patient satisfaction was low."

The radiology department had a highly professional and proactive staff, but they lacked clearly delineated roles, responsibilities, and authority. There was unclear separation of duties within Radiology, and no clear lead person besides the director; when the director was gone, it was unclear who was responsible. The department head needed to be more involved in decisions concerning flow of patients and paperwork, and the USC team recommended assigning a "traffic cop" to keep people doing their specific jobs, identify delays, and monitor performance.

The hospital's management also suspected that the diagnostic imaging department was overstaffed, but the challenge for a relatively small hospital is to be able to offer a wide range of services to relatively few patients. The hospital employed seven to nine people to serve about 30 patients during the average day, or six patients per employee. That's about one and one-half paid hours per exam against a national average of 0.89. A reduction of two to four personnel, or an increase in patient exams, would bring the department in line with industry averages. Alternately, the hospital could reduce hours or days of service for individual services, or reduce the scope of services offered.

Finally, the staff at MCDH also needed a change in mentality toward patient-centered service. The hospital needed to provide training, management, and feedback to reinforce the message to staff that, "It's your job to make sure the patient has an excellent experience."

Solutions and Results

The single biggest outcome of this study was that MCDH decided to invest in a new facility and physically relocate the radiology department. The CEO says, "Due to Dr. Belson's work, we're going to move the department. We'll break ground on a new diagnostic imaging center in the next few months. The department had been neglected. It was poorly configured. The new building is 8,000 square feet attached to the hospital, so it's very convenient for inpatients. There will be a new MRI, new CT scan, new thoroscopy… Since we're in the home stretch with financing, showing [Dr. Belson's] report to the financing entities really impressed them. This is a very important revenue producing department for the hospital. To the extent that we can operate efficiently, it helps the bottom line."

Lessons for Safety-Net Hospitals

- **Don't rule out big changes if big improvements are needed.** MCDH had severe limitations due to its physical layout, so the hospital's leadership made a huge commitment to reconfiguring the radiology department in a new building. However, sometimes starting with smaller incremental changes is the best way to get buy in to a major improvement initiative.
- **Clearly define roles and responsibilities.** This improves everyone's workflow and helps morale. A single centralized "traffic cop" keeps patients moving and helps everyone know what's going on.

- **Use accurate scorecards to keep everyone on track.** Accurate and relevant operating reports with visible scorecards are essential to running an efficient department. Radiology now uses a visible, public scorecard to keep track of patient flow and efficiency. Even with limited automation or technology, it's still possible to track basic data and improve performance.
- **Make the patient your focus.** In addition to making improvements in the actual patient experience (such as reducing wait time), a patient-centric approach to service from the staff goes a long way to improving patient satisfaction.
- **Share what you learn from efficiency studies.** Management engineering can be a useful technique for all parts of the hospital. "The biggest value is that it opened our eyes to the potential of management engineering. We plan to utilize the techniques and training to assess patient flow in other areas of the hospital," says Ray Hino.

About the Hospital

Mendocino Coast District Hospital, in Fort Bragg, California, is a relatively small (25 beds) hospital; administrators reduced MCDH's capacity so that it could qualify as a designated critical-access hospital. The radiology department has a full range of radiology services, including MRI, CT, mammography, x-ray, nuclear medicine, ultrasound, and fluoroscope. In early 2006, the hospital added a wing on the main building to house outpatient registration for radiology and other services.

Interview List for Appendix Case Studies

Randy Cook, Manager of Surgery
Childrens Hospital Los Angeles

Cynde R. Herman, Administrative Director
Department of Surgery
Childrens Hospital Los Angeles

Brad Ditto, Manager, Surgical Services
Ventura County Medical Center

Roxanne Baden, Director of Surgical Services
Valley Presbyterian Hospital

Elizabeth Navarro, Administrative Fellow
Valley Presbyterian Hospital

James D. Marks, M.D., Ph.D., Chief of Anesthesia
San Francisco General Hospital

Louise O'Rourke, OR Nurse Manager
Riverside County Regional Medical Center

Raymond Hino, CEO
Mendocino Coast District Hospital

Young Kang, M.D., Chair of Radiology
Santa Clara Valley Medical Center

Endnotes

1. Hines, Lora, "Engineering Study Helps Hospital Department Improve On-Time Record," *Press-Enterprise,* January 17, 2009, www.pe.com/localnews/inland/stories/PE_News_Local_S_surgery18.3f1f2e0.html.
2. Utilization benchmarks are published by several sources including hospital associations such as the University Hospital Consortium, consultants such as Premier, Inc., and publications such as OR Manager, November 2004, and in David Katz, "The High Performance OR: Elevating Efficiency Through Strategic OR Management," *The Advisory Board Company,* 2007.
3. Report cards developed at Childrens Hospital of Los Angeles and Riverside County Regional Medical Center were used at Olive View, Valley Presbyterian, and San Francisco General. Formulas to calculate performance for report cards were developed at Childrens Hospital of Los Angeles and Ventura County Hospitals were used at Mammoth, Olive View, and other hospitals. The calculations are incorporated into templates available from USC.
4. A white paper comparing Lean, Six Sigma, Management Engineering, and other approaches to operations improvement is available from California HealthCare Foundation at www.chcf.org/topics/chronicdisease/index.cfm?itemID=133861.
5. Regarding having patient flow communications centralized at the control desk, USC proposed an interim alternative since the initial recommendation was not fully supported by the surgeons, who preferred to manage the flow to their room individually. They suggested using the control desk as a coordinator rather than a central point, a sort of control tower. They also proposed creating three groups of operating rooms, with a single circulating nurse responsible for each "pod". As of the date of this report, the hospital was still considering these alternatives.
6. VCMC uses a computer to record the schedule, but the software vendor does not consider it a scheduling system. The hospital has requested a computerized surgery scheduling system, but the county has not been able to budget it.
7. The surgery manager felt that the July number was actually more impressive than it seemed, because in July they bring in new resident surgeons who tend to slow down the turnover times. The new surgeons are unfamiliar with the hospital and less experienced generally.
8. This metric varies by type of surgery; some are more complex in terms of moving one patient out and moving another in. Also, a teaching hospital may have longer turnover times but this need not be a large difference since the students, like the residents, are not responsible for many of the events that occur during turnover.
9. Individual times vary, and seasonal factors may influence results.
10. In a textual analysis of patient records, approximately 39 percent of the comments reported one or more delays.
11. The data was recorded in the system but output reports could not be generated. The closest source of operational data was a text file listing all the patients that were seen. Exam start and end times were generally found to be inaccurate because they were usually recorded at the end of the day or after the fact.

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