Optimizing Weekend Availability for Sophisticated Tests and Procedures in a Large Hospital

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The reduced availability of sophisticated tests and procedures in hospitals on weekends (the so-called "weekend effect") delays care. Addressing this problem requires hospital managers to balance the desire for timeliness with the need for efficient operations. We illustrate how a hospital can profile timeliness, demand, and capacity utilization across the week for multiple testing areas. This simple, practical method, using data extracted from the hospital's accounting system, makes visible the pattern and magnitude of delays caused by reduced availability on weekends, while also showing how capacity is deployed. We combined the analytical tool with a process of transparent feedback and local problem solving that engages multiple stakeholders in the hospital. The goal is to optimally configure capacity so as to balance the imperatives of timely availability and efficient resource utilization.

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For a large hospital that must deploy expensive capacity while containing costs, the desire for timely care and efficient operations may require balancing competing aims. The care in US hospitals increasingly revolves around sophisticated, resource-intensive tests and procedures (eg, computed tomography [CT], magnetic resonance imaging [MRI], invasive cardiovascular procedures, interventional radiology, and gastrointestinal [GI] endoscopy).[1-5] On weekends, hospitals often reduce the availability of these services, thereby producing a "weekend effect" that has been shown to prolong hospitalization,[6-8] and may contribute to increased mortality observed in patients admitted on weekends.[9,10]

In this article, we describe how the desire for across-the-week timely availability of sophisticated tests and procedures relates to (and may compete with) the quest for efficient use of resources. We then describe how we are balancing those aims in our institution by using a practical analytical tool that gives hospital managers a comprehensive, reproducible view of timeliness, demand, and capacity utilization for multiple testing areas throughout the hospital. We then explain how we use the tool to support continuous improvement by engaging the providers and requestors of these procedures as stakeholders. We believe our methods are adoptable by other organizations.

TIMELY AVAILABILITY VS RESOURCE EFFICIENCY

Delays that prolong hospitalization increase the time that patients are exposed to hazards known to occur in hospitals, such as medication errors and infection.[11] Delays also negatively affect a hospital's operating economics by adding days of hospitalization that are not reimbursed under prospective, case-rate payment.

Hospitals balance their wish for "24-by-7" availability against the high costs of that availability. Most do it informally, relying on traditional working-day hours to establish a base schedule. Capacity has to be planned and processes designed in ways that meet the needs of hospitalized patients for timely care, while avoiding suboptimal deployment of scarce, expensive resources (labor and equipment). In other words, hospitals need to efficiently translate these inputs into the outputs of completed plans of care, while avoiding waste.

In any service operation (eg, a hospital's testing or procedural laboratory), the amount of infrastructure and the associated fixed cost are functions of peak workload.[12] If time-sensitive capacity is mismatched to time-sensitive demand, artificially high peak workloads may require coverage with fixed-cost resources. Avoidable peaks represent waste.

Another source of waste is batch production. For a particular testing or procedural area, the volume and timing of demand often necessitate intermittent operations, where volume is served in batches, interspersed with periods of shutdown. If a procedural laboratory can be conceptualized like a manufacturing operation, starting each batch from a state of shutdown incurs costs of "setting up." Personnel, machines, and materials must be

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positioned and prepared for the batch, regardless of size.[13] Excessive setups because of small batch sizes represent waste.

ANALYTICAL TOOL

Our main hospital is a 1157-bed, general, acute-care facility with approximately 40 000 admissions per year. We developed an automated data-extraction tool from our hospital's accounting analytical system (Sunrise Decision Support Manager, Eclipsys Corporation, Boca Raton, Fla). At our institution each testing area is an accounting cost center.

For an inpatient served by a particular testing area, our accounting system counts the days elapsing between admission and the first billed service from that cost center. Procedures performed the same day as admission are counted as zero days of waiting. A patient is assumed to receive services only once from that cost center during a hospitalization. Calculations of average waiting times use only the first 6 days of hospitalization.

By using the day of admission (rather than the day of request) to estimate waiting time, we intended to measure the waiting involved in executing a plan of care formulated upon admission. This is an important simplifying assumption that we believe is more objective than measuring the interval from request to procedure, which could be influenced by the requester's perceptions and expectations of availability. By using the admission-to-procedure interval, we include the waiting involved in the communication and receipt of requests, which are elements of the overall service process.

Twice a year we download data for all the inpatients served by a particular testing area in the immediately preceding 6 months, with each data record representing 1 hospital discharge. Included in each record are fields for the diagnosis-related group, principal procedure, length of stay (LOS, in days), inpatient ward service, and emergency department admission status (yes or no).

For each 6-month dataset from each testing area (typically containing 400 to more than 3000 cases), we use the weekday of admission to divide the patients served into 7 cohorts. We assume cohorts are similar in terms of medical needs. Within each cohort, we count how many patients receive procedures on the day of admission (called day 0) and on subsequent days, thereby generating a time-to-performance profile. We look for effects of differential availability, which appear graphically as a weekend "gap" and post-weekend "cluster" (**Figure 1**).

To estimate the opportunity to improve timeliness, we calculate days of potentially avoidable waiting by equalization (DPAWE) by estimating how many days of waiting could be avoided if patients admitted on Friday, Saturday, and Sunday (who would likely encounter weekend delays) received their procedures with the same timeliness as patients admitted on Monday, Tuesday, and Wednesday (Thursday admissions are omitted from the calculation). To focus on the execution of the initial plan of care, the calculation ignores procedures occurring beyond the sixth day of hospitalization.

We produce a graphical "dashboard" for each testing area (**Figure 2**), showing the profiles for the 7 admission-day cohorts, as well as the area's admission and procedural volume by weekday. The admission volume by weekday portrays the pattern of demand. The procedural volume by weekday portrays capacity utilization relative to the weekday with the highest volume. The dashboard allows users to quickly see patterns of volume and timing in order to spot gaps, lags, peaks, and surges that may be opportunities for reconfiguring capacity. The dashboard includes a summary "box score" that shows the average days of waiting and volumes used to calculate DPAWE. Dashboards also can be run for subsets of patients who were served by a testing area—for example, particular procedure(s), diagnosis-related group(s), admission site (emergency department), or ward service.

MANAGERIAL APPLICATION

To enable problem solving at the local level, analysts within each testing area (typically administrators) run the spreadsheet tool to create the dashboards, which are then shared freely among testing areas and the hospital's clinicians. The local analysts also perform targeted subset analyses for their clinical leaders and managers, who plan capacity, make policy, and design operating processes. A transparent, participatory approach allows stakeholders to find a balance between timeliness of service and efficient use of resources.

An institutional committee maintains oversight, sets expectations for improvement, and facilitates dialogue between the testing areas ("suppliers") and the clinicians ("customers"). Managers are asked to focus on areas with high volumes and high DPAWE scores. The committee also oversees the exchange of best practices and innovation for ordering, scheduling, and staffing. Typical questions addressed in these dialogues include:

"Do the data confirm prior impressions of timeliness and availability?"

"Could more timely admission assessment and ordering mitigate delays?"

"Would a Saturday procedural session (eg, a half-day) substantially mitigate delays? For the anticipated volume, what would be required for staffing and upstream/downstream coordination?"

The tool provided our hospital leaders and managers with their first comprehensive view of timeliness across the week for high-impact testing procedures throughout the hospital. In some areas, waiting time for tests ordered for patients admitted late in the week (Friday, Saturday, Sunday) appeared to improve modestly after the tool was implemented in 2002. For example, for echocardiography, the average number of days from admission to procedure decreased from 1.7 in 2002 to 1.5 in 2004. For body CT, the number of days decreased from 1.2 in 2002 to 0.9 in 2004; for GI endoscopy, the decrease was from 2 days in 2002 to 1.7 days in 2004. In most areas timeliness remained about the same or improved slightly from 2002 to 2004, despite growth in volume in some areas (data not shown). For many areas (echocardiography, cardiac catheterization, neurological MRI, GI endoscopy) the disparity in average waiting times between late-week and early-week admissions appeared to modestly decrease.

The profiling technique allowed us to see how well the admission volume by weekday that used a particular testing area ("demand") aligned with its procedural volume by weekday ("capacity," relative to the peak weekday). In areas with excellent timeliness across the week, the procedural-volume profile closely resembled the admission-volume profile. However, in areas with weekend-related delays, the procedural-volume profile looked very different from the admission-volume profile. We found a relative burst of activity on Mondays (from cases held over the weekend) and a burst on Fridays (presumably trying to "clear the decks" ahead of the weekend) (**Figure 3**).

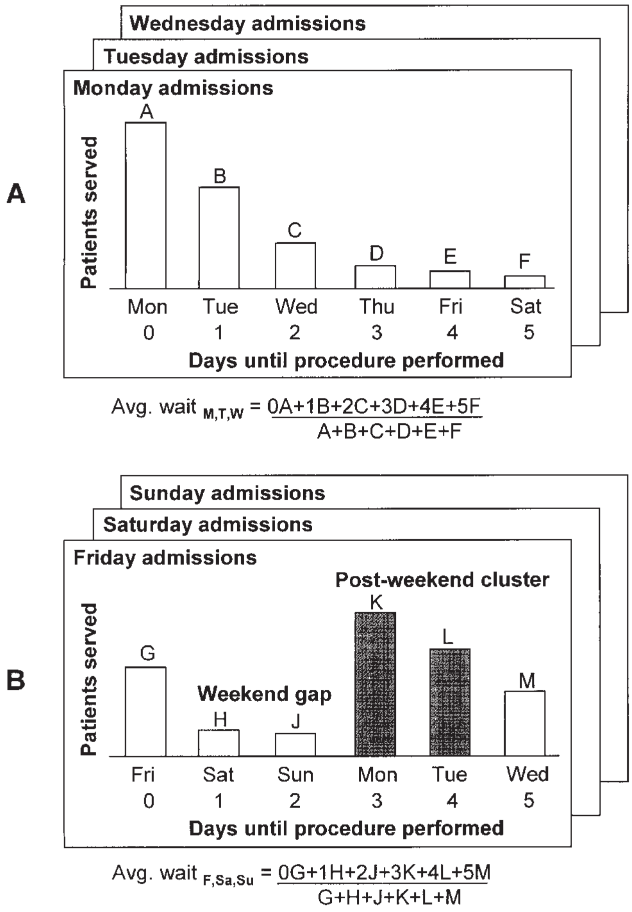
Rather than mandating specific weekend schedules, we designed a more locally driven process that engages stakeholders who have clinical-leadership, managerial, provider, and front-line production roles. Nearly all users have commented that the tool is easy to understand and helps them appreciate the magnitude of opportunities. In response to our method, several areas plan to expand availability on weekends or evenings, guided by cost-benefit analysis made possible by using the tool to better understand differential waiting, demand, and capacity. Areas also are looking at ways to do procedures earlier in order to alleviate high peak-volume weekdays (typically Mondays) and reduce associated fixed-cost resources.

PERSPECTIVE

Using administrative data, we developed an analytical tool that profiles timeliness, demand, and capacity utilization for sophisticated tests and procedures across the week, thereby making visible the pattern and magnitude of delays caused by reduced availability on weekends. We deployed the tool within the cooperative management structure of our hospital to engage the stakeholders who would produce change. Because the data are readily accessible from the hospital's accounting system, we believe other hospitals could easily perform this profiling.

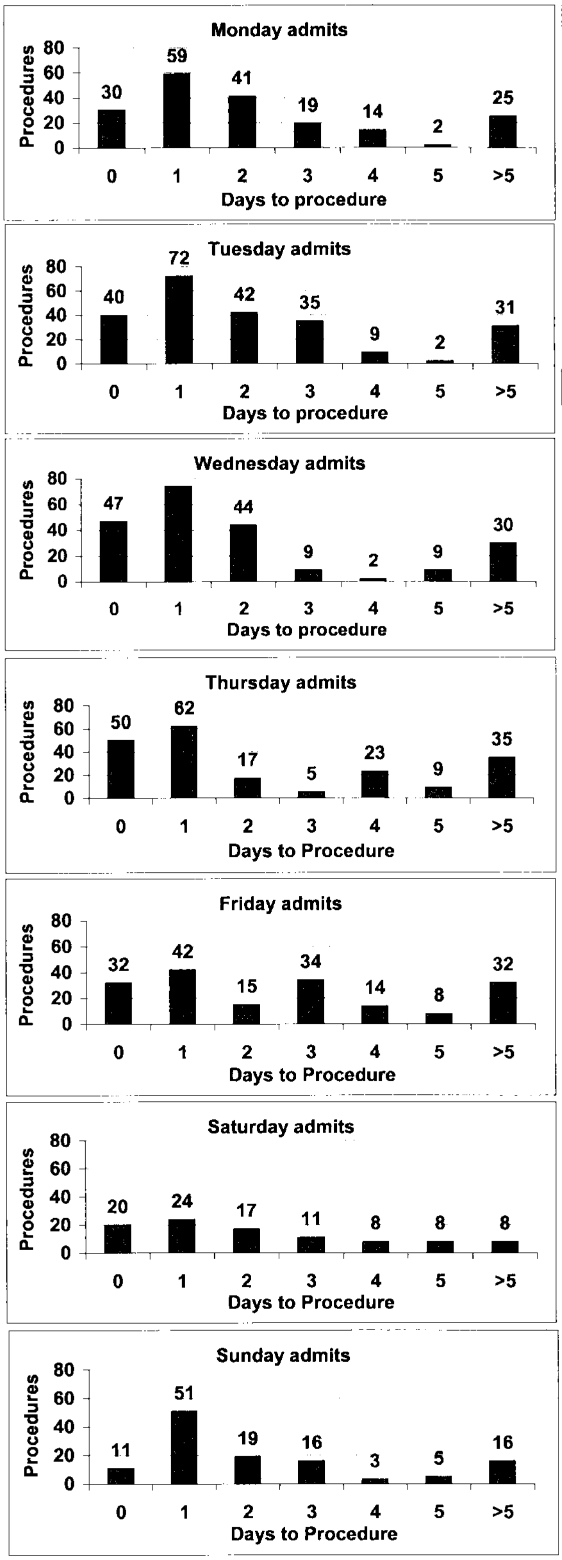
Figure 1. Schematic of the Time-to-Performance Profile*

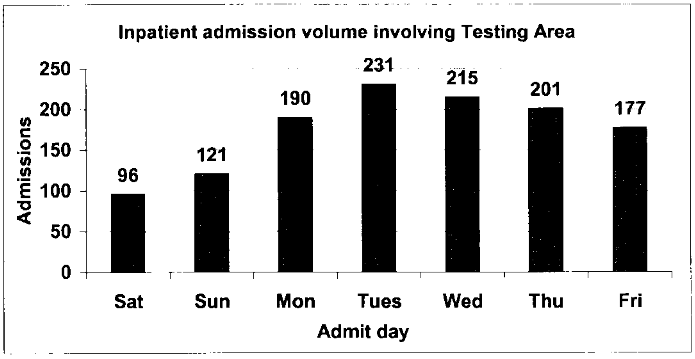
Panel A shows a hypothetical distribution of procedure wait times for patients admitted on a Monday. **Panel B** shows the distribution for patients admitted on a Friday. Panel B displays a typical weekend gap followed by a post-weekend cluster.



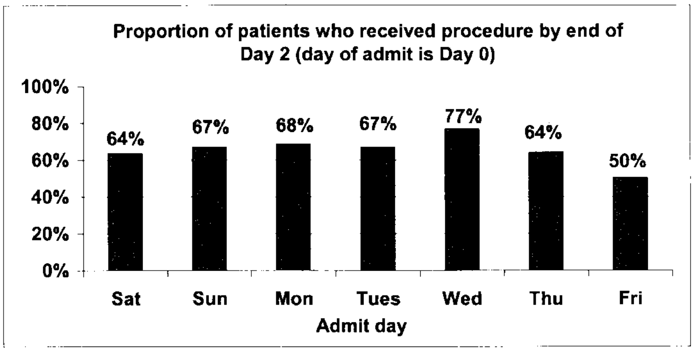
*If average (Avg.) wait F,Sa,Su > Avg. wait M,T,W, then days of potentially avoidable waiting by equalization =
(Avg. wait F,Sa,Su - Avg. wait M,T,W) * (G + H + J + K + L + M).

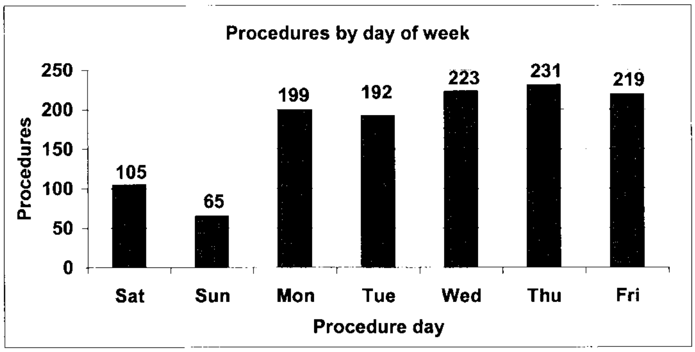
Figure 2. Graphical Dashboard Profiling 1 Testing Area (Actual Data)*





Total admissions = 1,231





The first instance of a service delivered by the cost center to an inpatient determines the day of the procedure. Each patient is assumed to receive only 1 procedure.

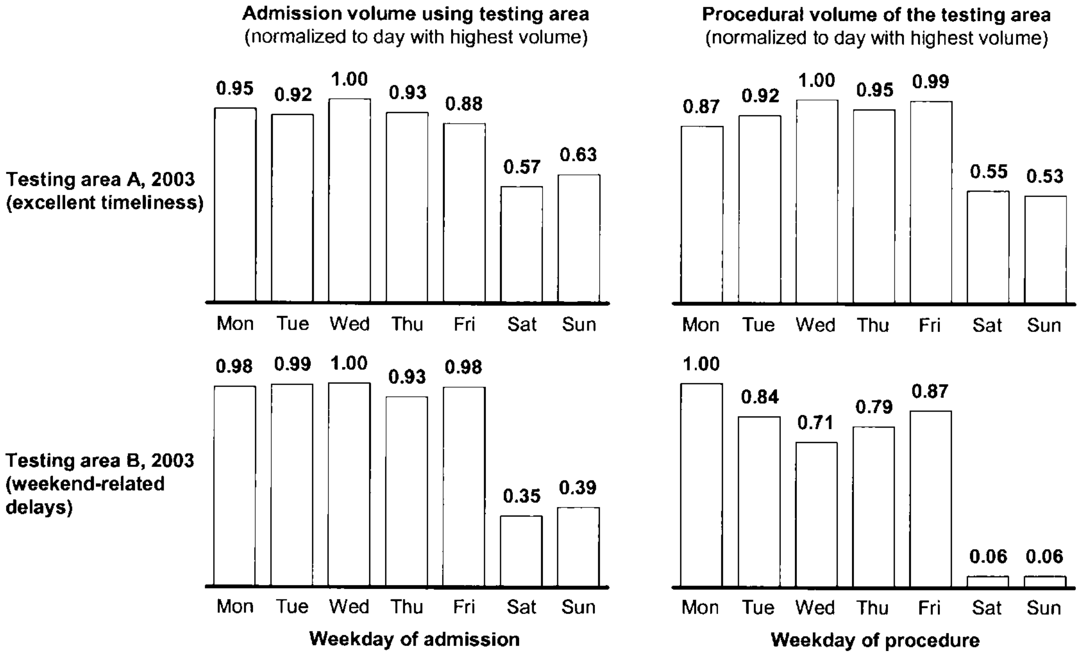
Days of Potentially Avoidable Waiting by Equalization

	Total wait (days)*	Patients*	Average wait
M, T, W admits	813	550	1.48 days
F, Sa, Su admits	607	338	1.80 days
		Average waiting difference	0.32 days
			X
		F, Sa, Su patients	338 patients
		Potential days avoided	107 patient-days

* Only patients with 0 to 5 days of waiting are in these calculations

*The spreadsheet template is available from the authors by request.

Figure 3. Admission Volume Versus Procedural Volume by Weekday for 2 Testing Areas*



*In testing area A, which had good weekend availability and no differential waiting across the week, the procedural-volume profile closely resembled the admission-volume profile. In testing area B, which had reduced weekend availability and had differential waiting, the procedural-volume profile was very different from the admission-volume profile. The procedural-volume profile showed a surge on Monday and Friday, with little activity on Saturday and Sunday.

Previously published efforts to improve availability of inpatient testing and procedures to expedite care have addressed 1 testing area at a time.[14-16] In contrast, we have introduced a more comprehensive system of assessing and improving timeliness and capacity management for multiple areas. The transparency, objectivity, and simplicity of our method help identify problems and facilitate a cooperative approach toward solving them.

Our analytical method is similar to that of Bell and Redelmeier, who documented weekend-related delays for selected urgent procedures for emergently hospitalized patients in the Canadian province of Ontario.[17] Using administrative data, they measured the days waiting from admission to procedure and showed how waiting varied according to weekday of admission.

Our administrative data captured timing detail at the level of the day of service. We did not use medical record data or hourly service logs (which could paint a more detailed picture of testing timeliness), although we encourage managers to tap into (or prospectively generate) these types of data locally to facilitate problem solving.

A sufficiently long run of administrative data should reveal patterns of timeliness, demand, and capacity utilization that are meaningful enough to justify changes in capacity and availability. Because follow-up measurement using administrative data is fast and inexpensive, managers can implement changes, assess results, make adjustments, and later repeat the measurement.

Although reducing the waiting for a given test or procedure should contribute to shortening LOS, it may be difficult to predict the aggregate LOS reduction attributable to reconfiguring 1 area. The relationship of 1 testing area to LOS is sometimes straightforward (eg, a patient admitted with angina who needs only cardiac catheterization and angioplasty). More often, the relationship of the testing area to LOS is more indirect, because it is part of a sequence of contingent steps (eg, a patient admitted with GI bleeding who is found to have a gastric cancer, but then needs surgery). Waiting for testing has been shown to be an important cause of delayed care in a large teaching hospital, but there are many other causes.[18]

Removing a "bottleneck" in 1 area may reveal another downstream impediment. Multiple areas of the hospital may need to improve simultaneously to accelerate the care of large numbers of patients. We believe our method has the advantage of being able to examine multiple areas simultaneously using a uniform, systemic approach.

Because every hospital has its own combination of operating configuration, cost functions, and stakeholder dynamics, finding the optimal balance between timeliness of service and efficient resource utilization probably defies a formulaic "cookbook" solution. We are using a local approach to problem solving, in which the persons most intimately familiar with operations develop solutions and implement change, guided by a tool that provides easy-to-understand feedback and reinforcement. We believe that the insights revealed by this transparent, intuitive analysis help clinical leaders, managers, and front-line personnel work together to develop optimal solutions.

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