From Front Office to Front Line

Essential Issues for Health Care Leaders

Improving Health Care Quality and Safety

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Optimizing Patient Flow by Managing Its Variability

Eugene Litvak, Ph.D.

Efficient management of patient flow has become one of the most important issues on the agenda of many hospitals. The relatively new concept has become increasingly recognized in the hospital community as imbalance between hospital patient demand and capacity occurs more often. As hospital capacity becomes more frequently insufficient to meet growing patient demand, periodic fluctuations in patient volume overwhelm the hospital's capacity to respond. Furthermore, emergency department (ED) overcrowding, nurse staffing shortages, and medical errors have all been linked to shortages of hospital beds and associated stresses on staff when patient volume peaks.

The complex problem of patient flow management extends beyond the hospital to include pre-hospital patient flow (for example, why patients use the ED rather than their primary care physicians) and post-hospital patient flow (for example, availability of rehabilitation or skilled nursing facility beds). Comprehensive coverage of all these issues would not be possible in this chapter, but the references shown in Table 4.1 (page 92) provide further information for those who are interested in these issues.

Detection of bottlenecks in patient flow within the hospital poses a very complex issue. Many hospital overcrowding problems in particular departments are the consequence of the downstream bottleneck in patient flow—for example, a backup in the ED occurs because of a lack of beds in the intensive care unit (ICU). It is analogous to having a wide pipe followed by a narrow pipe that

TABLE 4.1

Further Resources for Patient Flow

- Joint Commission Resources: *Managing Patient Flow. Strategies and Solutions for Addressing Hospital Overcrowding*. 2004. http://www.jcrinc.com/publications.asp?durki=78 (accessed Jun. 19, 2005).
- Institute of Medicine: *The Future of Emergency Care in the United States Health System*. http://www.iom.edu/project.asp?id=16107 (accessed Jun. 19, 2005).
- Institute for Healthcare Improvement: *Patient Flow: Getting Started*. http://www.ihi.org/IHI/Topics/Flow/PatientFlow/ (accessed Jun. 19, 2005).
- Boston University: Management of Variability Program. https://www.bu.edu/mvp/ (accessed Jun. 19, 2005).

determines the throughput of their serial connection. However, this is not always obvious in a hospital environment. Although this complex technical problem is also beyond the scope of this chapter, we will concentrate on another very important issue—variability in patient flow and its impact on hospital revenue, nurse staffing, and quality of care.

The Goal of Patient Flow Improvement: Myths and Reality

There are many myths about the desired outcomes of improved patient flow through acute care settings, including the following:

- High unit or hospital occupancy rates
- High utilization rates in different units
- Reduction in the time of patient transfers between units to, in itself, improves hospital flow

Achieving any of these three “goals” could make particular hospital departments happy for a while, but none can guarantee achievement of what should be the overall goal: maximizing patient throughput, defined as the number of patients moved through the hospital during a month, year, or other time period, and increasing access to care. Moreover, these goals do not necessarily lead to the right means to maximize throughput, as they could put the system under unnecessary stress. It is important to dispel these myths (*see* Sidebar 4.1, page 94), so that organizations can focus their improvement efforts effectively.[1]

Of course, increased throughput should never come at the expense of quality of care (for example, by artificially reducing patient length of stay). Neither should managing scheduled demand or improving the discharge process necessarily be the goal. But they are definitely among the right (although not sufficient) means to achieve an overall goal to increase patient throughput while maintaining or increasing quality of care, thereby maximizing patient access to care and improving the financial health of health care providers.

Why should increasing patient throughput be the goal? ED overcrowding, excessive demand, and limited access to care cannot be resolved by individual hospitals. They are systemic problems. As soon as an individual hospital reduces its ED waiting time, it is likely to become a magnet to patients who otherwise would go to its neighboring hospitals. Only increased hospital patient throughput would be an objective sign of improved access to care and better management of demand.

Role of Operations Management

The Harvard Business School McDonald's and Burger King case studies are well known at many business schools.[2] From them one can learn that operations at these two food chains have a huge impact on work climate, marketability, financial results, and so forth. There are two main differences between McDonald's and Burger King described in the case studies. The first is that McDonald's has a grill, whereas Burger King has a broiler. The second is that Burger King must maintain additional inventory compared to McDonald's.

These two differences alone have a major impact not just on cost but also on job retention, management style, salaries, and many other parameters. For example, assembly workers at Burger King must listen carefully to all communications as an expanded inventory increases the likelihood of "misassembling" sandwiches, which along with customizing sandwiches, potentially reduces productivity and revenue. On the other hand, it is possible at Burger King to bypass a slow worker, whereas McDonald's connected system (all workers must work at the same pace) places greater importance on teamwork.

SIDEBAR 4.1

Three Myths of the Goals for Improved Patient Flow

Myth 1. High Unit or Hospital Occupancy Rates Is a Goal of Improved Hospital Flow

A high occupancy rate does not provide any detail on the effectiveness of patient flow. Consider this analogy: A restaurant manager who counts the number of tables occupied at lunchtime has learned little about the ability to serve its customers. If the restaurant is full of diners, it does not therefore follow that the throughput and the revenue are optimal. To get a clear picture of flow, the restaurant manager must consider how often those tables turn over.

Myth 2. High Utilization Rates in Different Units Is a Goal of Improved Hospital Flow

In general, high utilization rates will either increase waiting time for incoming patients or increase the likelihood of rejecting or diverting patients, particularly with random patient demand for the unit (or hospital). Assuming a smooth scheduled demand, a hospital with a greater proportion of scheduled patients in the incoming flow can afford a higher utilization rate without diverting more patients. With a greater proportion of unscheduled patients (for example, from the ED), the hospital should keep a lower utilization rate so as not to divert more patients—because more rooms need to be left open for unpredictable arrivals. Thus, increasing the utilization rate and reducing the number of open rooms has the potential to divert from the very goal of maximizing patient throughput and access to care. Rejection rates or waiting times for any incoming patient flow mix of scheduled and unscheduled patients can be calculated to support this assertion.

Myth 3. Reduce the Time of Patient Transfers Between Units to Improve Hospital Flow

Suppose that the average time to transfer a patient from the ED to an inpatient bed has been reduced to 15 minutes, yet patient throughput stays the same. Such a scenario would be caused by a downstream bottleneck to patient flow (for example, no nursing home beds to which to discharge patients). There is no benefit of putting ED and floor staff under stress to achieve this artificial goal of 15-minute transfer time when patients will only wait much longer on the floor, and the overall length of stay and throughput will stay the same. On the other hand, maximizing throughput will, by definition, guarantee that the average time of patient transfers between any units remains low.

Source: Institute for Healthcare Improvement: IHI Web member discussion. *Patient Flow. Discussion*. http://www.ihi.org/ihi/forums/ShowPost.aspx?PostID=1691 (access restricted to IHI registrants).

Similarly, operating systems of the health care delivery system have a significant impact on such things as the work climate, staffing, and financial results. Yet we are trying to change health care delivery without changing its core operations. We are trying to achieve the results we want just by changing the reimbursement system, by asking different parties to collaborate, and so forth. Imagine, for example, that the Ford Motor Company found that their cars could not compete on the market. They probably would work to improve the engine, transmission, or product lines…whatever they could do with their cars to compete with other manufacturers. In contrast, when health care does not work, we try to throw more money at the system and demand additional resources.

Consider the following analogy: A pizza shop can produce a pizza at a cost of $5; the cost of delivery is $3. The cost of delivery is inflated because the driver does not know the proper routes, and the manager does not know them either. But that doesn't matter as long as customers are buying pizza for $8. Suppose now that customers, the government, or competitors say that the pizza can no longer sell for $8. So the cost of pizza must be reduced. How would you do it? You have not done it before, you do not know how to approach the subject, and you do not have a way to learn how to do it. In this situation, the only alternative is to take away some pepperoni and mushrooms from the pizza, decreasing the quality of the product.

This mirrors what takes place in health care. The cost of health care delivery is inflated because we do not appropriately apply operations management methodologies. And yet we limit the price, so the quality of care is being negatively impacted. Somehow we manage to have both waste and unsatisfactory quality of care. As long as we limit our *total* cost, which is clinical cost plus delivery cost, and as long as we do not actively employ operation management methods, which allow combining both cost and quality objectives, we will continue to experience this unfortunate scenario.

Problems with Current Patient Flow

There are at least four problems caused to some degree by poor management of patient flow:

1. ED overcrowding and limited access to care
2. Nurse understaffing/overloading
3. Diminished quality of care
4. High health care cost

None of these problems can be satisfactorily resolved without properly managing patient flow. In turn, addressing variability in patient flow is absolutely necessary, although not sufficient, to managing patient flow. So there is no way one can resolve any of the above problems without addressing variability in patient flow.

Figure 4.1, page 97, represents a typical hospital census for weekdays only. Different hospitals have different peaks and valleys (outliers from the mean census), usually varying from ±15% to ±40%. This implies that the difference between a peak and valley (that is, the difference in bed occupancy between two neighboring days) could be 30%, or even as high as 80%, of the mean census. How should one staff hospitals that are subjected to such dramatic swings in demand, given that hospitals are spending at least half of their budgets for this purpose? We staff below the peaks level in demand (represented by the dashed line), frequently at the average level. Hospital census could be higher or lower than the dashed line, but it rarely peaks at this level.

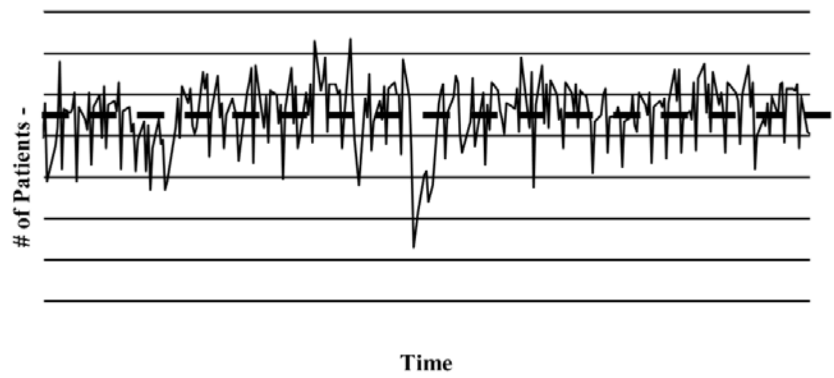
When the hospital census falls below the dashed line, it experiences waste of resources. But staffed beds, radiology equipment, and the like that are not used today cannot be preserved for tomorrow's peak. They are wasted. Now consider what happens when there is a peak in demand. Most hospitals typically experience the following systemic effects of the peak in demand:

- Internal divert (for example, patients sent to alternative floors or intensive care locations)
- Internal delays (for example, the postanesthesia care unit [PACU] backs up)
- External divert such as ED diversions
- Staff overload, which can contribute to medical errors or inability to retain staff
- System gridlock, which can increase lengths of stay
- Decreased throughput and revenue

Patients suffer. Physicians suffer. Nurses suffer. Everyone suffers when patient demand exceeds the staffing level. Neither does the hospital make more money. Patient throughput and the associated revenue decrease. In addition, decision making concerning patient admission can be altered with high demand and an overcrowded ED. During periods of stress, the decision whether to admit a patient may not necessarily be purely clinically driven. One example would be a

FIGURE 4.1

Tracking Patient Census



This graph represents typical hospital census for weekdays (each point represents a day). The peaks and valleys represent residuals from the mean census identified by the dashed line.

decision to discharge a patient from the ED or maybe to transfer a patient when, under normal circumstances, the patient would be admitted. Thus, a hospital underutilizes its resources on one day, and the next day these resources are put under stress with resultant consequences for access to and quality of care.

One may conclude that hospital capacity in its current form is not sufficient to guarantee quality care. Does the health care delivery system need additional resources? The typical answer is "yes." Then, the next logical question is What additional resources are needed to guarantee quality care? For example, What kind of beds does a particular hospital need? Does it need more ICU beds? more maternity beds? more telemetry beds? If yes, how many?

Surprisingly, not many hospitals, if any, can justify their answers to those questions. They cannot specifically demonstrate how many of which types of beds will guarantee quality of care. But consider an individual going to the bank under similar circumstances to borrow money. In response, the bank, asks two basic questions: How much money and What is it for? If the person answers, "I do not know" to each question, the bank cannot help them effectively. Yet this is exactly where health care leaders are in estimating resources needed to meet demand as they now ask the same question to payers, health maintenance organizations, the Centers for Medicare & Medicaid Services, and the like. Many among these groups believe (often correctly) that hospitals do not efficiently use their resources and think that there is a need to further reduce them. However, they cannot point to exactly what kind of resources need to be reduced and by how much (for example, should one close three ICU beds)?

Managing Variability: The Solution to Many Patient Flow Problems

Natural Variability

Suppose all the patients in a hospital had the same disease and same severity. Suppose also that all patients arrive at the same rate: Let us say a new patient every 10 minutes—not 9, not 11. Every 10 minutes a new patient comes to the hospital. Furthermore, let us assume that all providers—physicians and nurses—are the same in their ability to provide quality care. What would be the efficiency of the system? It would be 100% efficient. It would be similar to Toyota's manufacturing product line. So what prevents us from being Toyota? None of these assumptions are correct. Patients do not present with the disease or the acuity that might be readiest to treat. In addition, they come to our ED unexpectedly. Finally, providers are not all equal in their ability to provide quality care. These three types of natural variability (clinical presentation, patient flow, and professional expertise) are random and, in the case of the first two, patient driven.

Natural variability cannot be eliminated nor even reduced. Instead, it must be optimally managed. Let us briefly examine what optimal management of natural variability involves. In general, managing natural variability means creating homogeneous patient subgroups on the basis of patient acuity or other criteria. Hospitals do that already, but they do it intuitively rather than scientifically. For example, they address clinical variability by having different floors for cardiac and orthopedic patients, creating a fast track in the ED, or having ICUs separate from regular medical/surgical departments. They address flow variability with different portals to the hospital, as ED patients arrive differently than scheduled surgery patients. Hospitals reduce professional variability by providing additional training and like processes.

However, managing natural variability can involve difficult decisions to balance clinical, patient flow, and professional variables. For example, one can create homogeneous patient subgroups to reduce clinical variability by having a separate surgical team for patients of specific ages. But if a team was pulled together for a 70-year-old woman with hip replacement, should a 71-year-old woman be directed to another team? Although it would reduce clinical variability, it would, at the same time, make the patient flow variability significant. This negative impact would outweigh the benefit of addressing clinical variability.

By trying to suppress one type of variability, the risk of increasing another rises. One has to find the right scientifically justified balance. This is why fast track and other flow measures are not universally appropriate for individual hospitals. Scientifically managed natural variability can save millions of dollars.

Artificial Variability and Its Impact on Patient Flow

Natural flow variability is not the only source of fluctuations in patient demand in hospitals. To see the complete picture, we have to analyze the nature and the source of the peaks, or stresses, in patient demand. Let us consider two major portals to a hypothetical hospital: Half of total admissions come through the ED (including unscheduled surgeries) and elective surgery in the operating room (OR) accounts for 35% of admissions. (The remaining 15% of admissions are comprised of medical transfers, referrals, and the like.)

Which of these two portals, the ED or the OR, is the main contributor to census variability? The intuitive answer would be the ED because patient demand there is variable by its nature and because a higher percentage of admissions come from the ED. However, this answer is rarely correct. Usually, the ED and the elective surgery schedule have an approximately equal effect on census variability. Moreover, if adjusted for patient volume, scheduled surgical admissions vary more often than admissions through the ED—a very counterintuitive fact.[3] This indicates that hospital-scheduled admissions are less predictable than arrivals to the ED. In other words, it means that Mother Nature does a better job sending patients through the ED than a scheduling system does.

What makes the OR schedule so variable? Another hidden type of variability—artificial variability—is nonrandom, nonpredictable, and driven by individual priorities.[3] Unlike natural variability, artificial variability should not be managed.

Rather, it must be identified and eliminated. It is important to mention that by no means is the OR the only location for artificial variability, (for example, catheterization labs often experience artificial variability).

Artificial peaks in patient demand remain a major roadblock to increasing patient throughput and, therefore, increasing hospital revenue. In addition to the effect on ED throughput, which is discussed on pages 103–105 in the section "Variability and ED Overcrowding," artificial variability also has a negative impact on surgical throughput. When a high volume of scheduled surgeries has been performed, it increases the likelihood of surgical bumps (delaying scheduled surgeries) or even cancellations of elective surgery (for example, due to the shortage of ICU beds). In addition, it artificially increases the waiting time for an available OR for unscheduled emergent or urgent surgeries, as well as increases OR overtime.

For example, a hospital may admit 40 scheduled patients one day and 70 patients for another day while it budgets an average of 50 scheduled daily admissions. It is clear that 70 admissions create a significant demand above the hospital's capacity in terms of staffed beds, nurses, and so forth. That demand creates a competition for scarce hospital resources between those scheduled admissions and those seeking admission through the ED, often resulting in ED overcrowding, ambulance diversion, and boarding of patients awaiting admission as the staff frequently give preference to scheduled patients (given the same acuity level). It results in nurse overload, understaffing, medical errors, and an undesirable work environment. It also creates a patient flow bottleneck, which reduces hospital revenue. All of these problems stem from the same source: artificial peaks in patient demand.

As discussed below, eliminating artificial variability has an immediate effect on surgical patient flow. It can increase surgical case volume and hospital revenue, and reduces surgical backlog, surgical bumps, and waiting time for an available OR opening.

The Importance of Eliminating Artificial Variability

We found that variability in patient demand causes stresses on the health care delivery system. Further, we found that there is an artificial component in this variability that could be eliminated. Though this is not new to health care, the issue of variability may be more important now than it was years ago.

Consider the analogy between the following scenario and patient flow. Suppose that early one January morning at 2 A.M. you are driving from your hometown to the nearest beach, where you often spend the weekend. You have to drive on a major three-lane highway to get there. Suppose that you see the police cars and ambulances next to two cars obviously involved in a recent accident. Because there is little traffic at this time, the accident will have an effect on your driving time only if all lanes are closed. Yet suppose that the same accident takes place at 10 A.M. on a Saturday in July. The difference on the effect on your driving time then would be dramatic.

Similarly, hospital inpatient revenue (driving time) increases when more patients (cars) are attracted, demonstrated by Figure 4.2 on page 102. When the average census increases (traffic becomes dense) and hospital capacity stays the same, then peaks in patient demand start "hitting the ceiling" (car accidents) of hospital capacity, shown by the dashed line in Figure 4.2. Insufficiency in hospital capacity could manifest itself in shortage of inpatient staffed beds, lack of radiological equipment, and the like. The difference between Figure 4.1 and Figure 4.2 is that the average census is stable on the first figure, while the second demonstrates historical census growth.

This results in all the negative outcomes discussed above: ED overcrowding, nurse understaffing/overloading, diminished quality of care, and artificial bottlenecks in patient flow. These, in turn, result in decreased revenue.

There are only three choices to prevent this from happening:

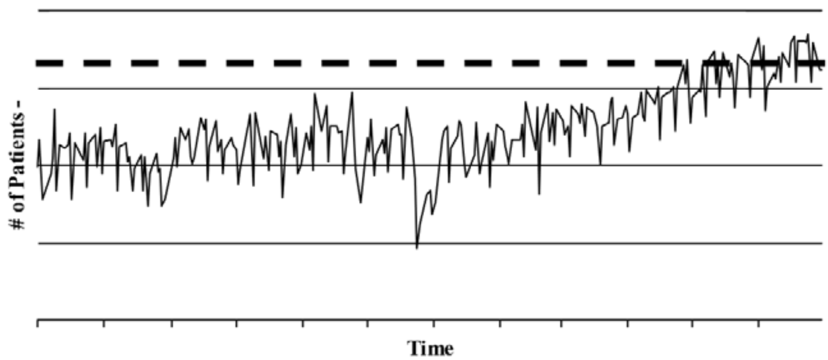
1. Raise the ceiling by adding hospital capacity. This is not likely to be a common solution due to the shortage of health care funds. In any case it is an expensive solution.

2. Reduce the average hospital census by artificially limiting the number of patients admitted. This solution is not financially viable.

3. Reduce flow variability—the magnitude and frequency of peaks—thereby allowing higher average hospital census to approach the ceiling without hitting it. This option provides the only practical and satisfactory solution. It can be achieved by eliminating artificial variability in patient flow.

FIGURE 4.2

Tracking Increasing Patient Census



This graph shows the average census increasing over time (each point represents a day) while hospital capacity (represented by the dashed line) stays the same. Eventually, peaks in patient demand will start to max out hospital capacity if it does not expand in response.

Benchmarking: Utilization, Patient Demand, and Hospital Size

Suppose Hospital A and Hospital B have the same patient acuity levels, as well as patient volumes. Hospital A has a mean daily census (bed utilization rate) at the 90% level. Should Hospital B follow its example? The answer to this question is more complicated than it may seem at first glance. If 95% of all Hospital A admissions are surgical and only 5% medical, yet 95% of Hospital B admissions are medical and only 5% surgical, we cannot compare utilization rates and patient throughput. Only 5% of patients (medical) at Hospital A contribute natural, uncontrollable variability to patient demand. If Hospital A eliminates (that is, smooths) artificial variability in patient admissions, it may be able to afford a very high (90% or above) mean census and substantial patient throughput.

Hospital B should not have a mean census above about 80%—a figure based on experience in applying queuing theory—because most of its patient flow occurs from natural variability. An attempt to increase the utilization rate at Hospital B beyond this level would result in ED overcrowding, nurse overloading, and diminished quality of care. Thus, the pattern of patient arrival to the hospital (scheduled versus unscheduled) has a significant impact on the optimal hospital utilization rate, patient throughput, and available techniques to manage patient flow.

Can one benchmark these two hospitals if they have the same pattern of patient admissions? Not necessarily. Consider for simplicity two medical ICUs, one with 5 beds and another with 10 beds, which have the same patient acuity levels, pattern of patient arrivals, and average length of stay, which is 2.5 days. Suppose also that patient arrivals to these units are one patient per day and two patients per day, respectively, giving the ICU that is twice as large a patient demand that is twice as big. If an ICU bed is not available in either ICU, patients are waiting (that is, being boarded) in the ED.

The likelihood that there is no bed available for each of these ICUs would not be the same. According to queuing theory,[4] the smaller ICU has an approximately 0.13 likelihood of having no bed available. For the larger ICU, this likelihood will be approximately 0.036—less than one third as large. It is clear, therefore, that patient throughput for the larger ICU will be significantly greater and that it can afford a much higher utilization rate than the small ICU without taking the risk of not having a bed available when needed. The same is true for hospitals as a whole. The larger the hospital, the higher the utilization rate it can afford, assuming all other parameters (such as acuity or demand pattern) are equal. Thus, benchmarking between hospitals or units should be performed scientifically, before any attempts to practically apply other hospitals' experience.

Variability and ED Overcrowding

We have already discussed how variability affects hospital throughput and revenue. Let us consider now how variability affects ED overcrowding. During the last several years, ED overcrowding became a major health care concern manifested in ambulance diversions, excessive waiting times for treatment in the ED, and, for patients admitted through the ED, long waits (known as "boarding") for inpatient beds, including ICU beds.

The main reason for ED overcrowding—lack of ICU and medical/surgical beds—has been presented and documented in several studies.[5–7] Thus, outgoing patient flows obstruct EDs and result in overcrowding. However, many hospitals that experienced ED overcrowding made an intuitive, but usually incorrect, decision to enlarge the department. Take, for example, a large room with two doors—an average size entrance door and a narrow exit door—through which people are trying to pass. They are entering the room at the rate permitted by the size of the entrance door. Soon the room will be overcrowded because there is a bottleneck at the narrow exit. To reduce the overcrowding, one would have to make the exit wider (making more room for inpatients), not the entrance. Unless the ED itself, rather than internal hospital beds, is the source of the bottleneck, enlarging it would only exacerbate the problem.

There are two possible scenarios that could explain why staffed hospital beds may not be available to admitted ED patients:

1. The hospital *constantly* experiences a lack of beds.
2. The hospital *periodically* experiences a bed shortage.

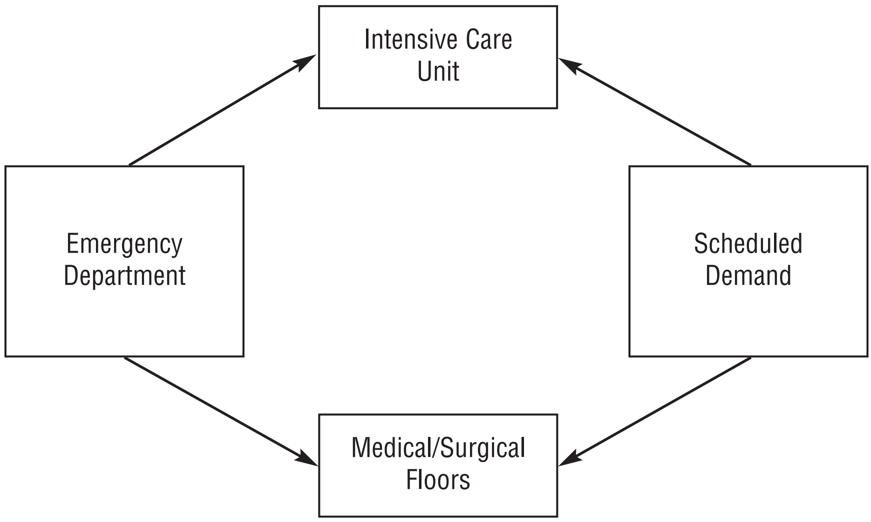
Consider patient flow as presented in Figure 4.3, page 105. First of all, it is important to note that ED demand can be predicted and is more or less stable. In most hospitals the ED nurse manager would be able to predict approximately how many patients are going to arrive at the ED today or tomorrow. If there is a *permanent* shortage of a particular inpatient bed type for ED patients, then there is simply a need for additional beds of this type (for example, ICU beds). However, if there is only a *periodic* shortage of beds, then it is reasonable to ask who is occupying these beds when they are not available for ED patients.

Figure 4.3 clearly shows who is occupying the beds: scheduled admissions. Almost every hospital experiences competition for hospital beds between scheduled and ED admissions. If many beds have been reserved for elective surgery patients, then an ED patient will more likely have to wait for an available bed to open. When there is an artificial peak in scheduled demand, there are fewer beds available for ED patients, and the ED can quickly become overcrowded with boarders. One study demonstrated that peaks in scheduled admissions are the main determinant of ED overcrowding at two Massachusetts hospitals.[7]

Reducing artificial variability in scheduled admissions effectively addresses this issue, making it more likely that an appropriate inpatient bed will be available for an ED admission. The same holds true for hospital discharges. Smoothing hospital discharges will positively affect ED overcrowding as long as it is done in combination with reducing artificial variability in admissions.

FIGURE 4.3

Identifying Paths of Patient Flow in the Hospital



This diagram represents patient flow within a hospital. Natural and artificial variability are represented by emergency department admissions and scheduled demand.

ED overcrowding is so pervasive that sometimes we have the attitude that it affects everyone the same way. But according to Brad Prenney, deputy director of Boston University's Program for Management of Variability, more than 70% of admissions through the ED in Massachusetts hospitals are of patients who are insured by Medicare or Medicaid or who are uninsured, whereas private payers cover most of the scheduled admissions.[8] Thus, the patients most likely to suffer the consequences of variability in admissions and the resultant ED overcrowding are the elderly, disabled, poor, and uninsured.

Besides ED overcrowding, now the focus of much public attention, there is a silent epidemic of ICU overcrowding. ICU patients also suffer from artificial variability. A study at a leading pediatric hospital demonstrated that more than 70% of diversions from the ICU have been correlated with artificial peaks in scheduled surgical demand.[9]

Variability and Nurse Staffing and Care Quality

Variability in patient flow can also have an effect on nurse staffing and quality of care. The issue of nurse-to-patient ratios surfaced primarily due to the widely acknowledged fact that nurses have been exposed to frequent overloads of additional patients. Understaffing and patient overloading are two sides of the same coin when patient demand frequently exceeds nursing capacity. As multiple studies have suggested, when nurses are subjected to such overloading, patient care is affected, quite possibly resulting in an increase in mortality rates, an increase in the number of medical errors, and higher complication rates.[10] The linkages between nurse understaffing and sentinel events are also well established. Inadequate numbers of nursing staff contribute to 24% of all sentinel events in hospitals. In addition, inadequate orientation and in-service education of staff is a contributing factor in more than 70% of sentinel events.[11] This is why nurse staffing is such a critical issue. Alternatively, overloading can force patient placement in the wrong clinical setting (for example, PACU instead of an unnecessarily overcrowded ICU).

Shortages of personnel, overtime, and unpredictable schedules make nurses' work very difficult. The problem stems from the imbalance between patient demand and hospital capacity (in this case, nurse staffing). As discussed previously, hospital census is extremely variable. The difference in the number of inpatients cared for between two neighboring days can easily exceed 20% to 30%. Staffing for the current census comprises the main hospital expense. The challenge is to provide an adequate staffing level for so variable a census.

The solution used in hospitals many years ago was simple: Staff to the peaks in patient demand. This resulted in substantial waste during census valleys, but the hospital did not compromise patient care quality or the nursing work environment. Today, such a solution is simply not affordable as hospitals' margins become thinner. However, whenever we staff to a level lower than the peak, we put nurses under stress, thereby creating an unacceptable work environment and diminishing quality of care. Thus, we cannot afford staffing to the peaks in demand, yet we should not staff below these peaks as it results in nurse overloading.

So far, attempts to resolve this dilemma have been concentrated mainly on only one side of the demand-capacity imbalance. Mandating nurse-to-patient ratios represents an attempt to address the hospital capacity side of the problem. This approach assumes that the other side of this imbalance—patient demand—has been somehow imposed on the hospital and that we have no control over it. However, a large portion of patient demand can and should be controlled by eliminating artificial peaks. These peaks could even be the sources of incremental mortality rate that is being imposed on hospital patients.[11] Eliminating artificial variability by controlling scheduled demand significantly improves nurse staffing by reducing variations in the numbers of patients for whom nurses must care.

When the hospital eliminates or significantly reduces artificial variability in patient demand, many of the peaks and valleys in census driven by this variable would disappear, and the remaining natural census variability would be patient driven. Operations management techniques, such as queuing theory, allow hospitals to effectively manage the type of natural variability seen in ED admissions. Additionally, by addressing variability on the demand side, hospitals are in a better position to cost-effectively and routinely assure the necessary capacity to meet demand. Then two possibilities could occur:

1. The additional hospital resources that have been freed up by reducing artificial variability sufficiently cover costs to staff to the remaining natural peaks in demand.
2. The hospital needs additional resources to staff to these natural peaks in demand.

In any case, a hospital should have sufficient resources to staff to the remaining patient-driven, natural peaks in demand over which it has no control. Any attempt to staff below these uncontrollable patient-driven peaks in demand would result in nurse understaffing, medical errors, and the like. However, to estimate the resources needed for patient-driven demand one should first eliminate (or significantly reduce) artificial peaks in demand, which are created by broken scheduling systems. Only then will one know the frequency and magnitude of the census peaks in demand that are indeed patient driven. Establishing a nurse-to-patient ratio for staffing to these peaks will become a practical solution.

Patient Flow Simulation and Information Technology

Simulating hospitalwide patient flow can be a very powerful tool when done correctly and based on accurate data. It allows leaders to play out different "what-if" scenarios (for example, how will adding two ICU beds affect hospital throughput? How would ED overcrowding be improved if the length of stay for the telemetry beds was reduced 10%?) This was demonstrated by such a model developed at the Cambridge Health Alliance.[12] The model allows leaders to simulate scenarios for different hospital resource distribution (such as staffed beds), as well as for different patterns of demand and length of stay in different units. However, experience in this area is very limited.

Many models allow one to simulate manufacturing, transportation, telecommunications and other processes. So why is developing such models a problem in the hospital environment? The major reason is lack of patient flow data. One of the most critical parts to simulation model development is validating the model, by comparing the model's output with the data observed. To rely on such comparison one has to make sure of the accuracy of the incoming data for the model, as well as the data observed for comparison with the model, output. Given that patient flow was not on the radar screen of most hospitals even a few years ago, there is almost no reliable data collected on patient movement through hospitals. The new radio frequency identification technology has a great potential to close this gap.

Success Stories

St John's Hospital

During the first phase of patient flow improvement at St. John's Hospital (Springfield, Missouri), the goal was separating two types of flow that are competing for the same resources, that is, creating homogeneous patient groups as suggested by Boston University's Management of Variability Program.[3] Applying variability methodology to their OR, designating an OR for unscheduled services, and partially smoothing some of the surgical weekday case volume allowed this hospital to achieve the following results:

- The efficiency at which care is provided has been greatly improved with no reduction in quality
- A 45% reduction in rooms running "after hours"
- An increase in volume of at least 5% during regular business hours
- An increase in ability to accommodate growth in overall surgical volume of 10% annually for the last two years
- Surgeons are not routinely working late into the evening on-add on cases
- Surgeons involved have realized a conservatively estimated 4.6% increase in revenue[13-15]

Success Story: Boston Medical Center

The surgical step-down unit at Boston Medical Center experienced a lack of beds, particularly on Wednesdays and Thursdays. During these two days there was a strong competition for beds between OR and ICU patients coming to the unit. Thus, there was a need to reduce artificial variability in the incoming OR patient flow to eliminate the situations when both flows peaked on the same day resulting in demand exceeding bed capacity. Controlling artificial variability in vascular and cardiothoracic surgical demand for the surgical step-down unit, along with applying variability methodology to the OR by designating an OR for unscheduled surgeries (similar to St. John's Hospital) and eliminating block scheduling in the OR allowed the hospital to achieve the following results:

- Reduced variability (number and magnitude of peaks and valleys) in the step-down unit by 55%
- Decreased nursing hours per patient day in the unit by 0.5 hour, resulting in annualized savings of $130,000
- Cut the number of surgeries delayed or canceled from 334 to 3 for the same time periods April to September in 2003 and 2004 (before and after implementation)[16–17]

Success Story: Elliot Hospital

At Elliot Hospital (Manchester, New Hampshire) surgical deliveries and labor inductions have been scheduled early in the morning, thereby creating a competition with another natural patient flow: women going into spontaneous labor and delivery.[12] The overall patient flow for this unit could be subdivided into two homogeneous subflows, scheduled and unscheduled, and the resources (beds) for these two types of flow should be separated.[3]

This hospital experienced significant improvement by applying variability methodology to its maternity center such as separating staffed beds for scheduled deliveries from beds for women going into labor naturally. Almost immediately, obstetricians began spreading deliveries through the day, the morning chaos disappeared, and an issue that had festered for years was resolved.[12]

First Steps in Addressing Patient Flow

As has been demonstrated above, managing variability is absolutely necessary to optimize patient flow. Hospitals can begin to address this issue through the following steps:

1. Assign responsibility for the patient flow problem. Currently, patient flow is everybody's problem and nobody's problem. Every hospital needs to appoint a director of patient flow management (or to assign this responsibility to the chief operations officer or a vice president) who should report to the hospital CEO, thus establishing clear accountability for this issue.
2. Establish a multidisciplinary team with representatives from the ED, OR, patient care, catheterization lab, and other appropriate departments and units. Include an operations management specialist(s) if possible. This team should start collecting and analyzing the necessary patient flow data (for example, patient throughput, waiting times to get in and out of the hospital units) to determine patient flow bottlenecks and artificial peaks in patient demand.
3. Take practical steps to manage patient flow. Measure and then smooth any artificial variability that has been revealed, manage natural variability, and eliminate bottlenecks through adjusting the size of hospital departments to make them compatible with each other.

The failure to address patient flow issues will continue to result in ED overcrowding, nurse understaffing/overloading, diminished quality of care, significant waste of resources, and decreased revenue.

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References

1. Institute for Healthcare Improvement: IHI Web member discussion. *Patient flow. Discussion*. http://www.ihi.org/ihi/forums/ShowPost.aspx?PostID=1691 (access restricted to IHI registrants).
2. Sasser W.E., Jr., Rikert D.C.: *McDonald's Corp*. (case study 681-044); *Burger King Corp*. (case study 681-045). Watertown, MA: Harvard Business School Publishing, 1980 (rev. 1998).
3. Litvak E., Long M.C.: Cost and quality under managed care: Irreconcilable differences? *Am J Manag Care* 6: 305–312, Mar. 2000.
4. Gross D., Harris C.M.: *Fundamentals of Queueing Theory*, 3rd edition. New York: John Wiley and Sons. 1998.
5. U.S. General Accounting Office (GAO): *Hospital Emergency Departments: Crowded Conditions Vary Among Hospitals and Communities*, GAO-03-460, a report to the Ranking Minority Member, Committee on Finance, U.S. Senate. Mar. 2003. http://www.gao.gov/new.items/d03460.pdf (accessed Jun. 19, 2005).
6. Litvak E., et al.: Emergency department diversion: Causes and solutions. *Acad Emerg Med* 8:1108–1110, Nov. 2001.
7. Litvak E., Cooper A., McManus M.: *Root Cause Analysis of Emergency Department Crowding and Ambulance Diversion in Massachusetts*. Boston University Program for Management of Variability in Health Care Delivery for the Massachusetts Department of Public Health. Oct. 2002. http://www.mass.gov/dph/dhcq/pdfs/final_report_exec_summary.pdf (accessed Jun. 19, 2005).
8. Personal communication between the author and Brad Prenney, Deputy Director, Program for the Management of Variability, Boston University, May 2004.
9. McManus M.L., et al.: Variability in demand and access to intensive care services. *Anesthesiology* 98:1491–1496, Jun. 2003.
10. Litvak E., et al.: Managing unnecessary variability in patient demand to reduce nursing stress and improve patient safety. *Jt Comm J Qual Saf* 31: 330–338, Jun. 2005.
11. Personal communication between the author and Dennis S. O'Leary, M.D., president, Joint Commission on Accreditation of Healthcare Organizations, Oakbrook Terrace, IL, Jul. 28, 2004.
12. Scott A.: Getting with the flow helps hospital deliver service. *Boston Globe,* Jan. 25, 2005. http://www.boston.com/news/local/articles/2005/01/25/getting_with_the_flow_helps_hospital_deliver_service/ (accessed Jun. 19, 2005).
13. Joint Commission Resources: *Managing Patient Flow. Strategies and Solutions for Addressing Hospital Overcrowding*. Oakbrook Terrace, IL: Joint Commission Resources, 2004. http://www.jcrinc.com/publications.asp?durki=78 (accessed Jun. 19, 2005).
14. Henderson D., et al.: The impact of IMPACT on St. John's Regional Health Center. *Mo Med* 100:590–592, Nov.–Dec. 2003
15. Patterson P.: Add-on room helps trauma center up case volume, shorten waits. *OR Manager* 19:12, Nov. 2003.
16. Scott A.: Emergency room recovery: Busy Boston Medical Center eases delays by keeping "customers" moving. *Boston Globe*, Jul. 8, 2004. http://www.boston.com/globe/search/stories/reprints/emergencyroom070804.html (accessed Jun. 19, 2005).
17. Boston hospital sees big impact from smoothing elective surgery. *OR Manager* 20:1, 10–12, Dec. 2004.