Cracking the Code: Fixing the Crowded Emergency Department, Part 2 — Creating the Analytic Model

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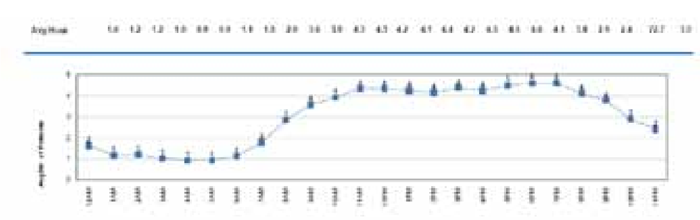
Welcome back! This submission, part 2 of a three-part series, directed at understanding and solving the problem of emergency department crowding, will focus on an analytic model that can be used to create work-flow and staffing solutions to the problem. Part 1, published in the Sep/Oct issue of *Common Sense*, sought to create a burning platform for change. The burning platform is built on understanding the impact of crowding on patient satisfaction, service goals, quality of care, financial performance, and risk management. Part 1 examined why this problem must be addressed and sought to establish a sense of shared purpose between those who practice emergency medicine and those who manage and administer the resources and processes that enable solutions. It explained why failure to meet this challenge jeopardizes the success of emergency departments (EDs), hospitals, and entire health care systems.

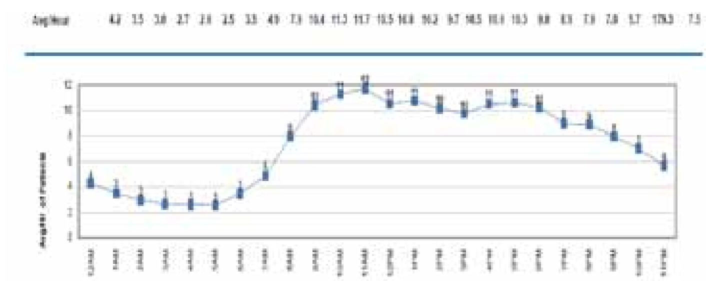
Solutions to ED crowding obviously involve operational issues at all levels, including patient intake, departmental throughput, and outflow from the department. Those of us who practice emergency medicine know that the major obstacle to throughput is output to the inpatient units of the hospital, most importantly due to constraints such as bed availability. Despite that reality, those of us in operations believe that a major opportunity exists on the input side to mitigate, if not eliminate, the impact of hospital crowding on ED operations. Therefore, part 2 of this series continues to focus on the input side of ED operations as a major game-changer in ED crowding.

We now begin to build the operational model in which we harvest performance and operational data as inputs to predictive analytic tools. This involves gathering data, validating it, and most importantly understanding it. The importance of analytics in ED operations is driven by the realization that much of what we experience in the ED is predictable. What appears to most to be chaos is simply variation around predictable events. Mapping and understanding variation creates the opportunity to predict events within a range of probabilities, allowing us to solve ED crowding mathematically. This ultimately provides the solution to crowding which will be explained in detail in part 3. So, let's build that operational model.

Below are patient arrival demand curves at two very different emergency departments in the Ochsner Health System[3] — one ED seeing 30,000 patients/year and one seeing 60,000 patients/year.

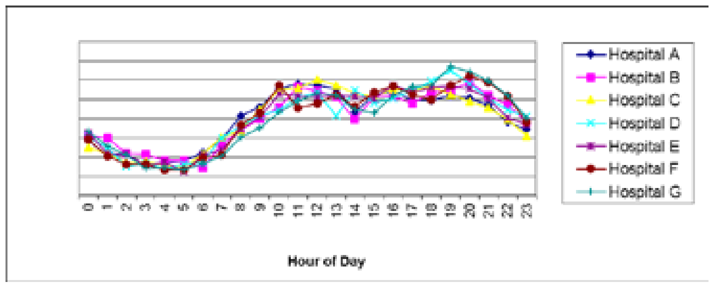


North Shore ED 30,000 visits/year



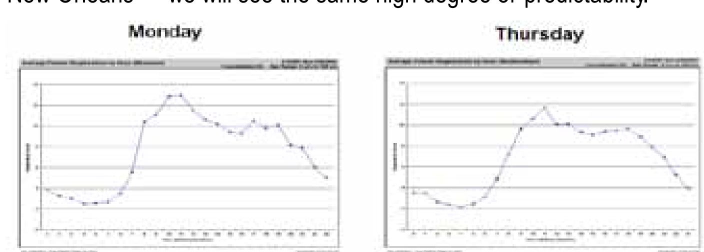
Jefferson ED 60,000 visits/year

The demand curves above are virtually identical for these two emergency departments. Is this predictability unique to a particular system or region? The answer is "no." In the normalized graph below, the relative demand curve for all seven of these emergency departments, part of the Banner Health System,[2] are virtually identical.



Arrival Distributions for Seven EDs (volumes normalized)

If I created a transparency for each of the three images above, reflecting data from all nine hospitals in two health care systems, layered them one over the other and normalized the volume differences, the patient arrival curves would mirror each other almost identically. Drilling this theory of predictability down one level and showing the patient arrival curve for two different days throughout the year, Monday and Thursday — once again from our experience at the Ochsner Health System[3] in New Orleans — we will see the same high degree of predictability.



Obtaining this type of data is easy now that most EDs are automated, and I don't think this predictability surprises anyone who works in our specialty. Next, let's take it one step further and look at acuity for multiple emergency departments. Again, these data from the Banner Health System[2] reflect the acuity distribution of patients from the same seven

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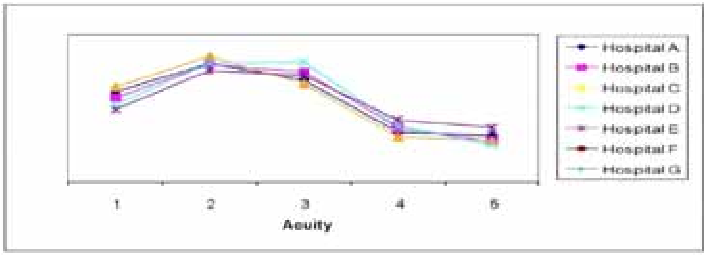
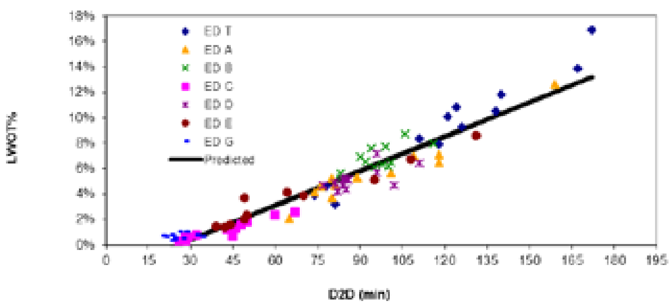
EDs, and are shown in the image below. The data are once again normalized for varying volumes at each site, so that the relationship of one facility to the other in terms of acuity distribution is clear.



Acuity Distribution at Seven Banner Health EDs (volumes normalized)

As shown in part 1 of this series, wait times are directly related to patient satisfaction. The graph below, also based on data obtained from the Banner Health System,[2] shows the predictable "left without being seen" (LWBS) rates based on patient wait times. The graph shows multiple emergency departments and multiple times at each facility, and the resulting predictable impact on the LWBS or "left without treatment" (LWOT) percentages.

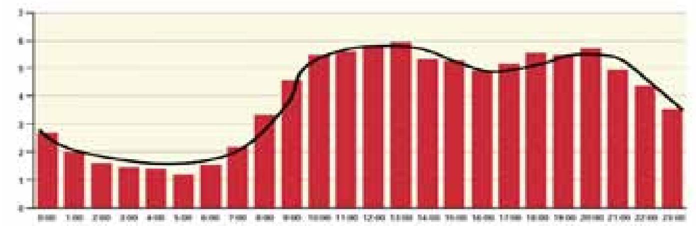


LWOT percent at Various Wait Times

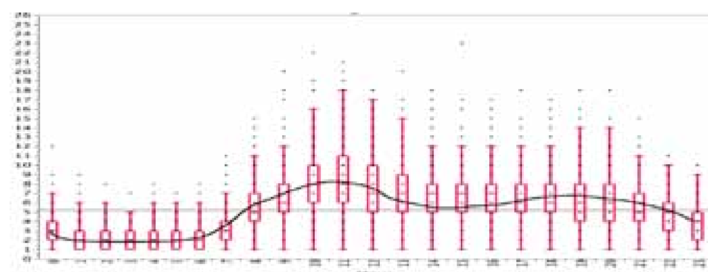
Enough, right? You get the point. We know with great predictability the average number of patients who might arrive on any given day, during any given month, in any year. We also know with great predictability the average acuity distribution. We even know how long patients will wait on average before they get frustrated and leave. Stating this in simpler terms: on average we know how many patients are coming; we know when they're coming; we know how sick they will be; and we know how long they will wait. With such powerful predictive analysis at our disposal, the question that must be asked is why is the problem of ED crowding so difficult to solve? Why can't we have just the right number of nurses, physicians and beds at the right times to meet this predictable demand? The answer is hidden in a simple but poorly understood phenomenon known as variation. Failing to measure, map, and understand "variability around the mean" is partly responsible for our failure to fully and finally solve the crowding problem.

So now let's explore variation and use that knowledge to provide the solution to crowding. Remember that crowding is simply the result of more patients seeking ED services than are available. Most health care systems and EDs attempt to solve capacity issues by allocating resources, both providers and beds, on the basis of data focused around the mean — as shown in the graphs above. This means that half the time we meet or exceed patient demand and half the time we fail. This is why the CEO calls three days a week to ask "What happened last night?" The answer is "Well, we had a bad night." The point is that unless we understand variability and probability, then three to four days a week we will have a bad night. That's probability. It's just math.

Don't get me wrong. By itself, understanding variation and how we calculate probabilities will not solve the problem. The solution requires a different staffing model and different work-flow. That will be explained in part 3 of this series, in which we look at staffing to 95% demand probabilities rather than 50%. For now let's continue to build the basis for the solution. Let's look at the data from a variation and probability viewpoint, by looking once again at average patient arrivals on a distribution curve represented by a bar chart overlaid by a curvilinear line, as below.

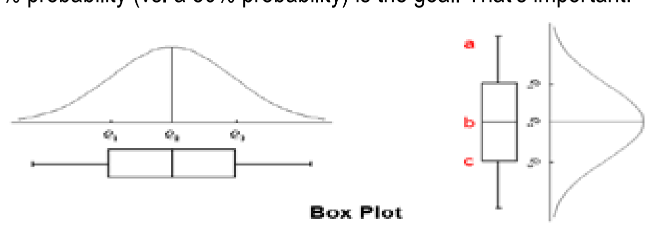


This chart does not reflect what happens in a real ED. The second chart below[1] uses that same curvilinear line based on patient arrivals, but this time displayed as box plots showing the reality that created the mean arrival patterns displayed in the graph above.



Box Plot Arrivals 24 Hours

The box plot shows patient arrivals using large numbers of data points, showing how the average was created from a variety of actual arrivals. The distribution of actual arrivals is shown. As shown below and explaining box plots further, the middle (b) of each box indicates the mean or average, with the upper limit (c) of the box being the 75th percentile and the whisker at the top of the line (a) representing roughly the 90th percentile of the data set. It's the classic Gaussian curve turned on its head. It is important to state that our goal is not to predict the expected volumes and required staffing precisely, but to define required resources to match demand within a range of probabilities. This is how all service industries match customer demand. Meeting service demands with a 90% probability (vs. a 50% probability) is the goal. That's important!



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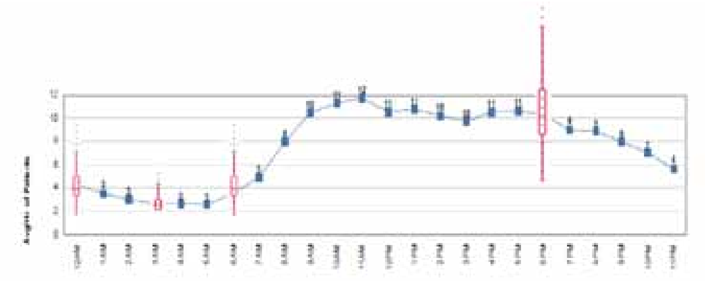
Another way to visualize this for even more clarity is to display, as below, the variation in the original patient arrival curve shown at the beginning of this article.



Arrival Curve with Box Plot

Management would typically shoot for staffing for the mean and then hoping for the best. Whether it's physician productivity (patients per hour) or nursing FTEs (full-time equivalents) per visit, calculating labor standards to the mean will result in failure half the time. So how does one succeed in meeting customer (patient) demand 90% of the time? In the current health care environment very few health systems have the financial power to solve this without fundamentally changing both ED work-flow and staffing models. There is a practical solution that allows 90% service guarantees with minimal financial risk.

Solving this problem of demand matching, with the probability that you will have adequate provider resources 90% of the time, essentially solves one of the two major causes of ED crowding. Besides labor (physicians and nurses), the other major resource constraint is space — physical ED beds. The staffing model that will be proposed in part 3, drives a work-flow solution that, in the end, also drives the space solution by creating virtual ED space.

So, in the next and final submission in this series we will explore an integrated work-flow and staffing model that allows you to "crack the code" on this problem. Successful industries have created business models with a cost structure that provides for service demand matching at the 90% probability level, but that maintain operating margins. I suggest that we can do the same. See you next time. ■

1. Ed Popovich. (2002 – 2005) at Boca Raton Community Hospital (now Boca Raton Regional Hospital).
2. Door-to-Doc (D2D) Patient Safety Toolkit. Banner Health and Arizona State University. AHRQ Grant #Hs015921-01.
3. Ochsner Health System, Jefferson, LA.

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