ED Overcrowding: An Assessment Tool to Monitor ED Registered Nurse Workload that Accounts for Admitted Patients Residing in the Emergency Department

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ED overcrowding has been gaining national attention in recent years. It is becoming apparent that, like the canary in the coal mine, ED conditions are emblematic of systemwide health care failures: too many patients, not enough room, inadequate resources, and
inadequate reimbursement. The causes of ED overcrowding are myriad, but government reports\textsuperscript{1} and most ED directors agree\textsuperscript{2} that the inability to move admitted patients to an inpatient bed critically compromises the ED mission of caring for incoming acute patients. These unevaluated patients are the most at risk for unexpected adverse outcomes, because they have not had their disease process evaluated nor their treatment initiated.

Industry experts have quantified solutions to the need for more inpatient beds:

“… a 300 bed hospital should plan on building 104 beds to accommodate both the short and long term increases in patient volume. With 40 percent of a typical hospital’s in-patient admissions coming in through the ED…104 beds will provide a 300 bed hospital with a safe buffer zone to accommodate increased admissions as the result of increased ED volume.”\textsuperscript{3}

Most of us cannot expect a 33\% increase in available inpatient beds in the near future. Even if such a building program were to materialize, the aging of our patients guarantees that these beds will be absorbed quickly.\textsuperscript{4} In addition, the utilization of hospital beds for expanding outpatient programs that generate “outpatient in a bed” stays, such as ambulatory surgery programs, ensure prolonged ED stays for boarders well into the next decade.\textsuperscript{5}

The impact on our profession is unavoidable. This is especially true as more metrics become focused on ED-centric variables, our patient volumes continue to rise, and our customer service mandate becomes vital to competitive viability:

“…even the best run EDs will experience an eventual plateau, or possible decline, with respect to patient satisfaction, if there is a lack of inpatient medical/surgical beds at their hospitals.”\textsuperscript{3}

The problem affects an astounding number of hospitals. Fifty-one percent of all metropolitan hospital emergency departments report patients waiting an average of 4 hours or more to get an inpatient bed.\textsuperscript{4} With ED visits rising 18\% between 1994 and 2004 across the United States, and in that same time period, the number of U.S. emergency departments decreasing by 12.4\%,\textsuperscript{6} overcrowding has no choice but to worsen. The impact on patients, while obvious, bears repeating:

“…crowding has multiple effects, including prolonged pain and suffering for some patients, long patient waits, increased transport times for ambulance patients, inconvenience and dissatisfaction for the patients and their families, and increased frustration among
medical staff. In addition to delays in treatment, some emergency department directors have reported that patient care was compromised and patients experienced poor outcomes as a result of crowded conditions in emergency departments.”}

Hospital overcrowding spills out into the community when EMS providers are forced to bypass overcrowded emergency departments and go to a more distant facility because of diversion. Seventy percent of all hospitals report diverting ED patients at some point, and a significant number of hospitals report diversion periods greater than 20% of the time. While not widely appreciated, ambulance diversion and patients who leave without seeing a physician (“left without being evaluated” or LWOBE) can dramatically affect a hospital’s bottom line. One study from a 450-bed community teaching hospital quantified revenue loss due to diversion and patient elopement of almost $4 million in a 1-year period.

To capture this lost revenue and to promote quality patient care and satisfaction, diversion and elopement must be minimized. In the absence of inpatient bed availability to decant boarding patients from the emergency department, some facilities have had success utilizing ED-managed overflow units (acute care units, or ACUs) to manage a variety of boarding and short-stay type patients. One such unit reported ambulance diversion and LWOBE rates dropping nearly 50% after initiating such a unit. One would expect that this translates into significant revenue, thus supporting the ACU financially.

For facilities that have not embraced the ACU concept or that currently are constrained by space limitations, it is imperative that the patients who are boarding in the emergency department not affect the care delivered to the new, unevaluated patients. Because ED boarders use ED staff resources that are generally “sized” to deliver care only to new ED arrivals, care of these boarders endanger new patients by absorbing staff work. This situation can result in inadequate work capacity to address newly arriving ill patients. Alternatively, the finite staff might direct their attention to newly arriving patients, thus being forced to neglect the boarders and providing nowhere near the requisite attention to these deserving inpatients.

In fact, it is this latter behavior that is evident to even a casual observer in any overcrowded emergency department. Admitted patients line the hallways, receiving only scant attention as staff scurry to greet ambulances, care for critically ill patients, and scramble to address vital “admitting orders” on the boarders whose care cannot be deferred. Staff often will avert eye contact with the ubiquitous
boarders, especially the less sick ones. Staff know that to interact with a boarder might require them to delay caring for a new sick patient, and so they avoid contact. Naturally, the boarders’ perception of the ED staff negatively affects their rating of the institution as a whole, with attendant impact on satisfaction metrics like Press-Ganey scores and the like.

We set out to evaluate nursing staffing in a major teaching hospital’s emergency department as part of a consulting project to evaluate ED operations. Observational data immediately revealed the plight of the ED boarders, and we then began to quantitate available registered nurse (RN) work capacity and how it was distributed over the different types of ED patients. Because it has been shown that nursing staffing affects the number of LWOBE patients, and therefore facility revenue, right-sizing the workforce has both economic and patient safety implications.

Based on the work of Asplin et al, it was clear that ED boarders, as shown in Figure 1, critically affect the ED throughput. As such, we sought to integrate the care of such patients into the recognized workload assigned to ED nurses. The resulting model, described herein, can be used to more closely “right-size” ED RN staffing to existing conditions in an emergency department, recognizing that ED boarders utilize RN work that must be accounted for.
Materials and Methods

To properly size RN staff for an emergency department, all their work obligations must be accounted for. Models exist that can reasonably calculate the work required to care for arriving patients. Measuring and projecting arrival rate and acuity and allocating a certain number of minutes of work for each patient can achieve this goal, and then it is necessary to assign staff so that staffing availability is matched to arriving workload. Because arrival rates are an uncontrolled variable, staffing becomes a probability. Clearly a staffing pattern that succeeds in exceeding or matching arriving workload 90% of the time will be more successful at meeting performance targets than a staffing pattern that matches arriving workload only 50% of the time. Calculation of arriving workload does not, however, give a complete picture of ED RN work obligations. Care of boarders represents an additional burden that must be quantified. The difficulty in quantifying this workload lies in measuring the presence of such patients in an emergency department, given that typical ED metrics do not include longitudinal occupancy statistics that reflect the presence of boarders and their attached work.

Furthermore, calculations of RN work to care for ED boarders requires a different paradigm than work for new ED patients; typically, care for such “inpatients” is measured in RN-to-patient ratios, a less-used yardstick in emergency departments. On the other hand, because maintaining such fixed RN-to-patient ratios in the hospital often is the argument used by administrators as to why an ED boarder cannot be admitted to a “hallway bed” on an inpatient unit, it seems that using this measurement to assess care of ED boarders is more than legitimate. (One recurring argument made by ED administrators is that it makes more sense to have 2 hallway patients on each inpatient unit rather than 30 hallway patients in the emergency department, but this has not attained much traction with hospital administrators.)

Our model, based on observational analysis, assumes that ED nurses will care for arriving unevaluated patients first, and then devote their remaining time to caring for boarders. We therefore quantified the arriving workload based on a 100% sample of 7 days of ED patients. This sample was compared with random samples from other months and was found to be statistically identical in terms of
patient volume, acuity, arrival rate, and admission percentage. Workload was established by using the following criteria gleaned from published standards:

- Critical care patients were assigned a 90 “work-minute” workload for the nurse(s) caring for the patient on arrival.
- Patients admitted to a monitored unit who were not judged to be ICU-type patients were assigned level II acuity, given a 60 work-minute load.
- Regular bed admission and discharges were given a 30 work-minute load.

The arriving workload per hour was calculated and subtracted from the available pool of nursing labor, as in the example in Table 1.

Example of workload calculation

<table>
<thead>
<tr>
<th>Patient arrivals</th>
<th>Minutes of work</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 ICU patients @ 90 minutes of work</td>
<td>180a</td>
</tr>
<tr>
<td>4 telemetry patients @ 60 minutes of work</td>
<td>240</td>
</tr>
<tr>
<td>1 regular bed admission @ 30 minutes of work</td>
<td>30</td>
</tr>
<tr>
<td>4 discharges @ 30 minutes of work</td>
<td>120</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>11 patients</td>
<td>510</td>
</tr>
</tbody>
</table>

This calculation was set up in an Excel spreadsheet for each hour of the 7-day sample. It was matched against the actual number of nurses present in the emergency department that hour, accounting for sick calls and unfilled positions, to give a true picture of the ED workforce. The next step was to subtract the real work presenting as new patients from the real workforce to give residual work capacity. Given that incoming new patients receive priority, it is clear that this residual work capacity is the only labor available to
care for the ED boarders. Using the example in Table 1 for a single hour, if there are 10 nurses doing direct patient care, this represents 600 minutes of potential work (we did not subtract lunches, breaks, etc). Doing 510 minutes of work on the arriving 11 patients leaves 90 minutes of residual work capacity.

The next step is to calculate the number of ED boarders physically present in the emergency department. A boarder was defined as a patient who, it had been decided, needed to be admitted but who remained in the emergency department longer than 30 minutes, which is considered a best practice for so-called “dispo to inpatient bed” time. Using the time of physician “decision to admit” and a patient’s length of stay, we were able to set up a grid that showed how long each patient stayed in the emergency department after “decision to admit,” map that on an hourly grid for the 7-day study period, and calculate the sum of admitted patients residing in the emergency department at any hour (boarders per hour). The residual work capacity at every hour was then distributed among boarders present every hour. For instance, the residual work capacity from our example in Table 1 (90 minutes) represents 1.5 nurses available during that hour. These 1.5 nurses are “spread” over the existing boarders and represented as a staffing ratio, giving a true reflection of the care rendered to boarders using a metric familiar to administrators. If there is one ICU boarder requiring a 1:2 staffing, they would “use” 30 minutes of the available 1.5 hours of residual work capacity. The remaining “1.0 nurse” would have to cover the rest of the boarders. If there were 15 other boarders, this would make a 1:15 nurse-to-patient ratio if those 15 boarders were of minimal acuity. If any of those 15 boarding patients were sicker, they would obviously use more of the “1.0 nurse’s” time, worsening the staffing ratio for the remaining boarding patients.

The final step in this analysis is to define an acceptable staffing ratio for boarders based on acuity. We make this a variable in our spreadsheet model, allowing an administrator to adjust this ratio to his or her level of comfort. At the outset, our model “mandates” that boarders receive care in the emergency department that is similar to inpatient care: 1:2 for ICU patients, 1:4 for other monitored patients, and 1:10 for unmonitored patients. (We recognize that this understates the need based on current research, which finds that nurse burnout and patient care errors increase for every patient over a 1:4 ratio.[13] and [14] We then overlay this requirement for care onto the actual number of boarders and their acuity and the actual residual work capacity. We then ask the following binary question
within the spreadsheet grid: are there enough nurses to provide care for the incoming new ED patients and meet the staffing ratios mandated for the boarders? We pose this query for every hour of the 7-day study period and yield a table that shows how many hours per week nursing capacity is exceeded.

Figure 2 is the algebraic summary of the inputs to this table for each hour. Table 2 shows the output for a small segment of the study period; the word “over” in Table 2 represents hours that nursing capacity was exceeded.

<table>
<thead>
<tr>
<th>C = (A-B)</th>
<th>IF C&lt;D+E+F, OVERLOAD</th>
<th>IF C&lt;0, OVERLOAD</th>
</tr>
</thead>
</table>

A. Actual work minutes per hour for new arriving patients, with acuity and volume converted to nursing work minutes using the operating assumptions described above, as follows:

\[\geq \text{level 1 new patients/h} \times 90 + \text{level 2 new patients/h} \times 60 + \text{level 3 new patients/h} \times 30\]

B. Number of nurses who actually reported to work on the days studied, present that hour, multiplied \times 60 (total minutes RN work available)

C. Minutes of nursing work available to care for boarders

D. ICU boarder work (1:2, or 30 nursing minutes/hour) \times number of ICU boarders

E. Telemetry boarder work (1:4 or 15 nursing minutes/hour) \times number of telemetry boarders

F. Regular boarder work (1:10, or 6 nursing minutes/hour) \times number of regular boarders

Figure 2. Inputs into spreadsheet calculation of workload.
Output (partial) of spreadsheet showing workload with overload conditions

<table>
<thead>
<tr>
<th>Date of available vs. needed RN work</th>
<th>Midnight</th>
<th>1:00 am</th>
<th>2:00 am</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/1/2006</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>2/2/2006</td>
<td>Over</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>2/3/2006</td>
<td>OK</td>
<td>Over</td>
<td>OK</td>
</tr>
<tr>
<td>2/4/2006</td>
<td>OK</td>
<td>Over</td>
<td>OK</td>
</tr>
<tr>
<td>2/5/2006</td>
<td>Over</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>2/6/2006</td>
<td>Over</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>2/7/2006</td>
<td>Over</td>
<td>Over</td>
<td>Over</td>
</tr>
</tbody>
</table>

Percentage of days overloaded at each hour

<table>
<thead>
<tr>
<th></th>
<th>Midnight</th>
<th>1:00 am</th>
<th>2:00 am</th>
</tr>
</thead>
<tbody>
<tr>
<td>57%</td>
<td></td>
<td>43%</td>
<td>14%</td>
</tr>
</tbody>
</table>

Whenever C is less than D + E + F (the work of caring for the boarders exceeds nursing work minutes available), this is considered overload. Naturally, if C is negative, the nurses were overloaded by caring for arriving new patients, and the issue of overload if they care for boarders is moot. Boarders get virtually no care in that circumstance.

Work can, of course, flow to the next hour, delaying care somewhat. However, if the next hour itself is overloaded with new work, relief is delayed again, and in fact when multiple contiguous hours show the overload condition, the ED care of boarders is largely absent. At this point, arriving work (new patients) and ongoing work (care of admissions) exceeds the staff’s ability to meet the needs of the patients.
Analysis “down” any single hour (column) in Table 2 can reveal problem times, such as periods before 2 am in the above example, when more nurses are needed. If specific days (rows) such as 2/7/2006 show long periods of overload, one must check that weekday in other surveyed weeks for volume surges and predictable causes of inpatient bed delays (eg, ambulatory surgery cases might peak on that day of the week).

Analysis across the entire range of 168 cells (7 days × 24 hours/day) will reveal what percentage of time ED nursing staff was overloaded. By varying any of the inputs (eg, adding nurses, lowering the staffing ratio for boarders, or lowering arrivals to simulate diversion), one can raise or lower the percentage of time that the emergency department is overloaded. In this way, non-ED administrators can easily see the impact of staffing decisions and make a probabilistic decision of what percentage of time an “out of control” emergency department will be tolerable to them. If one accepts a 1:30 staffing ratio for ED boarders, then of course the ED will not be overloaded, from the perspective of this model. Of course, once one accepts a diminution in staffing for such patients, their arguments about not accepting such patients to the floors is seen for what it is: a shifting of risk and poor service to the emergency department and not a concern about lowering staffing ratios too far. Administrators then should understand that if they accept a 1:30 nursing ratio in the emergency department, no measure of customer satisfaction will ever improve. Alternatively, if this staffing analysis reveals an emergency department that is correctly sized for arriving work and care of boarders, poor customer service metrics cannot be blamed on inadequate nursing resources, and other factors must be investigated.

Conclusion

Sophisticated managers will recognize the aforementioned model as forming the basis for computerized modeling and simulation of ED flow. Such simulations are expensive and time-consuming to build and require extensive statistical analysis of all the important throughput variables in order to get a model that accurately predicts system behavior. Our approach, on the other hand, was to use data readily available in almost any emergency department to build a more static model, but one that allows some variation in the inputs to predict how staffing will match historical patient workload. Once a staffing level is decided upon, the “overload grid” should be run on actual patient arrivals weekly to ensure that actual patient workloads are staying consistent with the historical data that was used to
generate the staffing matrix. Of note is that we chose to include work required for an important group of patients, the ED boarders, whose presence is becoming more frequent in our overloaded health care system. To neglect our obligation to these patients in our calculations of staffing levels does a disservice to them and the nurses trying to care for them under near-battlefield conditions.

References


Earn Up to 10 CE Hours. See page 495.

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a The 90 minutes of work per ICU patient is naturally 45 minutes done in 1 hour by 2 nurses, because a nurse cannot perform more
than 60 minutes work in 1 hour. Alternatively, the excess 30 minutes can flow to the next hour. For the purposes of the model, all work was considered to be done in the hour the patient arrived.

**Vitae**

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*Journal of Emergency Nursing*
Volume 34, Issue 5, October 2008, Pages 441-446