Challenging Organizational Factors Associated With Admission Delay to the Intensive Care Unit – A Novel Quality Indicator

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Research Article

Keywords: Admission, Quality, software, Intensive Care Unit, Availability, efficiency, Shortening time, Organization.

Posted Date: October 4th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1966914/v2

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Abstract

**Background:** Delays in admitting patients to the ICU can defer the timely initiation of life-sustaining therapies and invasive monitoring, jeopardizing the success of the treatment. The current study aimed to assess the factors related to delays in admission times of critically ill patients transferred to the ICU using a proactive approach to admission process analysis.

**Methods:** A specifically designed software was created to follow up, compare and measure the defined laps of the time to admission, implemented at the ICU for six months. Measurements included five time-lapse, referral department, and work shift at admission. Data of 1004 patients admitted to the ICU between July 2017 to January 2020 were analyzed in a retrospective observational study.

**Results:** A significant shortening of time to admission before and after the intervention done by the institutional Quality Control Commission. The mean time to admission was shortened by 14 minutes, from a mean of 92.4 minutes to 78.6 minutes. Insights about the organizational factors delaying transfer provide meaningful information for future efficacy interventions.

**Conclusions:** The current study shows the positive effect of a protracted follow-up of the complex process divided into several stations, where possible preventable situations can be found and modified.

**Trial registration:** The study was approved by the Ashkelon Academic College Ethics Committee with a waiver of informed consent. (Approval # 25/1-2020).

Introduction

Shortening the length-of-stay (LOS) is a priority for all intensive care units (ICU) as the shortage of ICU beds is a global problem.

A negative effect on patient outcomes was found for patients with delayed admission to ICU (Oliveira EG). Lower staffing in hospitals during weekends increases the risk of death, possibly related to delays linked to the organizational structure of the hospital\(^1\). Worse conditions of patients admitted during night shifts can explain poorer outcome\(^2\), and communication flaws between healthcare professionals can delay the admission.

The reasons for delays are complex. Patients admitted at the time of bed shortage were found to be more severely ill than those admitted when beds were unoccupied\(^3\). Prolonged waiting time to get to the ICU was associated with higher mortality for surgical patients\(^4\). For mechanically-ventilated patients waiting in the emergency department for ICU, the time effect on mortality emerged after four hours\(^5\). Shortening admission time should have a significant impact on survival and be seen as a goal of treatment.

A recent review\(^6\) explored the organizational factors associated with the incidence of patients’ admission and discharge delays in critical care. Organizational factors negatively influence approximately 38% of
admissions, including teamwork issues, communication breakdowns, lack of shared situational awareness, lack of resources, busy workload (unit/hospital), lack of an available bed, specific requirements as infection precautions, lack of adequate staff, receiving unit not ready for transfer, and time of discharge (night and weekend transfers).

Lean is considered a continuous improvement model, allowing healthcare organizations to identify and remove wasteful activities in wide clinical settings. One of the tools in the lean approach includes the analysis of time lags in a defined process. This allows understanding of the stream of a process, identifying points causing the workflow to become backed up or slower.

We aimed to assess the factors related to delays in admission of critically ill patients to the ICU, using a proactive approach to admission process analysis.

**Methods**

The association between organizational factors in delays of patient admission to the ICU was examined through a retrospective analysis of a sample of 1004 transfer episodes in the ICU of Barzilai Medical Center in Israel.

**Icu Description**

Barzilai Medical Center ICU is a Medico-Surgical Unit, admitting adult (older than 17 years old) patients from the emergency department, trauma, operating room, obstetrics/gynecology, ear, nose, and throat, orthopedics, and medical wards. In August 2018, the ICU moved to a new installation growing from 6 to 10 beds.

**DATA processing and analyses**

Registry of the time required for every step of the patient transfer and the effect of the intervention from July 1st, 2017, up to January 31th, 2020, were retrospectively analyzed to identify, shorten or remove obstacles deferring admission.

Registered times were:

Time "1" is the decision to admit a patient by the ICU physician.

Time "2": a request to transfer a patient out of the ICU was communicated to the admitting ward if no ICU bed was available at Time 1.

Time "3": the time the ICU patient was transferred, freeing the ICU bed, but the bed was yet to be prepared for admission.
Time "4": the ICU bed freed was arranged, and notification about readiness to admit the new patient was communicated to the referring department.

Time "5": the new patient enters the ICU for admission.

Every time was manually annotated (Fig. 1 original in Hebrew).

The registry ran without evaluation from July 1, 2017, to July 30, 2019. On August 1, 2019, a Quality Control Commission software designed to measure and compare laps of the time to admission was implemented up to the end of the study period on 31th of January 2020.

Five laps were defined:

1st Lap: from time 1 to time 2. The time required to decide who is the most appropriate patient for transfer out of the ICU and find an adequate admitting ward.

2\textsuperscript{d} Lap: from time 2 to time 3. The time required for transfer preparations includes the receiving ward permission to transfer.

3rd Lap: from time 3 to time 4. The time required for space preparation for admission.

4th Lap: from time 4 to time 5. The time the referral department gets permission to transfer the patient up to patient admission.

5th Lap: from time 1 to time 4. The time required for the ICU to be ready to admit a new patient.

Total Time Lap: from time 1 to time 5. The entire time from decision to admission.

The referral department and work shift of admission (morning, evening, or night) were also recorded.

**Results**

During the study, 1004 transfer episodes were registered. The number of patients referred by ward and shift is shown in Table 1.
Table 1
Number of patients referred by ward and respective shift

<table>
<thead>
<tr>
<th>Referral department</th>
<th>Morning shift</th>
<th>Evening shift</th>
<th>Night shift</th>
<th>Total transfers by referral ward (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (%) / (% by shift)</td>
<td>N (%) / (% by shift)</td>
<td>N (%) / (% by shift)</td>
<td></td>
</tr>
<tr>
<td>Medical ward</td>
<td>87 (24.0) / (43.9)</td>
<td>82 (20.1) / (41.4)</td>
<td>29 (15.5) / (14.6)</td>
<td>198 (21)</td>
</tr>
<tr>
<td>Surgical ward</td>
<td>29 (8) / (46.7)</td>
<td>21 (5.4) / (33.8)</td>
<td>12 (6.4) / (19.3)</td>
<td>62 (6.6)</td>
</tr>
<tr>
<td>Operating room</td>
<td>68 (18.7) / (39.1)</td>
<td>84 (21.4) / (48.3)</td>
<td>22 (11.8) / (12.6)</td>
<td>174 (18.4)</td>
</tr>
<tr>
<td>Emergency department</td>
<td>179 (49.3) / (35.2)</td>
<td>205 (52.3) / (40.4)</td>
<td>124 (66.3) / (24.4)</td>
<td>508 (53.9)</td>
</tr>
<tr>
<td>total</td>
<td>363 (100)</td>
<td>392 (100)</td>
<td>187 (100)</td>
<td>942 (100)</td>
</tr>
</tbody>
</table>

X² = 19.56 p < 0.01

Most ICU admissions were referred by the emergency department, followed by the surgical and the medical departments. The evening shift was the busiest, followed by the morning, and finally, the night shift was the less transfer-burdened among all the departments. The morning round had the longer admission time, the shorter time noted at the evening shift (Table 2).

Table 2
Mean and SD by Lap and Shift

<table>
<thead>
<tr>
<th></th>
<th>Morning shift (N = 475)</th>
<th>Evening Shift (N = 431)</th>
<th>Night Shift (N = 197)</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (minutes)</td>
<td>SD</td>
<td>Mean (minutes)</td>
<td>SD</td>
</tr>
<tr>
<td>1st Lap</td>
<td>71.8</td>
<td>92.3</td>
<td>31.9</td>
<td>33.6</td>
</tr>
<tr>
<td>2nd Lap</td>
<td>65.8</td>
<td>55.3</td>
<td>59.4</td>
<td>43</td>
</tr>
<tr>
<td>3rd Lap</td>
<td>53.4</td>
<td>54.6</td>
<td>46.1</td>
<td>33.4</td>
</tr>
<tr>
<td>4th Lap</td>
<td>44.2</td>
<td>44.5</td>
<td>42.4</td>
<td>33.9</td>
</tr>
<tr>
<td>5th Lap</td>
<td>54.3</td>
<td>81.4</td>
<td>37.8</td>
<td>33.9</td>
</tr>
<tr>
<td>Total time</td>
<td>97.6</td>
<td>86.5</td>
<td>82.9</td>
<td>52.1</td>
</tr>
</tbody>
</table>

* p < 0.05, **p < 0.01
A difference was found in the total admission time if the ICU was at full capacity when the decision to admit a new patient was taken (Table 3), being those times significantly longer.

Table 3
Comparison of Mean and SD of total time to admission at unavailable or available ICU bed

<table>
<thead>
<tr>
<th>Bed not available</th>
<th>Bed available</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 269</td>
<td>N = 735</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Total time lap</td>
<td>98.4</td>
<td>95.4</td>
</tr>
<tr>
<td>4th Lap</td>
<td>56.4</td>
<td>86.4</td>
</tr>
</tbody>
</table>

***p < 0.001

An Interaction between lapses was found. If some of the laps were longer, all of the laps were longer, despite not being dependent on each other. Table 4 shows the Pearson correlation between laps.

Table 4
Pearson correlation between laps.

<table>
<thead>
<tr>
<th>6th Lap</th>
<th>1st Lap</th>
<th>2nd Lap</th>
<th>3rd Lap</th>
<th>4th Lap</th>
<th>5th Lap</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Lap</td>
<td>0.61***</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>2nd Lap</td>
<td>0.37***</td>
<td>-0.79</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>3rd Lap</td>
<td>0.49***</td>
<td>0.20</td>
<td>0.06</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>4th Lap</td>
<td>0.41***</td>
<td>-0.57</td>
<td>0.37***</td>
<td>-0.87</td>
<td>—</td>
</tr>
<tr>
<td>5th Lap</td>
<td>0.88***</td>
<td>0.76***</td>
<td>0.35*</td>
<td>0.56***</td>
<td>0.003</td>
</tr>
<tr>
<td>Total time</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

The time comparison showed a significant difference in the study intervention (Table 5).

Table 5
Mean and SD of 6th Lap (total admission time) before and after the intervention

<table>
<thead>
<tr>
<th>Before study intervention</th>
<th>After study intervention</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 693</td>
<td>N = 311</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Total time</td>
<td>92.4</td>
<td>83.4</td>
</tr>
</tbody>
</table>

*p < 0.05
Discussion

This study showed that applying a lean approach to the laps of admission to ICU and the introduction of a novel quality indicator effectively reduced the time to admission to ICU.

There is an association between delayed ICU admission and higher mortality. It was shown that patients meeting ICU admission criteria but treated out of the ICU have higher mortality. An admission delay from the emergency department of four hours and as short as one hour was shown to increase the mortality of mechanically ventilated patients. Mortality increase was also seen in non-ventilated patients with community-acquired pneumonia. Septic patients managed at the emergency department for more than 12 hours showed a significantly increased risk of death compared with patients transferred to the ICU in less than six hours.

In a recent meta-analysis, delayed admission was associated with significantly higher mortality, with an overall quantitative synthesis of findings indicating an increase in the odds for mortality by 61%. However, if the referral department is of high complexity, no association was found.

A significant association was found between the number of ICU beds available and ICU admission within two hours. However, in this study, hospital mortality was similar between groups.

To have enough ICU beds and staff availability is an undoubted and undisputed vision for every hospital and society, although not always real because of the high cost and the scarcity of medical and nursing professionals.

Our study found that the emergency department was the most frequent referral (54%), followed by the combined surgical department and the operating room (25%), then the combined six internal medicine departments of the hospital (21%).

Both the surgical and medical departments referred most of their patients during the morning shift and less during the night shift. The evening shift was the busiest for patients transferred from the emergency department and the operating room, being the night shift the less transfer-burdened from all the departments. Despite the morning round admitting fewer patients and being better staffed than the evening shift, longer admission time was revealed, followed by the night shift and the shorter time noted at the evening shift (Table 2). It is to note that the morning shift is usually the busiest time at the unit. Although better staffed, our findings point to a possible disproportion between the amount of work expected to be done and the number of staff doing the work.

The evening shift also showed a shorter delay to transfer of a patient from ICU to other departments when zero ICU beds were available and a shorter time to arrange the bed for new admission. The arrangement of the space for admission requires special cleaning. This activity is done by a team that is not organic to the unit and takes longer to recruit at night.
As expected, significantly longer time-to-admission was recorded when no ICU bed was available (Table 3). As shown, a significant difference was noted up to the 4th lap, as no significant difference was seen from then to the patient admission.

Surprising interactions between lapses were found. If some lap was longer, all the laps were longer despite not being dependent on each other, as seen by the Pearson correlation (Table 4). We can only hypothesize that similar factors influenced each lapse correlated in time, situation, and referral department.

Finally, our study showed a significant shortening in time to admission before and after the intervention (Table 5), as the total mean time to admission was shortened by 14 minutes, from 92.4 minutes to a mean of 78.6 minutes.

The limitations of the present study must, however, be acknowledged. Manually registering each time can be subjected to manipulation. Though that was periodically supervised, and neither the supervisor nor the staff doing the registration wasn't aware of the intention of registering the data. Referral departments were not aware of the study at any of their phases. It is also to note that the initial registers were not used until consistent annotation was achieved. Being a single-site study, our conclusions cannot be directly extrapolated and are only supposed to be the same at other institutions. Nonetheless, our hospital is a secondary trauma level university institution periodically supervised by the Joint Commission for Quality in Hospital Care Accreditation and Certification. Other similar institutions are then supposed to have to cope with comparable situations.

We didn't compare other variables such as patient's severity, length of stay in the unit, or mortality, but this was beyond the goals of the study and the intervention, anyhow, shortening time to ICU admission and fastening interventions to improve the level of care are believed to be significant corners to professional care.

Many variables cannot be modified by the ICU staff. The time demanded the transfer of a stable patient from the ICU to another department depends on the availability of a free bed in the receiving ward. The early hours of the morning shift, before discharges started at the different hospital departments, were puzzling because the admitting ward was also at full capacity. Finally, the time required by the referral department to transfer the patient after the ICU approval can also be barely changed by the ICU team.

One of the main amendable reasons for the delay was identified in our study as the lapse required from the decision to admit a patient to the ICU until the authorization given by the ICU to the referral department to transfer the patient. As we learned that the referral department needs an average of 44.5 minutes to move the patient to the ICU, another door for intervention was open as we started to superpose actions that were done in sequence in the past. This data is being acquired now, and we hope to furtherly shorten the time to admission to our ICU.

Conclusion
Reducing ICU admission delays requires an inter-professional and multifactorial evaluation approach to the critical care process due to the multiple actors and disciplines involved in critical care. The current study shows a novel quality indicator and the positive effect of a protracted follow-up of the complex process divided into several stations, where possible preventable situations can be found and modified. As the reasons for delay can present isolated or shared at many steps, it is necessary to analyze every step as a separate lap. The requested time to admit a patient to the ICU can then be shortened by non-expensive interventions.

**Declarations**

Ethical approval: the study was approved by the Ashkelon Academic College Ethics Committee with a waiver of informed consent, all methods were carried out in accordance with relevant guidelines and regulations. (Approval # 25/1-2020).

Founding:

All the Authors declare that they have not Competing-Interest.

Consent to Publish: NA. This manuscript does not include information or images that could lead to identification of a study participant.

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

All the authors give consent to publication.

Availability of data and materials:

All datasets can be reviewed contacting author Evgeny Chernoguz, evgenyc@bmc.gov.il.

Authors’ contribution: DJ conceptualized the registry and quality control and wrote the manuscript. OB analyzed and interpreted the data and was a significant contributor to writing the manuscript. VK and HV analyzed the data, and EC created the new software used in work. VN, HL, and YS contributed to the conception of quality control. All the authors read and approved the final manuscript.

**ACKNOWLEDGEMENTS**

We thank Ms. Dana Azaria-Peleg for her committed secretarial assistance.

**References**


**Figures**

<table>
<thead>
<tr>
<th>Patients name</th>
<th>Date to admit time</th>
<th>Decision to admit time</th>
<th>Referral department</th>
<th>Number of patients in ICU at decision time</th>
<th>Transfer ICU patient to other department time</th>
<th>Time of patient transfer out of ICU</th>
<th>Time of permission to transfer the patient to the ICU</th>
<th>Admission time</th>
<th>Main Diagnosis</th>
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</tbody>
</table>

**Figure 1**

Admission form