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Increased Inpatient Length of Stay After Early Unplanned Transfer to Higher Levels of Care

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Objectives: Patients admitted to a medical-surgical unit infrequently require early transfer to higher level care, although how their inpatient length of stay compares to untransferred patients, or those directly admitted to intermediate care, is unknown. We sought to compare the inpatient length of stay of these groups.

Design: Single-site retrospective analysis.

Setting: An academic hospital specializing in complex care.

Patients: We evaluated 23,694 patients admitted to the Hospital Internal Medicine service over a 4-year period (January 1, 2013, to December 31, 2016).

Interventions: None.

Measurements and Main Results: Using 6- and 24-hour definitions of early transfer, we categorized patients as admitted to medical-surgical unit without early transfer (medical-surgical unit), transferred (TX) early to higher level care, or initially admitted to an intermediate care unit. We report patient characteristics and inpatient length of stay adjusted for patient demographics (age and sex) and initial acuity (measured by Emergency Severity Index). There were significant increases in both unadjusted inpatient length of stay (6 hr: medical-surgical unit = 73.4 hr, TX = 137.9 hr, intermediate care unit = 101.1 hr; 24 hr: medical-surgical unit = 72.4 hr, TX = 141.9 hr, intermediate care unit = 98.2 hr; $p < 0.01$ for all groups) and adjusted inpatient length of stay (6-hr definition: medical-surgical unit = 50.9 hr [95% CI, 50.3–51.6 hr], TX = 100.4 hr [90.4–112.0 hr], intermediate care unit = 72.3 hr [70.6–74.0 hr]; 24-hr definition: medical-surgical unit = 50.3 hr [49.7–50.9 hr], TX = 108.3 hr [101.5–116.0 hr], intermediate care unit = 70.7 hr [69.0–72.3 hr]; $p < 0.0001$ for comparison of TX to medical-surgical unit and intermediate care unit in both groups). The increases in inpatient length of stay for the TX groups were not explained by differences in demographics or acuity.

Conclusions: In a single facility study, patients admitted to a medical/surgical unit who require early transfer to intermediate care unit have a significant and unexplained increase in inpatient length of stay. This unexplained increased inpatient length of stay suggests that triage to the appropriate inpatient unit significantly affects inpatient length of stay.

Key Words: emergency department admission; inpatient length of stay; intermediate care unit; medical-surgical unit; transfer of care; triage

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Hospitals increasingly use intermediate care units (IMCs), high-acuity care areas focusing on moderate to severe patient conditions, to better allocate limited critical care (CC) beds (1). Appropriate assignment of patients to IMCs can lead to reduced mortality, lower costs, and improved CC utilization (2–6). IMCs typically admit patients with higher care needs than medical-surgical units (M/Ss) but who do not require extensive invasive monitoring (7).

Substantial variation in IMC qualification and admission persists, leading to overuse of CC resources and expensive CC unit expansion (8, 9). The lack of standardization of IMC status is reflected in the large disparity in data regarding the percentage of patients admitted to CC directly versus indirectly through transfers (10, 11). The difficulty of correctly identifying patient care needs has significant consequences for patient outcomes, such as increased inpatient length of stay (IPLOS), mortality (12–16), and cost (17–19). Thus, the importance of appropriate early placement is well recognized (14, 16).

Limited data exist comparing lengths of stay of patients admitted to M/S status without need for further transfer of care to those who require early transfer to IMC (transferred [TX]), and to those admitted directly to an IMC. We performed an exploratory study to evaluate the relationship between initial patient placement (and early transfer to IMC) and IPLOS.

MATERIALS AND METHODS

The protocol for this study was approved by the Mayo Clinic Arizona institutional review board. We retrospectively evaluated patients admitted from the Mayo Clinic Hospital emergency department (ED) to the Hospital Internal Medicine (HIM) service on M/S and IMC. Mayo Clinic Hospital is an academic medical center in Phoenix, AZ, specializing in complex care. The IMC manages all acutely ill patients up to the point of requiring vasopressor support and intubation.

We included all adult patients admitted to the HIM service from January 1, 2013, to December 31, 2016. We collected data from the Cerner electronic health record system and abstracted them into a customized operational database (Microsoft Excel; Microsoft Corporation, Redmond, WA). Data used in the analysis include unit (IMC or M/S), age, sex, Emergency Severity Index (ESI) scores, and IPLOS.

We compared proportions of sex and high acuity (ESI < 3) between groups using the chi-square test. We compared IPLOS and age using the Wilcoxon rank-sum test due to the non-normality of their distributions. Unadjusted IPLOS was compared between all groups using the Kruskal-Wallis test. Log normal multivariable regression models were used to adjust IPLOS for age, ESI, and sex. The mean-adjusted IPLOS was estimated using 2,000 stratified bootstrap samples using predicted length of stay (LOS) values generated with the fitted models. The predicted values were exponentiated to return the predicted value from $\log_e$ hours to hours. The modeling was performed in every bootstrap iteration. The mean for each of the three groups for each outcome was calculated by taking the average of their respective bootstrap averages. Ninety-five percent CIs were estimated for both mean-adjusted LOS times using the 2.5 and 97.5 percentile of their respective bootstrap distributions. The reported p values result from the log normal multivariable regressions and were adjusted using the Tukey-Kramer method for post hoc pairwise comparisons. All hypothesis tests were two sided and p values less than 0.05 were considered statistically significant. Analyses were performed using SAS v9.4 (SAS Institute, Cary, NC) and R 3.5.2 (R Foundation for Statistical Computing, Vienna, Austria) with the boot package (20, 21).

We established three cohorts of patients: those admitted to a M/S who did not require an early transfer to a higher level of care (M/S), those admitted to a M/S who did require transfer to a higher level of care (TX), and those admitted directly to the IMC. We analyzed the differences between these groups using two separate time definitions of early transfer: within 6 hours of arrival to a M/S bed and within 24 hours of arriving to an M/S bed.

RESULTS

IPLOS by Cohort: 6-Hour definition of Early Transfer

Using this definition of early transfer, there were 18,578 M/S patients, 199 TX patients, and 4,917 IMC patients. Age showed a

TABLE 1. Demographics and Inpatient Length of Stay of Patients Admitted From the Emergency Department to Medical-Surgical Status Who Were Not Transferred, Those Transferred From Medical-Surgical Status to Intermediate Care Unit Within 6 or 24 Hours After Admission From the Emergency Department, and Those Directly Admitted to the Intermediate Care Unit

Criterion	Admitted to Medical-Surgical and Not Transferred Within 6 hr	Admitted to Medical-Surgical and Transferred to IMC Within 6 hr	Admitted Directly to IMC	Total	p
Patients (n)	18,578	199	4,917	23,694	
Age (SD)	67.9 (17.32)	67.5 (17.37)	65.8 (17.36)	67.5 (17.35)	< 0.01[a]
Sex (% male)	47.9	50.3	53.4	49.0	< 0.01[a]
ESI score (%, < 3)	22.1	39.2	49.7	28.0	< 0.01[a]
Mean inpatient LOS (hr)	73.4	137.9	101.1	79.7	< 0.01[b]
Median inpatient LOS (hr)	48.0	98.0	71.0	53.0	< 0.01[b]
Criterion	**Admitted to Medical-Surgical and Not Transferred Within 24 hr**	**Admitted to Medical-Surgical and Transferred to IMC Within 24 hr**	**Admitted Directly to IMC[a]**	**Total**	**p**
Patients (n)	18,325	452	4,748	23,525	
Age (SD)	67.9 (17.34)	68.5 (16.17)	65.7 (17.42)	67.5 (17.35)	< 0.01[b]
Sex (% male)	47.9	49.1	53.2	49.0	< 0.01[b]
ESI score (%, < 3)	22.0	35.0	49.4	27.8	< 0.01[b]
Mean inpatient LOS (hr)	72.4	141.9	98.2	79.0	< 0.01[c]
Median inpatient LOS (hr)	47.0	107.5	70.0	52.0	< 0.01[c]

ESI = Emergency Severity Index, IMC = intermediate care unit, LOS = length of stay.
[a]One hundred sixty-nine patients excluded from analysis due to missing demographic data.
[b]χ^2 p value.
[c]Kruskal-Wallis p value.

TABLE 2. Multivariable Regression Analysis of Estimated Inpatient Length of Stay Adjusting for Age, Emergency Severity Index, and Sex of Patients Admitted to Medical-Surgical Status Without Transfer, Transferred From Medical-Surgical Status to Intermediate Care Unit Within 6 or 24 hours After Admission From the Emergency Department, and Directly Admitted From the Emergency Department to the Intermediate Care Units

Group	Measurements	Inpatient Length of Stay (hr)	*p*
(1) Admitted to floor and did not transfer within 6 hr	*n* Mean (95% CI)	18,414 50.9 (50.3–51.6)	
(2) Admitted to floor then transferred within 6 hr	*n* Mean (95% CI)	198 100.4 (90.4–112.0)	
(3) Admitted directly to intermediate unit	*n* Mean (95% CI)	4,875 72.3 (70.6–74.0)	
(1) vs (2)	Change in mean (95% CI)	−49.5 (−61.3 to −39.4)	< 0.001
(1) vs (3)	Change in mean (95% CI)	−21.4 (−23.1 to −19.6)	< 0.001
(2) vs (3)	Change in mean (95% CI)	28.1 (18.0–39.7)	< 0.001
(4) Admitted to floor and did not transfer within 24 hr	*n* Mean (95% CI)	18,162 50.3 (49.7–50.9)	
(5) Admitted to medical-surgical then transferred within 24 hr	*n* Mean (95% CI)	450 108.3 (101.5–116.0)	
(6) Admitted directly to intermediate unit	*n* Mean (95% CI)	4,707 70.7 (69.0–72.3)	
(4) vs (5)	Change in mean (95% CI)	−58.0 (−65.5 to −51.3)	< 0.001
(4) vs (6)	Change in mean (95% CI)	−20.4 (−22.1 to −18.6)	< 0.001
(5) vs (6)	Change in mean (95% CI)	37.6 (30.4–45.6)	< 0.001

unidirectional stepwise decrease from M/S to TX to IMC, whereas male sex and acuity showed a unidirectional stepwise increase from M/S to TX to IMC (**Table 1**).

IPLOS did not demonstrate a unidirectional stepwise change. After adjusting for age, sex, and acuity, IPLOS was lowest (50.9 hr [95% CI, 50.3–51.6 hr]) in the M/S group, highest (100.4 hr [90.4–112.0 hr]) in the TX group, and intermediate (72.3 hr [70.6–74.0 hr]) in the IMC group ($p < 0.0001$ for comparisons between M/S and TX as well as TX and IMC) (**Table 2**).

IPLOS by Cohort: 24-Hour Definition of Early Transfer

Using this definition of early transfer, there were 18,325 M/S patients, 452 TX patients, and 4,748 IMC patients. Age in the 24-hour definition cohort was similar in M/S and TX groups and lower in IMC patients, whereas male sex and acuity showed a unidirectional stepwise increase from M/S to TX to IMC (Table 1).

IPLOS in the 24-hour definition cohort did not demonstrate a unidirectional stepwise change. After adjusting for age, sex, and acuity, IPLOS was lowest (50.3 hr [49.7–50.9 hr]) in the M/S group, highest (108.3 hr [101.5–116.0 hr]) in the TX group, and intermediate (70.7 hr [69.0–72.3 hr]) in the IMC group ($p < 0.0001$ for comparisons between M/S and TX as well as TX and IMC) (Table 2).

DISCUSSION

We compared three cohorts of patients: those admitted to a M/S bed who did not require an early transfer to IMC, those admitted to a M/S bed who required early transfer, and those admitted directly to IMC. Our results, although preliminary and exploratory, are notable for several significant findings.

First, we found that the number of patients requiring early transfer to IMC was low (approximately 1% at 6 hr and 2.4% at 24 hr), suggesting that the human process of assigning patients to the appropriate unit works well (97.6–99%). These findings refute a frequently voiced concern that patients are often mistriaged in the ED.

Second, we demonstrated that the initial admission to M/S followed by early transfer (at 6 or 24 hr) is accompanied by a dramatic increase in IPLOS that is unexplained by differences in age, sex, or acuity. From a quality standpoint, TX patients may represent "edge cases" who were initially deemed stable for admission to M/S but who, in hindsight, would have benefitted from IMC admission. This hypothesis is consistent with the observation that risk factor demographics (age and ESI) of the TX patients were in between those of the M/S and IMC populations.

This study also identified that the IPLOS for TX patients is much higher than that of patients originally allocated to the appropriate environment. It is possible that TX patients presented to the ED earlier in their illness trajectories and, therefore, took longer to reach their peak of illness severity. Alternatively, the TX cohort may have decompensated after admission to M/S from a pathology unrelated to that identified at admission. Due to inherent staffing and monitoring differences, the individual time spent with each patient by staff is lower on the M/S floors than in the IMC, which could contribute to decompensation in "borderline" patients. These preliminary results suggest that the initial disposition decision may play a significant role in patient throughput and potentially overall outcomes. These findings are consistent with previous studies evaluating IPLOS in patients transferred from IMC to CC, as well as the previously documented lower LOS of patients who remain on M/S (9, 22). Similar findings have also been described in a series of studies of a high-risk general surgical population in the United Kingdom, which although accounting for only 13% of surgical admissions and over 80% of postoperative deaths, only a minority are directly admitted to CC postoperatively (23). In this cohort, postoperative admission to M/S with subsequent transfer to CC (within a median of 2 d) as well as premature discharge from CC were associated with significant increases in mortality rate, illustrating how clinicians' underestimation of the potential benefits provided by higher level care can have dire consequences (24).

Our study was solely retrospective and only establishes an association between early transfer IMC and increased IPLOS. We recognize the substantial variation in ED workflows between the group of patients evaluated in this study and attempted to minimize confounding variables by limiting the analysis to a single service (HIM) and using a multivariable regression model. Additionally, this study was performed at a tertiary care center specializing in complex care, which may limit generalizability. We did not investigate the chief concerns associated with direct or indirect transfer. Finally, given that various possibilities could explain why our patient cohort may have been undertriaged or decompensated, comparing additional measures of the patients' medical stability, such as organ dysfunction scores, could help better delineate the severity of patient status at admission and transfer. Unfortunately, the necessary data required for calculation of such scores were absent from our database, which limits further interpretation of our findings.

CONCLUSIONS

In this exploratory study, we report a significant association between admission to a M/S with early (6 and 24 hr) transfer to a higher level of care and an increase in IPLOS. This increase could not be attributed to patient demographic factors or acuity upon presentation in the ED. Our data suggest that missed opportunities in triage may be associated with significant downstream resource utilization. Future studies focusing on patient mortality and hospitalization costs would further contribute to our understanding of this important topic.

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REFERENCES

1. Ridley SA: Intermediate care, possibilities, requirements and solutions. *Anaesthesia* 1998; 53:654–664
2. Capuzzo M, Volta C, Tassinati T, et al; Working Group on Health Economics of the European Society of Intensive Care Medicine. Hospital mortality of adults admitted to intensive care units in hospitals with and without intermediate care units: A multicentre European cohort study. *Crit Care* 2014; 18:551
3. Durbin CG Jr, Kopel RF: A case-control study of patients readmitted to the intensive care unit. *Crit Care Med* 1993; 21:1547–1553
4. Franklin CM, Rackow EC, Mamdani B, et al: Decreases in mortality on a large urban medical service by facilitating access to critical care. An alternative to rationing. *Arch Intern Med* 1988; 148:1403–1405
5. Byrick RJ, Mazer CD, Caskennette GM: Closure of an intermediate care unit. Impact on critical care utilization. *Chest* 1993; 104:876–881
6. Keenan SP, Massel D, Inman KJ, et al: A systematic review of the cost-effectiveness of noncardiac transitional care units. *Chest* 1998; 113:172–177
7. Nasraway SA, Cohen IL, Dennis RC, et al: Guidelines on admission and discharge for adult intermediate care units. American College of Critical Care Medicine of the Society of Critical Care Medicine. *Crit Care Med* 1998; 26:607–610
8. Zimmerman JE, Wagner DP, Knaus WA, et al: The use of risk predictions to identify candidates for intermediate care units. Implications for intensive care utilization and cost. *Chest* 1995; 108:490–499
9. Simpson CE, Sahetya SK, Bradsher RW 3rd, et al: Outcomes of emergency medical patients admitted to an intermediate care unit with detailed admission guidelines. *Am J Crit Care* 2017; 26:e1–e10
10. Molina JA, Seow E, Heng BH, et al: Outcomes of direct and indirect medical intensive care unit admissions from the emergency department of an acute care hospital: A retrospective cohort study. *BMJ Open* 2014; 4:e005553
11. Renaud B, Santin A, Coma E, et al: Association between timing of intensive care unit admission and outcomes for emergency department patients with community-acquired pneumonia. *Crit Care Med* 2009; 37:2867–2874
12. Chalfin DB, Trzeciak S, Likourezos A, et al; DELAY-ED Study Group. Impact of delayed transfer of critically ill patients from the emergency department to the intensive care unit. *Crit Care Med* 2007; 35:1477–1483
13. Churpek MM, Wendlandt B, Zadravecz FJ, et al: Association between intensive care unit transfer delay and hospital mortality: A multicenter investigation. *J Hosp Med* 2016; 11:757–762
14. Young MP, Gooder VJ, McBride K, et al: Inpatient transfers to the intensive care unit: Delays are associated with increased mortality and morbidity. *J Gen Intern Med* 2003; 18:77–83
15. McQuillan P, Pilkington S, Allan A, et al: Confidential inquiry into quality of care before admission to intensive care. *BMJ* 1998; 316:1853–1858
16. Liu V, Kipnis P, Rizk NW, et al: Adverse outcomes associated with delayed intensive care unit transfers in an integrated healthcare system. *J Hosp Med* 2012; 7:224–230
17. Rapoport J, Teres D, Lemeshow S, et al: Timing of intensive care unit admission in relation to ICU outcome. *Crit Care Med* 1990; 18:1231–1235

18. Schroeder SA, Showstack JA, Schwartz J: Survival of adult high-cost patients. Report of a follow-up study from nine acute-care hospitals. *JAMA* 1981; 245:1446–1449
19. Oye RK, Bellamy PE: Patterns of resource consumption in medical intensive care. *Chest* 1991; 99:685–689
20. The Comprehensive R Archive Network: boot: Bootstrap R (S-Plus) Functions R package version 1.3-22. Available at: https://cran.r-project.org/web/packages/boot/boot.pdf. Accessed May 1, 2018
21. Davison A, Hinkley D: Bootstrap methods and their Application. *J Am Stat Assoc* 1997; 94:94–95
22. Escobar GJ, Greene JD, Gardner MN, et al: Intra-hospital transfers to a higher level of care: Contribution to total hospital and intensive care unit (ICU) mortality and length of stay (LOS). *J Hosp Med* 2011; 6:74–80
23. Pearse RM, Harrison DA, James P, et al: Identification and characterisation of the high-risk surgical population in the United Kingdom. *Crit Care* 2006; 10:10–15
24. Jhanji S, Thomas B, Ely A, et al: Mortality and utilisation of critical care resources amongst high-risk surgical patients in a large NHS trust. *Anaesthesia* 2008; 63:695–700