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Is there a relation between emergency department and inpatient lengths of stay?

Pria M.D. Nippak, PhD, MSc, HBSc, HBA
Winston W. Isaac, PhD, MPA, CHE
Candace J. Ikeda-Douglas, MSc, HBSc
School of Health Services Management, Ryerson University, Toronto, Ont.

Anne Marie Marion, BHA, CHIM
School of Health Services Management, Ryerson University, Toronto, Ont., and Ross Memorial Hospital, Lindsay, Ont.

Mike VandenBroek, MSW, RSW
Ross Memorial Hospital, Lindsay, Ont.

Correspondence to:
Pria Nippak,
pnippak@ryerson.ca

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Introduction: Emergency departments (EDs) are key entry points to hospital care, and issues of overcrowding and poor patient flow have become a priority in Canada. Studies have sought to determine factors that influence ED wait times in an effort to improve patient flow. We sought to identify the impact of factors such as patient age, triage level, comorbid factor level and sex to determine their effects on length of stay (LOS) and the role that they play in the ED and in an inpatient setting.
Methods: We analyzed 2 years of data from 2007 to 2009. We conducted a repeated-measures analysis of variance to measure the effects of age, triage level, comorbid level and sex as they relate to ED and inpatient LOS.
Results: Our analysis resulted in a final sample of 4743 patient visits. A longer LOS in the ED was correlated with a longer inpatient LOS. Age, comorbidity level and sex were shown to have an influence on LOS.
Conclusion: Continued efforts to further reduce ED LOS are crucial, because this has the potential to influence outcomes, efficiency of EDs and succession to inpatient status, which may affect costs to the health care system. Patient-specific factors need to be considered when formulating and refining policies and processes to improve patient flow.

Introduction : Le service d'urgence est la porte d'entrée des soins hospitaliers et les problèmes d'engorgement et de lenteur de roulement des patients deviennent une priorité au Canada. Des études ont tenté de déterminer quels facteurs influent sur les temps d'attente à l'urgence dans le but d'améliorer le roulement des patients. Nous avons donc voulu mesurer l'impact de différents facteurs, tels que l'âge des patient, la catégorie de triage, le niveau de comorbidités et le sexe, sur la durée des séjours et le rôle qu'ils jouent à l'urgence et dans les unités de soins.
Méthodes : Nous avons analysé 2 années de données, soit de 2007 à 2009. Nous avons procédé à une analyse de la variance par mesures répétées afin d'évaluer les effets de l'âge, de la catégorie de triage, du niveau de comorbidités et du sexe sur la durée des séjours à l'urgence et dans les unités de soins.
Résultats : Notre analyse nous a donné un échantillon final de 4743 consultations. Nous avons établi une corrélation entre un séjour plus long à l'urgence et un séjour plus long dans les unités de soins. L'âge, le niveau de comorbidités et le sexe ont exercé une influence sur la durée du séjour.
Conclusion : Il est indispensable de poursuivre les efforts pour abréger la durée des séjours à l'urgence, puisqu'elle influe sur les résultats au plan de la santé, sur l'efficience des services d'urgence et sur la transition vers l'hospitalisation, ce qui peut affecter les coûts pour le système de santé. Il faut tenir compte de facteurs spécifiques aux patients au moment de formuler et de parfaire les politiques et les procédés qui ont pour but d'améliorer le roulement des patients.

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INTRODUCTION

Overcrowding is a chronic condition that exists in emergency departments (EDs) worldwide, and Ontario is no exception.[1–4] Research has shown that the causes of ED overcrowding are often multifactorial in nature,[5–7] with lack of inpatient bed availability cited as one of the key issues.[2,3,5,8] Other studies have shown ED overcrowding can have a negative impact on resources, affect patient safety,[1,3,9–11] produce poor outcomes[6,12–14] and limit a hospital's capacity to respond to an external crisis or pandemic.[15]

The literature indicates that systemic factors such as ratios of nursing and physician staff play a role in impeding flow; however, community factors, patient demographics (e.g., age, triage level and diagnosis[10,16–18]) and hospital-specific factors (e.g., hospital size and location) also play contributory roles.[1,14,19–21]

Many hospital-specific factors have been shown to contribute to ED length of stay (LOS) and overcrowding,[14] such as inpatient LOS.[22] Several studies have shown that there is a specific relation between ED and inpatient LOS.[23–26] Richardson[23] demonstrated that admitted patients who spent longer than 8 hours in the ED had a mean inpatient LOS of 0.8 days longer than patients who did not experience delays in the ED. Li and colleagues[26] concluded that ED wait times under 8 hours were linked with the shortest overall stays. Similarly, Liew and coauthors[24] found a strong correlation between ED and inpatient LOS, independent of other variables.

Others have shown that this relation between ED and inpatient LOS creates a systemic bottleneck, which reduces the ED's ability to adequately manage the flow of patients who do not require admission.[25] Furthermore, studies have suggested that initiatives aimed at reducing ED LOS can influence outcomes beyond the ED, namely inpatient LOS.[8,19,23,27] Whereas these studies have shown a positive correlation between ED and inpatient LOS, there is a paucity of in-depth analysis to establish the factors that contribute to LOS within the ED and inpatient settings. Thus, an examination of patient flow through the ED supports the idea that several factors contribute to ED and inpatient LOS.

Addressing ED overcrowding, through an examination of ED LOS, has been a key health care priority in Ontario over the past few years. The Ontario Ministry of Health and Long-term Care has set a specific 8-hour target from time of triage to transfer to an inpatient unit for admission based on the Canadian Triage and Acuity Scale.[8] Although hospitals are currently moving toward achieving this target, some Ontario hospitals are still in excess of the 8-hour target time. Hospitals are now receiving incentives based on their ability to meet key targets for ED wait times set out by the ministry.[28] It is clear that the goal of improving wait times is linked to a better understanding of what the key contributing factors are and how they are interrelated. Given that there have been only a few Canadian studies and there is a diversity of hospital types and settings within Canada, it is essential that this be examined in a variety of contexts to establish the influence of hospital-specific factors.

The aims of this study were to identify the relation between ED and inpatient LOS at Ross Memorial Hospital, an acute care hospital located in Lindsay Ont., and to determine the influence of patient age, comorbid factor level and sex on the LOS within a rural hospital setting. The findings of this study may help to identify whether these patient factors significantly contribute to inpatient LOS, which may lead to suggestions to improve patient flow as a means of reducing inpatient LOS at a rural hospital. This could ultimately have an impact on cost and care outcomes.[23,24,27]

METHODS

Study design

This study took place at Ross Memorial Hospital; a 170-bed community hospital in Ontario. This was a quantitative retrospective descriptive analysis of adult patients admitted to acute care via the ED during the fiscal years 2007/08 and 2008/09.

The Canadian Triage Acuity Scale was used to determine acuity of illness as patients presented to the ED.[29] The scale ranges from 1 (most urgent conditions) to 5 (conditions may be acute but nonurgent).[29]

Sample

To measure LOS in the ED, we used time in hours from triage to transfer to an inpatient bed, the standardized definition of the Ontario Ministry of Health Long-term Care.[8] To define LOS in the inpatient setting, we used time in hours from transfer from the ED to discharge from hospital. To calculate ED and inpatient LOS, we extracted the time from transfer to an inpatient bed from the Discharge Abstract Database, which contains the date and time that patients left the ED.

Exclusion criteria were as follows: patients who were admitted but remained in the ED; patients who did not physically access an inpatient bed; patients who died in the ED or were transferred to

another facility; and patients who were admitted from the ED to the mental health unit, complex continuing care or rehabilitation.

Procedures

We extracted age, sex, triage level, comorbidity factor level, and ED and inpatient LOS from the MED2020 WinRecs software that populates the National Ambulatory Care Reporting System and the Discharge Abstract Database.[30] Extreme outliers were removed from inpatient LOS by filtering 2 standard deviations (SDs) from the mean. The sample was further stratified into 6 comorbid factor levels that have been defined by the Canadian Institute for Health Information (CIHI),[31] with level 5 representing diagnosis groups in which no comorbid factor level was applied.

Analysis

We analyzed data using Microsoft Office Excel 2003 and PASW Statistics SPSS version 20.

We used a Pearson correlation coefficient to analyze the relation between ED and inpatient LOS. We stratified ED LOS into 3 distinct groups: 1) < 9 hours (in line with ministry targets); 2) 9–24 hours; and 3) 24 hours from time of triage to transfer to an inpatient bed. We used one-way analysis of variance (ANOVA) with post hoc tests of least significant difference to determine inpatient LOS differences in the respective means for the 3 groups. We used repeated-measures ANOVA to test for main effects and interactions.

RESULTS

Demographics

From the initial sample of 4987 patient visits, 4.9% were excluded because of incomplete data needed to calculate either the ED or inpatient LOS. This resulted in a final sample of 4743 visits. There were a total of 84 808 visits to this rural ED during the study period. There were 8606 admissions to acute care, and of these, 7064 involved adult patients. Of the adult admissions to acute care, 70.6% originated from the ED. The mean age of patients was 69.6 (SD 17.0) years (Table 1).

Effect of ED LOS on overall LOS

The mean ED LOS was 23.03 hours and the mean inpatient LOS was 158.76 hours. There was a positive correlation between time spent in the ED and the corresponding inpatient LOS, which suggests that as the LOS in the ED increased, there was an associated increase in LOS in the inpatient setting ($r_{1, 4742} = 0.073$, $p < 0.001$). This translated into 774 bed-days per year for the group with an ED LOS of 9 to 24 hours, and 1234 bed-days per year for the group with an ED LOS of greater than 24 hours. Stratification of ED LOS into 3 different time frames and a post hoc analysis of least significant difference identified significant differences between each group of ED time frames and inpatient LOS ($F_{2, 4740} = 28.92$, $p < 0.001$) (Fig. 1). As well, results of the repeated-measures

Table 1. Characteristics of 4743 patient visits admitted to the emergency department

Characteristic	No. (%) of patients
Patient age, yr	
19–35	255 (5.4)
36–52	529 (11.2)
53–69	1172 (24.7)
70–86	2180 (46.0)
87–104	607 (12.8)
Comorbid factor level	
0	3590 (75.7)
1	701 (14.8)
2	252 (5.3)
3	158 (3.3)
4	25 (0.5)
5	17 (0.4)
CTAS level	
1	101 (2.1)
2	1410 (29.7)
3	2976 (62.7)
4	251 (5.3)
5	5 (0.1)

CTAS = Canadian Triage and Acuity Scale.

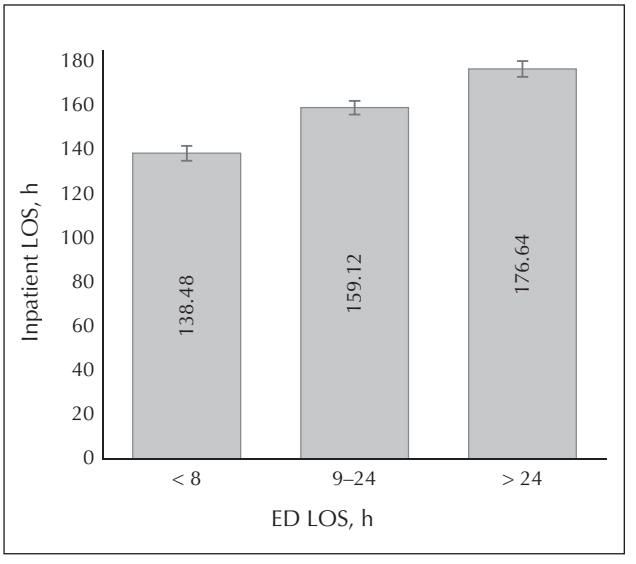


Fig. 1. Inpatient length of stay (LOS) by emergency department (ED) LOS.

ANOVA revealed that there was a main effect of LOS, indicating that the ED LOS was shorter (M = 19.62, standard error [SE] 0.86) than the inpatient LOS (M = 188.44, SE 6.09; F_1 = 185.06, p < 0.001).

Effects of age

Results of a repeated-measures ANOVA showed a main effect of age indicating that as age increased, so did the LOS (F_4 = 4.55, p = 0.001) (Fig. 2). A pairwise comparison showed the 2 older age groups (70–86 and 87–104 yr) had significantly longer stays than the 2 younger age groups (19–35 and 36–52 yr) (p < 0.001).

We found a significant interaction between age and LOS (F_4 = 3.43, p = 0.008). There was a within-group effect of age, with patients aged 19–35 years (M = 13.62, SE 2.61) having a shorter LOS than patients aged 87–104 years (M = 25.38, SE 1.92). Inpatient stays were shorter for the 19–35 age group (M = 103.07, SE 18.44) and longer for each of the older age groups (Fig. 3). Among patients

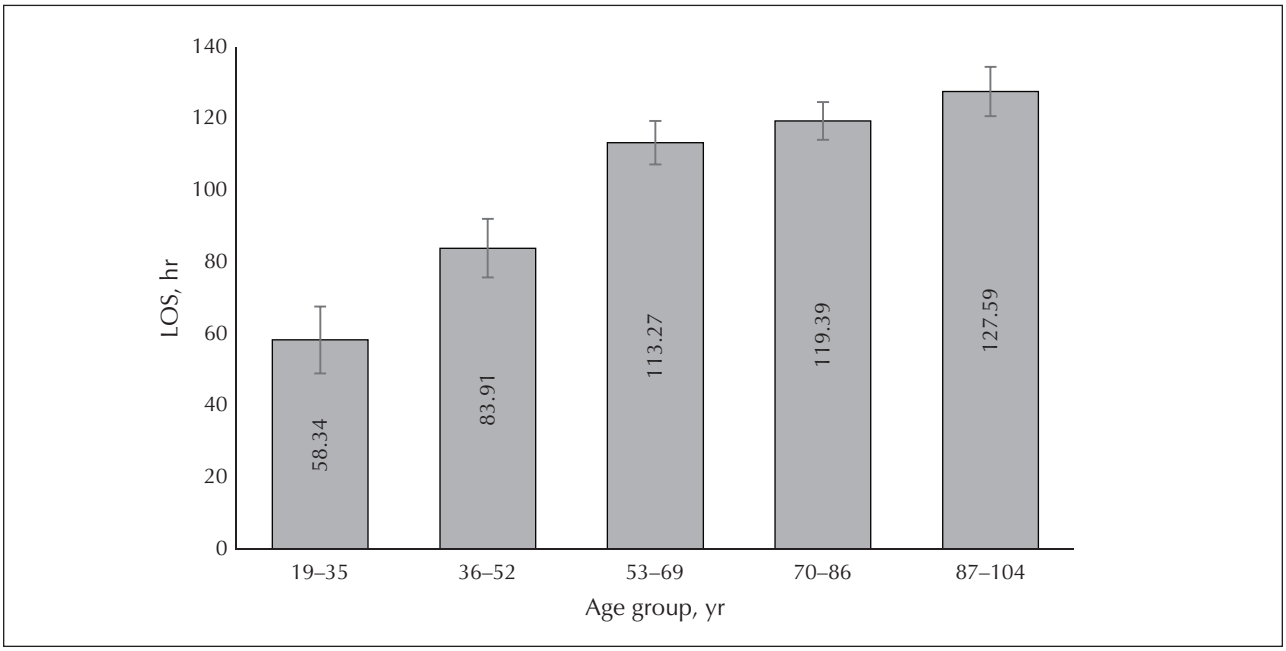


Fig. 2. Length of stay (LOS) in hospital, by age group.

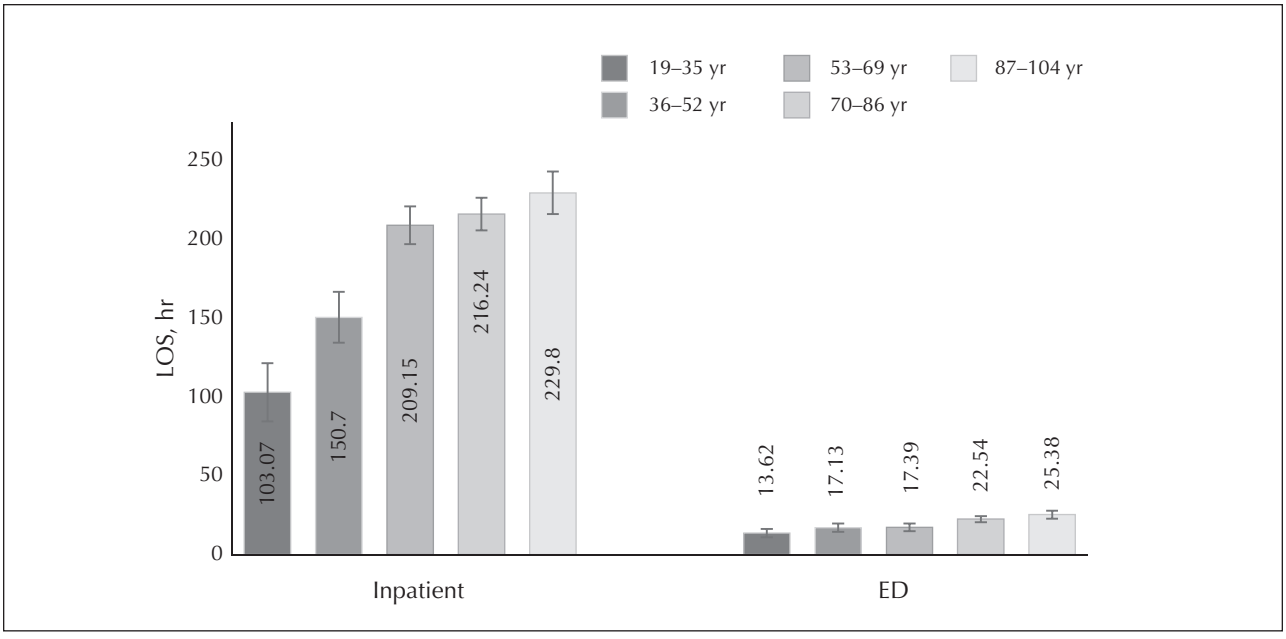


Fig. 3. Inpatient and emergency department (ED) length of stay (LOS), by age group.

older than 53, there were no significant differences between the age ranges, but they had the longest LOS.

Effects of comorbidity factor levels

There was a significant main effect of comorbid factor level on LOS, which showed a corresponding increase in LOS as the level of comorbidity increased from 0 to 4 (F_5 = 9.68, p < 0.001) (Fig. 4). A significant interaction between comorbid factor level and LOS (F_5 = 9.05, p < 0.001) indicated that the mean inpatient LOS for comorbid level 0 was the shortest and rose as the comorbid level increased (Fig. 5). Comorbidity level 4 showed a significantly increased inpatient LOS (p < 0.05).

We performed pairwise comparisons between different comorbid factor levels and found a significant difference between levels 3 and 0 (p < 0.001, p = 0.01) and between levels 4 and 1 (p < 0.001, p < 0.001). These results suggest that longer stays were associated with higher comorbidity factor levels. We found no other significant comparisons.

Effects of sex

There was a main effect of sex indicating that women had a shorter LOS at 93.54 hours than men

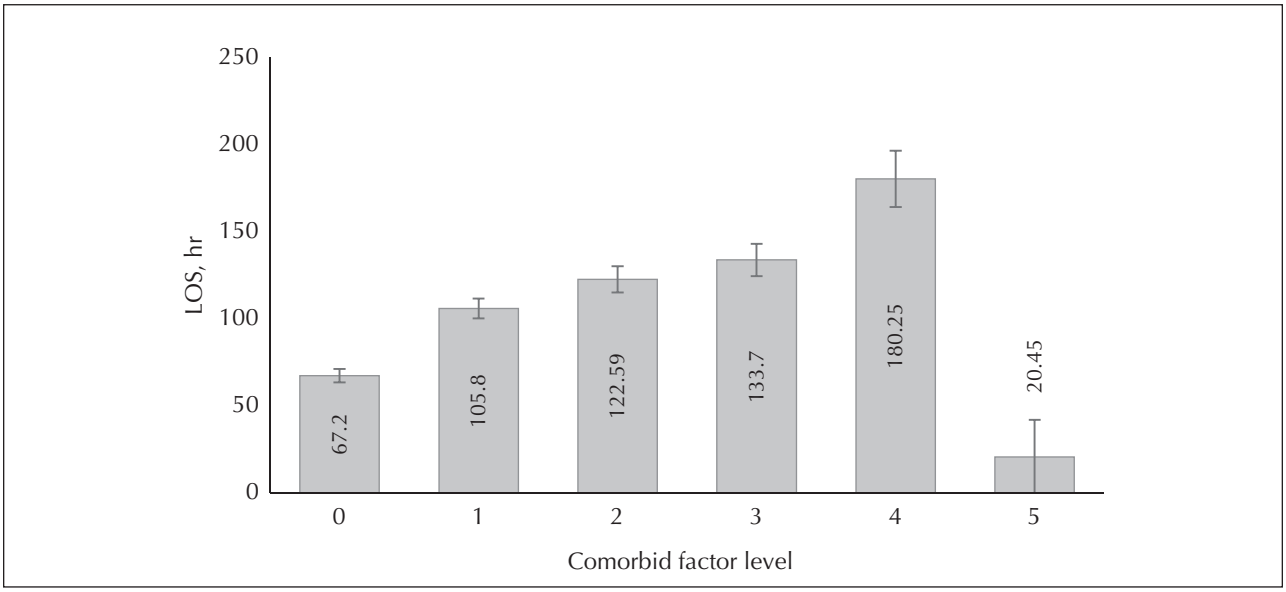


Fig. 4. Length of stay (LOS) in hospital, by comorbid factor level.

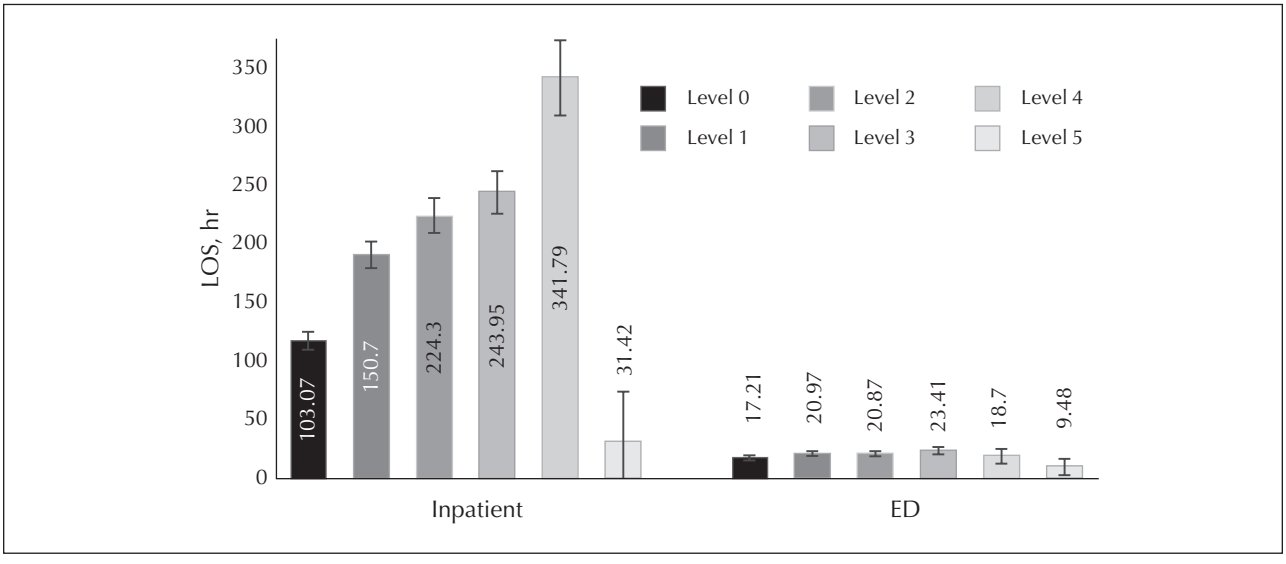


Fig. 5. Inpatient and emergency department (ED) length of stay (LOS), by comorbid factor level.

at 115.28 hours ($F_1 = 7.53$, $p = 0.006$). An interaction between sex and LOS suggested that men had longer stays ($F_1 = 6.42$, $p = 0.01$) (Fig. 6).

Effects of triage level

Triage level did not show a significant main effect on LOS, ($F_4 = 1.87$, $p = 0.1$). As expected, however, the shortest ED LOS was observed among patients with triage level 1 ($M = 9.04$, SE 2.56), with a longer ED LOS reported for each additional triage level. Triage level 3 ($M = 222.65$, SE 8.05) had the longest inpatient LOS in comparison to the other triage levels.

DISCUSSION

This study provided evidence of a potential relation between ED and inpatient LOS, with the findings indicating that a longer LOS in the ED was associated with a longer inpatient LOS. Further examination showed that comorbid factor level, age and sex also influenced LOS. Similar to previous findings, older patients experienced longer ED and inpatient stays than their younger counterparts.[25,28,32] Our findings suggested that although women and men spent a similar amount of time in the ED, women had shorter inpatient stays than their male counterparts.

The correlation analysis reinforces the need to deal with ED overcrowding and impaired patient flow with a system response.[2,9,33] This requires finding solutions to barriers at each departmental level to improve patient flow through the system.[33,34] Strategies on the inpatient side could include an integrated approach to discharge planning with more involvement of the Community Care Access Centre, improved capacity and operational planning, and increased collaboration with other outside community agencies.[8] Ruger and colleagues[35] suggested that initiatives need to target specific groups to improve patient flow, such as those with comorbidities, to reduce the strain on EDs. These could include prescribing medications and having appropriate follow-up to improve health outcomes.[7,17,24,34]

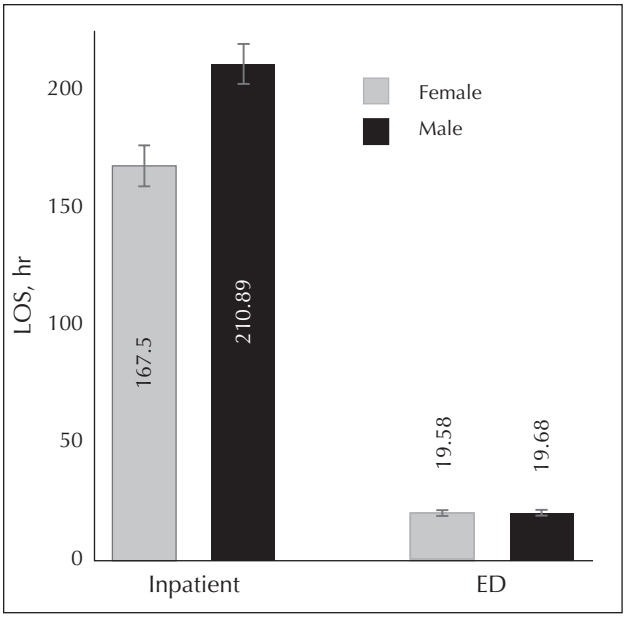


Fig. 6. Inpatient and emergency department (ED) length of stay (LOS), by patient sex.

The results of this study support continued efforts to reduce ED wait times for those patients admitted via the ED to improve outcomes, efficiency and cost.[9,36–38] Currently, provincial health care agencies have laid out a group of recommendations to address ED overcrowding and reach performance targets in terms of reducing time in the ED.[8] These recommendations have proven invaluable, because many Ontario hospitals are now reaching their performance targets; however, patient flow through the system is still a challenge. Improving the flow of admitted patients from emergency to inpatient wards could have a positive effect, freeing up valuable resources and expanding the hospital's capacity to deal with surges in activity.

Stratification of ED LOS into 3 distinct time frames allowed for analysis of the effect of incremental increases in ED LOS on inpatient LOS. The results showed that the group that spent 9–24 hours in the ED had a significantly longer inpatient LOS compared with the group that spent less than 9 hours in the ED. This excess in LOS equates to 774 bed-days per year, which has a great impact on hospital resources and costs.[8] Patients who spent more than 24 hours in the ED before accessing an inpatient bed also had significantly longer stays than the 8-hour group, equivalent to 1238 bed-days per year. This is similar to the findings of Liew and colleagues[24] and Bernstein and coauthors,[19] although different time groups were used to measure ED LOS. Whereas Huang and colleagues[27] also used different parameters for measuring ED LOS, they too found an effect of ED delay on inpatient LOS of about 1.2 days among patients experiencing delays of greater than 12 hours.

Age, comorbid factor level and sex were shown to influence LOS in this study, which indicates that ED LOS alone did not account for longer inpatient LOS. The study sample's mean age of 69.6 years is higher than in a report released by the CIHI in 2007, in which the mean age of patients admitted

via the ED was 56 years.[39] This demographic difference was perhaps due to the rural setting, because the largest (46%) age group serviced in this study was 70–86 years. Chen and Tescher[40] examined the demographic profile of a rural Australian hospital and noted similar rates of use by older individuals. In the current study, inpatient LOS increased with age, with a significant difference found within the first 3 age groups. However among patients older than 53 years, there were no significant differences between the age ranges, although they had the longest LOSs. These results are supported by Richardson,[23] and Liew and colleagues[24] who determined that "access blocked" patients tended to be in older age groups[23,24] and were at risk of exceeding the state average LOS for inpatients.[24] These findings suggest that strategies targeted at older patients could have a positive effect in a rural hospital. Potential improvements may include enhanced geriatric nursing care, better involvement from the local Community Care Access Centre and advanced home care nursing teams, and increased community-based programs targeted at supporting seniors.[8]

We chose comorbid factor level as a variable for analysis because it represents a measure of the impact of comorbidity or secondary conditions on resource use. This comorbidity variable was introduced by the CIHI in 2007 into their grouping methodology, and it appeared to be the strongest predictor on LOS.[32,39] Increased comorbidity was associated with increased LOS; however, the limited sample size for comorbid factor level 4 must be considered. The reported effect was largely from the inpatient side, which warrants further investigation given the potential impact on resource use. Several strategies to deal with comorbidity have been explored.[24, 27, 29,41] These strategies are largely focused on the development of sensitive screening techniques to ensure that comorbid conditions are appropriately identified to facilitate the concurrent treatment of conditions from the point of entry to the ED.

Patient sex also influenced LOS, with men staying in hospital 21.7 hours longer than women when ED and inpatient LOS were combined. With consideration of ED and inpatient LOS separately, it would appear that the effect of sex was far greater on the inpatient side, with men staying 43 hours longer than women. There was no sex difference in time spent in the ED. These findings differ from other studies that found women had longer inpatient stays.[32,42] One reason for this could be linked to the theory that men wait longer to seek help on health issues and as a result are sicker, thus requiring a longer inpatient stay than women. However, several studies have opposing results.[43,44] Given the lack of research on the influence of demographic factors in rural hospital settings, it is difficult to discern the role of geographic location on the effect of patient sex.

Limitations

We derived the data used for this study from a single rural community hospital, and the findings may not be representative of or generalizable to other settings or communities. This study showed an association and did not demonstrate any cause and effect relation.

Our operational definition of inpatient LOS was different than that of the CIHI.[45] The CIHI defines inpatient LOS as equal to the total number of hours a patient spent in acute care over the course of the day. We used an alternative definition to ensure that ED LOS was entirely excluded from the inpatient LOS. Another limitation was the calculation of ED and inpatient LOS. The time that the patient left the ED derived from the Discharge Abstract Database was a manual data entry at the organization and, as such, human error may have led to potential issues with data quality issues.

To determine the effect of comorbidities on LOS, it may have been more appropriate to use the Charlson comorbidity index score; however, we chose the comorbid factor level because of available resources.

A significant limitation was that this study did not consider "alternate level of care" (i.e., patients no longer in need of acute care who are waiting to be discharged to a more appropriate care setting)[46] days in relation to inpatient LOS. It has been noted that a high volume of patients requiring an alternate level of care significantly impedes the flow of patients from emergency to inpatient care and, as such, this may warrant further analysis.[38]

CONCLUSION

This study reinforces the idea that continued efforts to reduce LOS in the ED may improve the flow of patients from emergency to inpatient wards. Our results showed a relation between ED and inpatient LOS, in that increased ED LOS was associated with increased inpatient LOS. Reducing LOS in the ED to the recommended 8-hour target set by the Ontario Ministry of Health and Long-term Care has the potential to free up resources, thus reducing access block in the ED as well as in inpatient wards. This would be contingent on patient flow being addressed as a parallel interdepartmental process.[33]

Patient age, comorbid factor level and sex influenced LOS. These factors may be important to consider when formulating solutions to improve patient flow, which in turn can affect patient outcomes, efficiency and cost.[8,27] Solutions to improving flow can be especially challenging in a rural community where patient volumes for noncritical cases may not warrant the cost to deliver a service (e.g., 24/7 laboratory or diagnostic imaging services) and resource shortages may limit the ability to deliver such services.[47]

Competing interests: None declared.

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