

Comparing the Effect of Throughput and Output Factors on Emergency Department Crowding: A Retrospective Observational Cohort Study

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Study objective: This study compares how throughput and output factors affect emergency department (ED) median waiting room time.

Methods: Administrative health care use records were used to identify all daytime (8 AM to 8 PM) visits made to adult EDs in Winnipeg, Canada, between April 1, 2012, and March 31, 2013. First, we measured the waiting room time (from patient registration until transfer into the ED) of each index visit (incoming patient). We then linked each index visit to a group of existing patients surrounding it and counted the number of existing patients engaged in throughput processes (radiographs, computed tomography [CT] scans, advanced diagnostic tests) and one output process (waiting to be hospitalized). Regression analysis was used to measure how strongly each factor uniquely affected incoming patient median waiting room time, stratified by the acuity level.

Results: Analyses were performed on 143,172 index visits. On average, 153.4 radiographs and 48.5 CT scans were conducted daily, whereas 45.3 patients were admitted daily to hospital. Median waiting room time was shortest (8.0 minutes) for the highest-acuity index visits and was not influenced by these throughput or output factors. For all other index visits, median waiting room time was associated strongly with the number of existing patients receiving radiographs, and, to a lesser extent, with the number of existing patients receiving CT scans and waiting for hospital admission.

Conclusion: Both throughput and output factors affect how long newly arriving ED patients remain in the waiting room. This suggests that a range of strategies may help to reduce ED wait time, each requiring stronger ED and hospital partnerships. [Ann Emerg Med. 2018;■:1-10.]

Please see page XX for the Editor's Capsule Summary of this article.

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INTRODUCTION

Background

Emergency department (ED) crowding occurs when the demand for care exceeds the available resources required to provide it in a timely manner. This challenge exists worldwide¹ and is associated with increased patient mortality, more medication errors, and longer waits to receive time-sensitive care.²⁻⁵ Although there is no standard definition of ED crowding,⁶ this phenomenon is generally measured by total visit durations⁷⁻¹¹ or wait times to consult a physician.^{12,13} Solutions to ED crowding are needed because ED visit rates continue to increase in North America.^{14,15}

The conceptual framework by Asplin et al¹⁶ describes how various input, throughput, and output factors affect ED

crowding. Although experts agree that the causes of ED crowding are multifactorial,¹⁷ evidence shows that larger volumes of lower-acuity patients (ie, input factors) affect crowding minimally,^{18,19} whereas output factors (eg, delays in transferring patients to a hospital bed) play a significant role.^{20,21} Some of the proposed solutions to address ED crowding therefore include improving ED-to-hospital transition strategies and increasing hospital bed availability (eg, by ensuring that a sufficient number of skilled nursing home facilities exist to accept discharged hospital patients).²²⁻²⁴

Importance

Throughput factors, including laboratory tests, diagnostic imaging, and specialist consultations, are

Editor's Capsule Summary*What is already known on this topic*

It is well established that the boarding of inpatients in the emergency department (ED) leads to crowding and delays for newly arriving patients.

What question this study addressed

To what extent do queues for diagnostic activities such as imaging study contribute to waiting room time for newly arriving ED patients?

What this study adds to our knowledge

In this study of 143,000 adult patients attending Winnipeg, Canada, EDs, throughput factors, particularly those for imaging, affected waiting room time as much as boarding time.

How this is relevant to clinical practice

Although it is important to continue to optimize the admission and disposition of patients, flow can also be improved by optimizing the rapidity with which diagnostic tests are carried out.

essential to ED care. However, using lean principles (ie, change management techniques intended to optimize efficiency and reduce waste),²⁵ investigators have shown that less than half of the time in an ED visit is “value added” and that patients experience considerable delays related to examinations and the ordering and completion of test results.^{26,27} Furthermore, although throughput testing and consultations are shown to prolong ED visit durations,^{9-11,28,29} the effect that this has on the wait time of incoming patients is unknown. Only a few authors have studied how output factors affect ED wait time, and this literature does not account for throughput processes.^{12,13}

Goals of This Investigation

The goal of this research is to compare how the number of existing ED patients engaged in throughput and output processes affected the waiting room time of incoming patients.

MATERIALS AND METHODS**Setting**

Manitoba is one of 10 Canadian provinces, with a population of 1.3 million people residing in 5 geographically diverse health care regions.³⁰ Four of these regions are rural and the fifth (the Winnipeg Regional

Health Authority) is a large metropolitan area (population 730,000). The majority of Manitoba's tertiary care specialized services (eg, cardiac sciences, neurosurgery, intensive care) are provided in the Winnipeg Regional Health Authority, and two thirds of Manitoba's hospital beds are located in this region. The supply of hospital beds (3.4 beds/1,000 people) and annual ED visit rates (3.2/1,000 people) in the Winnipeg Regional Health Authority are similar to those reported elsewhere in North America.^{31,32}

Study Design

This study was conducted using a retrospective observational cohort design and is based on visits made to the 6 adult EDs located in the Winnipeg Regional Health Authority. Visits to these sites are recorded using the Emergency Department Information System. This system has been in use since 2009 when most ED sites were renovated. We elected to use the 2012 to 2013 Emergency Department Information System data in this research to allow time for providers to adapt to their new physical environment and information system, and because these were the most recent data available at the time of our analysis.

Each visit in Emergency Department Information System is recorded with a unique patient identifier. Patients were triaged after registration. At triage, the acuity of each patient was defined with the (computer-generated) Canadian Triage and Acuity Scale (CTAS).³³ The scale categorizes patients into 5 acuity levels: 1=patients requiring resuscitation; 2=patients with emergency conditions that are a potential threat to life, limb, or function; 3=patients with urgent or potentially serious conditions such as abdominal pain in the elderly; and 4 and 5=patients with minor acute conditions or stable chronic diseases. The Emergency Department Information System also records visit-level data on patient wait, treatment, and postactive treatment times; the number and type of diagnostic tests performed; and additional information such as chief complaint and disposition status. Approval to use the Emergency Department Information System for this research was provided by the University of Manitoba Health Research Ethics Board (file H2013:424) and by the Provincial Health Information Privacy Committee (file 2013/2014-45).

Methods of Measurement

Throughput factors measured in this study include the number of radiographs, computed tomography (CT) scans, and advanced diagnostic tests performed (magnetic

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