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(RESEARCH ARTICLE)

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Internal medicine consults within the emergency department: A workflow intervention to match workforce with workload

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Abstract

Background. Emergency departments (ED) are increasingly overcrowded, exacerbated by patients awaiting consultations and inpatient beds. Internal Medicine (IM) is the most consulted specialty service from the ED. Patients experience long delays after being consulted to Internal Medicine (IM).

Objective. Decrease these delays by improving the IM consult process.

Methods. A three stage process was designed. First: Analysis of the IM consult workflow over a 27-day period to identify the longest delays. Then implement a data-driven intervention. Second: Quantitatively assess the intervention by comparing three-month periods Pre-Intervention (Time A) with Post-Intervention (Time B). Third: Qualitatively assess the intervention by surveying residents.

Results. The first stage included 398 consults. The longest delays were awaiting bed availability post admission order completion (mean 19.5 hours) and awaiting the initial junior resident assessment (mean 3.6 hours). This assessment delay significantly increased during busy shifts. The intervention involved the addition of an extra IM resident during the busiest four hours of the day. The second stage compared 1162 patients from Time A with 1263 patients from Time B. There was no significant change in assessment times post-intervention. However, there was an 8% increase in consult volume in Time B as compared to Time A. The third stage captured 100% of the 23 senior residents. Overall, residents reported the change as beneficial to themselves and the patients.

Conclusions. For patients consulted to IM in the ED, inpatient bed availability contributed to the largest delay to leave the ED. Increasing IM resident staffing during peak hours did not decrease time to complete consults. However, increased IM resident staffing was perceived as beneficial to both residents and patients.

Keywords: Emergency Medicine; Internal Medicine; Workflow; Medical Education

1. Introduction

Emergency departments across Canada are becoming increasingly overcrowded [1-4]. This phenomenon affects patient care, increases patient mortality, and contributes to a poor work environment for health care practitioners [1,5-9]. This is a complex problem with multiple contributing factors. One of the most common factors world-wide is the wait-times for various consultants to assess and potentially admit patients to hospital floor beds [3,4,10-14]. What is currently unknown is how best to decrease this consultant associated wait-time.

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Prior studies have focused on time to admission to improve patient flow through the emergency department. Choi *et all* in 2020 showed that empowering emergency physicians to admit patients, followed by specialty consultation, reduced time in the emergency department without any measured harm [15]. Educational interventions around resident triaging, with a target time to admit, had similar effects [16]. Providing daily performance metrics for medical leadership (regarding consultation and admission timing) also reduced patient time in the emergency department [10]. These interventions emphasized the timing of admission orders, often placed before the consultation was complete. However, there is a paucity of data regarding interventions designed to optimize the time to perform complete consultations.

The specialty most frequently consulted in the Emergency Department is Internal Medicine [17]. This study aims to address emergency department overcrowding by improving the internal medicine consultation process. The process from consultation to admission decision, to moving the patient to a floor bed, has numerous smaller steps. Further complications of this process arise in academic centers, which incorporate successive assessments performed by learners at various stages in training. This complex multi-step process is poorly understood from a workflow perspective. With a detailed understanding of this process, a targeted intervention can be operationalized and monitored.

2. Material and Methods

This study was performed at a single Canadian academic teaching hospital from September 2015 to November 2016. This hospital has 5 medical teaching units (MTUs) which share the role of providing Internal Medicine (IM) consults in the Emergency Department (ED). The IM team in the ED consists of a senior IM resident (PGY-2 or PGY-3), two junior residents (PGY-1) and two senior medical students (Year 3 or 4). The individuals on this team change throughout the day, and from 22:00 to 08:00 a 'night float' resident (PGY-3) relieves the senior IM resident in the ED.

2.1. Stage 1: In-depth workflow analysis

From 08:00 October 20, to 08:00 November 16, all new consults in the ED to IM were tracked. This corresponds to a 27-day period. This duration was chosen because a standard medical elective is 4 weeks (28 days), and the principal data collector used the 28th day to travel to the next elective in another city. During this period, the consult tracking sheet was recorded during handover between IM senior residents (08:00, 12:00, 22:00). All consults during this time period were entered into a spreadsheet. The principal data collector manually copied all timestamps from the patient's paper charts, the ED electronic medical record system, and the separate inpatient electronic medical record system. Each data value for all patients was manually verified, creating a robust database. All patients were followed everyday from admission until discharge to track other variables such as length of stay and mortality. During data collection only the principal data collector had access to information which could identify individual participants. After data collection all identifying information was removed from the database before distribution to other authors, and before any analysis. This database was analysed to understand the complex multi-step IM consult workflow in the ED and to identify the longest delays.

2.1.1. The Intervention

Based on the analysis of Stage 1, the longest assessment period was the initial IM assessment. Delays also appeared to be extended during peak consult time. Furthermore, peak consult time was predictable. This information was discussed within the resident body, IM program leadership, and MTU leadership. The consensus was to add an additional resident to the IM consult team during peak hours in effort to reduce the IM consult time. This was implemented July 1st, 2016.

2.2. Stage 2: Quantitative Intervention Assessment

The database used for this stage was separate from the first stage and used existing timestamps in the ED electronic medical records. Timestamps from September 1st to November 31st were compared between Time A (2015) and Time B (2016). Time A included 1215 consults, of which 53 were excluded from analysis due to data errors, leaving 1162. Time B included 1318 consults, of which 54 were excluded due to data errors, leaving 1264. This time period was chosen to envelope the period of in-depth analysis to ensure the databases were consistent. This period is also one full year apart to minimize the effect of seasonal fluctuation and begins two months after the intervention to allow the new system to become routine. This database consists of the times when IM consult was requested and when the IM admission or discharge orders occurred.

2.3. Stage 3: Qualitative Intervention Assessment

The PGY-2 IM residents during Time A were PGY-3 IM residents during Time B. This cohort is the only resident group who experienced both systems from the perspective of an IM senior in the ED. To qualitatively assess the intervention,

all residents within this cohort were invited to participate in a non-incentivised voluntary survey the month after completing their PGY-3 year in July 2017. This was a 6-question survey followed by a free text box.

2.4. Data analysis

Databases were created in Microsoft Excel and imported to IBM SPSS for statistical analysis. analysed with the Statistical Package for the Social Sciences. We predefined a p value of <0.05 as statistically significant based on convention. A one-way ANOVA was used to compare 3-level tests (i.e. Effect of work volume on assessment time). Independent sample t-test was used to compare times between the two times (i.e. Pre- and post- intervention times for consult completion and leaving the ED). Variability is reported as the standard deviation (SD).

This project was approved by the health ethics research board at our institution (Queen's University Health Sciences & Affiliated Teaching Hospitals Research Ethics Board #6016663). Due to the nature of the study involving retrospective chart audits without any foreseeable patient harm, no patient consent was required. No potential author conflicts of interest are present.

3. Results

3.1. Stage 1: In-depth workflow analysis

Over the 27-day period of detailed analysis, there was a total of 398 consults (14.7 consults per day, SD 4.9). The volume of daily consults ranged from 1 to 29. The characteristics of the patients consulted to internal medicine are shown in Table 1. The 398 consults included 309 patients originating in the local ED and 89 consults originating elsewhere, who were transferred to our ED once accepted by IM. 41 of the 89 non-local consults originated from the ED located in the only other hospital within our city (which does not have inpatient services). The remaining 48 consults were from clinics or other hospitals in the surrounding region. The frequency of consults throughout the day was predictable, peaking around 16:00 (Fig 1). The frequency of consults by day of the week was different between weekends (average 11.2 consults per day) and weekdays (average 15.5 consults per day).

Table 1 Patient characteristics

This includes all 398 patients consulted to Internal Medicine during the 27-day period of data collection.

Mean age in years (SD)	**64.3 (19.1)**
Sex (% Male)	52%
Charleson Comorbidity Index: 0	22%
Charleson Comorbidity Index: 1	22%
Charleson Comorbidity Index: 2	18%
Charleson Comorbidity Index: >2	38%
Average number of Medications	8.4
Dwelling in Long Term Care	6.7%
Mortality during hospitalization	6.3%
Median LOS in days ($25^{th,}$ 75^{th} quartile)	4 (2-9)

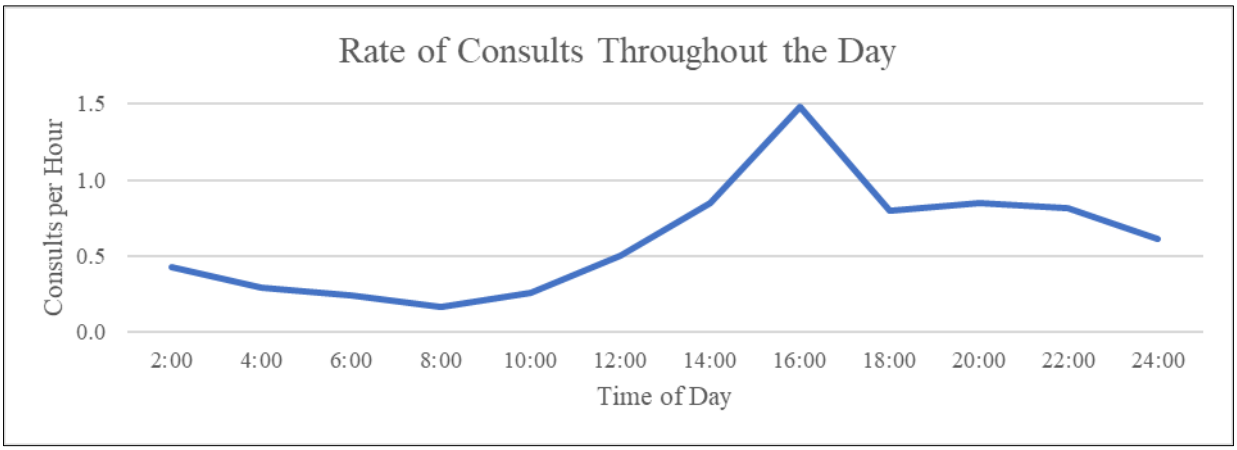

Figure 1 Rate of consults throughout the day. The mean number of consults per hour during the 27-day period of data collection

Between April and December of 2015 an average 7.4% of all ER visits to our hospital were consulted to IM. Of those, 81% were admitted to IM and 9% admitted to another service. The remaining 10% were discharged home without admission.

Captured within this analysis were 32 ED attending physicians, 14 IM attending physicians, 3 general IM Fellows (PGY-4 and PGY-5), 15 Senior IM Residents (PGY-2 and PGY-3), 8 junior IM residents (PGY-1), 7 junior off-service residents (PGY-1), and 32 medical students. All local medical students spend 6 weeks in their third or fourth year on a MTU. The off-service residents at our center are family medicine residents who spend 8 weeks on a MTU, and psychiatry or obstetrics-gynecology residents who spend 4 weeks on a MTU. The PGY-1 IM residents spend 16 weeks on MTU and would be expected to be more efficient completing IM consults. Occasionally, a senior IM resident will perform the initial assessment, after which they do not review with another senior and can go straight to submitting orders. The assessment times for each stage of the consultation and admission process is shown in Fig 2. There is a trend for more junior and off service residents to take longer to complete consults, although, this trend fell short of statistical significance (p=0.059).

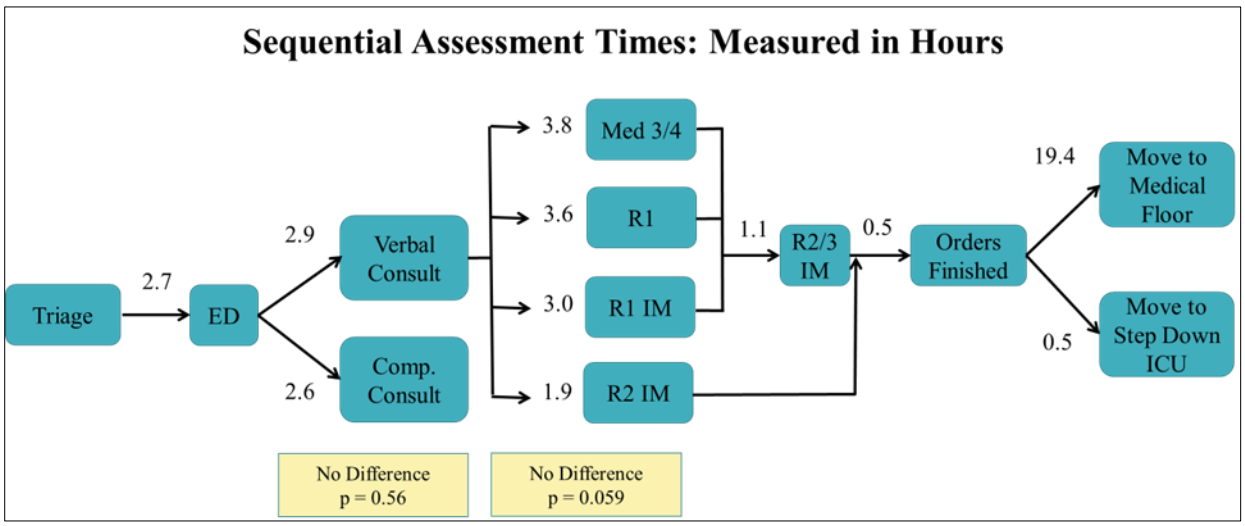

Figure 2 Sequential assessment times measures in hours

Triage time is the timestamp on the triage nurse note. ED is the timestamp on the first physician note by the ED team. Verbal consult is the verbal delivery of the consult noted by the IM senior. Computer consult is when the consult was logged by the nursing team. There was no signifiacnt difference between verbal and computer consult (p=0.56). The initial assessment was performed by third and fourth year medical students, off-service PGY-1 residents (R1), or PGY-1/2 IM residents (R1 IM, R2 IM). A R2 IM resident's initial assessment was not subsequently review, wheras all others were reviewed by a R2/3. Orders finished is the timestamp on the admission orders when submitted to the charge nurse

for processing. The time the patient physically left the ED was tracked for both regular medical floor admissions and the step-down ICU admissions.

To determine the effect of work volume on assessment time, the work volume was calculated for each shift based on the number of consults per hour. Shifts were then sorted into three equal groups (quiet, average, and busy). The time required to complete the initial assessment was significantly longer during the busiest shifts (Table 2).

Table 2 Effect of work volume on assessment time

	Low Volume (<0.7 consults/hr)	**Moderate Volume (0.7-1.2 consults/hr)**	**High Volume (1.2-1.6 consults/hr)**
Mean time in hours for junior assessment (SD)	2.7 (0.27)	3.1 (0.22)	4.6 (0.24) $p < 0.001$
Mean time in hours for senior assessment (SD)	1.0 (0.26)	1.3 (0.22)	1.1 (0.22)
Total mean time in hours from consult until leaving ED (SD)	21.8 (1.9)	22.3 (1.7)	22.5 (1.7)

Comparison of the mean time for assessments in the ED compared between shifts of differing work volumes. High, average, and low work volume is defined by the 33rd and 67th percentile of the observed shift volumes. There was no significant difference in junior assessment times between low and moderate volume shifts ($p = 0.25$). Junior assessment time during busy shifts is significantly longer compared to both the average and low volume shifts ($p < 0.001$). Differences in shift volume did not affect senior assessment or total time the patient spent in the ED.

3.1.1. Intervention

After discussion with residents, program leadership, and hospital leadership, there was a consensus to increase the IM workforce by one senior resident in the Emergency Room from 16:00-20:00 during weekdays, starting July 1st, 2016. This was decided due to a long initial assessment time, prolonged assessments during high consult volumes, and predictable work volumes peaking around 16:00 during weekdays. This senior could review consults or do consults directly as required.

3.2. Stage 2: Quantitative intervention assessment

The post-intervention time period had an 8.8% increase in consult volume compared to the pre-intervention time period. Time A (pre-intervention) captured 1162 consulted patients, and Time B (post-intervention) captured 1264. Of those consulted to IM, 89.1% were admitted to hospital in Time A and 90.8% in Time B.

The time for consult completion in Time B was not significantly shorter (5.77 hours versus 5.78 hours). However, the times of waiting for an inpatient bed was significantly longer (Table 3).

Table 3 Pre- and post- intervention times for consult completion and leaving the ED

	2015	**2016**	**p-value**
Mean time in hours from consult until completed orders logged (SD)	5.77 (4.5)	5.78 (4.5)	0.97
Mean time in hours from consult until patient left the ED (SD)	18.56 (18.0)	25.12 (20.7)	<0.001

A three-month period is compared between 2015 and 2016. There is no significant change in the time to complete a consult. Patients spent significantly increased time in the ED in 2016 compared to 2015.

The time for consult completion in this stage of analysis (5.8 hours) is consistent with the timing of the in-depth analysis. This can be seen by adding up the average of the 0.3 hour lead on computer versus in person consult delivery, to the 3.5 hour initial consult time, to the 1.1 hour senior review time, to the 0.5 hour time to complete the orders, totaling 5.4 hours. The remaining difference between 5.4 and 5.8 hours (24 minutes) would represent the time between the orders being finished, to the time they are delivered to the charge nurse, and subsequently logged into the computer system.

3.3. Stage 3: Qualitative intervention assessment

Of the 23 invited residents, 100% completed the survey. The majority of residents felt that the intervention improved work environment, patient care, consult speed, teaching, and was overall worthwhile. The only identified concern was increased work hours, with 11 of 23 residents feeling that the intervention made the medicine rotation unreasonably busy (Table 4).

Table 4 Qualitative post intervention survey results

	Disagree	Neutral	Agree
Having another senior in the ER in the evenings improved the work environment for the primary senior	3	3	17
Having another senior helping in the evenings improves patient care	1	7	15
Having another senior improved the speed in which patients were assessed	3	5	15
Having another senior helping in the evenings improves teaching and learning around cases	7	2	14
The increase in evening shifts makes the CTU rotation unreasonably busy	6	8	11
Overall having another senior in the evenings is a worthwhile change	5	4	14

Survey results included all IM residents who worked as a senior resident in both systems.

4. Discussion

4.1. Stage 1: In-depth analysis

The largest bottleneck in our study contributing to ED overcrowding was patients awaiting inpatient medicine hospital bed availability. This is similar to prior patient flow work in Pediatric Emergency Departments [18]. Unfortunately, limitations in hospital inpatient capacity is not easily addressed within the context of this study.

The second largest delay at our academic hospital was the initial IM assessments performed by senior medical students and junior residents. The average initial assessment time was larger than anticipated. This time was determined from when the consult was received by the senior IM resident until it was completed by the junior and ready to review. During high work volumes, therefore, many consults may be in queue awaiting available juniors. Time pending distribution of consults was included in the initial assessment time and helps to explain the large values. Junior residents also cover inpatient issues overnight and are frequently called away from the ED, further adding to this delay.

In contrast, the senior resident's assessment time did not significantly increase during high work volumes. Several explanations were considered for this unexpected finding: We posited that one senior IM resident was able to keep up with four junior IM residents without a significant queue of juniors forming. An alternate explanation is that at high volumes, the juniors slow down their assessments to prevent a queue from forming, as they are unable to review until the senior is free.

4.1.1. Intervention

One of the proposed factors leading to delays was a mismatch of workforce to work volume. Increasing the workforce by an additional senior IM resident during peak times would increase capacity to review completed consults or allow the senior to complete pending consults directly. This intervention targets the system's capacity to perform complete consultations, which is different from prior published strategies, which often target earlier disposition decisions and admission orders [15,16,19]. Other possible interventions could include creation of medical assessment units, or hiring nurses with expanded roles (such as nurse practitioners) as was highlighted in a 2015 systematic review [20]. However, those types of structural interventions are beyond the authority of this study group. Adjusting internal medicine resident staffing was a feasible intervention within our purview.

4.2. Stage 2: Quantitative intervention assessment

Our intervention was expected to decrease the initial assessment time, leading to a decrease in the time between receiving the consult and placing admission orders, which did not occur. ED overcrowding is a complex issue, and the IM consult system has multiple components which are interrelated. This intervention focused on only a single step within this system, without addressing the largest delay related to lack of inpatient medicine beds.

While our intervention did not meet its predefined objective, the increase in consult volume of 8.8% is important to discuss. The results from the first stage of analysis showed an increase in initial assessment times during shifts with high work volume. With an increase in consult volume during Time B, the work volume would increased, and the assessment times would be expected to also increase. Therefore, not seeing the expected increase in the post-intervention assessment times may be indirect evidence of our intervention's effectiveness.

There are other factors which may have limited this intervention's measured effectiveness. First, this was a major change to the operation of IM consults in the ED. Initially there was some role confusion between seniors. Assessing the impact 2 months after intervention may have been too early to measure the full potential benefit. Secondly, the IM consult team was aware of the lack of inpatient beds and long ED wait times. This knowledge may have decreased the urgency to completing consults. It is important to note that over this time period, there were no other major changes to MTU structure, bed capacity, or the ED/IM teams.

4.3. Stage 3: Qualitative intervention assessment

The resident perception of improved patient care appears discordant with the quantitative assessment. However, our quantitative measure looked only at speed, and did not include metrics for assessing quality of consult. It is also important to note that the residents felt that their wellbeing was improved by the intervention, despite the increased work volumes. Increase in mentorship and the frequency of utilized teachable moments are difficult to capture in work-flow analysis but are of great importance within academic hospitals. As competency based medical education is implemented, it will be important to maximize strategies that allow for increased teaching and assessment. The majority of residents felt that this intervention improved care-based teaching and learning.

5. Conclusion

This study demonstrates how a detailed work-flow analysis can be used to identify major delays contributing to ED overcrowding. While the targeted intervention did not improve consult speed, there were confounding variables which may have minimized the effect, primarily the increased consult volume post-intervention. The qualitative post-intervention assessment shows positive resident perceptions regarding improved wellbeing, patient care, and care-based education. These methods can be applied to future studies in effort to optimize consult services and help with overcrowded emergency departments.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

The present research work does not contain any studies performed on animals/humans subjects by any of the authors.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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