The Impact of Full Capacity Protocol on the Operational Performance in an
Emergency Department: An Empirical Investigation

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1. Introduction

Emergency Department (ED) overcrowding is a significant issue in the U.S. healthcare system, and is often associated with potentially adverse outcomes. This problem has been well studied by researchers from disciplines as varied as emergency medicine, operations management, strategy, and accounting. The proposed remedies of ED crowding in the literature can be broadly classified into two categories: *permanent solutions* and *temporary interventions*. *The permanent solutions* typically remain in place irrespective of the crowding level at the ED. *The temporary interventions*, in contrast, take effect as the crowding in the ED increases and remains in effect until the ED census gets back to its normal levels.

Previous studies on *temporary interventions* can further be categorized into two: *formal interventions* and *informal adjustments*. *Formal interventions* like ambulance diversion, non-urgent referral, and hospital-wide and/or ED-wide interventions have been shown to alleviate crowding during peak hours. The existing papers on *informal adjustments* assume that the servers in a human-paced queuing system can adjust the service rates in response to the workload. Based on the findings in the prior literature, Batt and Terwiesch (2016) group the effects of workload on service times into four categories: rushing, task reduction, multitasking, and early task initiation. Using data from a restaurant chain, Tan and Netessine (2014) find an inverted U-shape relationship between workload and service time. While Batt & Terwiesch (2016) find a similar inverted U-shape relationship between waiting room census and treatment time in an ED, Berry Jaeker and Tucker (2016) show an N-shaped effect of occupancy on Length of Stay (LOS) in a hospital. In this study, we aim to investigate how the workload impacts patients’ LOS during a hospital-wide formal intervention called the Full Capacity Protocol (FCP) that facilitates the patient flow in the ED.
2. Data Description and Model

We use a data set from a large urban teaching hospital, which contains detailed patient-level time stamp data (e.g., patients’ arrival time, roomed time, and departure time) and laboratory data (e.g., lab test initial time, specimen taken time, and result available time). The data set ranges from 2012 to 2014, covering both pre- and post-implementation time periods of FCP. The FCP is a hospital-wide temporary formal intervention which moves the admitted patients from the ED to inpatient areas to spread out the burden of boarded patients and thus helps ease the crowding at the ED. The FCP only takes effect when certain pre-defined trigger conditions are met, and is eventually deactivated when the crowding levels go back to normal. The study ED introduced the FCP on February 4, 2014. After it was introduced, the FCP was activated for 30 different days until September 30, 2014, affecting 943 patient visits. Additionally, we find 11,140 instances of patient visits when FCP was not activated even though the defined trigger conditions were met. We conduct an event study to test the effectiveness of the FCP. We build an accelerated failure time model using pre-implementation period data and perform score based model fitness check for variable selection and model error term distribution diagnostics. We further estimate the “normal” LOS in the post-implementation period, and capture the “abnormal” LOS by taking the difference between the actual LOS and the estimated LOS. Accordingly, a negative “abnormal” LOS indicates an improvement which has been achieved by the introduction of FCP. In addition, we test if the activation of the FCP brings extra benefits. Given the distribution of “abnormal” LOS and LOS itself, we choose to measure the effectiveness of the FCP using the median rather than the mean since the long tail shifts the mean toward the direction of higher values.

3. Results and Contribution

We find that the median “abnormal” LOS for pre-, post-implementation, and FCP-activated groups are 0.31, -26.8 and -42.65 respectively. Hence, our analyses suggest that after FCP was introduced, patients’ median LOS was improved by 26.49 minutes, and that an additional 15.85 minutes of improvement was
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obtained during the periods when the FCP was on. We further divide the LOS into three sub-intervals: the wait time, the in-service time, and the after-service time. We find that while all three sub-intervals contribute to the improvement of LOS, improvement in the in-service time contributes the most. We perform robustness analyses to verify the consistency of our findings, using propensity score matching and exact matching. These robustness checks confirm our main results.

We then investigate how the FCP possibly affects the impact of workload (occupancy level) on the patient’s LOS as well as on the three sub-intervals. We find that the impacts of different census variables on the LOS and on the three sub-intervals do not change between the pre- and post-implementation time periods. When the FCP is in effect, as the census of the admitted patients rises, we observe that the increase in after-service time dominates the reduction in the wait time and the in-service time, resulting in an increase in the LOS. One potential explanation of this increase in the LOS is the situation known as “access block,” which happens when the admitted patients are delayed at the ED due to lack of inpatient bed capacity. Therefore, we conclude that the effectiveness of the FCP depends on a successful coordination and cooperation between the ED and the other parts of the hospital. Finally, we examine the effectiveness of the current FCP, and suggest an alternative set of trigger conditions.

4. References

