

Literature on EV charging, battery swapping

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Abstract

Introduction

Emergency department (ED) operations are naturally modeled as queueing systems, which requires a good understanding of the demand and service process. Evidences from the existing literature has supported the use of non-stationary Poisson process to model the patient arrival to EDs. However, it remains unclear how to model the service process of patients in the ED.

A distinguishing feather of emergency care is that patients return to the same physician multiple times for service.

Definitions of Service Times

In the literature, different definitions and measures of physician service times have been used.

- Time to disposition (from roomed to disposition decision)
 - This is also the total bed time, right?
- ED length of stay (LOS)
- Pick-to-pick time (P2P time)
- Initial assessment times
- PPH

1. To Batch or Not to Batch? Impact of Admission Batching on Emergency Department Boarding Time and Physician Productivity, by Arshya Feizi, Anita Tucker [\[pdf\]](#)

Two productivity measures used in the healthcare operations literature: (1) time to making a disposition decision (akin to discharge rate used in Song et al. 2015); (2) number of patients served (KC et al. 2020)

A good discussion from this paper (they used both the patient volumn from KC et al. 2020 and the throughput time from Song et al. 2015): We use both measures of productivity since they complement each other. Considering only the number of patients served could be misleading because it does not capture *how long* it took to serve the patients. In other words, serving more patients does not automatically translate to higher patient flow if they are not discharged or admitted in a timely manner. Likewise, considering average shift throughput time, alone, may not necessarily indicate higher productivity since it does not capture the number of patietns on whom the average is generated.

2. The Diseconomies of Queue Pooling: An Empirical Investigation of Emergency Department Length of Stay, by Hummy Song, Anita Tucker [\[pdf\]](#)

What is the measure of physician service time (or productivity)? A patient throughput time, i.e., Disposition time - Roomed time, where disposition time is equivalent to the time of discharge decision for patients who are discharged, and time of bed request for patients who are admitted.

3. Task Selection and Workload: A Focus on Completing Easy Tasks Hurts Performance, by Diwas S. KC, Bradley R. Staats, Maryam Kouchaki, Francesca Gino [\[pdf\]](#)

Productivity: Total volume of patients discharged by a physician during her shift

Reassessments vs. Bed Time

We could also use how many reassessments were requested and processed by physicians for a patient as the service time.

Our descriptive data analysis shows that the average time that admit patients stay in ED beds is about 3 times of that for discharge patients for all acuity levels (see Table 1 in the revised paper). However, if the service times are measured by the number of interactions between physicians and patients, then our data tells a different story: within the same triage level, discharge patients have on average more interactions with physicians than admit patients. One explanation may be that physicians need more interactions with discharge patients to ensure that they are safe to be discharged home, whereas admit patients' conditions are obviously serious and therefore they require less interactions with physicians to be diagnosed. Hence, it is unclear whether admit patients are more demanding or more difficult to diagnose than discharge patients.