

**Discrete work-shifts in a continuous world:  
An empirical study of emergency physician  
productivity**

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# Discrete work-shifts in a continuous world: An empirical study of emergency physician productivity

Submitted to MSOM Conference, 2015

*Key words:* Healthcare; Service Operations; Empirical;

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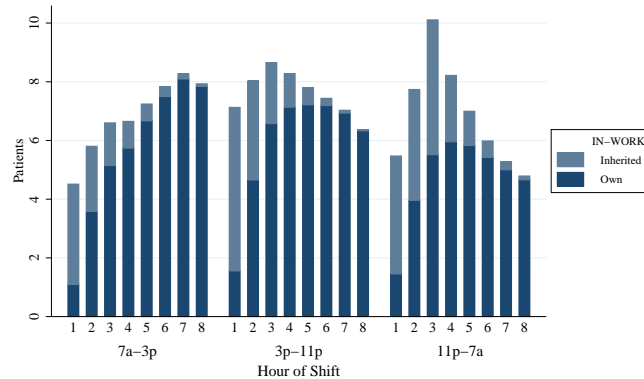
Hospital emergency departments (EDs) provide around-the-clock medical care and as such are generally modeled as nonterminating queues. Such models typically assume that the human servers (doctors, nurses, technicians) behave uniformly through time. However, from the care-provider's point of view, ED care is not a never-ending process, but rather occurs in discrete work shifts of predetermined length. This juxtaposition of discrete work shifts on a continuous care process may lead to behavior that changes over the course of a shift reducing productivity and violating the assumptions of continuous, nonterminating queues.

One artifact of the continuous-yet-discrete nature of the ED is the need to transfer or hand off responsibility for in-process patients from one doctor to another when a shift change occurs. Prior research has shown that handing off responsibility of emergency department patients from one physician to the next at shift change times increases the probability of occurrence of medical errors (Cheung et al. 2010). Further, anecdotal evidence suggests that in many EDs, handing off patients is seen as “dumping” one's work on another doctor and thus there is social pressure to avoid excessive hand-offs. Because of these pressures to avoid handoffs, doctors may take actions to reduce the number in-process patients requiring handoff at the end of their shift. This could include rushing to finish some patients, or avoiding starting new patients in the closing hours of the shift.

We use data from a large, academic medical center ED to explore how physician behavior changes over the course of the work shift. First, we use survival analysis to show that physicians make a disproportionate number of patient “disposition” decisions (i.e., discharge or admit) near the shift end. Similarly, we use count models and find a spike in the number of diagnostic tests ordered in the last hour of the physician’s shift as physicians rush to make a disposition decision, or at least to hand off the patient with a clear plan of action.

Second, we use OLS models to show that as a result of the doctors’ efforts to reduce the number of patients handed off at shift change, the number of patients a doctor is simultaneously caring for (their “multitasking level” in the language of KC (2013)) follows an inverted-U shape over the course of the work shift (Figure 1). Depending on the shift, doctors inherit, on average, between 4 and 6 patients

**Figure 1** Physician mean workload per hour



at the start of the shift, ramp up to 8 to 10 patients during the shift and then ramp back down over the rest of the eight hour shift. We show that this ramp-up-then-down behavior reduces doctor productivity and ED throughput as doctors spend very little time working at their full capacity. This suggests the need for an optimal workload policy that balances the costs of handing off patients with the productivity loss of ramping up an down physician workload.

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