

Reducing Ambulance Diversions: Policy Intervention in Los Angeles County

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Ambulance Diversion is a mechanism that allows emergency departments (EDs) to request incoming ambulances to be rerouted to other neighboring EDs in periods of significant crowding. However, the emergency medicine literature associates rerouted ambulances with adverse health outcomes as a result of longer transport times. Further, empirical evidence suggests that often multiple neighboring EDs are simultaneously on ambulance diversion episodes (during which the ED is said to be “on diversion”) thereby effectively nullifying any potential benefits of rerouting. Consequently, several Emergency Medical Service (EMS) agencies have instituted policy interventions to coordinate the use of diversion by EDs. The extent of these interventions ranges from complete ban (e.g. Massachusetts) to regulating the length and frequency of diversion episodes (e.g. San Diego, Sacramento, Albuquerque). The argument in favor of regulating diversion episodes hinges, in part, on the assumption that fewer time spent on diversion by EDs would lead to fewer ambulance reroutes.

We investigate the effectiveness of such an intervention undertaken in Los Angeles, California in 2006 wherein EDs were restricted in the length of a diversion episode to one hour each and required that two consecutive episodes must be separated by at least 15 minutes. We analyze a unique dataset for over 48000 individual ambulance dispatches between 2003 and 2009 associated with one of seven EDs in a geographically close region. Our data includes destination data (the nearest ED to patient location and the actual destination), various patient characteristics and a rationale for the reroute if the ambulance was rerouted. On the ED's end, we have detailed time stamps marking the time each ED entered and exited a diversion episode.

Descriptive statistics show that the policy intervention successfully reduced the fraction of time EDs spent on diversion by 68.0%, while the fraction of rerouted ambulances decreased by only 8.2% (Table 1).

Fractional measures	Before intervention	After intervention	Change
ED time-on-diversion	24.2%	7.7%	-68.0%
Rerouted ambulances	26.9%	24.7%	-8.2%

Table 1: Two operational measures and their respective change after the policy intervention

In order to understand this seemingly large discrepancy, we study the underlying mechanism of ambulance diversion: how the signal of ED diversion (a decision taken by the ED) leads to rerouting of ambulances (a decision taken by the paramedic on that ambulance). In particular, we estimate the paramedic's decision whether to reroute or not reroute the ambulance from the nearest ED as a function of ED diversion signals by a Probit model. After controlling for factors that affect the reroute decision such as patient conditions; time, day, week, month and year of the dispatch; fixed effects of the nearest ED; patient request for a specific ED, we find the following results:

R1. Not all ambulances that observed the nearest ED on diversion were rerouted. A non-negligible fraction of ambulances ($\geq 18\%$ both before and after) were rerouted from an off diversion nearest ED.

R2. After the intervention, ambulances were less likely to be rerouted from an on diversion nearest ED than before.

R3. If the nearest and neighboring EDs were simultaneously on diversion, ambulances were less likely to be rerouted from the nearest ED.

Regarding the diversion signals, we find two results:

S1. The intervention not only reduced the duration and frequency of ED on-diversion episodes but also overlap between on-diversion episodes of neighboring EDs.

S2. Before the intervention, the likelihood of an ambulance observing the nearest ED on diversion was much lower (19.0%) than the likeliness of the ED being on diversion (24.2% in Table 1).

Findings R1 and S2 resulted in limiting the impact of decreased ED time-on-diversion in reducing the fraction of rerouted ambulances. R2 contributed in reducing the fraction of rerouted ambulances. The combination of R3 and S1 resulted in increasing the fraction of rerouted ambulances and compensated a significant amount of effects from R1, R2, and S2.

We find that the policy intervention was limited in its effectiveness largely due to the paramedic's discretionary response to the ED diversion signals. Especially, findings R1 and R2 suggest that the paramedics may decide to reroute based on the way they perceive the "meaning" of the diversion signals in reflecting the congestion of the EDs. We identify finding R3 as the network effect in the ambulance reroute decision process which is different from the network effect between EDs in diversion signaling. Our findings highlight that the paramedics' response to ED diversion signals and their role as another decision maker in the network of EDs are important aspects that might have been overlooked in ambulance diversion policy designs.