



Changes in Health Care Financing & Organization (HCFO)

# findings brief

## Association Between Ambulance Diversion and Survival Among Patients with Acute Myocardial Infarction

### key findings

- Between 2000 and 2006, the average emergency department (ED) daily ambulance diversion length was 7.9 hours in populous counties in California.
- Exposure to at least 12 hours of diversion by a patient's nearest ED on the day of acute myocardial infarction was associated with increased 30-day, 90-day, 9-month, and one-year mortality.
- There were no statistically significant differences in mortality rates between zero hours of diversion and less than 12 hours of diversion.

### Overview

Emergency department (ED) crowding has become increasingly common in the United States. Experts point to multiple contributing factors, including decreased primary care capacity and access that leads patients with non-urgent cases to the ED.<sup>1</sup> In addition, from 1990 to 2009, the number of hospitals with EDs in non-rural areas declined from 2,446 to 1,779.<sup>2</sup> The escalating demand for services coupled with challenges that arise at the site of care can create pressure on the system and have adverse consequences for patients being transported to a hospital who are in need of urgent attention.

When EDs are overextended or lack the resources to treat particular types of patients, they may initiate ambulance diversion. Ambulance diversion temporarily closes an ED to ambulance traffic because it does not have the necessary resources (typically staff, specialty facilities, or staffed beds) or is too crowded to accept ambulance patients. The National Center for Health Statistics estimates that there are a half a million ambulance diversions a year in the United States.<sup>3</sup> They

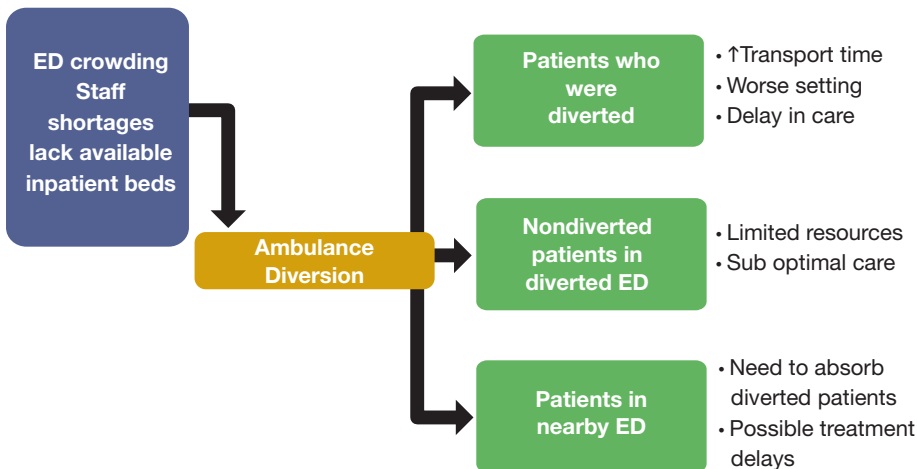
occur most often in urban areas and longer periods of diversion happen during the winter and in the most densely populated areas. Conceptually, ambulance diversion is a signal of a hospital in distress, and could have implications for both patients who are diverted to other hospitals and non-diverted patients within the diverting hospital (see Figure 1).

For patients who have to be diverted elsewhere, ambulance diversion increases transport time, likely causing delays in treatment and potentially worsening the prognosis for time-sensitive conditions, such as acute myocardial infarction (AMI). Even if the increased transport time is trivial, the patients may be in a less desirable setting. For patients in an ED that is on divert (either because these patients were admitted before the status change, arrived by private vehicles, or were brought in under exception), their outcome could still be affected because they are in an ED when providers or resources are limited in a way that prevents optimal patient care. Moreover, diversion in one hospital can potentially affect patients in nearby hospitals, as nearby hospitals would receive diverted patients. This



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**Figure 1: Consequences of Ambulance Diversion**

increased patient load could similarly cause treatment delays.

In a HCFO-funded study,<sup>4</sup> Yu-Chu Shen, Ph.D., of the Naval Postgraduate School and her colleague, Renee Hsia, M.D., M.Sc., of the University of California San Francisco, used Medicare claims and daily ambulance diversion logs for four California counties to examine the relationship between ambulance diversion and health outcomes for AMI patients.

“Almost all the published literature on ambulance diversion concentrates on interventions to decrease diversion, and there is scant evidence on how diversion affects patient outcomes,” said Dr. Shen. “To the best of our knowledge, our study is the first multi-site, multi-county analysis using daily ambulance diversion and patient level data to evaluate the effect of diversion on patient outcomes for patients suffering from AMI.”

## Methods

Dr. Shen and Dr. Hsia examined daily ambulance diversion logs of four California counties—Los Angeles, San Francisco, San Mateo, and Santa Clara—that together represent 37 percent of California’s population based on 2000 U.S. Census numbers. The researchers obtained the logs for the years 2000 to 2006 from each county’s emergency medical services agency. They excluded ambulance diversion that only applied to trauma centers, psychiatric EDs,

and diversion due to lack of neurosurgeon or CT scan downtime, because these diversions do not affect the admission of patients with AMI. Data on patients from the same four counties, including patient zip codes, was drawn from the Medicare Provider Analysis and Review (MedPAR). Hospital facility data was gathered from the California Office of Statewide Health Planning and Development and from Medicare Healthcare System Cost Report Information System data sets.

Using the MedPAR data, the researchers linked each patient’s zip code with the longitude and latitude coordinates of each zip code’s population center along with the longitude and latitude coordinates of each hospital. They used these results to identify the nearest hospital to each patient by calculating the driving distance between each patient’s zip code and all EDs. They designated the facility with the shortest driving distance as the nearest ED.

The researchers compared the percent of AMI patients who died within seven, 30, 90, 270, and 365 days when their nearest ED was in normal operation (i.e., no exposure to diversion) and when the same ED was exposed to different levels of diversion. To determine if mortality rates were higher at hospitals that diverted patients for longer periods of time, they examined four levels of diversion -- zero hours of diversion on the day of ED admission, up to six hours, six to 12 hours, and more than 12 hours.

Finally, the researchers examined whether hospital characteristics, including cardiac catheterization capacity, hospital ownership status, and size, affected their results. This study design allowed the researchers to eliminate any inherent differences across EDs, such as possible differences in baseline mortality rates, quality of care, case-mix of the patient population, teaching status, or other unobserved characteristics that might be confounded with mortality rates.

## Results

The researchers analyzed 11,625 patients admitted to the ED between 2000 and 2005. Among these patients, the diversion breakdown was 3,541 (no diversion), 3,357 (less than six hours), 2,667 (six to less than 12 hours), and 2,060 (greater than 12 hours). Patient demographics and comorbid conditions did not differ significantly by levels of diversion, with the exception that there was a higher share of black patients in the category of 12 or more hours of diversion.

When patients were exposed to diversion, there were no statistically significant differences in mortality rates between groups that experienced no diversion and groups that experienced diversion less than 12 hours. However, as compared with the no diversion group, patients that were exposed to more than 12 hours of diversion experienced higher 30-day (19 percent vs. 15 percent), 90-day (26 percent vs. 22 percent), nine-month (33 percent vs. 28 percent), and one-year (35 percent vs. 29 percent) mortality. Even after adjusting for patient demographics and comorbid conditions and underlying hospital characteristics, there remains a three percentage point difference in mortality gap between those exposed to more than 12 hours of diversion and those in the no diversion group.

“To give you a sense of the magnitude of this 3-percentage point gap,” said Dr. Shen, “if you have 100 patients that were admitted to the ED for AMI condition, 15 of them are likely to die within 30 days even if their ED was in normal operation. But if the same 100 patients were subject to long peri-

ods of ambulance diversion, 18 of them are likely to die. In other words, three deaths are potentially avoidable had patients not been subject to long diversion.”

In their examination of admitting hospital characteristics, the researchers found that when the closest ED was on diversion, a lower of share of patients was admitted to hospitals that have a cardiac catheterization laboratory. This finding suggests that hospitals with these facilities may be on diversion more than those that do not. Additionally, they found that a higher share of patients were admitted to for-profit and government hospitals when their nearest ED had instituted 12 or more hours of diversion than when the same ED was not on diversion.

### Study Limitations

The researchers acknowledge several important limitations to their study. Among these was the fact that each patient’s ED was identified using zip code and hospital location, so it is possible that two patients from the same zip code have different distances to the same ED. The researchers believe this problem is minimized in the study because all four counties are densely populated. A related limitation is that the patient’s zip code on file is based on mailing address, which may not reflect actual residence. To correct for this potential problem, the researchers excluded patients whose ZIP code is more than 100 miles from their admitted hospital. Additionally, while errors in the diversion reporting logs were possible, the researchers do not expect that these differed systematically by diversion duration, so the estimates should not be biased.

The study was limited to elderly populations, which account for between 50 and 60 percent of patients with AMI. Accordingly, the results should not be generalized to younger populations. Similarly,

these counties have few rural residents, so the results may not be generalizable to other parts of the United States. Finally, although the counties studied are diverse, the proportion of black residents is much lower and the proportion of other non-white minorities is much higher than in the United States as a whole.

### Policy Discussion

The results suggest that hospitals should try to minimize periods of ambulance diversion due to the potential effects on patients with time-sensitive conditions. Massachusetts became the first state to introduce a ban on ambulance diversion in 2009. The early evidence shows that this has not had adverse effects for patients in terms of wait times.<sup>5</sup> However, when considering diversion bans, attention must be paid to hospital-level changes to improve inpatient capacity and patient flow in order to prevent adverse consequences for patients. Uninterrupted access to the closest ED is critical for a patient suffering from a life-threatening condition. The complex factors that may impede such access underscore the fact that a solution to the problem of diversion is likely to be multi-faceted. The results of the analysis suggest that a restructuring of resources is called for to improve care delivery and efficiency for patients with time-sensitive conditions.

“It is well documented that demand for emergency care continues to go up, while supply of emergency care is decreasing,” said Dr. Shen. “This trend will only make the diversion situation worse. If the issues are not addressed on a larger scale, the conditions in EDs may continue to deteriorate, which could have serious consequences for all patients.”

### Conclusion

Frequent ambulance diversion may portend larger systemic problems in the health care system. The work of Dr. Shen and Dr.

Hsia suggests that when these problems manifest themselves in EDs, it can have adverse consequences for sick patients in need of timely care. “It is important to recognize that diversion is not an isolated event in the ED, but reflects a larger capacity constraint of the hospital and the care delivery system,” said Dr. Shen. “Ultimately, policies or initiatives aiming to minimize prolonged diversion and its associated adverse outcomes should look beyond ED. If the overall health care delivery system were more efficient, time-sensitive conditions could be prevented or treated in non-ED settings, which could help alleviate the burden on the emergency care system.”

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### Endnotes

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