

# Mode of Arrival to the Emergency Department and Outcomes in Nontraumatic Critically Ill Adults

## To the Editor:

Critical care demand in the emergency department (ED) is increasing disproportionately to total ED visits, leading to longer ED lengths of stay and increased strain on already limited emergency care resources (1, 2). As this volume increases, the mode in which critically ill patients arrive to the ED may be a potential source of outcome disparity. A segment of literature in emergency medical services (EMS) operations research is concerned with optimizing EMS delivery interval and avoiding ambulance offload delay (AOD) or ambulance diversion (3). AOD occurs when patients cannot be transferred immediately from paramedics to ED staff, often due to EDs operating near capacity. As a result of improvements in triage flow that alert dispatchers when EDs are congested, patients arriving by EMS often bypass ED triage delays in addition to receiving prehospital interventions, both of which have been shown to affect time to important therapies (4–6). Even simple interventions like IV access may affect downstream care (6), as hospitals generally do not want patients with IV catheters waiting in the lobby. Although there are promising results from earlier administration of antibiotics or IV fluids in ED patients (7, 8), there are limited data supporting efficacy of many therapies prior to hospital arrival or detailing how mode of arrival to the ED affects the time to resuscitation or outcomes in similarly ill medical patients. Recent literature comparing outcomes by transport mode in trauma patients with stab and gunshot wounds showed that arrival by private vehicle (POV) was associated with improved mortality versus awaiting EMS arrival (9). Based on these concerns, we believe there are potential disparities in care between POV and EMS arrival that influence downstream care and outcomes in critically ill, nontraumatically injured adults.

We sought to evaluate the association between mode of arrival to the ED and outcomes in a large cohort of critically ill adults by conducting a retrospective analysis of critically ill adult ED patients from two academic medical centers over 3 years. One academic center is a tertiary care center with around 84,000 annual ED visits; the other is not a referral center but has about 54,000 annual ED visits. Both centers have around 30% admission rates from their EDs. Patients greater than or equal to 18 years old with an Emergency Severity Index (ESI) of 1 or 2 who required admission to an ICU or died in the ED were included. The ESI is a validated and well described triage system to allocate ED resources according to presumed need (10). Patients were excluded for trauma or cardiac arrest, intubation by EMS prior to ED arrival, or for a triage ESI greater than 2. The primary outcome was in-hospital mortality. Secondary outcomes were time to orders for and administration of IV fluids and antibiotics, and need for and timing of intubation and vasopressors.

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In preplanned unadjusted analyses comparing the two cohorts, we used Kruskal-Wallis equality-of-populations tests for continuous variables and Fisher exact for categorical variables. We then performed multivariable logistic regression adjusting for age, triage acuity, intubation required, vasopressor administered, triage

**TABLE 1.**  
**Baseline Characteristics of the Sample**

Demographic Variables	Emergency Medical Services Arrival	Private Vehicle Arrival	<i>p</i>
	<i>n</i> = 4,420 (74.9)	<i>n</i> = 1,485 (25.1)	
Age, median (25–75th IQR)	60 (18–72)	55 (39–67)	0.0001
Male gender, <i>n</i> (%)	2,490 (56.3)	821 (55.3)	0.4870
Emergency Severity Index 1, <i>n</i> (%)	1,162 (26.3)	221 (14.9)	< 0.0001
Emergency Severity Index 2, <i>n</i> (%)	3,258 (73.7)	1,264 (85.1)	< 0.0001
Admitting diagnosis, <i>n</i> (%)			
Respiratory	998 (22.6)	344 (23.2)	
Neurologic/psychiatric	1,000 (22.6)	154 (10.4)	
Cardiovascular	735 (16.6)	307 (20.7)	
Infectious/immunologic	530 (12.0)	238 (16.0)	
Toxins/toxidrome	347 (7.9)	57 (3.8)	
Endocrine	240 (5.4)	149 (10.0)	
Gastrointestinal	264 (6.0)	105 (7.1)	
Renal/genitourinary/acid-base	138 (3.1)	61 (4.1)	
Hematologic/oncologic	114 (2.6)	47 (3.2)	
Musculoskeletal	54 (1.2)	23 (1.5)	
Vital signs, median (25–75 IQR)			
Temperature (Fahrenheit)	98.1 (97.3–98.6)	98.1 (97.5–98.6)	0.0028
HR	102 (83–120)	102 (82–120)	0.5864
SBP (mm Hg)	131 (108–154)	130 (105–151)	0.0139
Diastolic blood pressure (mm Hg)	75 (60–92)	76 (59–92)	1.000
Mean arterial pressure (mm Hg)	95 (78–112)	95 (76–111)	0.2652
Shock index (HR/SBP)	0.77 (0.60–0.99)	0.80 (0.60–1.02)	0.0714
Oxygen saturation	97 (94–99)	97 (93–99)	0.0760
Respiratory rate	20 (16–25)	20 (18–24)	0.1579
Weight (kg)	77.1 (63.5–90.7)	74.8 (63.5–90.7)	0.1402
Initial lactate	2.3 (1.5–4.2)	2.1 (1.4–3.6)	0.0001

HR = heart rate, IQR = interquartile range, SBP = systolic blood pressure.

vital signs, and first measured lactate. The model performance was evaluated with the Hosmer-Lemeshow test. We performed analyses in Stata Version 14.2 (StataCorp LLC College Station, TX). This study was approved on July 12, 2016, by the University of Arizona Institutional Review Board (IRB number 1607695679).

Of 5,905 included patients, 74.9% (4,420) arrived by EMS, and these patients were on average older and were more often designated an ESI of 1. There were statistically significant but clinically insignificant differences in several triage vital signs between groups (**Table 1**). Unadjusted mortality was higher in the EMS arrival group (20.0% vs 14.9%;  $p \leq 0.001$ ) (**Table 2**). Door-to-doctor time was significantly shorter for EMS arrivals (5.3 vs 18.8 min;  $p < 0.0001$ ). More patients arriving by

EMS were intubated (35.1% vs 18.6%;  $p \leq 0.001$ ) and given vasopressors (30.3% vs 23.8%;  $p \leq 0.001$ ) during their stay. However, for the most critically ill patients, those who were intubated and given vasopressors, unadjusted mortality was not significantly different between groups (42.1% vs 44.5%;  $p = 0.60$ ). Patients arriving by EMS had statistically significantly reduced time to intubation, vasopressor initiation, times to antibiotic orders and administration, and times to intravenous fluid orders and administration. After multivariable adjustment, patients arriving by POV had no increased odds of death (adjusted odds ratio, 0.998 [0.828–1.202]) compared with those arriving by EMS (**Table 3**). There was good fit to the model, and the area under the receiver operating characteristics was 0.727. Additional

**TABLE 2.**  
**Unadjusted Outcomes for the Sample**

Outcome Variables	Emergency Medical Services Arrival	Private Vehicle Arrival	<i>p</i>
	<i>n</i> = 4,420 (74.8)	<i>n</i> = 1,485 (25.2)	
Door-to-doctor evaluation time, min, median (IQR)	5.3 (2.2–11)	18.8 (10–33)	< 0.0001
Mortality, <i>n</i> (%)	885 (20.0)	221 (14.9)	< 0.0001
Intubated, <i>n</i> (%)	1,551 (35.1)	277 (18.6)	< 0.0001
Intubated in ED, <i>n</i> (%)	1,253 (28.4)	179 (12.0)	< 0.0001
Intubated in ICU, <i>n</i> (%)	298 (6.7)	98 (6.6)	0.905
Time to intubation, hr, median (IQR)	1.2 (0.3–5)	4.8 (1.9–17.4)	0.0001
ED length of stay, hr, median (IQR)	5.8 (4.2–8.2)	6.7 (4.9–9.6)	0.0001
ICU length of stay, hr, median (IQR)	41.1 (22.7–78.3)	36.3 (20.7–65.6)	0.0001
IV fluids ordered, <i>n</i> (%)	3,401 (76.9)	1,125 (75.8)	0.357
Time to IV fluids order, min, median (IQR)	26 (13–100)	45 (24–111)	0.0001
Time to IV fluids given, min, median (IQR)	44 (22–123)	71 (38–144)	0.0001
IV fluid volume ordered, mL, mean	1,146	1,122	0.6629
Vasopressor administered (%)	1340 (30.3)	354 (23.8)	< 0.0001
Time to vasopressors, hr, median (IQR)	4.9 (1.7–11.8)	7.4 (3.3–15.6)	0.0001
Antibiotics administered, <i>n</i> (%)	2,849 (64.5)	849 (57.2)	< 0.0001
Time to antibiotics order, hr, median (IQR)	2.0 (0.7–5.6)	2.5 (1.3–6.5)	0.0001
Time to antibiotics given, hr, median (IQR)	3.2 (1.6–7.2)	3.6 (2.1–8.0)	0.0001

ED = emergency department, IQR = 25–75th interquartile range.

**TABLE 3.**  
**Adjusted Outcomes for the Entire Sample**

Variables	Adjusted OR of Outcome Death	95% CI	<i>p</i>
Emergency medical services arrival	Reference		
Private vehicle arrival	0.998	0.828–1.202	0.981
Age	1.02	1.02–1.03	< 0.001
Intubated	1.52	1.29–1.80	< 0.001
Vasopressor administered	2.66	2.25–3.15	< 0.001
Temperature	0.953	0.920–0.987	0.007
Mean arterial pressure	0.995	0.991–0.998	0.009
Initial O <sub>2</sub> saturation	0.984	0.976–0.992	< 0.001
First lactate	1.05	1.028–1.074	< 0.001
Shock index	1.23	0.928–1.622	0.150

OR = odds ratio.

Area under the receiver operating characteristics curve  $r = 0.727$ .

multivariable analysis using the same covariates revealed an association between POV arrival and increased time to intubation and IV fluids, but no association with increased time to vasopressors or antibiotics.

Our results show that arrival by ambulance was associated with differences in downstream care after arrival to the ED. However, after adjusting for important confounders, we found no increased odds of mortality between patients who arrived by EMS or POV. In unadjusted comparisons of the sickest patients (those using both vasopressors and mechanical ventilation), there was no statistically significant difference in mortality based on mode of arrival. These findings raise several questions which can be evaluated in future research: 1) Are patients who arrive by EMS consistently truly more ill, or does EMS arrival bias us to respond with heightened awareness or more invasive measures? 2) Do other studies also find that POV arrival consistently leads to delays in care or underrecognition of severity of illness in critically ill patients? 3) If there is no difference in outcomes based on mode of arrival, or if EMS arrival patients are truly “sicker”, are there any prehospital interventions that reduce mortality and if so, which ones?

Prior studies in patients with sepsis, acute hypoxemic respiratory failure, and other diseases have shown similar decrease in time to interventions following

EMS arrival but show mixed results on mortality (6, 11–15). In sepsis, if there is a linear association between time to antibiotics and mortality, then a reduction in that time by EMS arrival or even prehospital administration of antibiotics should be beneficial (11). However, a recent large prospective trial may suggest otherwise, with no difference in 28- or 90-day mortality despite receipt of antibiotics a median of greater than 1.5 hours sooner than the control group (12). In our study, the median difference in time to receipt of antibiotics was only 23 minutes. Similar conclusions can be drawn from the prehospital literature in other realms including acute hypoxemic respiratory failure, regarding mode of oxygen delivery comparing noninvasive ventilation versus cannula (13–15).

Total elapsed time from “time-zero” of disease onset until arrival at hospital, and thus lead-time bias, may influence mortality. Shorter time from symptom onset to decision to present to a hospital or seek evaluation by a physician could affect ultimate severity of illness and risk of mortality through earlier receipt of appropriate care. In one study of patients with acute coronary syndromes, a significantly higher rate of cardiac arrest occurred with transport by EMS as opposed to POV, which could suggest simply that sicker patients called EMS dispatch more frequently (16). However, a viable alternative explanation could be that delays experienced while

awaiting EMS arrival, stabilization, and transport were longer than any triage delay they may have experienced if they had self-transported and appeared critically ill during ED triage. Our study did not have access to data on EMS delivery time or unforeseen delays to support this argument, but the “Stay and Play” versus “Scoop and Run” debate in EMS care remains controversial. Overall, there is a lack of clarity and proof of benefit for many prehospital interventions able to be offered by EMS to nontrauma patients, and clarifying what interventions work or do not work may help improve algorithms for EMS response and perhaps patient outcomes.

Our study limitations include possibility of confounding by indication, in this case by severity of illness, as being labeled as more critically ill on arrival itself could influence the types and aggressiveness of therapies received during a hospitalization (17). The retrospective review design is also a limitation, as our dataset did not contain variables required to calculate comorbidity indices or Severity Of Illness scores such as Acute Physiology and Chronic Health Evaluation II or Simplified Acute Physiology Score, and these could not be obtained. We attempted to control for these limitations by including only patients who were admitted to the ICU or died in the ED, performing multivariable adjustment, and by only including the two highest resource-requiring ESI levels in our analysis.

Our hypothesis-generating results suggest reduced times to interventions in-hospital after EMS transport but did not demonstrate a reduced adjusted odds of in-hospital mortality compared with patients who arrived by POV. Some EMS arrival patients likely are truly sicker, and prehospital interventions to reduce their mortality need to be explored. Similarly, some patients who arrive by POV are equally as sick and may be identified at triage rapidly. However, there is likely a group in between those extremes that present disparities based on their mode of arrival, and research is needed to better characterize that group of patients and identify triage and workflow processes for reducing disparities between arrival modes that can optimize their outcomes.

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