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Outcomes of Basic Versus Advanced Life Support for Out-of-Hospital Medical Emergencies

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Abstract

Background—Most Medicare patients seeking emergency medical transport are treated by ambulance providers trained in advanced life support (ALS). Evidence supporting the superiority of ALS over basic life support (BLS) is limited, but some studies suggest ALS may harm patients.

Objective—To compare outcomes after ALS and BLS in out-of-hospital medical emergencies.

Design—Observational study with adjustment for propensity score weights and instrumental variable analyses based on county-level variations in ALS use.

Setting—Traditional Medicare.

Patients—20% random sample of Medicare beneficiaries from nonrural counties between 2006 and 2011 with major trauma, stroke, acute myocardial infarction (AMI), or respiratory failure.

Measurements—Neurologic functioning and survival to 30 days, 90 days, 1 year, and 2 years.

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Results—Except in cases of AMI, patients showed superior unadjusted outcomes with BLS despite being older and having more comorbidities. In propensity score analyses, survival to 90 days among patients with trauma, stroke, and respiratory failure was higher with BLS than ALS (6.1 percentage points [95% CI, 5.4 to 6.8 percentage points] for trauma; 7.0 percentage points [CI, 6.2 to 7.7 percentage points] for stroke; and 3.7 percentage points [CI, 2.5 to 4.8 percentage points] for respiratory failure). Patients with AMI did not exhibit differences in survival at 30 days but had better survival at 90 days with ALS (1.0 percentage point [CI, 0.1 to 1.9 percentage points]). Neurologic functioning favored BLS for all diagnoses. Results from instrumental variable analyses were broadly consistent with propensity score analyses for trauma and stroke, showed no survival differences between BLS and ALS for respiratory failure, and showed better survival at all time points with BLS than ALS for patients with AMI.

Limitation—Only Medicare beneficiaries from nonrural counties were studied.

Conclusion—Advanced life support is associated with substantially higher mortality for several acute medical emergencies than BLS.

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The predominant response to out-of-hospital medical emergencies by ambulance providers in the United States is advanced life support (ALS) rather than basic life support (BLS). Advanced life support accounts for 65% of emergency medical care among Medicare beneficiaries (1) and even more among patients with high-acuity conditions, such as stroke. Ambulance crews using ALS are trained and equipped to provide sophisticated care on site (“stay and play”), whereas BLS emphasizes rapid transport to the hospital, so BLS ambulance crews provide only minimal treatment at the scene (“scoop and run”) (2–4). Whereas ALS providers can use invasive interventions, such as endotracheal intubation for airway management and intravenous catheters for drug and fluid delivery, BLS providers use noninvasive interventions, such as bag valve masks for respiratory support. The ALS providers spend more time at the scene on average (3, 5–7) and receive higher reimbursement (8).

Despite the predominance of ALS, the sparse existing evidence does not support its value. Prior studies, mostly from outside the United States, show evidence of similar or longer survival associated with BLS (2–5, 7, 9–16). But with few exceptions, these studies are limited by small sample sizes and lack of adjustment for key confounders. The World Health Organization has advised countries without ALS not to implement it for trauma until there is greater evidence of its benefits (17, 18).

Because a randomized trial comparing ALS with BLS is unlikely, we conducted a large-scale observational study to compare survival and neurologic outcomes between Medicare beneficiaries with major trauma, stroke, acute myocardial infarction (AMI), or respiratory failure who received ALS versus BLS prehospital care.

Methods

Study Overview

We began by comparing unadjusted survival and neurologic functioning between patients receiving BLS and ALS. We then used 2 methodological approaches to address measured and unmeasured confounding. Our primary approach was to use propensity score weights to balance ALS and BLS distributions of observed characteristics, thus comparing outcomes between patients with similar characteristics who used ALS versus BLS. This analysis focused on within-county comparisons and removed confounding by observed variables, but it could still be confounded by unobserved differences between the 2 groups. In an additional instrumental variable analysis, we estimated county ALS penetration rates for each focal diagnosis group using data from other diagnoses and compared outcomes in counties with higher and lower rates to estimate the effects of ALS.

Data

We analyzed claims between 1 January 2006 and 2 October 2011 from a 20% random sample of Medicare fee-for-service beneficiaries who lived in nonrural counties and were transported to a hospital for out-of-hospital trauma, stroke, AMI, or respiratory failure (Appendixes 1 and 2 of the Supplement, available at www.annals.org). Approximately 89% of Medicare beneficiaries who received emergency transport to a hospital for these conditions lived in nonrural counties (Appendix 1 of the Supplement). We identified ground emergency ambulance rides by Healthcare Common Procedure Coding System codes (Appendix 3 of the Supplement). We linked 96% of ambulance rides to in-patient and outpatient claims by matching on beneficiary identification number and service date.

We linked each observation to validated death dates and demographic data in the Medicare Denominator and Beneficiary Summary Files and chronic medical conditions in the Chronic Conditions Data Warehouse File. We used demographic data for ZIP code tabulation areas in 2009 (19) and county-level demographic and health information from the Area Health Resources Files (20).

Using claims data from the year before the emergency event, we calculated combined Charlson–Elixhauser comorbidity scores (21). For trauma cases, we computed New Injury Severity Scores from hospital claim diagnosis codes (Appendix 4 of the Supplement) (22). We generated risk-adjusted hospital quality scores based on nonemergent surgical survival (Appendix 5 of the Supplement).

Sample Construction

Our study included all patients who were seen as either inpatients or outpatients after ambulance transport. We based patient diagnoses on hospital-assigned International Classification of Diseases, Ninth Revision, Clinical Modification, diagnosis codes rather than ambulance-assigned codes, which are probably less accurate. The Supplement provides flowcharts for the sample construction of each diagnosis group (Appendix Figure 1 to Appendix Figure 4 of the Supplement) and the diagnosis codes used to define the sample (Appendix 2 of the Supplement).

Among trauma patients, we focused on major trauma, defined as a New Injury Severity Score greater than 15 (7% of scored cases) (23, 24), which comprised 79 687 patients (BLS, 30 919; ALS, 48 768). Sample sizes for the other diagnoses were 119 989 patients for stroke (BLS, 19 985; ALS, 100 004), 114 469 for AMI (BLS, 14 434; ALS, 100 035), and 82 530 for respiratory failure (BLS, 9502; ALS, 73 028).

Identification of ALS and BLS Services

We identified whether a patient received BLS or ALS using the Healthcare Common Procedure Coding System code on the ambulance claim. Although provider training, local protocols, and clinical interventions are not recorded, the ambulance provider level indicates the set of interventions and transport times that are characteristic of that level.

Of note, even if ALS providers delivered only BLS interventions, Medicare allows billing at the ALS level if assessment by ALS-trained providers was considered necessary at dispatch. On the basis of telephone interviews about cardiac arrest with emergency medical services officials in 45 states, we established that symptoms, such as chest pain or difficulty breathing (which generally precede the conditions we studied other than trauma), would result in BLS dispatch only if ALS were unavailable within a reasonable amount of time because of travel distance, attendance at another call, or a staffing shortage. Although we did not ask about trauma-related conditions in our interviews, we believe the higher proportion of BLS patients in trauma relative to other diagnosis groups reflects more emphasis on dispatch of the nearest ambulance. Given the high severity of the medical conditions under study, the policy of allowing ALS billing if ALS was considered necessary at dispatch, and reimbursement differences between BLS and ALS, it is unlikely that the BLS patients in our sample were actually treated by providers trained in ALS.

Outcome Measures

Our primary outcome measures were survival at 30, 90, 365, and 730 days after ambulance transport. We also created an indicator for poor neurologic functioning based on the presence of International Classification of Diseases, Ninth Revision, Clinical Modification, diagnosis codes for anoxic brain injury (348.1), coma (700.01), persistent vegetative state (780.03), or brain death (348.82); from this information, we inferred Cerebral Performance Categories 4 and 5 (25).

Statistical Analysis

We compared unadjusted survival between ALS and BLS. To address confounding due to observable patient, hospital, and geographic characteristics, we compared outcomes between ALS and BLS using propensity score–based balancing weights (Appendix 6 of the Supplement). For each diagnosis, we first modeled the probability that a beneficiary received ALS using logistic regression as a function of the type of pickup location (for example, residence or outdoor scene); mileage from the pickup location to a hospital; county of residence; and a range of individual and ZIP code characteristics, including local hospital quality (Appendixes 5 to 7 of the Supplement). From these models, we derived weights (26) that balanced the BLS and ALS distributions over the observed set of covariates and compared weighted BLS and ALS outcomes. A key assumption in this analysis is that

balance over observed covariates also applies to potential unobserved confounders, especially severity. This assumption is plausible because, with the exception of trauma, BLS providers would generally be dispatched only when ALS providers are unavailable, so the decision to dispatch ALS providers may not be correlated with unobserved illness severity. For trauma, we included a severity measure in the analysis. Further, because the weighted distributions of ALS and BLS are balanced over counties, distributions of county-level characteristics, whether observed or unobserved, were balanced in this analysis.

We also conducted another analysis that relied solely on variation in ALS penetration across counties (Figure 1) and thus did not need to assume that the within-county distribution of unobserved illness severity is similar for ALS and BLS patients. We predicted the probability of ALS use for each patient as a function of ALS rates in the county for patients with other diagnoses. This approach estimated survival differences between ALS and BLS using only variation in county-level rates of ALS use that are presumptively driven by local ambulance supply and dispatch protocols common to all included diagnoses rather than by unobserved illness severity of persons in the focal diagnosis. We adjusted estimates with the same covariates we used in the propensity score analysis.

This latter approach formally constitutes an instrumental variable analysis (27–29) (Appendix 8 of the Supplement). In effect, it uses the varying penetration of ALS across counties to implement a quasi-experimental design that compares patients who are treated with ALS in high-penetration counties because an ALS ambulance was available at the time of their health event with observably similar patients in low-penetration counties who are treated with BLS because no ALS ambulance was reasonably available at the time of the event (27). This approach requires the assumption that county variation in ALS use for other conditions is correlated with an individual patient's likelihood of receiving ALS but is otherwise uncorrelated with that patient's clinical outcome. Because this analysis uses between-county variation in ALS penetration rather than within-county variation in the type of ambulance dispatched, the size of the estimated differences is not the same as in the propensity score analyses and the precision is less.

We did a falsification analysis to test the assumption that the rate of ALS use in a county is not associated with the quality of hospital care, which may independently influence outcomes (30). To do so, we repeated the instrumental variable analysis with an outcome of risk-adjusted nonemergency inpatient surgical mortality and, separately, an outcome of risk-adjusted nonemergency intensive care unit mortality, both of which are unlikely to be affected by ALS penetration in a county if ALS penetration is not correlated with unobserved quality of hospital care.

In both the propensity score and instrumental variable analyses, we compared BLS and ALS outcomes with 5%-level *t* tests. We plotted Kaplan–Meier survival curves, which were censored at the end of our data. Finally, we did prespecified subgroup analyses of trauma patients who experienced falls (Appendix 2 of the Supplement), the most common external cause of trauma (75% of patients), and patients with relatively low (16 to 24) and high (25 to 75) injury severity scores. The Supplement gives modeling details (Appendixes 6 to 8 of the Supplement) and multiple sensitivity analyses (Appendixes 9 to 16 of the Supplement).

The research protocol was approved by Institutional Review Boards at Harvard University and the National Bureau of Economic Research. Analyses were done using SAS, version 9.3 (SAS Institute); R, version 3.0.2 (R Foundation for Statistical Computing); and Stata, version 13.1 (StataCorp).

Role of the Funding Source

The National Science Foundation, Agency for Healthcare Research and Quality, and National Institutes of Health played no role in design, conduct, or reporting of the study.

Results

Patient Characteristics

On average, patients who received BLS were older; were more likely to be women; had higher comorbidity scores; and were more likely to be black, except for those who had trauma (Table 1). To the degree that these characteristics are positively associated with unobserved illness severity differences, unadjusted comparisons are biased against BLS. Nonetheless, unadjusted survival differences for trauma, stroke, and respiratory failure favored BLS (Table 2).

After weighting with propensity scores, we found that BLS and ALS samples were similar on observable characteristics (Appendix Table 2 of the Supplement, available at www.annals.org).

Trauma

In propensity score analysis, survival after BLS was 6.1 percentage points (95% CI, 5.4 to 6.8 percentage points) higher at 90 days and remained higher at intervals up to 2 years (Table 2). Much of the difference in survival between ALS and BLS was explained by higher mortality among ALS patients in the days immediately after trauma (Figure 2, A). After this period, the near constancy of survival ratios over time suggests that BLS patients survive as well as ALS patients. Patients receiving BLS were also 0.22 percentage point (CI, 0.14 to 0.31 percentage points) less likely to have poor neurologic functioning by the time of hospital discharge or hospital death.

In instrumental variable analysis, patients receiving BLS were 4.1 percentage points (CI, 1.3 to 6.9 percentage points) more likely to survive to 90 days (Table 3). At 1 year and 2 years, survival was higher with BLS but not statistically significantly so.

Survival differences at 90 days between BLS and ALS were more pronounced in patients with severe trauma compared with those with less severe trauma in instrumental variable analysis (12.5 percentage points [CI, 4.7 to 20.2 percentage points] vs. 2.7 percentage points [CI, -0.2 to 5.5 percentage points]) and propensity score analysis (14.7 percentage points [CI, 12.7 to 16.7 percentage points] vs. 4.6 percentage points [CI, 4.0 to 5.3 percentage points]) (Table 4). For patients experiencing falls, 90-day survival was higher with BLS in both propensity score analysis (4.8 percentage points [CI, 3.5 to 6.2 percentage points]) and instrumental variable analysis (7.1 percentage points [CI, 2.0 to 12.3 percentage points]) (Table 4).

Stroke

In propensity score analysis, 90-day survival was 7.0 percentage points (CI, 6.2 to 7.7 percentage points) higher with BLS and remained higher up to 2 years (Table 2). In instrumental variable analysis, 90-day survival was 4.3 percentage points (CI, 1.3 to 7.3 percentage points) higher with BLS (Table 3). As with trauma, this difference was largely explained by higher survival among BLS patients in the initial period after the event (Figure 2, *B*). The BLS patients were 0.29 percentage point (CI, 0.20 to 0.39 percentage points) less likely to have poor neurologic functioning in propensity score analysis, but there was no statistically significant difference in neurologic functioning between BLS and ALS patients in instrumental variable analysis.

AMI

Survival to 30 days did not statistically significantly differ between ALS and BLS in propensity score analysis (Table 2). At 90 days, however, survival was 1.0 percentage point (CI, 0.1 to 1.9 percentage points) higher with ALS, and the Kaplan–Meier plot (Figure 2, *C*) shows that BLS and ALS curves remain separate after this period. The instrumental variable analysis, in contrast, shows that receipt of BLS versus ALS was associated with higher survival at all intervals (Table 3). Patients receiving BLS were 0.88 percentage point (CI, 0.70 to 1.06 percentage points) less likely to have poor neurologic functioning in propensity score analysis, but neurologic performance did not statistically differ between BLS and ALS patients in instrumental variable analysis.

Respiratory Failure

In propensity score analysis, survival with BLS was 3.7 percentage points (CI, 2.5 to 4.8 percentage points) higher at 90 days (Table 2), but in instrumental variable analysis, there were no statistically significant survival differences between ALS and BLS (Table 3). Early survival gains among patients receiving BLS narrowed with time (Figure 2, *D*). In propensity score analysis, patients receiving BLS were 3.10 percentage points (CI, 2.71 to 3.50 percentage points) less likely to have poor neurologic functioning.

Discussion

For 3 of the 4 conditions we studied, unadjusted survival rates were higher among patients receiving BLS despite these patients being older and having more comorbid conditions on average than those receiving ALS. After adjustment, these outcome differences persisted; we found similar or better health outcomes associated with prehospital BLS than ALS in all of our analyses for major trauma, stroke, and respiratory failure. Because these high-acuity conditions necessitate early optimization of care, one would have expected any advantage of ALS over BLS to manifest itself in these diagnoses. Although ALS may be expected to improve outcomes because of early treatment, the opposite may occur in practice if ALS is associated with delays in hospital management or iatrogenic injury (3, 5–7, 31).

We used 2 methodological approaches to adjust for potential confounders of comparisons between BLS and ALS outcomes. One analysis used propensity score methods to balance observed characteristics. This approach is susceptible to confounding by any unobserved

patient characteristics associated with survival and ALS use; however, because ambulance dispatch protocols prioritize ALS for the conditions we studied, such individual-level confounding is plausibly minimal. Our second approach used the instrumental variable of county-level variation in overall ALS prevalence to predict the likelihood that a patient would receive ALS. This approach is less susceptible to confounding by unobserved patient characteristics but is subject to confounding by associations between rates of ALS use and other county characteristics that affect mortality. However, our falsification tests suggest that such confounding is unlikely.

The propensity score analysis compares outcomes within counties, whereas the instrumental variable analysis compares outcomes between counties. Because the 2 approaches rely on different comparisons, their estimates of effects will not be the same. The 2 distinct approaches, however, allowed us to test the robustness of our inferences.

With the exception of patients who had AMI, BLS was associated with outcomes similar to or significantly better than ALS using both methodological approaches. Survival after AMI was substantially better with BLS than ALS in instrumental variable analysis (between 4 and 8 percentage points across all time points), but the propensity score analysis found higher survival with ALS than BLS (between 1 and 2 percentage points at 90 days, 1 year, and 2 years). We did several sensitivity analyses (Appendixes 9 to 16 of the Supplement), none of which changed the direction or significance of our main findings. Our findings are consistent with other evidence for cardiac arrest (Appendix 17 of the Supplement) and trauma (4, 5, 7, 10–18). Little prior evidence, however, exists for patients with stroke, AMI, and respiratory failure.

In addition to potentially better outcomes, greater use of BLS would also save money. Using 2011 reimbursement levels of ALS and BLS, Medicare would have spent \$322 million less on ambulance services in 2011 if all ground emergency rides had used BLS (1).

How might ALS result in worse outcomes? First, ALS may delay hospital care that would otherwise offer definitive clinical management (3, 5–7). Even when clinical guidelines recommend not delaying transport for prehospital interventions, delays may still result from the on-site provision of optional interventions that are intended to be done en route to the hospital (32). For example, in the Ontario study of ALS versus BLS for the treatment of cardiac arrest (7), the median time that ALS crews spent from arrival at the patient's side to arrival at the hospital was 27 minutes, whereas the corresponding time for BLS crews was only 13 minutes. For trauma patients in the Ontario study (5), these times were 22 minutes for ALS crews and 19.1 minutes for BLS crews. Second, prehospital endotracheal intubation by ALS has risks (31). Successful intubation requires high competency and practice, but in Pennsylvania, the median paramedic did only 1 intubation annually (33). Bag valve mask ventilation, commonly performed by BLS providers, may not pose the same threat of harm as intubation (11, 34–38). Finally, several studies suggest that prehospital administration of intravenous fluids may be harmful to patients with major penetrating trauma, which may partly explain worse outcomes associated with ALS in trauma patients (39, 40). Further study, however, is warranted to evaluate the mechanisms that might have led to differences in the outcomes that we investigated.

Our study has several limitations. Selection bias may confound our findings if patients receiving ALS and BLS differ in unobserved illness severity or in the quality of hospital care that they receive. To address this issue, we did 2 types of analyses that are subject to different types of confounding. The propensity score analysis would be biased toward finding worse outcomes associated with ALS if ALS providers were dispatched to patients with greater unobserved illness severity. Interviews we conducted with 45 state emergency medical service representatives, however, indicate that, if available, ALS would routinely be dispatched for many of the conditions that we investigated. As a result, the decision to dispatch ALS providers may plausibly be uncorrelated with unobserved illness severity for conditions other than trauma; for trauma, we controlled for severity. Moreover, BLS patients were older and had more comorbidities than ALS patients, which suggests that any unobserved differences in severity may actually have biased our results against BLS.

The instrumental variable analysis could be confounded if counties with poorer quality hospital care had higher ALS penetration. Our falsification tests found no association of ALS penetration with nonemergent surgical mortality or nonemergent intensive care unit mortality at the county level. Although these tests increase confidence in our results, we had no way of directly assessing the quality of care for emergency patients that was not susceptible to potential confounding by characteristics of ambulance services.

Estimates and significance tests under the propensity score analysis could be subject to bias if ALS providers evaluated a patient and then selectively provided care and billed at the BLS level for less acute cases. Given substantial reimbursement differences between ALS and BLS, it is unlikely that ALS providers billed at BLS rates because Medicare allows billing at the ALS level if assessment by ALS-trained providers was considered necessary at dispatch. Further, analysis of survival differences in 2005 claims, which distinguish ALS claims billed at the BLS level, showed little sensitivity to whether this small group was categorized as ALS or BLS (Appendix 15 of the Supplement). Finally, significance tests under the instrumental variable analysis would still be valid in this case as long as higher rates of ALS claims reflect higher utilization rates of ALS providers, although estimates of the effect magnitude might be biased.

Because our sample included only patients with hospital claims, another potential limitation may be that more BLS patients died at the scene or en route to the hospital. In sensitivity analyses that considered these cases, however, the direction and significance of our findings were unchanged (Appendixes 10 and 11 of the Supplement).

Our results are limited to the U.S. health care system and the Medicare population in particular. Our comparisons may not generalize to countries in which prehospital ALS is provided by physicians. Finally, administrative data may not always accurately reflect diagnoses, comorbidities, or neurologic performance.

In conclusion, our findings suggest that survival is longer with BLS and that BLS may also offer benefits for nonfatal outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Country-level ALS penetration rates for major trauma.

These rates are for a standardized population with major trauma but are not derived from characteristics of trauma patients. Rather, they are predicted from rates of ALS use in other diagnosis groups in each county. ALS = advanced life support.

Figure 2.

Kaplan–Meier analysis of survival after emergency event, by ambulance service level.

The insets show the survival probability over the full observational period, and the main graphs shows it for the first 90 d. Data include emergency medical events between 1 January 2006 and 2 October 2011. Mortality was monitored until 31 December 2011, when the data were censored, and thus there was follow-up to at least 90 days for each beneficiary. Plots use different y-axis scales. ALS = advanced life support; BLS = basic life support. **A.**

B. Trauma. **B.** Stroke. **C.** Acute myocardial infarction. **D.** Respiratory failure.

Table 1

Differences in Characteristics, by Ambulance Service Level*

Characteristic	Trauma			AMI			Stroke			Respiratory Failure		
	BLS	ALS	ALS	BLS	ALS	ALS	BLS	ALS	ALS	BLS	ALS	ALS
Patients, <i>n</i>	30 919	48 768	14 434	100 035	19 985	100 004	9502	73 028				
Mean age, <i>y</i>	82	79 [‡]	81	78 [‡]	80	79 [‡]	75	74 [‡]				
Women, %	69	61 [‡]	60	53 [‡]	63	61 [‡]	59	56 [‡]				
Race, %												
White	91	91	83	87	79	84	78	81				
Black	5	5	12	9	15	12	16	14				
Hispanic	2	1	3	2	3	2	3	2				
Asian	1	1	2	1	2	1	1	1				
Other	1	1	1	1	2	1	2	1				
Mean comorbidity score	3.3	2.9 [‡]	4.2	3.3 [‡]	3.6	3.1 [‡]	5.9	5.3 [‡]				
Mean distance, <i>mi</i>	6.2	7.8 [‡]	6.4	7.5 [‡]	6.4	7.5 [‡]	6.0	6.5 [‡]				
Pickup location, %												
Residence	57	60	61	71	63	71	49	64				
SNF	18	10	23	11	22	12	36	19				
Scene	18	24	10	14	10	13	9	11				
Non-SNF nursing home [‡]	6	5	5	4	5	4	6	5				
ZIP code characteristics												
Income/race mix, % [§]												

Characteristic	Trauma			AMI		Stroke		Respiratory Failure	
	BLS	ALS	BLS	BLS	ALS	BLS	ALS	BLS	ALS
High/white	51	52	45	49	48	44	48	39	43
Low/white	7	8	8	9	8	7	8	9	9
High/black	0	0	1	0	0	1	0	1	1
Low/black	1	1	2	1	2	2	2	2	2
High/integrated	30	27	31	27	28	33	28	33	29
Low/integrated	10	12	13	13	14	14	14	16	16
Hospital quality measure ^{//}	0.0001	-0.0011 [†]	0.0003	-0.0009 [†]	-0.0001	-0.0001	-0.0011 [†]	-0.0001	-0.0011 [†]
County, %									
Metropolitan [¶]	87	84 [†]	87	84 [†]	87	87	85 [†]	87	85 [†]
Any hospital with medical school affiliation	68	61 [†]	69	62 [†]	69	69	63 [†]	69	63 [†]
Any trauma center	72	67 [†]	74	67 [†]	75	75	68 [†]	74	68 [†]
General practice physicians	14	16 [†]	14	16 [†]	14	14	16 [†]	14	16 [†]
Persons with 4 y of college	25	24 [†]	24	23 [†]	25	25	23 [†]	24	23 [†]

ALS = advanced life support; AMI = acute myocardial infarction; BLS = basic life support; SNF = skilled-nursing facility.

* Percentages may not sum to 100 due to rounding.

[†] $P < 0.001$. Differences between BLS and ALS observations were tested for statistical significance using t test or chi-square test, as appropriate.

[¶] Includes non-SNF residential, domiciliary, custodial, or nursing home facilities.

[§] High if median household income is $> \$40\,000$; low if otherwise. Predominantly black if $> 80\%$ were black, predominantly white if $> 80\%$ were white, and integrated if otherwise.

^{//} Average difference between actual and predicted surgical survival for hospitals, weighted by number of patients transported to hospital within ZIP code. The Supplement (available at www.annals.org) contains more details.

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Versus micropolitan. Counties in the sample are either metropolitan or micropolitan. Metropolitan counties have 1 urbanized area with a population 50 000; micropolitan areas have 1 urban cluster of 10 000 but a population <50 000. Both area types have adjacent territory that has a high degree of social and economic integration, with the core as measured by commuting ties.

Table 2Unadjusted and Propensity Score Analyses of Health Outcomes, by Ambulance Service Level ^{*}

Outcome	BLS (95% CI), %	ALS (95% CI), %	Difference (95% CI), <i>percentage points</i>
Major trauma			
Sample, <i>n</i>	30 919	48 768	–
Unadjusted outcomes			
Survival to discharge	95.5 (95.3 to 95.7)	90.1 (89.8 to 90.3)	5.4 (5.1 to 5.8)
Survival to 30 d	89.2 (88.9 to 89.5)	83.1 (82.8 to 83.5)	6.1 (5.6 to 6.5)
Survival to 90 d	81.7 (81.3 to 82.2)	76.8 (76.5 to 77.2)	4.9 (4.3 to 5.5)
Poor neurologic performance	0.17 (0.12 to 0.21)	0.43 (0.37 to 0.49)	–0.26 (–0.34 to –0.19)
Adjusted outcomes			
Survival to discharge	95.5 (95.3 to 95.8)	90.5 (90.2 to 90.8)	5.0 (4.6 to 5.4)
Survival to 30 d	89.4 (89.0 to 89.7)	83.1 (82.7 to 83.5)	6.3 (5.7 to 6.8)
Survival to 90 d	82.3 (81.9 to 82.8)	76.2 (75.8 to 76.7)	6.1 (5.4 to 6.8)
Survival to 1 y	70.0 (69.4 to 70.6)	64.9 (64.4 to 65.5)	5.1 (4.2 to 5.9)
Survival to 2 y	59.3 (58.5 to 60.0)	54.9 (54.2 to 55.5)	4.4 (3.4 to 5.4)
Poor neurologic performance	0.16 (0.12 to 0.21)	0.39 (0.32 to 0.45)	–0.22 (–0.31 to –0.14)
Stroke			
Sample, <i>n</i>	19 985	100 004	–
Unadjusted outcomes			
Survival to discharge	94.6 (94.3 to 95.0)	91.9 (91.8 to 92.1)	2.7 (2.4 to 3.1)
Survival to 30 d	84.4 (83.9 to 84.9)	79.3 (79.1 to 79.6)	5.1 (4.5 to 5.6)
Survival to 90 d	76.6 (76.0 to 77.2)	72.2 (72.0 to 72.5)	4.4 (3.7 to 5.0)
Poor neurologic performance	0.23 (0.16 to 0.30)	0.46 (0.41 to 0.50)	–0.23 (–0.30 to –0.15)
Adjusted outcomes			
Survival to discharge	94.9 (94.6 to 95.2)	91.2 (90.9 to 91.4)	3.8 (3.3 to 4.2)
Survival to 30 d	84.8 (84.3 to 85.3)	77.8 (77.5 to 78.2)	7.0 (6.3 to 7.6)
Survival to 90 d	77.2 (76.6 to 77.8)	70.3 (69.9 to 70.7)	7.0 (6.2 to 7.7)
Survival to 1 y	62.8 (62.1 to 63.6)	57.4 (56.9 to 57.8)	5.5 (4.6 to 6.4)
Survival to 2 y	51.6 (50.7 to 52.5)	47.3 (46.7 to 47.8)	4.3 (3.3 to 5.4)
Poor neurologic performance	0.21 (0.15 to 0.28)	0.51 (0.44 to 0.57)	–0.29 (–0.39 to –0.20)
AMI			

Outcome	BLS (95% CI), %	ALS (95% CI), %	Difference (95% CI), percentage points
Sample, <i>n</i>	14 434	100 035	–
Unadjusted outcomes			
Survival to discharge	87.9 (87.4 to 88.5)	87.6 (87.4 to 87.8)	0.3 (–0.3 to 0.9)
Survival to 30 d	77.5 (76.8 to 78.2)	80.3 (80.0 to 80.5)	–2.8 (–3.5 to –2.1)
Survival to 90 d	68.6 (67.8 to 69.3)	73.6 (73.3 to 73.9)	–5.1 (–5.9 to –4.3)
Poor neurologic performance	0.71 (0.58 to 0.85)	2.07 (1.98 to 2.15)	–1.35 (–1.51 to –1.19)
Adjusted outcomes			
Survival to discharge	88.4 (87.9 to 89.0)	87.3 (87.0 to 87.6)	1.1 (0.5 to 1.8)
Survival to 30 d	78.2 (77.5 to 78.9)	78.5 (78.1 to 78.8)	–0.3 (–1.1 to 0.5)
Survival to 90 d	69.5 (68.8 to 70.3)	70.5 (70.1 to 70.9)	–1.0 (–1.9 to –0.1)
Survival to 1 y	55.2 (54.3 to 56.0)	57.2 (56.7 to 57.7)	–2.0 (–3.0 to –1.1)
Survival to 2 y	44.1 (43.1 to 45.2)	45.9 (45.4 to 46.5)	–1.8 (–2.9 to –0.6)
Poor neurologic performance	0.73 (0.58 to 0.87)	1.61 (1.50 to 1.71)	–0.88 (–1.06 to –0.70)
Respiratory failure			
Sample, <i>n</i>	9502	73 028	–
Unadjusted outcomes			
Survival to discharge	77.0 (76.1 to 77.8)	75.2 (74.9 to 75.5)	1.8 (0.9 to 2.7)
Survival to 30 d	66.4 (65.4 to 67.3)	64.3 (63.9 to 64.6)	2.1 (1.1 to 3.1)
Survival to 90 d	55.6 (54.6 to 56.6)	55.4 (55.0 to 55.7)	0.2 (–0.9 to 1.2)
Poor neurologic performance	2.39 (2.08 to 2.70)	5.86 (5.69 to 6.03)	–3.47 (–3.83 to –3.12)
Adjusted outcomes			
Survival to discharge	77.5 (76.7 to 78.4)	73.6 (73.1 to 74.1)	3.9 (3.0 to 4.9)
Survival to 30 d	66.9 (66.0 to 67.9)	62.5 (61.9 to 63.0)	4.5 (3.4 to 5.6)
Survival to 90 d	56.5 (55.4 to 57.5)	52.8 (52.3 to 53.3)	3.7 (2.5 to 4.8)
Survival to 1 y	40.1 (39.0 to 41.3)	37.5 (36.9 to 38.0)	2.7 (1.4 to 3.9)
Survival to 2 y	29.1 (28.0 to 30.3)	27.9 (27.3 to 28.5)	1.2 (–0.1 to 2.5)
Poor neurologic performance	2.39 (2.07 to 2.71)	5.50 (5.26 to 5.73)	–3.10 (–3.50 to –2.71)

ALS = advanced life support; AMI = acute myocardial infarction; BLS = basic life support.

* Unless otherwise indicated, estimates are adjusted by propensity score–based balancing weights. Estimates for survival to 1 y used data from 2006 to 2010, and estimates for survival to 2 y used data from 2006 to 2009.

Table 3Instrumental Variable Analysis of Differences Between BLS and ALS in Health Outcomes ^{*}

Variable	Trauma	Stroke	AMI	Respiratory Failure
30-d survival	3.7 (1.3 to 6.0)	5.3 (2.7 to 8.0)	4.8 (1.2 to 8.4)	4.2 (−0.9 to 9.4)
90-d survival	4.1 (1.3 to 6.9)	4.3 (1.3 to 7.3)	5.9 (2.2 to 9.6)	0.2 (−4.7 to 5.1)
1-y survival	1.8 (−1.4 to 5.0)	3.6 (0.4 to 6.8)	7.1 (2.6 to 11.6)	−2.9 (−7.8 to 1.9)
2-y survival	2.4 (−1.3 to 6.1)	3.2 (−0.2 to 6.7)	8.4 (2.7 to 14.2)	−2.4 (−7.2 to 2.3)
Poor neurologic performance	−0.30 (−0.60 to 0.04)	0.2 (−0.1 to 0.5)	−0.7 (−1.5 to 0.2)	−0.6 (−2.5 to 1.2)

ALS = advanced life support; AMI = acute myocardial infarction; BLS = basic life support.

^{*} Instrumental variable estimates represent the effect on survival (in percentage points [95% CIs]) of receiving BLS rather than ALS for a “switcher” (i.e., a person who would receive BLS in an area with a higher rate of BLS use but ALS in an area with lower BLS use).

Table 4Differences Between BLS and ALS in 90-d Survival, by Trauma Subgroups^{*}

Subgroup	BLS, <i>n</i>	ALS, <i>n</i>	Survival Difference in Propensity Score Analysis (95% CI), <i>percentage points</i>	Survival Difference in Instrumental Variable Analysis (95% CI), <i>percentage points</i>
Low severity [†]	27 297	39 341	4.6 (4.0 to 5.3)	2.7 (−0.2 to 5.5)
High severity [‡]	3622	9427	14.7 (12.7 to 16.7)	12.5 (4.7 to 20.2)
Accidental falls	7568	11 947	4.8 (3.5 to 6.2)	7.1 (2.0 to 12.3)

ALS = advanced life support; BLS = basic life support.

^{*} Propensity score estimates are the difference in 90-d survival between BLS and ALS recipients, adjusted by propensity score–based balancing weights. The instrumental variable estimates represent the effect on survival of receiving BLS rather than ALS for a “switcher” (i.e., a person who would receive BLS in an area with a higher rate of BLS use but ALS in an area with lower BLS use). Accidental falls were analyzed only for 2010 and 2011, in which separate external-cause code fields existed and were complete for 92% of observations.

[†] New Injury Severity Score between 16 and 24.

[‡] New Injury Severity Score between 25 and 75.