

ORIGINAL ARTICLE

Advanced Life Support for Out-of-Hospital Respiratory Distress

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ABSTRACT

BACKGROUND

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Respiratory distress is a common symptom of patients transported to hospitals by emergency medical services (EMS) personnel. The benefit of advanced life support for such patients has not been established.

METHODS

The Ontario Prehospital Advanced Life Support (OPALS) Study was a controlled clinical trial that was conducted in 15 cities before and after the implementation of a program to provide advanced life support for patients with out-of-hospital respiratory distress. Paramedics were trained in standard advanced life support, including endotracheal intubation and the administration of intravenous drugs.

RESULTS

The clinical characteristics of the 8138 patients in the two phases of the study were similar. During the first phase, no patients were treated by paramedics trained in advanced life support; during the second phase, 56.6% of patients received this treatment. Endotracheal intubation was performed in 1.4% of the patients, and intravenous drugs were administered to 15.0% during the second phase. This phase of the study was also marked by a substantial increase in the use of nebulized salbutamol and sublingual nitroglycerin for the relief of symptoms. The rate of death among all patients decreased significantly, from 14.3% to 12.4% (absolute difference, 1.9%; 95% confidence interval [CI], 0.4 to 3.4; $P=0.01$) from the basic-life-support phase to the advanced-life-support phase (adjusted odds ratio, 1.3; 95% CI, 1.1 to 1.5).

CONCLUSIONS

The addition of a specific regimen of out-of-hospital advanced-life-support interventions to an existing EMS system that provides basic life support was associated with a decrease in the rate of death of 1.9 percentage points among patients with respiratory distress.

EACH YEAR, EMERGENCY MEDICAL SERVICES (EMS) personnel in the United States transport 2 million patients with respiratory distress to hospitals by ambulance. Respiratory distress is the second most common symptom of adults transported by ambulance and is associated with a relatively high overall mortality before hospital discharge of 18%.¹⁻³ Among the most common causes of respiratory distress in this setting are congestive heart failure, pneumonia, chronic obstructive pulmonary disease, and asthma.

In many cities in the United States and Canada, out-of-hospital care for critically ill and injured patients is provided by paramedics who are trained in advanced-life-support measures. Advanced life support includes endotracheal intubation and intravenous drug therapy.⁴ In contrast, paramedics who are trained in basic-life-support measures administer oxygen, bag-valve-mask ventilation, and in some cases nebulized bronchodilators and sublingual nitroglycerin, but they do not perform endotracheal intubation or administer intravenous drugs.

The benefit of advanced life support for patients with respiratory distress has not been established. There are few controlled clinical trials of out-of-hospital advanced life support and respiratory distress and, consequently, there is very little evidence regarding the optimal therapy for patients before they arrive at the hospital. To our knowledge, no studies have shown improved survival for patients with respiratory distress who receive advanced life support before they arrive at the hospital, and there is some evidence that inappropriate drug therapy in this setting may increase the rate of death.⁵⁻¹²

In Ontario, a Canadian jurisdiction of 12 million people, the provincial government has funded the Ontario Prehospital Advanced Life Support (OPALS) Study, a large, multicenter, controlled clinical trial. This multiphase study evaluated specific programs in several cities to determine the incremental benefit to survival and morbidity associated with out-of-hospital advanced life support for four major groups of critically ill and injured patients (those with cardiac arrest, major trauma, respiratory distress, and chest pain).^{3,13,14} We have shown that advanced-life-support programs have no significant effect on the outcomes of patients with cardiac arrest.¹⁵ The objective of the current study, the OPALS Respiratory Distress Study, was to assess the incremental benefit with respect to

morbidity and mortality that results from the implementation of an advanced-life-support program for the evaluation and management of respiratory distress before patients arrive at the hospital.

METHODS

DESIGN

Detailed methods for the OPALS Respiratory Distress Study have been described previously.³ We performed a prospective “before-and-after” controlled trial (before and after advanced-life-support programs were instituted) among all eligible patients with respiratory distress seen during two distinct phases of the study: the basic-life-support phase (6 months) and the advanced-life-support phase (6 months). The study was funded by peer-reviewed grants from the Emergency Health Services Branch of the Ontario Ministry of Health and Long-Term Care and the Canadian Health Services Research Foundation.

SETTING AND POPULATION

The study was conducted in 18 urban communities throughout Ontario under the medical direction of 11 base-hospital programs. The aggregate population was 2.5 million people, with the populations of individual cities ranging from 20,000 to 750,000. One community had a population of less than 30,000, five had populations of 30,000 to 99,999, four had populations of 100,000 to 199,999, four had populations of 200,000 to 500,000, and one had a population of more than 500,000. Each community was served by a Central Ambulance Communications Center, which provided the study with electronic and synchronized dispatch information regarding all patients transported by ambulance during the study. Out-of-hospital care was documented with the use of the standard Ontario Ambulance Call Report form, which included specific data regarding the call code, time of events, medications administered, and procedures performed.

The study population included all patients 16 years of age and older whose primary symptom was shortness of breath, including those who were assessed by EMS personnel but not transported to the hospital. Excluded were patients with full cardiac arrest before the arrival of EMS personnel, patients whose primary symptom was chest pain or any other nonrespiratory symptom, and patients with respiratory distress due to trauma, a postictal

state, or another nonrespiratory illness, according to information available to paramedics at the time of the initial assessment of the patient in the field. The study received full approval of the Ottawa Hospital Research Ethics Board, and the requirement for informed consent was waived.

INTERVENTION

During the basic-life-support phase, each community provided tiered EMS, with firefighters responding first, followed by “primary care” paramedics. These paramedics had previously graduated from a 10-month program at a community college and were trained to provide all basic-life-support measures, including oxygen, bag–valve–mask ventilation, and automated external defibrillation. All paramedics also had several years of experience (median, 5 years).

The study intervention consisted of an advanced-life-support program in which primary care paramedics were trained to perform endotracheal intubation, insert intravenous lines, and administer intravenous medications. After this training, they were called “advanced-care” paramedics. The Emergency Medical Technician Level III training program of the Canadian Medical Association involved 6 weeks of didactic instruction, 6 weeks of clinical instruction, and 12 weeks of preceptorship training in the field. To qualify for the advanced-life-support phase of the OPALS Study, each community had to meet four criteria with regard to patients with cardiac arrest. First, EMS technicians had to achieve a rapid-defibrillation response interval of 8 minutes or less for 90% of patients. Second, paramedics trained to provide advanced care had to respond for 95% of patients. Third, paramedics trained to provide advanced care had to respond to the scene within 11 minutes for 80% of patients. Finally, paramedics trained to provide advanced care had to successfully perform endotracheal intubation for 90% of patients. These criteria were monitored regularly, and data collection for the advanced-life-support phase of the study in each community did not begin until the criteria were met. The three communities that did not meet the standards were excluded from the study.

During the advanced-life-support phase, the decision to dispatch a crew trained to provide advanced life support was made by the dispatcher on the basis of information provided during the initial emergency call and the availability of a team

that could provide this type of support at the time of the call. Medications administered to patients with respiratory distress during this phase included intravenous furosemide and morphine as well as nebulized salbutamol and sublingual nitroglycerin. In some instances, patients also received nebulized salbutamol and sublingual nitroglycerin during the basic-life-support phase as part of a “symptom relief” program. This program was gradually introduced to primary care paramedics throughout Ontario during the end of the basic-life-support phase of the OPALS Study.

OUTCOME MEASURES

The primary outcome measure was mortality, defined as the rate of death before hospital discharge regardless of the duration of admission. Secondary outcome measures included intubation in the emergency department, evidence of aspiration, admission to a hospital, the length of stay in the hospital, the patient’s destination after discharge, and the patient’s functional status according to a five-point cerebral-performance category scale.¹⁶ An additional end point was paramedic coding of the patient’s status as being improved, unchanged, or worsened on the patient’s arrival in the emergency department. Study data provided by each base-hospital program included ambulance call reports, dispatch reports, and a review of hospital records. Trained analysts determined the final discharge diagnoses on the basis of hospital records. For a few patients for whom hospital records were not available, data regarding survival to 30 days after the day of study enrollment was ascertained by a review of records from the Ontario Death Registry.

STATISTICAL ANALYSIS

For comparisons of mortality, the minimal sample size was estimated to be 4630 patients in the basic-life-support phase and 4630 patients in the advanced-life-support phase, on the basis of a type I error of 0.05, a type II error of 0.20, a baseline mortality of 17%, and a clinically important difference of 2%. We therefore defined the 6-month duration of each phase of the study based on the expectation that we would be able to enroll at least this number of patients in that time interval.

The primary outcome measure of death before hospital discharge was assessed with chi-square analysis. Ninety-five percent confidence intervals were calculated for the absolute difference in mor-

tality between phases. Stepwise logistic-regression analysis was performed to control for possible confounding variables. These variables included age, sex, initial respiratory rate, initial pulse rate, EMS priority return code (a measure of urgency assigned by the on-site paramedic after initial assessment of the patient's condition), treatment administered, and final diagnosis. Comparisons of the rates of death between the two phases were made for the following subgroups: community size, discharge diagnosis, and EMS return code. Differences between the phases for data other than mortality were analyzed with the Wilcoxon signed rank-sum test, the chi-square test, Fisher's exact test, or Student's t-test, as appropriate. All reported P values are two-sided and not adjusted for multiple testing.

RESULTS

The study enrolled 8138 patients from 15 communities: 3920 in the 6-month basic-life-support phase (from January 1995 to February 1998) and 4218 in the advanced-life-support phase (from February 1998 to November 2000). In each community, the two phases were separated by a run-in period of 6 to 36 months to allow for training in advanced life support. In general, patients in the two phases had similar characteristics (Table 1).

Table 2 shows the EMS responses during the two phases. The median response intervals were similar in the two phases. Advanced-life-support crews responded to 56.6% of patients in the advanced-life-support phase. Although the use of respiratory support measures increased in this phase, fewer than 3.0% of patients received bag-valve-mask ventilation and fewer than 2.0% of patients underwent intubation. Intravenous medications (most often furosemide) were given to 15.0% of patients in the advanced-life-support phase. The use of medications for symptom relief (primarily nebulized salbutamol) increased markedly (from 15.7% to 59.4%) between phases.

Table 3 shows patient outcomes. Vital status was obtained for all 8138 patients; the status of 7663 patients was obtained from hospital records and the status of 475 patients was obtained from the Ontario Death Registry. The primary outcome measure, mortality, decreased significantly, from 14.3% to 12.4% (absolute difference, 1.9%; 95% confidence interval [CI], 0.4 to 3.4; $P=0.01$). This

difference in mortality was entirely accounted for by a decrease in the in-hospital mortality, whereas the mortality in the emergency department was unchanged. In a multivariate analysis, the study phase remained a significant predictor of survival after correction for potential confounding variables, including age, sex, initial respiratory rate, initial pulse rate, priority return code, treatment administered, and final diagnosis (adjusted odds ratio, 1.28; 95% CI, 1.11 to 1.47).

The proportion of survivors with the best cerebral-performance category score of level 1 (on a scale of 1 to 5, with a higher score indicating more disability) increased significantly (from 52.3% to 62.5%, $P<0.001$). The proportion of patients whose condition was subjectively judged by the paramedics to have improved on arrival at the emergency department increased substantially (from 24.5% to 45.8%, $P<0.001$). In addition, the rate of intubation in the emergency department decreased from the basic-life-support phase to the advanced-life-support phase (from 5.3% to 3.1%, $P<0.001$). There was no significant change in the presence of aspiration on chest radiography, although surveillance for this outcome was much more thorough in the advanced-life-support phase. There was only a very small difference between phases for hospital admission rates (67.8% vs. 65.0%), and no significant difference in mean length of hospital stay in days.

We evaluated a number of clinically important subgroups (Table 4). A reduction in mortality during the advanced-life-support phase was suggested for patients with the final diagnosis of congestive heart failure (15.1% vs. 10.9%) but not for those with other discharge diagnoses. However, a test for interaction did not confirm a statistically demonstrable difference between the effect of out-of-hospital advanced-life-support measures in patients with congestive heart failure and in patients with other diagnoses.

In another subgroup analysis, there was evidence that the benefit of advanced-life-support measures on mortality was seen only among patients in the larger cities in the study (those with more than 100,000 people) but not in the smaller communities. Finally, as compared with the basic-life-support phase, a reduction in mortality was seen in the advanced-life-support phase when the EMS return code was recorded as "not urgent" (11.7% vs. 9.8%) but not when the EMS return code was recorded as "urgent." However, a test for

Table 1. Baseline Characteristics of the 8138 Patients in the OPALS Respiratory Distress Study.*

Characteristic	Basic-Life-Support Phase (N = 3920)	Advanced-Life-Support Phase (N = 4218)
Age — yr		
Mean	70.8±16.6	70.2±17.2
Range	16–107	16–102
Male sex — no. (%)	1882 (48.0)	1934 (45.9)
Population of city — no. (%)		
<30,000	63 (1.6)	90 (2.1)
30,000–99,999	729 (18.6)	601 (14.2)
100,000–199,999	642 (16.4)	769 (18.2)
200,000–500,000	1438 (36.7)	1586 (37.6)
>500,000	1048 (26.7)	1172 (27.8)
EMS return code — no. (%)		
Urgent	1418 (36.2)	1413 (33.5)
Prompt	2445 (62.4)	2579 (61.1)
Deferrable	30 (0.8)	100 (2.4)
Declined transport	27 (0.7)	126 (3.0)
EMS severity status score of “severe” — no./total no. (%)†	1383/3651 (37.9)	1444/4073 (35.5)
Initial GCS score of 15 — no./total no. (%)‡	3050/3548 (86.0)	3588/4160 (86.2)
Initial heart rate — beats per minute	99.6±22.3	101.2± 22.7
Initial respiratory rate — breaths per minute	28.4±7.9	28.5±8.3
Final diagnosis — no./total no. (%)		
Congestive heart failure	1009/3605 (28.0)	861/3649 (23.6)
Chronic obstructive pulmonary disease	670/3605 (18.6)	702/3649 (19.2)
Pneumonia	500/3605 (13.9)	468/3649 (12.8)
Other respiratory condition	258/3605 (7.2)	341/3649 (9.3)
Asthma	269/3605 (7.5)	279/3649 (7.6)
Other cardiovascular condition	151/3605 (4.2)	175/3649 (4.8)
Myocardial infarction	86/3605 (2.4)	106/3649 (2.9)
Bronchitis	130/3605 (3.6)	159/3649 (4.4)
Lung cancer	140/3605 (3.9)	106/3649 (2.9)
Congestive heart failure or chronic obstructive pulmonary disease	60/3605 (1.7)	29/3649 (0.8)
Other condition	332/3605 (9.2)	423/3649 (11.6)

* Plus–minus values are means ±SD. GCS denotes Glasgow Coma Scale.

† Scores range from minor to moderate, severe, life-threatening, and “vital signs absent.”

‡ Scores range from 3 to 15, with higher scores indicating a better condition.

interaction showed that neither of these trends was statistically significant.

DISCUSSION

In this trial, we evaluated the effect of out-of-hospital advanced life support on the outcomes of pa-

tients with respiratory distress. Although there was a significant reduction in overall mortality during the advanced-life-support phase of the trial, the magnitude of the observed decrease did not exceed the prespecified, minimal, clinically important difference of 2 percentage points. In addition, there was a significant increase in the proportion

Table 2. EMS Response for the 8138 Patients in the OPALS Respiratory Distress Study.*

Characteristic	Basic-Life-Support Phase (N = 3920)	Advanced-Life-Support Phase (N = 4218)
Paramedics		
Primary-care paramedics on scene — no. (%)	3920 (100.0)	1829 (43.4)
Advanced-care paramedics — no. (%)		
On scene	0	2389 (56.6)
On scene in 11 min	0	1988 (47.1)
EMS return code		
Patients with EMS return code “urgent” — no./total no. (%)	0/1418	866/1413 (61.3)
Intervention		
Bag–valve–mask ventilation — no. (%)	92 (2.3)	123 (2.9)
Endotracheal intubation — no. (%)		
Attempted	NA	70 (1.7)
Successful	NA	61 (1.4)
Administration of intravenous medications — no. (%)	NA	637 (15.1)
Furosemide	NA	609 (14.4)
Morphine	NA	62 (1.5)
Fluid bolus	NA	48 (1.1)
Administration of medications for symptom relief — no. (%)	614 (15.7)	2507 (59.4)
Nebulized salbutamol — no. (%)	585 (14.9)	2268 (53.8)
Sublingual nitroglycerin — no. (%)	29 (0.7)	397 (9.4)
Response intervals — min		
Call receipt to crew notification		
Median	0.8	0.7
Interquartile range	0.5–1.2	0.5–1.1
Crew notification to vehicle arrival at scene		
Median	5.9	6.3
Interquartile range	4.3–8.1	4.6–8.4
Crew notification to ambulance with basic-life-support team at scene		
Median	5.9	6.1
Interquartile range	4.3–8.1	4.5–8.3
Crew notification to ambulance with advanced-life-support team at scene		
Median	NA	6.4
Interquartile range	NA	4.7–8.5
Vehicle arrival at scene to arrival at patient’s side		
Median	2.0	2.0
Interquartile range	1.0–2.0	2.0–2.0
Arrival at patient’s side to departure from scene		
Median	11.7	14.8
Interquartile range	9.0–14.9	11.4–18.7
Departure from scene to arrival at hospital		
Median	6.1	6.9
Interquartile range	3.9–9.6	4.5–10.6

* NA denotes not applicable.

Table 3. Mortality, Functional Status, and Other Outcomes of Patients from the Two Study Phases.*

Outcome	Basic-Life-Support Phase (N=3920)	Advanced-Life-Support Phase (N=4218)	Absolute Change (95% CI)	P Value
Overall mortality — no. (%)†	560 (14.3)	522 (12.4)	1.9 (0.4 to 3.4)	0.01
Cerebral-performance category score, level 1 — no./total no. (%)	1559/2983 (52.3)	1723/2756 (62.5)	10.3 (7.7 to 12.8)	<0.001
Outcomes in emergency department — no./total no. (%)				
GCS score of 15 on arrival	1055/1215 (86.8)	1274/1455 (87.6)	0.7 (−1.9 to 3.3)	0.57
Status of patient on arrival				<0.001
Improved	927/3784 (24.5)	1876/4096 (45.8)	21.3 (19.2 to 23.4)	
Unchanged	2673/3784 (70.6)	2033/4096 (49.6)	21.0 (18.9 to 23.1)	
Worsened	182/3784 (4.8)	177/4096 (4.3)	0.5 (−0.4 to 1.4)	
Lost vital signs en route	2/3784 (0.1)	10/4096 (0.2)	0.2 (0.0 to 0.4)	
Underwent intubation	190/3583 (5.3)	110/3580 (3.1)	2.2 (1.3 to 3.2)	<0.001
Aspiration	45/2155 (2.1)	67/3471 (1.9)	0.2 (−0.6 to 0.9)	0.68
Death	46/3657 (1.3)	46/3702 (1.2)	0.0 (−0.5 to 0.5)	1.0
Outcomes in hospital				
Admission — no./total no. (%)	2478/3657 (67.8)	2405/3702 (65.0)	2.8 (0.6 to 5.0)	0.01
Length of stay — days	9.8±13.2	9.4±12.2	0.4	0.20
Disposition to home — no./total no. (%)	2415/3665 (65.9)	2457/3668 (67.0)	1.1 (−1.1 to 3.3)	0.32
Death — no./total no. (%)	514 (13.1)	476 (11.3)	1.7 (0.3 to 3.2)	0.01

* Plus-minus values are means ±SD. GCS denotes Glasgow Coma Scale.

† Ontario Death Registry records were used to determine the vital status of 475 patients for whom hospital medical records were not available. Since no hospital discharge date was known for these patients, death within 30 days after study enrollment was used to define mortality for the purposes of this study. Death according to this definition was recorded for 51 of these 475 patients.

of patients with a cerebral-performance category score of level 1. These improvements in outcome were achieved despite the fact that providers of advanced life support attended fewer than 60% of patients in the second phase of the study and the two advanced-life-support interventions (endotracheal intubation and the administration of intravenous medication) were performed in only 1.4% and 15.0% of patients, respectively.

We performed subgroup analyses to determine whether the survival benefit varied from group to group. The subgroup of patients with a discharge diagnosis of congestive heart failure, as compared with those with other diagnoses, was more likely to have a reduction in mortality during the advanced-life-support phase. However, an interaction test did not confirm a significant difference in effect among patients with the most common discharge diagnoses. Patients in cities with a population of more than 100,000 were also more likely to benefit during the second phase of the trial, as were patients with an EMS return code of “not urgent.”

Previous data regarding the benefit of advanced life support for patients with shortness of breath are limited. To our knowledge, there have been no previous controlled trials and no previous studies that clearly show improved survival with advanced airway measures or the administration of medication for patients with congestive heart failure.^{6,7,12,17} Three small studies evaluated the feasibility but not the effectiveness of techniques to maintain positive airway pressure in patients being transported in ambulances.¹⁸⁻²⁰ For patients with asthma, several small studies evaluated the administration of beta-agonists in out-of-hospital settings and showed an improvement in the peak expiratory flow rate but no improvement in the rate of deaths among patients.^{5,8,9}

An important potential limitation of our study is that it was designed as a before-and-after controlled trial rather than as a randomized trial and, as such, it had a historical rather than a contemporaneous control group. It was not possible for individual patients to undergo randomization because the paramedics considered the random with-

Table 4. Mortality among Clinically Important Subgroups.

Variable	All Patients		Patients Who Died before Discharge		Difference (95% CI)	P Value for Interaction
	Basic-Life-Support Phase (N=3920)	Advanced-Life-Support Phase (N=4218)	Basic-Life-Support Phase (N=560)	Advanced-Life-Support Phase (N=522)		
Population of city — no./total no. (%)						0.36
<30,000	63 (1.6)	90 (2.1)	7/63 (11.1)	12/90 (13.3)	2.2% (–9.1 to 13.6)	
30,000–99,999	729 (18.6)	601 (14.2)	92/729 (12.6)	102/601 (17.0)	4.4% (0.4 to 8.3)	
100,000–199,999	644 (16.4)	769 (18.2)	102/644 (15.8)	85/769 (11.1)	–4.7% (–8.5 to –1.1)	
200,000–500,000	1438 (36.7)	1600 (37.9)	211/1438 (14.7)	199/1600 (12.4)	–2.3% (–4.7 to 0.2)	
>500,000	1048 (26.7)	1175 (27.9)	148/1048 (14.1)	124/1175 (10.6)	–3.5% (–6.4 to –0.8)	
Discharge diagnosis — no./total no. (%)						0.25
Congestive heart failure	1009/3605 (28.0)	861/3649 (23.6)	152 (15.1)	94 (10.9)	–4.2% (–7.2 to –1.1)	
Chronic obstructive pulmonary disease	670/3605 (18.6)	702/3649 (19.2)	51 (7.6)	52 (7.4)	–0.2% (–3.1 to –2.7)	
Pneumonia	500/3605 (13.9)	468/3649 (12.8)	113 (22.6)	94 (20.0)	–3.7% (–7.8 to –2.8)	
Asthma	269/3605 (7.5)	279/3649 (7.6)	0 (0.0)	1 (0.4)	1.0% (0.5 to 1.3)	
EMS return code — no. (%)						0.66
Not urgent	2475 (63.1)	2679 (63.5)	290 (11.7)	263 (9.8)	–1.9% (–3.6 to –0.2)	
Urgent	1418 (36.2)	1413 (33.5)	270 (19.0)	258 (18.3)	–0.7% (–3.7 to 0.2)	

holding of potentially lifesaving procedures to be unethical. Such a study would have been logistically difficult to carry out in any case. In addition, the primary outcome measure, death, was not subject to ascertainment bias. Selection bias was minimized by the population-based approach of including all patients from the study communities. A program to administer medications for symptom relief (nebulized salbutamol and sublingual nitroglycerin) was introduced toward the end of the first phase of this study. Although this program was not specifically related to advanced life support, it may have been a factor that influenced the benefit in the second phase of the study. Positive-airway-pressure therapy was also introduced in some emergency departments during the study period; this could have influenced the outcome for some of the patients in the study.

The implications of this study require careful consideration. The patients in the second phase of the study had a significantly lower mortality than those in the first phase. We estimate that 53 is the number needed to treat for the entire cohort with shortness of breath, and in the study regions with 2.5 million people, approximately 161 lives would be saved each year.

However, it is less clear which interventions should be considered essential and how they should be implemented. In this study, very few patients underwent intubation, and of the intravenous medications, only furosemide was given to a large number of patients (14.4%). The most substantial change in therapeutic intervention was the marked increase in the use of medications for symptom relief; this intervention is not a component of advanced life support, and it was implemented as part of a separate program. Thus, the benefit of the intervention in this trial may have been primarily due not to the availability of advanced-life-support techniques but to the use of nebulized salbutamol and sublingual nitroglycerin. However, it is difficult to analyze the effect of individual measures in this study, since the patients treated with any given intervention likely differed from those who did not receive that intervention and it would be difficult to define a comparable subgroup within the control sample. The reduction in mortality among patients in this study was entirely due to a reduction in the in-hospital mortality, with no change in the mortality in the emergency department. Although many of the patients who died presumably did so soon after admission,

these data do raise the question of whether other interventions occurring after the patients arrived at the hospital played a role in the improvement in outcome.

Analyses of the benefit for patients with specific discharge diagnoses are of some interest, but the decision to dispatch an advanced-life-support team cannot be made on the basis of a subsequently determined discharge diagnosis. There was more evidence of a survival benefit among patients with an EMS return code of "not urgent" than among those with a code of "urgent," so it is unclear whether patients were more likely to benefit if they were less ill. Finally, the benefit of an advanced-life-support program must be balanced against the relatively high cost of its implementation.

The OPALS Respiratory Distress Study showed that the introduction of an EMS advanced-life-sup-

port program and interventions for symptom relief significantly reduced mortality for patients with shortness of breath. It is unclear whether these data are sufficient to justify implementation of the entire program of interventions described here. Further research should target populations and evaluate the optimal treatment regimens for patients with out-of-hospital respiratory distress.

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APPENDIX

The OPALS Study Group investigators from the following base hospital programs participated in the study: *Burlington* — M.W. Stempien, C.I. Parkinson; *Cambridge* — D. Waldbillig, K.W. Ballah; *Kingston* — G.J. Jones, M.R. Halladay; *London* — J.F. Dreyer, K.A. Boyle; *Niagara* — D.P. Munkley, L.G. Luinstra Toohey; *Ottawa* — J.P. Maloney, J.P. Trickett; *Peterborough* — V. Arcieri, J.W. Fader; *Sarnia* — M.G.J. Lees, D.D. LaBarre; *Sudbury* — R.S. Lepage, S. Michaud; *Thunder Bay* — A.W. Affleck, T.A. Tyson; *Windsor* — J.C. Fedoruk, M. Gobet.

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