Is prehospital advanced life support really necessary?

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Prehospital care by paramedics — emergency personnel trained in advanced life support (ALS) — has been seen to reduce morbidity and mortality rates associated with some medical and trauma-related emergencies. Paramedics are skilled in several major modalities — airway maintenance, defibrillation, administration of intravenous fluids, drug therapy and the use of military antishock trousers (MAST) — which together form ALS. But are all these skills really necessary?

There has been considerable research over the last two decades in Canada, the United States and elsewhere into the impact of paramedics on acute medical and surgical emergencies. Although ALS has been shown to reduce morbidity and mortality rates in some cases, which of its modalities, if any, contribute independently toward improved patient outcome has yet to be established. In light of the increasing pressure on the health care dollar this question is of mounting importance. Those interested in prehospital care must determine which modalities contribute most to survival before paramedics with full ALS capabilities become commonplace. Once paramedics become established, it will be much more difficult to selectively evaluate or discontinue individual modalities should their efficacy become questionable.

I reviewed the literature from 1971 to 1987 through the medical database Medline. To capture the widest range of articles the key words ambulance, cardiac, defibrillation, emergency medical technician, paramedic, prehospital, survival, training, transport and trauma were used. Additional references were obtained from the bibliographies. Of the 119 articles identified, 69 were subsequently analysed. Letters, editorials and articles addressing nonemergency treatment and transportation were discarded. The 69 papers included 14 review articles, 9 randomized controlled clinical trials, 8 prospective cohort studies, 1 retrospective cohort study, 11 prospective case studies, 14 retrospective case studies, 6 case studies whose directional status (prospective v. retrospective) was unclear and 9 other nonevaluative or descriptive studies (Table I).

There is now a consensus, based primarily on case studies, that the ALS capabilities of paramedics improve the outcome of out-of-hospital cardiac emergencies, principally cardiac arrest.[1-6] Eisenberg and coworkers,[7-9] in Seattle, and Vertesi and associates,[10] in Vancouver, used cohort studies to evaluate both long- and short-term survival in patients having out-of-hospital cardiac arrest. These studies compared survival rates either between two populations receiving differing prehospital care or in the same population before and after the advent of paramedics. All four cohort studies found that the survival rates in patients receiving care from paramedics were consistently higher than those among patients who received nonparamedic, or basic life support (BLS), services. BLS, the most common service in Canada, provides manual cardiopulmonary resuscitation (CPR) and injury stabilization. Most research to date has addressed the "all-or-nothing" approach: full ALS versus BLS. Survival rates (survival up to time of discharge from hospital) of 20% to 30% have been seen in patients with ventricular fibrillation who within 4 minutes received CPR and within the next 8 minutes received defibrillation, intubation, and intravenous administration of fluids and medication for the dysrhythmias.[4-11] There has been no clear indication of changes in patterns of illness or in length and cost of hospital stay for patients receiving ALS as opposed to BLS.

Bystander-initiated CPR

Prompt ambulance response or rapid application of CPR by bystanders, particularly health care professionals,[11] has been identified as one of the most important prognostic factors.[1,12-23] Some researchers found that bystander-initiated CPR was so closely associated with increased survival rates that paramedics without bystander support had only a marginally better chance of saving the victim than did bystanders.[5,17] The exact mechanism through which CPR increases the chance of

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survival has not been established.[24,25] Although there is evidence that rhythm deterioration occurs in patients who receive only BLS,[25] it is not clear how much rhythm deterioration would occur without any resuscitation attempts.

A randomized trial assessing the skill and knowledge retention of secondary school students emphasized that practical experience with mannequins was necessary for skills to be maintained.[26] The appropriateness of the target populations being trained in CPR (i.e., primary and secondary students v. public servants such as police officers, firefighters and public service workers) has been questioned since many of the people who are being taught are not likely to come in contact with individuals suffering out-of-hospital cardiac arrest.[12,26-29] The medical profession's control of this aspect of prehospital care is often tenuous.

Defibrillation

Prehospital defibrillation has been shown retrospectively and prospectively to increase the chance of surviving ventricular fibrillation. Stults and Brown,[30] among others, have found that ventricular fibrillation occurs in 55% to 60% of all persons suffering cardiac arrest. The rate of out-of-hospital cardiac arrest appears to vary between 0.55 and 1.0/1000 population.[8,30,31] Fortunately, ventricular fibrillation and tachycardia are the dysrhythmias most amenable to prompt resuscitation with electric shock.[9,11,30-42] Prompt prehospital defibrillation by emergency personnel with only BLS capabilities has "saved" up to 46% of cardiac arrest victims,[35,38,43] even when full paramedic support was not available.[4,9,28,40,43] Four randomized clinical trials have supported the efficacy of defibrillation, the survival rates being comparable to those achieved by paramedics.[44-47] Until recently, prehospital treatment required that the attendant recognize arrhythmias and manually defibrillate the patient. This skill requires between 10 and 15 hours' initial training followed by a quarterly review of 2 to 3 hours.[40] Automatic defibrillation requires only 4 hours' training followed by a semiannual review of 2 hours.[30] In addition, automatic defibrillation has been shown to be as effective as manual defibrillation[36] and can be activated in half the time.

Airway management

The management and maintenance of a patient's airway is essential in many medical emergencies, including those related to cardiac arrest and trauma.[2,48,49] In first aid and prehospital treatment airway maintenance is always the first priority.[50] O'Connor and Flannigan[51] found that in fewer than 40% of cases was airway ventilation effective when performed by ambulance attendants with BLS capabilities in a moving ambulance in Kingston, Ont. The attendants used a portable Flynn oxygen ventilator (O-Two Systems of Canada, Mississauga, Ont.) and an oropharyngeal airway on ResusciAnnie mannequins. The difficulties experienced by these attendants were consistent with those described by Cummins and colleagues[52] among attendants in King County, Washington; in the latter study more than four attempts with a bag mask were required before an adequate breath (more than 1 L) was delivered to a mannequin.[52] These two studies reinforce the need for a better method of maintaining an airway than using an oropharyngeal airway with either a bag mask or a Flynn oxygen ventilator.

The two current alternatives involve the use of the esophageal obturator airway and endotracheal intubation. There has been some concern about the former because of the frequency of failed attempts and complications;[53-55] hence, intubation continues

Table I — Analysed articles on advanced life support and associated modalities published from 1971 to 1987*

Focus of article	Randomized controlled clinical trial	Prospective cohort study	Retrospective cohort study	Prospective case study	Retrospective case study	Other
Airway maintenance	–	–	–	2	2	2
Military antishock trousers	3	–	–	–	2	–
Defibrillation	5	–	–	2	2	–
Medication	–	–	–	–	–	–
Administration of intravenous fluids	–	–	–	–	–	–
Advanced life support	–	1	1	–	3	6
Basic life support	1	–	–	–	1	–
Cardiopulmonary resuscitation	–	1	–	1	4	6
Cardiac arrest	–	5	–	6	9	9
Trauma	–	–	–	–	5	2
Other	–	1	–	–	–	3
Total	9	8	1	11	28	28

*Studies were tabulated according to their major focus; however, some examined more than one key element, so the totals may not accurately reflect the number of papers evaluated.

to be the preferred method of protecting the airways. In a prospective study Jacobs and coworkers[56] evaluated 149 patients who had received prehospital intubation by medical personnel and found a 96% success rate and no complications. The training for the personnel in that study included successful intubation of 15 patients in the operating room under the direct supervision of an anesthetist.

MAST

The use of MAST has been shown in retrospective studies to produce a minor increase in blood pressure and a decrease in heart rate in patients with hypovolemia or cardiogenic or anaphylactic shock,[57-59] and it has been suggested that the application of MAST may be beneficial when the prehospital time is likely to be more than 30 minutes. To date there have been three randomized controlled trials of these garments. Mattox and associates[60,61] did not find the use of MAST in 35 000 trauma patients to have a statistically significant benefit when the time before arrival at hospital was 30 minutes or less. In an earlier trial the use of MAST had led to improved rates of resuscitation and discharge for patients with refractory ventricular fibrillation. Although these results were clinically important they were not statistically significant.[58] Therefore, the benefit of MAST in urban areas, where patients are not long in transit, has not been unequivocally established and requires further study. It has been suggested that for patients for whom the prehospital time is likely to be more than 30 minutes the application of MAST may be beneficial.[58]

Intravenous administration of fluids

The intravenous administration of fluids appears to be most beneficial when there has been a reduction in blood volume.[62,63] However, there is still some controversy as to whether major fluid loss can be appropriately corrected by intravenous infusion before arrival at hospital or whether rapid transportation to a hospital where definitive treatment can be started is better.[64-66] The latter approach appears to be preferable when the travel time is less than the time required to set up an intravenous line.[66] There have been no controlled trials or cohort studies that have specifically assessed the outcome of fluid administration before arrival at hospital and when the travel time is long.

Intravenous drug administration

There have also been no studies demonstrating the advantages of early drug administration. Paramedics are permitted, according to either strict protocols or direct medical authorization, to administer a variety of cardiac medications as well as other drugs specific to individual medical conditions. There is no evidence that early administration of drugs, with the exception of epinephrine, influences morbidity or mortality rates.

Atkins[67] has outlined the four principal factors that contribute to successful resuscitation from cardiac arrest: time, defibrillation, epinephrine and BLS. Epinephrine promotes peripheral vasoconstriction and therefore the electrical potential of cardiac muscle and therefore increases the likelihood of successful defibrillation. Unlike many medications, epinephrine can be administered endotracheally.[68] Another first-line medication for ventricular arrhythmias, lidocaine hydrochloride, can also be administered endotracheally,[69] negating the need for intravenous access.

The dilemma

The modalities that have been shown to be effective in the prehospital care of cardiac patients — BLS, intubation, defibrillation and administration of epinephrine — are subcomponents of the "paramedic package". In addition, they are skills that can be taught in a relatively short time. However, except for defibrillation, it is not known to what extent each of these, or any of the other modalities in ALS, contributes to survival or decreases morbidity rates. Furthermore, there has been no research support for the need for paramedics who are qualified to start intravenous lines when the travel time to the closest hospital is less than 15 minutes.

Researchers and clinicians must determine which skills contribute most to survival. This can be accomplished only through the evaluation and critical appraisal of each component required for treating the most common illnesses and injuries. It may be that some personnel will need customized training and capabilities that depend on the environment (e.g., urban v. rural), where response and transport times may vary.

The best method of establishing efficacy remains the randomized controlled clinical trial or, barring that, a well-controlled cohort study. As long as the demand for services exceeds the availability it is possible to randomly allocate patients to experimental and control groups. An evaluation of each modality of prehospital ALS may yield valuable information on the contributions of each to increased survival and decreased morbidity rates.

Through such rigorous study it should be possible to determine which ALS procedures are indeed beneficial and should thus be included in future paramedical training and which ones can be safely excluded. If we want a high and regionally consistent level of prehospital care that we can afford, careful scientific evaluation of all aspects of ALS is essential.

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Duplicate publishing – again

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The typical journal reader may wonder why the International Committee of Medical Journal Editors and other scientific editors are so concerned about authors' publishing the same material in more than one journal.[1,2] After all, the reader who encounters a too-familiar article accepts that the medical literature is vastly redundant and will simply look for something else to read. Scientific method not only sanctions reiteration but insists on it. Findings have to be checked, challenged, discussed and related to other work from different perspectives.

However, duplicate publication does not meet the scientific requirement for re-examination and reconsideration: it merely repeats what has already been said. It blocks communication by taking up space for original work and creates conflict between author and editor. It serves the author's interests because it increases and diversifies readership and adds to the author's list of publications, but it is a disservice to the second journal for the converse of these reasons: it turns readers away from the journal and reduces the number of original articles the journal can publish.

In an earlier essay[3] I proposed a typology of "duplicators", ranging from the inadvertent to the diabolic, and proposed that editors could discourage some of these actors by notifying their superiors and embargoing their future contributions to the editor's journal. Since that essay was published *CMAJ* has been involved in further episodes of duplicate publication — in all of which, as far as we know, our journal was the second to publish, or to be asked to publish, the communication in question. Our tipoff to the proposed duplication rarely came directly from the author; typically there would be a seemingly incidental reference to an earlier paper by the same author or authors, which

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