INTRODUCTION OF ADVANCED CARE TO PRE-HOSPITAL SERVICES IN QUÉBEC

AGENCE D'ÉVALUATION DES TECHNOLOGIES ET DES MODES D'INTERVENTION EN SANTÉ

Québec

INTRODUCTION OF ADVANCED LIFE SUPPORT IN PRE-HOSPITAL EMERGENCY MEDICAL SERVICES IN QUÉBEC

Report prepared for AETMIS
by Reiner Banken, Brigitte Côté,
François de Champlain and André Lavoie

December 2005

Agence d'évaluation
des technologies
et des modes
d'intervention en santé
Québec

This report was translated from an official French publication of the Agence d'évaluation des technologies et des modes d'intervention en santé (AETMIS). Both the original report titled *Introduction des soins médicaux avancés dans les services préhospitaliers d'urgence au Québec* and the English report are available in PDF format on the Agency's Web site.

Scientific review
Dr. Véronique Déry, MD, MSc, Chief Executive Officer and Scientific Director
Jean-Marie R. Lance, MSc, Senior Scientific Advisor

Translation
Jocelyne Lauzière, MA, Certified Translator

Editorial supervision
Suzie Toutant

Proofreading
Frédérique Stephan

Page layout
Frédérique Stephan

Bibliography research
Micheline Paquin

Co-ordination
Lise-Ann Davignon

Communications and dissemination
Richard Lavoie, MA

For further information about this publication or any other AETMIS activity, please contact:

Agence d'évaluation des technologies et des modes d'intervention en santé
2021 Union Avenue, Suite 1050
Montréal (Québec) H3A 2S9

Telephone: (514) 873-2563
Fax: (514) 873-1369
E-mail: aetmis@aetmis.gouv.qc.ca
www.aetmis.gouv.qc.ca

How to cite this document:

Agence d'évaluation des technologies et des modes d'intervention en santé (AETMIS). Introduction of advanced life support in pre-hospital emergency medical services in Québec. Report prepared by Reiner Banken, Brigitte Côté, François de Champlain and André Lavoie (AETMIS 05-01). Montréal: AETMIS, 2005.

Legal deposit
Bibliothèque nationale du Québec, 2005
Library and Archives Canada, 2005
ISBN 2-550-44471-X (Print) (French edition ISBN 2-550-44197-4)
ISBN 2-550-44472-8 (PDF) (French edition ISBN 2-550-44484-1)

MISSION

The mission of the *Agence d'évaluation des technologies et des modes d'intervention en santé* (AETMIS) is to contribute to improving the Québec health-care system and to participate in the implementation of the Québec government's scientific policy. To accomplish this, the Agency advises and supports the Minister of Health and Social Services as well as the decision-makers in the health care system, in matters concerning the assessment of health services and technologies. The Agency makes recommendations based on scientific reports assessing the introduction, diffusion and use of health technologies, including technical aids for disabled persons, as well as the modes of providing and organizing services. The assessments take into account many factors, such as efficacy, safety and efficiency, as well as ethical, social, organizational and economic implications.

FOREWORD

In the fall of 2004, several Québec emergency medical technicians obtained Ontario certification as advanced care paramedics and asked for authorization to apply their training here. It was in this context that the Minister of Health and Social Services asked AETMIS *(Agence d'évaluation des technologies et des modes d'intervention en santé)* in November 2004 to prepare a report on the role of advanced life support (ALS) in the organization of pre-hospital emergency medical services in Québec.

The present assessment is based primarily on a comprehensive review of the scientific literature on this topic. The analysis also took into account developments in pre-hospital care, advanced life support practice models and training, internationally as well as in Canada and in Québec.

Examination of the scientific data led to four major findings. First, there is not enough solid evidence to support the widespread routine use of pre-hospital advanced life support throughout Québec. Second, some preliminary evidence shows that advanced life support could be beneficial, especially in cases of respiratory distress and cardiac chest pain. Third, the limited evidence that is available indicates that advanced life support is neither beneficial nor detrimental in terms of mortality or morbidity in patients experiencing non-traumatic cardiac arrest, although the hypothesis that this type of care may be beneficial remains plausible. Finally, evidence reveals that advanced life support is associated with adverse effects in certain circumstances, such as the pre-hospital endotracheal intubation of young children and trauma management.

In light of these findings, current developments and Québec's particular context, AETMIS recommends that, for the time being, Québec limit the use of advanced life support to duly evaluated pilot projects, with priority being given to the management of respiratory distress, chest pain and cardiac arrest. AETMIS also recommends implementing a series of measures designed to optimize pre-hospital basic life support and the chain of survival throughout Québec, chiefly by enhancing the training provided to emergency medical technicians.

In submitting this report, AETMIS hopes to inform the ongoing debate on the introduction of advanced life support in Québec's pre-hospital emergency medical services.

Dr. Luc Deschênes
President and Chief Executive Officer

ACKNOWLEDGEMENTS

This report was prepared at the request of the *Agence d'évaluation des technologies et des modes d'intervention en santé* (AETMIS) by **Reiner Banken**, MD, MSc (Community Health), Consultant Researcher, AETMIS, **Brigitte Côté**, MD, MSc (Public Health), Consultant Researcher, AETMIS, **François de Champlain**, MD, FRCPC, F.AC.E.P Emergency Medicine Specialist, and **André Lavoie**, PhD (Epidemiology), Epidemiologist.

We would like to thank Stephane Perron, MD, MSc (Public Health), for his contribution to the quality control of several sections of the present report.

AETMIS would like to thank the external reviewers of this report for their valuable feedback:

Marica Ferri, MD
Co-ordinator, *Unità di Progetto*: *EBM e Modelli Assistenziali, Agenzi di Sanità Pubblica della Regione Lazio*, Rome, Italy

Assunta De Luca, MD
Head of Emergency Unit, *Unità di Progetto: EBM e Modelli Assistenziali, Agenzi di Sanità Pubblica della Regione Lazio*, Rome, Italy

Alphonse Montminy, MD
President, *Comité des soins d'urgence cardiaque, Fondation des maladies du cœur du Québec*, Montréal, Québec

Joseph J. Osterwalder, MD
Head of Emergency Department, Kantonsspital St. Gallen, Switzerland

Pierre Poirier
Executive Director, Paramedic Association of Canada, and Chairman, National Occupational Competency Profiles for Paramedic Practitioners Review Committee, Ottawa, Ontario

Wayne Smith, MD
Medical Director, *Services préhospitaliers d'urgence, Agence de développement de réseaux locaux de services de santé et de services sociaux de l'Estrie*, Sherbrooke, Québec

The following individuals greatly contributed to this report by providing information, support and key advice:

Marcel Boucher, MD
Director, *Services professionnels et de l'assurance de la qualité, Corporation d'urgences-santé*, Montréal, Québec

Robert Burgess, ACP, AEMCA
Senior Manager, Division of Prehospital Care, Sunnybrook-Osler Centre for Prehospital Care, Toronto, Ontario

Mario Deschênes, MD
Assistant Syndic, *Collège des médecins du Québec*, Montréal, Québec

Claude Desrosiers
Co-ordinator, *Module de l'assurance de la qualité et de la formation clinique, Corporation d'urgences-santé*, Montréal, Québec

Daniel Lefrançois, MD

Medical Director, *Direction adjointe des services préhospitaliers d'urgence, ministère de la Santé et des Services sociaux*, Quebec City, Québec

Suzanne Michalk, MD

President, *Comité sur les soins préhospitaliers d'urgence, Collège des médecins du Québec*, Montréal, Québec

Gisèle Ouimet

Research Consultant, *Module de l'assurance de la qualité et de la formation clinique, Corporation d'urgences-santé*, Montréal, Québec

Eli Segal, MD

Research Co-ordinator, *Module de recherche, Corporation d'urgences-santé*, Montréal, Québec

Ian Stiell, MD

Senior Scientist, Clinical Epidemiology Clinic, Loeb Health Research Institute, and principal investigator, OPALS study, Ottawa, Ontario

Brian Schwartz, MD

Medical Director, Division of Prehospital Care, Sunnybrook-Osler Centre for Prehospital Care, Toronto, Ontario, and President, Canadian Relations Ad Hoc Committee, National Association of EMS Physicians (USA)

DISCLOSURE OF CONFLICTS OF INTEREST

Dr. François de Champlain is also a physician with the *Corporation d'urgences-santé*. André Lavoie was in charge of research and quality assurance for the *Corporation d'urgences-santé* from 1992 to 1999. He worked as a consultant for JSS Medical Research, especially in the context of a binding contract between this firm and the *Corporation d'urgences-santé*. Dr. de Champlain and André Lavoie informed AETMIS of this situation well before this work began.

SUMMARY

INTRODUCTION

In November 2004, the Minister of Health and Social Services asked AETMIS *(Agence d'évaluation des technologies et des modes d'intervention en santé)* to prepare a report on the role of advanced life support in the organization of pre-hospital emergency medical services in Québec. Based on an analysis of the scientific evidence of the efficacy and safety of this type of care, and of the conditions required to achieve effectiveness and safety objectives in the Québec context, this report formulates a series of recommendations designed to provide the scientific basis for the policy directions to be taken by the *Ministère de la Santé et des Services sociaux* in this regard.

NATURE AND STRUCTURE OF PRE-HOSPITAL EMERGENCY CARE

Basic life support (BLS) currently consists of a spectrum of non-invasive procedures, those limited to external application such as using direct pressure and bandages to control hemorrhaging, immobilizing suspected fractures, maintaining respiratory function, maintaining circulatory function by means of chest compressions (cardiopulmonary resuscitation) and, for the past few years, administering five types of medication in accordance with very strict protocols. Some of these emergency procedures can be performed by bystanders or by first responders. All basic life support procedures are performed by emergency medical technicians (EMTs).

Advanced life support (ALS) involves invasive procedures, such as endotracheal intubation, intravenous access (inserting an IV line into a vein), administering different types of medication, and fluid resuscitation (replacing blood volume by administering fluids to increase blood pressure and improve oxygenation of body tissues and organs).

The line between basic life support and advanced life support based on the invasiveness of the procedures used is becoming increasingly arbitrary, owing to the introduction of new procedures and the shift of certain pre-hospital advanced life support practices to basic life support services. This division is now founded more on the training given to advanced care practitioners, who must have greater background knowledge in life sciences and physical sciences to be able to use more complex treatment protocols safely and effectively.

In Canada, the regulation of pre-hospital practice is a provincial jurisdiction, and each legislature is free to determine its own practitioner categories and practice conditions. However, training standards for practitioners of pre-hospital emergency care were standardized in 2001 with the development of the *National Occupational Competency Profiles for Paramedic Practitioners*. These profiles consist of four different levels: emergency medical responder, primary care paramedic, advanced care paramedic and critical care paramedic. Most Canadian provinces are currently shifting toward this model.

A distinction must be made between training levels and practice levels in the provinces and regions. For example, Québec seems to be the only Canadian province where the Combitube® (an orotracheal tube with two ventilation ports) is used in the context of basic life support. Elsewhere in North America, this technique is used mainly in advanced life support when endotracheal intubation has failed. Inserting intravenous lines—one of the core characteristics of advanced life support—is making its way into pre-hospital basic life support care in Alberta and in certain regions of

Ontario, although this procedure is performed only to administer dextrose to hypoglycemic patients.

DEVELOPMENT OF PRE-HOSPITAL EMERGENCY MEDICAL SERVICES IN QUÉBEC

In Québec, the development of ambulance services was long marked by local and even individual initiatives. In the 1950s and 1960s, ambulance services were often run by funeral parlours. By the late 1970s, ambulance permits were being issued by the *Ministère de la Santé et des Services sociaux* (MSSS), which later delegated this responsibility to the regional health and social services boards. In the Montréal region, in the 1980s and 1990s, various changes to the pre-hospital system led to the creation of *Urgences-santé*, which until 2002 employed physicians to provide advanced life support. Elsewhere in Québec, the different regions were developing systems based exclusively on basic life support dispensed by emergency medical technicians (EMTs).

Since the 1990s, the development of pre-hospital care in Québec has been marked by two major planning initiatives. In 1992, the report *Chaque minute compte !* (Every minute counts!) was the first to propose that the various structures making up Québec's pre-hospital emergency medical services (EMS) system be organized into a consistent whole. It did not include any position statement on the usefulness of advanced life support. Published in 2000, the Dicaire report laid out policy directions for developing Québec's pre-hospital EMS system, focusing mainly on the relevance of extending the chain of survival throughout the province. This report also argued for conducting field evaluations of advanced life support within structured pilot projects rather than broadening the use of the full spectrum of advanced life support procedures.

The Dicaire report also paved the way for the adoption in 2002 of the Act respecting pre-hospital emergency services, which now frames the organization of these services provincewide. In addition, the use of advanced life support protocols is now permitted by virtue of the Regulation respecting the professional activities that may be engaged in within the framework of pre-hospital emergency services, adopted under Québec's Professional Code.

Over the past few years, Québec has made a sustained effort to extend the chain of survival throughout its jurisdiction in a bid to limit regional disparities insofar as possible. While other Canadian provinces have chosen the route of developing both basic life support and advanced life support, Québec has made rapid strides in expanding not only the scope and but also the geographic range of basic life support care.

RESULTS

The effectiveness and safety of advanced life support were analyzed through a comprehensive review of relevant scientific literature. Special attention was given to the evaluation of a pre-hospital advanced life support program in Ontario: the OPALS (Ontario Prehospital Advanced Life Support) study. This is probably the largest study ever undertaken on advanced life support, in terms of both the number of patients included in the study and the type of study design used, a before–after non-randomized comparative trial. Data on over 30 000 patients were compiled over a ten-year period (1994–2004).

Cardiac arrest

In the case of cardiac arrest, many studies have clearly established the efficacy of the first links in the chain of survival: early call to 9-1-1, early cardiopulmonary resuscitation (cardiac massage and ventilation) and early defibrillation.

In a system such as the one in Ontario, where early defibrillation is performed by paramedics, the addition of an ALS medication protocol does not improve patient sur-

vival. The OPALS study concludes that it is important for the general public to be trained in cardiopulmonary resuscitation (CPR) and for first responders to be able to perform early defibrillation.

Other cardiac problems

In the case of myocardial infarction, many publications have shown that early access to thrombolysis or angioplasty reduces mortality. If a patient with suspected cardiac chest pain is to be transported directly to a tertiary-care centre, a 12-lead electrocardiogram (ECG) must be performed in the pre-hospital setting. Studies with varying levels of methodological rigour have examined this question and shown an increase in the use of thrombolysis or primary angioplasty, along with a significant reduction in treatment delays when ECGs are obtained in the field. Similarly, certain studies have revealed that ECG results can be transmitted to the receiving hospital so that the interpretation can be confirmed.

In the OPALS study, treatment of suspected cardiac chest pain in accordance with ALS medication protocols led to a significant reduction in mortality rates, which dropped from 4.3% to 3.2%, and more specifically, from 13.1% to 8.5% for myocardial infarction. Abstracts of this study have been published and the results have been presented at several conferences. Publication of the full OPALS study should shed greater light on the conditions liable to explain the effects reported. It is currently impossible to know the extent to which this increased survival rate after cardiac chest pain is attributable to the two most commonly prescribed medications, aspirin and nitroglycerine, which are already included in the symptom-relief program of five drugs that is part of Québec's pre-hospital BLS care. Note that medication protocols are different in basic life support and advanced life support. Advanced care paramedics receive more in-depth training, which allows them to follow protocols requiring more acute clinical judgment to be able to administer the drugs safely.

Respiratory problems

Respiratory problems represent a significant proportion of the use of pre-hospital emergency services. According to the data provided by *Urgences-santé*, 11.1% of all the patients it transported in 2003 had respiratory problems, as assessed by ambulance technicians, representing a total of 16 366 patients. In Ontario, in-hospital mortality of patients in respiratory distress transported by ambulance was 18%. In hospital emergency departments (EDs), the care of patients with congestive heart failure has been greatly improved through the use of non-invasive positive pressure ventilation, such as CPAP (continuous positive airway pressure). Certain studies have shown the benefits of CPAP in pre-hospital settings, but it seems prudent to wait for the published results of an in-progress randomized clinical trial on the usefulness of this approach.

In the OPALS study, the treatment of respiratory distress in compliance with ALS medication protocols has led to a significant drop in mortality rates, from 14.3% to 12.3%. If we examine the different diagnosis subgroups, however, a statistically significant reduction in mortality (from 15.1% to 11.0%) was documented only in patients with congestive heart failure. The improved survival rates in these patients are indeed impressive; however, as is the case with cardiac chest pain, we have only abstracts and conference presentations to rely on. Once published, the complete OPALS study will probably explain the effects reported. Unlike the medications used for cardiac chest pain, those for congestive heart failure are not included in the symptom-relief program that is part of Québec's pre-hospital basic life support care.

Trauma

For the victims of major trauma, the interval between the arrival of emergency personnel and access to definitive trauma care is critical—approximately 80% of deaths occur within the first minutes or hours following the trauma. The tertiary trauma centres established in Québec have helped reduce intrahospital delays and mortality rates. Over the past ten years or so, all published studies and systematic reviews have indicated that the transportation of trauma patients should not be delayed by advanced life support.

Pediatric advanced life support

Few pre-hospital studies have addressed the effectiveness of pediatric advanced life support (PALS), mostly because of the relatively small number of children needing emergency care. Endotracheal intubation is one exception. A randomized controlled trial reveals that this procedure is difficult, if not dangerous, if performed as part of pediatric advanced life support. Since the release of that study, several pre-hospital emergency medical services (EMS) systems have halted this practice with children.

Other treatment avenues

For other conditions, such as convulsive seizures, pain, severe hypoglycemia, strokes and opioid overdoses, advanced life support could be beneficial, but evidence is either lacking or not conclusive enough to support the introduction of treatment protocols.

FIELD EVALUATION OF ADVANCED LIFE SUPPORT AT *URGENCES-SANTÉ*

The infrastructure built by *Urgences-santé* is more highly developed than that found elsewhere in Québec. This organization has a detailed information system, medical control through highly experienced pre-hospital emergency physicians, a well-established quality-assurance program and a training centre. It has been developing a pre-hospital research program for the past twenty years. Consequently, when the Dicaire report was published in 2000, *Urgences-santé* already had an environment that was favourable to conducting field evaluations of ALS protocols by a cohort of emergency medical technicians whose training was tailor-made for this project. Five advanced life support protocols were scheduled to be tested: 1) endotracheal intubation; 2) use of Magill forceps to remove foreign bodies from airways; 3) administration of vasopressin and amiodarone in the case of non-refractory (shockable) cardiac arrhythmia; 4) administration of epinephrine and atropine in the case of refractory (shock-resistant) cardiac arrhythmia; and 5) intravenous administration of dextrose in the case of severe hypoglycemia. The evaluation project was based on a quasi-experimental design.

Because of a series of modifications to the advanced life support project, the exposure of the eighteen emergency medical technicians trained in ALS was much more limited than originally anticipated. As a result, the original research study design had to be abandoned. It was nevertheless possible to evaluate the effectiveness of two of the five protocols related to cardiac arrest. Results were comparable to those observed by the OPALS researchers in Ontario and matched other outcomes documented in the literature: for cardiac arrest, ALS care seemed to provide very short-term results (e.g., increased return of spontaneous circulation or survival to hospital admission) but did not lead to any improvements in rates of survival to hospital discharge, compared with basic life support care.

ASSESSMENT LIMITATIONS

Our assessment rests on an evidence-based model that includes both scientific evidence and contextual information. These data, however, are limited in several respects. First, scientific evidence in this field is

scarce and its validity is weakened by the use of study designs that lack rigour. Published results deal more often with mortality, whereas effects on morbidity, quality of life or patient satisfaction deserve further study since they are liable to affect decisions regarding the organization of pre-hospital emergency medical services. Highly promising results, especially those from the OPALS study, are available only in the form of abstracts or conference presentations. Second, there is also very little contextual information available because most of the regions in Québec have sub-optimal information systems. Given the lack of economic evidence, it also was impossible to produce analyses establishing the cost-effectiveness of different scenarios for developing pre-hospital emergency medical services in Québec.

CONCLUSIONS AND RECOMMENDATIONS

Examination of the scientific evidence of the efficacy and safety of advanced life support care led to four major findings:

- There is currently not enough solid evidence to support the widespread routine use of an advanced life support program throughout Québec.
- Preliminary evidence shows that advanced life support could be beneficial, especially in the case of respiratory distress or cardiac chest pain.
- The limited evidence that is available indicates that advanced life support is neither beneficial nor detrimental in terms of mortality or morbidity in patients experiencing non-traumatic cardiac arrest, yet the hypothesis that it might be beneficial in reducing morbidity and mortality has not yet been set aside and deserves further research.
- Evidence indicates that advanced life support is associated with adverse effects in certain circumstances, mainly the pre-hospital endotracheal intubation of young children and trauma management in general.

Decisions on developing pre-hospital advanced life support must strike a balance between scientific uncertainties and the advisability of introducing highly promising medical care. A firm determination to ground the introduction of new interventions on a rigorous evidence-based analysis would increase the system's overall effectiveness and would place Québec at the forefront of such initiatives on an international scale.

An analysis of scientific evidence, field data and contextual information leads us to make a series of recommendations pertaining to the adoption of a reasoned approach to introducing pre-hospital advanced life support, the optimization of pre-hospital basic life support and the chain of survival, and the establishment of other conditions required for the overall optimization of pre-hospital emergency services in Québec.

Reasoned approach to introducing pre-hospital advanced life support

By reasoned approach, we mean a gradual and reflective process designed to make optimal use of resources within the context of an innovation. This entails understanding its mode of operation in context, measuring its effects, and drawing conclusions about its transferability or applicability to other practice situations.

Recommendation 1: It is recommended that the use of advanced life support in Québec be limited, for the time being and as an initial step, to pilot field projects.

Recommendation 2: It is recommended that pilot projects be set up in Québec with a view to assessing the effectiveness and efficiency of advanced life support protocols and to evaluating the organizational conditions required for their implementation, with priority being given to respiratory distress, chest pain and cardiac arrest. These

projects, which may be carried out in any region of the province, must nevertheless meet the following conditions:

a) They must be carried out in a pre-hospital emergency service capable of guaranteeing to the MSSS that it will comply with high standards with respect to both staff training and quality control of the procedures.

b) The pre-hospital service must offer rigorous medical control, whether online or on site, provided by physicians with expertise in emergency medicine and pre-hospital care.

c) The evaluation must be conducted under the scientific direction of a research group recognized for its independence and experience.

d) Given that evaluation of the impact of advanced life support will contribute to the advancement or application of knowledge in this field, it must be based on an experimental or a quasi-experimental study design approved by a research-granting agency or other recognized body.

e) The nature and scope of the project, the minimum standards of medical control to be observed and the reasons that would justify the premature termination of the pilot project shall be jointly determined by the MSSS, the *Collège des médecins du Québec*, pre-hospital emergency medical service authorities, and the researchers concerned.

f) The number of emergency medical technicians well trained in advanced life support shall be increased to obtain as quickly as possible the number of cases needed to guarantee the validity of the evaluation results.

g) Advanced life support protocols introduced shall explicitly exclude children and trauma patients for the time being.

h) The implementation of advanced life support protocols must be evaluated on an ongoing basis so that appropriate adjustments may be identified and put into effect.

Recommendation 3: It is recommended that a research program be established that deals specifically with evaluating pre-hospital advanced life support, open to the entire research community of Québec, under the leadership of the MSSS.

Recommendation 4: It is recommended that, to ensure throughout Québec a gradual introduction of proven pre-hospital advanced life support care that keeps pace with emerging evidence, a service-development plan be established that provides for the training of a sufficient number of emergency medical technicians capable of administering this care, and that sets out appropriate organizational conditions that would include building close partnerships between pre-hospital and hospital settings.

Optimization of pre-hospital basic life support and the chain of survival

Recommendation 5: It is recommended that the addition of new procedures to pre-hospital basic life support services be supported by evidence or by expert recognition that these new procedures have a significant potential for reducing mortality and morbidity.

Recommendation 6: It is recommended that the basic training provided to emergency medical technicians be enhanced so that the competencies acquired through this training match those stipulated in the National Occupational Competency Profiles (NOCP) for primary care paramedics.

Recommendation 7: It is recommended that measures be implemented to expand the general public's training in cardiopulmonary resuscitation (CPR) and to ensure that patients experiencing cardiac arrest have access to early defibrillation performed by first responders or bystanders.

Establishment of other conditions required to optimize the full spectrum of pre-hospital emergency care in Québec

Recommendation 8: It is recommended that the following be introduced throughout Québec: an enhanced continuing-education program; effective medical control; quality-assurance tools and information systems, such as electronic databases to keep a record of the patients served, their particular health problems, the clinical procedures performed by pre-hospital personnel, and the immediate effects of these procedures.

Recommendation 9: It is recommended that a horizon-scanning system be established to actively monitor emerging evidence in the field of pre-hospital care.

LIST OF ABBREVIATIONS

ACEP	American College of Emergency Physicians
ACLS	Advanced cardiac life support (specialized cardiopulmonary resuscitation techniques)
ACP	Advanced care paramedic
ACS	Acute coronary syndrome
AED	Automated external defibrillation
AETMIS	*Agence d'évaluation des technologies et des modes d'intervention en santé*
AHA	American Heart Association
ALIVE	Amiodarone vs Lidocaine in Prehospital Refractory Ventricular Fibrillation Evaluation
ALS	Advanced life support
AMI	Acute myocardial infarction
AMUQ	*Association des médecins d'urgence du Québec*
APPQ	*Association Professionnelle des Paramédics du Québec*
ARREST	Amiodarone in Out-of-Hospital Resuscitation of Refractory Sustained Ventricular Tachycardia
ASMUQ	*Association des spécialistes en médecine d'urgence du Québec*
BEPS	Belgian Eminase Prehospital Study
BiPAP	Bilevel positive airway pressure
BLS	Basic life support
BTLS	Basic trauma life support
CAEP	Canadian Association of Emergency Physicians
CCP	Critical care paramedic
CHSRF	Canadian Health Services Research Foundation
CI	Confidence interval
CMA	Canadian Medical Association
COPD	Chronic obstructive pulmonary disease
CPAP	Continuous positive airway pressure
CPR	Cardiopulmonary resuscitation
CVA	Cerebral vascular accident (stroke)
DCS	Diploma of College Studies
ECG	Electrocardiogram
ED	Emergency department

EMR	Emergency medical responder (first responder)
EMS	Emergency medical services
EMT	Emergency medical technician
EMT-B	Emergency medical technician-Basic
EMT-I	Emergency medical technician-Intermediate
EMT-P	Emergency medical technician-Paramedic
GREAT	Grampian Region Early Anistreplase Trial
HRDC	Human Resources Development Canada
ICP	Intermediate care paramedic
ISS	Injury Severity Score
JRCALC	Joint Royal Colleges Ambulance Liaison Committee
LAPSS	Los Angeles Prehospital Stroke Screen
MSSS	*Ministère de la Santé et des Services sociaux*
NAEMSP	National Association of EMS Physicians
NOCP	National Occupational Competency Profiles
OPALS	Ontario Prehospital Advanced Life Support study
OR	Odds ratio
PAC	Paramedic Association of Canada
PAD	Public Access Defibrillation program
PALS	Pediatric advanced life support
PCP	Primary care paramedic
RR	Risk ratio

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

1 INTRODUCTION

In the late fall of 2004, a controversy over the practice of advanced life support (ALS) in the Montréal and Laval pre-hospital emergency medical services (EMS) system made media headlines and had repercussions as far as the Québec National Assembly.[1] Eighteen emergency medical technicians (EMTs) employed by the *Corporation d'Urgences-santé* had obtained Ontario certification as advanced care paramedics and asked for authorization to apply their training here. The crux of the debate was that, in its policy directions on developing pre-hospital care in Québec, the *Ministère de la Santé et des Services sociaux* (MSSS) had not planned on introducing the widespread routine use of ALS care, even though it is provided virtually everywhere else in North America.

This is the controversy that prompted the Minister of Health and Social Services to ask AETMIS to prepare a report on advanced life support. He requested that the report specifically address certain issues: a) the safety of ALS procedures applied in North American pre-hospital EMS systems; b) the effectiveness and efficiency of the practices that these systems offer target populations; c) the role of performance of the chain of survival as a factor independent of the medical procedures performed by emergency medical technicians (EMTs) trained in ALS or by advanced care paramedics; and d) the optimal path for developing pre-hospital services in Québec, taking into account the importance to be given to each of the links in the chain of survival within the context of the system's population-based efficiency (see Appendix A).

The Health Minister also made a point of placing the debate on the introduction of ALS within the context of the development of pre-hospital emergency medical services in Québec. This development was predominantly influenced by two major planning initiatives, which took shape in the form of two reports: *Chaque minute compte !* (Every minute counts!) released in October 1992 [MSSS, 1992], and the Dicaire report published in December 2000 [MSSS, 2000]. Over a year in the making, the Dicaire report, prepared by the *Comité national sur la révision des services préhospitaliers d'urgence*, proposed overall recommendations to the Health Minister regarding the development of pre-hospital emergency services. The Committee did not endorse advanced life support as an overall concept but opted instead to introduce, after an evaluation period, some advanced life support procedures in regions capable of meeting pre-defined conditions. The Committee also pointed out that the organization of pre-hospital services was entering a transitional phase toward an explicit evidence-based model [MSSS, 2000, 172–3].

This report is therefore designed to inform the decisions to be made by the MSSS and to share current scientific evidence that is key to a better overall understanding of this issue. In this perspective it begins by describing the development of pre-hospital emergency services and selected ALS practice models and training, internationally, in Canada and in Québec, before going on to analyze the scientific evidence of the efficacy and safety of advanced life support. This background information is essential, as it will not only inform public debate but also permit a more refined interpretation of the results of research studies on pre-hospital EMS systems that differ from those in Québec. This evaluation approach is consistent with the path taken by a growing number of evaluation, funding and research agencies, as shown by the following quotation from the Canadian Health Services Research Foundation [CHSRF, 2004]:

1. Débats de l'Assemblée nationale (National Assembly debates), Wednesday, November 10, 2004, Vol. 38, No. 101. Available at: http://www.assnat.qc.ca/fra/37legislature1/Debats/journal/ch/041110.htm (in French).

"Evidence is a lot more than research, and it includes a lot of contextual information. We should not look at evidence as a way to end today's healthcare debates, but rather as a way of raising the level of dialogue around important decisions."

The concept of advanced life support refers to procedures that are more complex to apply, such as administering intravenous medications and performing endotracheal intubations. In practice, ALS refers to a range of pre-hospital emergency services that varies widely from place to place. Moreover, patient-care practices are routinely added to this range of advanced life support services, while others are shifted to basic life support services. Given the large number of possible interventions and this great variability, the present report reviews current evidence of the effectiveness and safety of the range of pre-hospital services called *advanced life support*. It also takes a look at the efficacy and safety of some ALS procedures applied to specific clinical problems, chiefly cardiac problems, respiratory problems and trauma. It goes on to describe the field evaluation of advanced life support carried out by *Urgences-santé* between 2002 and 2004. Lastly, it proposes an analytical framework for putting all this published evidence into context in order to draw conclusions and make recommendations that will help guide the decisions to be made on introducing ALS in Québec's pre-hospital EMS systems.

Note that this report is not a systematic review of all the possible interventions considered to be part of advanced life support. Furthermore, given the lack of available economic evidence on ALS interventions, this report does not contain analyses establishing the cost-effectiveness of different scenarios for developing pre-hospital emergency services in Québec.

2 DEVELOPMENT OF PRE-HOSPITAL SERVICES

2.1 BACKGROUND

From the earliest of times, the first aid supplied by bystanders and rescuers has helped the sick or the injured reach existing medical facilities. This type of intervention was further developed as part of military medicine, and evolved from stretcher evacuations to the air ambulance systems used during the Korean War, to the prompt evacuation of casualties in Vietnam. In the civilian world, the transportation of sick people unable to walk has existed since the dawn of medicine. Yet some first-aid techniques, such as resuscitating near-drowning victims, date back only to the early 20th century.

In the United States, it was not until 1966 that Congress passed the National Highway Safety Act and intervened in this matter for the first time by asking the Department of Transportation to set up pre-hospital EMS systems. In 1973, it passed the Emergency Medical Services Systems Act to fund the first regional systems. Pre-hospital emergency services structured into organized systems with government intervention, formal protocols and quality assurance date only from the mid-1970s.

Although evacuating and transporting the injured and the sick are now considered self-evident, the extent of the care to be provided at the scene of an emergency has been a hotly debated issue for more than a decade. Despite clear improvements in transportation methods, the recommended approach has always been to reach victims as quickly as possible, to do the best to control any external bleeding, and to rush them off to definitive care.

The concept of pre-hospital advanced life support was introduced in 1967 when Pantridge started up the first mobile cardiac-resuscitation units in Belfast, Northern Ireland [Pantridge and Geddes, 1967]. With an intensive-care physician and nurse on board, these mobile units raced from the hospital to give first aid to victims of acute myocardial infarction (AMI) and to provide them with advanced cardiac life support en route to the hospital. The idea of initiating cardiopulmonary resuscitation (CPR) in the field further evolved after the inception of paramedic programs in the United States. From the late 1970s to 1990, the research carried out by Weaver and Cobb [Weaver et al., 1988; 1986; Thompson et al., 1979] in Seattle, Washington, and by Eisenberg [Eisenberg et al., 1984; 1980; 1979] in King County, Washington, focused on evaluating the links in the chain of survival from out-of-hospital cardiac arrest. It was their work that led to the discovery of the factors known to influence survival: rapid response, bystander-initiated CPR, and early defibrillation, ideally with a semi-automated external defibrillator. Numerous studies have documented the critical impact of response intervals on survival from cardiac arrest ever since Eisenberg et al. [1979] demonstrated that the best outcomes were achieved if BLS was administered within four minutes of collapse and ALS within eight.

The idea of taking routine emergency-room procedures directly to the patient took root, developed and spread to different countries, and was later applied to other health problems. If victims of a heart attack or cardiac arrest were able to benefit from prompt medical care through such a system, it seemed tempting to extend these services to others, including trauma victims, people suffering from respiratory distress or other acute health conditions, and children.

Additionally, the massive return of Vietnam veterans trained to respond to battlefield emergencies provided a pool of workers pre-trained to handle the more advanced procedures involved in trauma management (endotracheal intubation, pneumatic anti-

shock garments, intravenous injections and transfusions).

2.2 BASIC LIFE SUPPORT AND ADVANCED LIFE SUPPORT

Pre-hospital emergency care is divided into two categories: basic life support (primary pre-hospital care) and advanced life support (advanced pre-hospital care).

2.2.1 Basic life support

Basic life support (BLS) generally consists of a set of non-invasive procedures, which are limited to external application. This type of care mainly involves 1) controlling bleeding by means of direct pressure and bandages; 2) immobilizing limbs or the spine (e.g., use of cervical collars) in cases of suspected fractures; 3) maintaining respiratory function (e.g., oxygen therapy, mouth-to-mouth resuscitation, aspiration of secretions, dislodging foreign bodies from airways, and the Heimlich manoeuvre); and 4) maintaining circulatory function through chest compressions (CPR). Some of these emergency procedures can be performed by bystanders and first responders. All BLS procedures are applied by emergency medical technicians (EMTs).

2.2.2 Advanced life support

Advanced life support (ALS) involves invasive procedures, such as endotracheal intubation, intravenous access (inserting an IV line into a vein), administering different types of medication, and managing hypovolemic shock through fluid resuscitation (replacement of blood volume with fluids) to increase blood pressure and improve oxygenation of body tissues and organs. Advanced life support measures are reserved to more highly specialized personnel. In Europe, ALS is generally dispensed by physicians, whereas in Anglo-American countries, it is provided by paramedics. In 2003, 92% of the 200 most populous cities in the United States were covered by paramedic systems, although several districts are still without [Monosky, 2004]. Except for Québec, all Canadian provinces are partially covered by advanced care practitioners.

2.2.3 Evolving concepts of basic life support and advanced life support

The line between BLS and ALS care based on the invasiveness of the procedures used is an arbitrary one and no longer really holds true either in Québec or elsewhere. In fact, over the past twenty years, several procedures previously considered to belong to ALS care have shifted to BLS care.

Cardiac defibrillation is a good example of an ALS procedure formerly reserved to the hospital setting that has shifted to practitioners with more limited training, if not to the general public. Defibrillation used to require the presence of a physician to interpret the patient's heart rhythm. In the United States, this procedure was first performed by paramedics [Eisenberg et al., 1979] and then by EMTs [Eisenberg et al., 1980]. The advent of semi-automated defibrillators capable of interpreting heart rhythms from pre-set algorithms helped extend this technique to all practitioners, including first responders [Weaver et al., 1986].

In Québec, semi-automated defibrillation has been performed by EMTs since 1993 in the Montérégie region and since February 1994 at *Urgences-santé*. It was later generalized to all EMTs in Québec, then to several first-responder services, and is now beginning to appear in some public places.

Another technique performed by EMTs and introduced in Québec at the same time as semi-automated defibrillation is the intubation using a Combitube®. This involves blindly inserting an airway tube to facilitate ventilation and does not require direct laryngoscopy to visualize the vocal cords. More recently, the introduction of a medication protocol allowing EMTs to administer a group of five drugs is the latest example of an ALS procedure now applied by practitioners trained in BLS. The five medications

included in the symptom-relief program are subcutaneous epinephrine (for allergic reactions), nebulized salbutamol (for asthma attacks), subcutaneous glucagon (for hypoglycemia), sublingual nitroglycerine, and oral aspirin (for cardiac chest pain).

This shift in responsibility has given rise to a plethora of designations for practitioner categories in Québec, Canada and around the world.

3 PRACTITIONER CATEGORIES, SCOPES OF PRACTICE AND TRAINING IN VARIOUS COUNTRIES

For the purpose of clearly differentiating between advanced life support (ALS) and basic life support (BLS), along with their related training, the situation prevailing in Canada and in other parts of the world is described below. The methodology used for this section included a literature-search strategy (described in Appendix B) and expert consultations.

3.1 SITUATION IN CANADA

In Canada, the regulation of pre-hospital emergency practice is a provincial jurisdiction, and each legislature is free to determine its own practitioner categories and practice conditions. The regulatory framework allows regional medical directors a great deal of latitude, as is the case in Ontario. The Ontario Ambulance Act[2] provides definitions for terms related to pre-hospital emergency care: *base hospital*, *base-hospital program* and *medical director*. The Health Minister designates base hospitals to provide the program. A base-hospital program is obligated to include the following components: a) delegation of controlled acts; b) on-line medical support; c) quality assurance of pre-hospital care; and d) continuing medical education required to maintain the delegation of controlled acts. The medical director heads the base-hospital program.

The Paramedic Association of Canada (PAC),[3] which was created in 1988 and now has over 14 000 members, is a major player on the Canadian scene of pre-hospital care.

Established in 2001, the *Association Professionnelle des Paramédics du Québec* (APPQ)[4] works closely with the PAC. Although the provinces are also responsible for regulating paramedic practice by authorizing the creation of professional corporations, the only one that has such a body uniting pre-hospital practitioners, or paramedics, is Alberta.[5] Other provinces are apparently considering this option (Saskatchewan, Manitoba and Nova Scotia).[6] In Québec, an application to that effect was submitted to the *Office des professions du Québec* in December 1994 and updated in December 2003 [APPQ, 2003].

Chapter 7 on labour mobility in the federal-provincial-territorial Agreement on Internal Trade (AIT) is geared to eliminating inter-provincial-territorial barriers existing in such matters as residency, certification and occupational standards for various categories of workers. With the financial support of Human Resources Development Canada (HRDC), the PAC [2001] developed the National Occupational Competency Profiles for Paramedic Practitioners (NOCP) to meet the requirements of the internal trade agreement. According to the HRDC, paramedics were the first group of workers to put this pan-Canadian consensus into action. The outcome of their effort is rooted in a consensual approach shared by the various actors concerned across Canada.[7] All the provinces, including Québec, signed the Mutual Recognition Agreement for Paramedics

2. http://www.e-laws.gov.on.ca/DBLaws/Regs/English/000257_e.htm.
3. http://www.paramedic.ca.
4. http://www.paramedicduquebec.org.
5. http://www.collegeofparamedics.org.
6. Robert Burgess, ACP, AEMCA, Senior Manager, Division of Prehospital Care, Sunnybrook-Osler Centre for Prehospital Care in Toronto, personal communication.
7. Brian Schwartz, MD, Director, Sunnybrook-Osler Centre for Prehospital Care, Toronto, and President, Canadian Relations Ad Hoc Committee, National Association of EMS Physicians (U.S.), personal communication, February 7, 2005.

(2002–2003) and recognized the NOCP as the Canadian benchmark for comparison.[8]

3.1.1 National Occupational Competency Profiles (NOCP)

The NOCP includes four levels[9] of competency [PAC, 2001]:

- Emergency medical responder (EMR), who has successfully completed a program in emergency patient care and transportation. This competency profile does not include any medical procedures.
- Primary care paramedic (PCP), who has successfully completed a recognized education program in paramedicine at the primary care level. This is the largest group in Canada. Controlled or delegated acts[10] include semi-automated defibrillation and administration of certain medications (not requiring intravenous access).
- Advanced care paramedic (ACP), who has successfully completed a recognized education program in paramedicine at the advanced care level. Controlled or delegated medical acts include advanced techniques for managing life-threatening health problems related to patient airway (e.g., endotracheal intubation), breathing (e.g., needle decompression of tension pneumothorax), and circulation (e.g., manual defibrillation, cardioversion, intravenous injection of medications, and fluid replacement). These measures may be invasive or pharmacological.
- Critical care paramedic (CCP), who has successfully completed a recognized education program in paramedicine at the critical care level. This is the highest level of training available. Critical care paramedics are trained to do thorough health-status assessments, including interpretation of patient laboratory and radiological data. They may sometimes decide that transport to hospital is not necessary (treat-and-release concept). They are able to perform a large number of controlled or delegated medical acts, both autonomously and after consultation with a physician. These medical acts include the use of invasive monitoring techniques, such as hemodynamic monitoring, and pharmacological treatments.

The number of training hours required to attain these competency levels is not specified and is not a certification criterion. The training time allotted to these competency levels by the different organizations is usually around 60 hours for EMRs, 1000 hours for PCPs, 2000 hours for ACPs and 3000 hours for CCPs.

The difference between a PCP and an ACP in terms of skills and skill application is the same as that between the levels of technician and technologist. A technician provides care basically by following algorithms and protocols applied on a "treat what you see" basis. Technologists provide care by following algorithms, protocols or guidelines that allow them to assess what they see and to use their discretion in formulating which action to take. The application of the treat-and-release concept, which allows prehospital practitioners to "deny transportation," is a provincial and local jurisdiction. Various protocols of this type exist in Canada whether at the PCP, ACP or CCP level[11]. The NOCP practitioner levels and their associated BLS and ALS competencies are summarized in Table 1 for certain categories of respiratory, circulatory and pharmacological interventions.

8. Claude Desrosiers, Co-ordinator, *Module de l'assurance de la qualité et de la formation clinique, Urgences-santé*, personal communication, February 10, 2005.

9. The competencies at each practitioner level are cumulative, in that each level includes the competencies of the previous level.

10. A delegated act allows a practitioner to perform an act reserved by law to physicians, in accordance with a specific protocol and after having received special training. This delegation is performed by a duly authorized health-care institution. A controlled act requires a physician to be present or in communication with the practitioner during the performance of the medical act.

11. Pierre Poirier, Executive Director, Paramedic Association of Canada, Chairman, National Occupational Competency Profiles Review Committee, written communication, February 28, 2005.

TABLE 1

NOCP competencies according to paramedic practitioner level

COMPETENCY/NOCP LEVEL*	PCP (BASIC LIFE SUPPORT)	ACP (ADVANCED LIFE SUPPORT)	CCP (CRITICAL CARE)
Perform intubations:			
▪ Combitube	No	Yes	Yes
▪ endotracheal intubation with visualization of the vocal cords	No	Yes	Yes
▪ rapid-sequence intubation	No	No†	Yes
Initiate and maintain intravenous access	Maintain only	Yes	Yes
Administer medications‡ by various routes:			
▪ subcutaneous (or sublingual)	Yes	Yes	Yes
▪ intramuscular	Yes	Yes	Yes
▪ intravenous	No	Yes	Yes
Perform defibrillation:			
▪ semi-automated	Yes	Yes	Yes
▪ manual	No	Yes	Yes
Record and interpret results:			
▪ 3-lead ECGs	Yes	Yes	Yes
▪ 12-lead ECGs	No	Yes	Yes

Source: Paramedic Association of Canada, 2001.
* These are the required competencies associated with the practitioner levels designated in the NOCP. The right to apply these skills is subject to each particular work environment and to the delegated acts in force.
† ACPs are not authorized to administer anesthetic or paralytic agents routinely used for rapid-sequence intubation, but the NOCP does not exclude the use of narcotics or benzodiazepines with this technique.
‡ The NOCP designates 9 groups and 37 subgroups of medications that PCPs, ACPs and CCPs are required to know, but PCPs are limited to only 7 subgroups. Nevertheless, paramedic administration of any medication depends exclusively on the authorization of the medical director.

3.1.2 Training and accreditation

The Canadian Medical Association (CMA) has co-ordinated and administered a conjoint accreditation process since 1938. This process serves to recognize that a training program meets national standards.[12] When the Paramedic Association of Canada published the NOCP, it suggested that the CMA use these profiles to ensure that all certified practitioners have acquired the defined competencies.[13] The CMA agreed to have the NOCP become the reference document for its accreditation process[14] and has used it since January 2001. Note that this accreditation service is offered to any education institution that voluntarily applies for it. Training programs accredited by the CMA are also recognized by major employers. In January 2005, no program had been or was in the process of being accredited in Québec. Since the NOCP is a training tool, it contains only competencies and not specific treatment protocols, for example, in trauma care or pediatrics.

The PAC has also published documents spelling out the essential skills and foundation knowledge that define the paramedic profession. In the NOCP, the PAC recommends that training programs ensure in a comprehensive and formal manner that candidates possess the specified essential skills and foundation knowledge. Essential skills include reading text, use of documents, writing, numeracy, oral communication, thinking skills (problem solving,

12. See the Accreditation section on the CMA Web site: http://www.cma.ca/index.cfm/ci_id/19316/la_id/2.htm.
13. Seven competency areas are defined: professional responsibilities; communication; health and safety; assessment and diagnostics; therapeutics; integration; and transportation. Each area comprises general and specific competencies.
14. Except for the emergency medical responder level, which is not part of the accreditation program.

decision making, job-task planning and organizing, significant use of memory and finding information), team work and computer use [PAC and HRDC, 2000]. Foundation knowledge includes life sciences (biochemistry, human biology, anatomy and physiology) and physical sciences (chemistry, physics) [PAC, 2001].

3.1.3 Current situation in Canada

In an article on the Canadian pre-hospital system, Symons and Shuster [2004] describe the situation of provincial pre-hospital emergency mdeical services (EMS) systems, and the roles and responsibilities of the various actors involved in pre-hospital emergency response across the country. This portrait reveals that there is tremendous interprovincial variability in the laws and regulations governing pre-hospital emergency care. There is also intraprovincial variability in the types of human and material resources allocated to EMS delivery, in the types of EMS providers and in the training they offer. According to Symons and Shuster, in spite of the existence of the NOCP, practitioners employed prior to its introduction do not fit neatly into these profiles, as their skills overlap the categories. The grey area that emerged during the transition period prior to the adoption of these standards and the fact that most continuing-education programs use U.S. or international terminology[15] leads to confusion in the classification of occupational categories. The authors also point out that new practitioners trained according to the NOCP model may not be allowed to practise to the full extent of their training, depending on provincial or local regulations. The levels of competency in the NOCP are minimum requirements, and regional medical authorities can expand practitioners' scopes of practice by offering made-to-measure complementary training courses. For example, Québec seems to be the only Canadian province that uses the Combitube in the delivery of BLS. In other parts of North America, this is an ALS technique used solely when endotracheal intubation has failed. Establishing intravenous access—one of the core characteristics of ALS—is making its way into BLS care in certain areas of Ontario, although this procedure is performed only to administer dextrose to hypoglycemic patients.[16]

This portrait was confirmed in the annual survey of provincial EMS directors conducted by the journal Emergency Medical Services.

Table 2 summarizes some of the survey data on the number of known practitioners in the different categories, their training and some practice models in each Canadian province.

Note that all Canadian provinces reported that they offer a level of advanced pre-hospital care, except for Québec, New Brunswick[17] and Newfoundland. According to this survey, there are relatively few critical care paramedics (only in Nova Scotia and Ontario). Some Canadian EMS experts[18] confirm that critical care paramedics are employed in at least two provinces. They are assigned either to air ambulance services or to interfacility transfers, and a nurse is generally part of the crew. According to another source,[19] practitioners in two other provinces perform the duties of critical care paramedics even though they are not explicitly designated as such. These include flight paramedics in Alberta and British Columbia, and members of the Infant Transport Team in British Columbia.

15. For example, BTLS (basic trauma life support), ACLS (advanced cardiac life support) and AED (automated external defibrillation).

16. Brian Schwartz, MD, Director, Sunnybrook-Osler Centre for Prehospital Care, Toronto, e-mail communication, January 23, 2005, and Robert Burgess, Senior Manager at the same centre, telephone communication, February 21, 2005.

17. Last year the New Brunswick Department of Health and Wellness implemented a health plan that includes ALS. http://www.gnb.ca/0051/pdf/healthplan-20042008_e.pdf.

18. Brian Schwartz, MD, Director, Sunnybrook-Osler Centre for Prehospital Care, Toronto, e-mail communication, January 23, 2005, and Robert Burgess, Senior Manager at the same centre, telephone communication, February 21, 2005.

19. Pierre Poirier, Executive Director, Paramedic Association of Canada, and Chairman, National Occupational Competency Profiles Review Committee.

TABLE 2

Summary of Canadian data from the Emergency Medical Services annual survey on pre-hospital care*

PROVINCE (YEAR AVAILABLE)	OCCUPATIONAL TITLES AND REPORTED PERSONNEL (N)†	REPORTED TRAINING
Québec (2002)	EMT-Intermediate‡ (n = 3150)	840 hours
Alberta (2004)	Emergency medical responder (EMR) (n = 2443)	120 hours
	Emergency medical technician (EMT) (n = 2761)	300 hours
	Emergency medical technician-Paramedic (EMT-P) (n = 1304)	2 years
British Columbia (2004)	Paramedic Level I (PCP equivalent)	Not available (N/A)
	Paramedic Level II (ALS assistant)	N/A
	Paramedic Level III (ALS paramedic) (advanced care paramedic [ACP] equivalent)	1000 hours (minimum)
Manitoba (2004)	Emergency medical responder (EMR) (first responder equivalent)	90 hours
	Emergency medical technician-Basic (EMT-B)	360 hours
	Emergency medical technician-Paramedic (EMT-P)	N/A
New Brunswick (2003)	Emergency medical technician-Basic (EMT-B)	350 hours
	Primary care paramedic (PCP)	1600 hours
Nova Scotia (2004)	Primary care paramedic (PCP) (n = 543)	N/A
	Intermediate care paramedic (ICP) (n = 229)	N/A
	Advanced care paramedic (ACP) (n = 171)	N/A
	Critical care paramedic (CCP) (n = 11)	N/A
Ontario§ (2004)	Advanced emergency medical care assistant (AEMCA)	N/A
	Primary care paramedic (PCP) (level 1)	1650 hours
	Level 2 paramedic¶	N/A
	Advanced care paramedic (ACP) (level 3 paramedic)	Additional training
	Critical care paramedic (CCP) (total n = 6746)	Additional training
Prince Edward Island (2004)	Basic-level license (PCP, P-1) (n = 51)	N/A
	Beyond-basic licensure (P-2, P-3, ACP) (n = 49)	N/A
Saskatchewan (1999)	Emergency medical technician (EMT) (n = 1200)	N/A
	EMT–Intermediate	N/A
	EMT-Paramedic (total n = 1800)	N/A
Newfoundland and Labrador (2004)	Emergency medical responder (EMR)	
	EMR-1 (n = 187)	7 days
	EMR-2 (n = 344)	17 days
	Paramedic 1 (n = 220)	N/A**
	Paramedic 2 (n = 47)	N/A**
	Primary care paramedic (PCP) (n = 145)	32 weeks (PCP)

* http://www.emsmagazine.com/SURVEY/index.html.
† The number (n) is included when this information is available.
‡ This designation, provided by a Québec government official for the Canadian survey, is debatable. In fact, according to the U.S. definitions, the Québec profile is closer to EMT-B with Combitube (see Table 3 further on).
§ More detailed information is available from the Ontario Paramedics Association Web site and related sites (www.ontarioparamedic.ca/chapters.html).
¶ This category exists mostly in the Toronto local chapter (Toronto Paramedics Association) (www.torontoparamedicassociation.com/levels_of_practice.aspx).
** Former classification.

3.2 SITUATION IN OTHER COUNTRIES

A series of articles on international EMS systems was published between 2003 and 2005 in the journal *Resuscitation*. Interestingly, Denmark divides its ambulance personnel into three levels of practice (basic, intermediate and advanced) according to a standard national protocol, and none includes endotracheal intubation, even at the advanced level. France and Germany confer pre-hospital care to physicians. As for the United Kingdom and the United States, the sections below profile the different types of personnel involved in their pre-hospital emergency response, along with their scopes of practice and training.

3.2.1 United Kingdom

Black and Davies [2005] describe the pre-hospital care system in the United Kingdom. Although the system is almost exclusively government-run, it is interesting to note that the major share of its pre-hospital emergency response is provided by EMTs and paramedics. Authorized practices are defined by a national committee, the Joint Royal Colleges Ambulance Liaison Committee (JRCALC), in the form of clinical practice guidelines. Variations from the national protocols may be authorized by a local Ambulance Service Advisory Group. These groups are composed of multidisciplinary teams of hospital consultants, general practitioners, pharmacists, senior ambulance service managers, and are chaired by the ambulance service medical directors. Admission requirements for both ambulance and paramedic training depend on each ambulance service (regional or municipal). Most of the training is provided by these ambulance services, while part of it is given in hospitals. Some ambulance services have established links with local universities to develop ambulance-training and assessment programs, and this approach may become increasingly common.

3.2.2 United States

Pozner et al. [2004] define the competency levels within the field of pre-hospital emergency care in the United States: first responder, EMT-basic (EMT-B), EMT-intermediate (EMT-I), EMT-paramedic (EMT-P), and more recently, critical care provider. The article also describes their required training (Table 3). In specific cases, such as multivictim accidents or amputations required for patient transfer, physicians intervene directly in the field. As a rule, medical control is exercised either on-line, for cases requiring direct contact between the physician and the paramedic in the field, or through standard treatment protocols. The development and use of protocols are part of quality-assurance and continuing-education programs [Pozner et al., 2004]. A U.S. national task force has undertaken to reform pre-hospital practices and has drafted *The National EMS Scope of Practice Model* (Table 4), which is expected to be approved in 2005 [Manz, 2005].

TABLE 3

Current categories of pre-hospital EMS practitioners: Skills and training in the United States

CATEGORY	SKILLS*	TRAINING
First responder	Cardiopulmonary resuscitation (CPR), spine immobilization, bleeding control and other basic first aid.	40–50 hours May require periodic recertification.
EMT-Basic	CPR, automated defibrillator, patient extrication, immobilization and transfer. Administration of medications (nitroglycerine, inhaled bronchodilators, epinephrine auto-injectors). Intubation with a laryngeal-mask airway.†	110 hours
EMT-Intermediate‡	Intravenous access, intubation, cardiac monitoring, manual defibrillation and administration of some drugs (cardiac medications).	Highly variable.
EMT-Paramedic	Advanced interventions such as intravenous injections, drug administration, intubation, needle cricothyroidotomy, needle thoracostomy, cardiac monitoring and manual defibrillation.	Over 1000 hours: 250–500 hours of classroom teaching and the rest as clinical training in hospital and pre-hospital settings. Specialized course providing training in advanced cardiac life support (ACLS§), pediatric advanced life support, and pre-hospital trauma life support.
Critical care provider¶	Variety of patient-care techniques applied during interfacility transfers.	Not available.

Source: Pozner et al., 2004.
* From Lilja [2004].
† Decision at the discretion of the medical directors of state EMS agencies.
‡ Varies widely from region to region, particularly in terms of the number and types of medications.
§ ACLS (advance cardiac life support) involves specialized cardiopulmonary resuscitation techniques.
¶ Lilja does not mention this category.

TABLE 4

Proposed classification and skills of pre-hospital EMS practitioners in the United States*

CATEGORY	SKILLS
Emergency medical responder (EMR)	First aid, CPR, obstetric delivery, wound care, immobilization of fractures and spine, oxygen therapy, triage, patient extrication and transportation. Rarely intubation. Occasional administration of medications (aspirin), including patient's own medication (nitroglycerine, inhaled bronchodilators or epinephrine auto-injector).
Emergency medical technician (EMT)	Varies greatly from place to place. May include establishing intravenous access, intubation, cardiac monitoring, manual defibrillation and administration of some medications.
Paramedic	Advanced techniques such as intravenous injections, administration of medications, intubation, cricothyroidotomy, needle thoracostomy, cardiac monitoring and manual defibrillation.
Advanced practice paramedic	Various techniques such as suturing, inserting Foley catheters, inserting central venous catheters, and so forth. May treat and release patients.

* The National EMS Scope of Practice Model, http://www.soundrock.com/sop.

3.3 SUMMARY

This brief overview of the definitions of the skills required for pre-hospital emergency care, their application and their regulatory framework reveals that competency levels vary according to occupational titles. The various levels of care may have differing definitions within the same country (Canada) and are gradually being redefined (Canada and the United States). The concept of pre-hospital medical control seems to exist in all countries, but in practice it may take the form of either direct on-line physician supervision or delegated acts stipulated in standard protocols. Supervision to ensure the quality of the medical procedures is also a key element. Some provincial regulations governing pre-hospital practice dictate that quality-assurance mechanisms be set up. These mechanisms may include mandatory continuing education, mandatory recertification, audits of emergency calls received (similar to the quality control of physicians' professional practice) and a complaint-investigation system. The advantage to the Canadian process of standardizing occupational titles linked to skill sets is that it allows diplomas to be recognized across the country. Even so, certified competencies do not entitle practitioners to apply their skills outside the regulatory framework for the delegation of medical acts. It is up to each regional pre-hospital medical authority to decide case by case which procedures it will allow, depending on the resources available and the context. This creates confusion between certified training levels and field practices, and makes it difficult to develop a standard definition that clearly differentiates between BLS and ALS care.

4 DEVELOPMENT OF PRE-HOSPITAL SERVICES IN QUÉBEC

Ambulance services in Québec followed a slow and variable course of development, long marked by local, if not individual, initiatives. In the 1950s and 1960s, ambulance-vehicle services were often run by funeral parlours. In 1958, the Montréal police force set up its own ambulance service, as did the joint police-fire department of Sainte-Foy (near Quebec City) in 1966. In the mid-1970s, some towns on the western tip of the island of Montréal set up a first-responder service, and Dawson College even offered the first paramedic-training program in Québec.

It was not until the late 1970s that the ministère de la Santé et des Services sociaux (MSSS) began issuing ambulance permits, a responsibility that it later delegated to the regional health and social services boards. In the Montréal region, in the 1980s and 1990s, different changes to the pre-hospital emergency medical services (EMS) system finally led to the creation of *Urgences-santé*, which employed physicians to offer advanced life support. Meanwhile, the other regions of Québec were developing systems based exclusively on basic life support provided by emergency medical techicians (EMTs).

Since the 1990s, the MSSS has taken part in at least two major pre-hospital EMS planning initiatives culminating in the 1992 report *Chaque minute compte !* (Every minute counts!) and the Dicaire report in 2000.

4.1 THE 1992 REPORT: *CHAQUE MINUTE COMPTE !*

In October 1992, the report *Chaque minute compte !* [MSSS, 1992] proposed guidelines that still guide Québec's pre-hospital EMS system to this day. This report was the first to give concrete shape to the structures and policy directions of the pre-hospital EMS system, including the roles of first responders and EMTs, the routine use of treatment protocols, the principle of medical control, the creation of a clinical information system for documenting EMTs' procedures, and the establishment of quality-assurance programs. For the first time, it was being proposed to build an integrated and co-ordinated system encompassing several classes of practitioners within a tiered structure designed to meet users' needs.

As far as pre-hospital training and practices were concerned, the report proposed to increase EMTs' initial training to 300 hours at the post-secondary level and to allow them to use the Combitube (an orotracheal tube with two ventilation ports) and semi-automated external defibrillators. A total of 13 protocols for first responders and 33 protocols for EMTs clearly spelled out their scopes of practice. The report did not include any position statement on the usefulness of pre-hospital advanced life support.

4.2 THE DICAIRE REPORT

In December 2000, the authors of the Dicaire report were mandated to conceive of a pre-hospital EMS system based on an effective and efficient network that would offer the Québec public high-quality pre-hospital care at the most reasonable cost possible, and to propose a plan for implementing it [MSSS, 2000, p. 1].

The report took account of how Québec's pre-hospital services had developed since the release of the 1992 report and explained why the proposed changes had not been implemented. It spelled out policy directions and made specific recommendations as to how the system should evolve: expansion of the chain of survival throughout the province, roles of practitioners at each level of care, enhancement of the profession of

emergency medical technician, and improved medical and clinical control for practitioners.

The Dicaire report also formalized the chain of survival concept (Table 5), which corresponds to the type of integrated pre-hospital services recommended in the 1992 report [MSSS, 1992]. The concept of the links in this chain is designed to illustrate the importance of activating a sequence of rapid, continuous and interlinked actions to reduce mortality and morbidity in patients with different types of health problems.

Regarding the specific issue of pre-hospital advanced life support (ALS) care, the Dicaire report recommended that *Urgences-santé* physicians (who provide ALS) be dispatched to the scene of emergencies only in special circumstances, in accordance with the recommendations made by the *Collège des médecins du Québec* and the *Association des médecins d'urgence du Québec* (p. 25). Physicians were to be assigned chiefly to provide medical control, quality assurance and EMT training.

The Dicaire report also stated that the Committee had analyzed the possibility of creating a tier of ambulance technicians who would have the status of a "paramedic" and who would be assigned some ALS procedures; however, it was decided to adopt a cautious and conservative attitude in that regard (p. 172).

The Dicaire report foresaw the possibility of carrying out field evaluations of ALS care in Québec but only within a very specific framework:

> Upon considering the overall discussions on the issue of advanced life support and its place within Québec's pre-hospital emergency services, the Committee believes that certain ALS practices could be introduced in some areas of Québec capable of meeting specified implementation conditions. The introduction of these ALS procedures must be subjected to objective scientific evaluation conducted over a reasonable period of time.
>
> For example, as part of the project designed to maintain and consolidate ALS care in Montréal and Laval, as presented by *Urgences-santé*, the reorganization of the services delivered by EMTs trained in ALS should take place in an assessment context demonstrating the value added by this new mode of operation. Objectively, the addition of a level of advanced life support provided by EMTs who have had additional training and supervision from teaching physicians should prove that it has an intrinsic benefit for mortality and morbidity. (p. 173) [Translation]

This report also paved the way for the Act respecting pre-hospital emergency services enacted in 2002, which now governs the organization of these services across the province. Moreover, the use of ALS protocols is permitted by virtue of the Regulation respecting the professional activities that may be engaged in within the framework of pre-hospital emergency services, under the Professional Code of Québec.

TABLE 5

Links in the chain of pre-hospital emergency response

Bystanders*	9-1-1 call centres	Medical control			Receiving hospitals
		Emergency dispatch centres	First responders	Ambulance services	
→	→	→	→	→	→

Source: MSSS and Dicaire, 2000, p. 19. [Translation]

* Bystanders are those who witness an event or who come across a person in distress.

4.3 SUSTAINED AND GRADUAL ENHANCEMENT OF TRAINING LEVELS

The different successive reforms in Québec led to the gradual enhancement of practitioner training levels. Before 1974, a simple St. John's Ambulance course was enough to work as an ambulance attendant. In 1974, fourteen CEGEPS (community colleges) began offering a 150-hour non-standard training program that did not lead to any official certification. These CEGEP programs rose to 250 hours in 1980, and then to 285 hours in 1982. In 1989, the MSSS authorized a new 336-hour training program, which was offered only in seven CEGEPS and still did not lead to an official diploma. In 1992, the program was raised to 810 hours and limited to two CEGEPS, which were the first to issue an Attestation of College Studies (ACS). The program was increased to 840 hours in 1996 and finally to 945 hours in 2004. Recall that the Dicaire report advocated gradually enhancing initial EMT training from the basic ACS level to the Diploma of College Studies (DCS).

This means that currently employed EMTs have received very different training. Continuing-education initiatives have nevertheless helped upgrade their skills, but these efforts have varied from region to region.

4.4 CURRENT PRE-HOSPITAL CARE IN QUÉBEC

Over the past few years, Québec has made a sustained effort to extend the chain of survival throughout its jurisdiction in a bid to limit regional inequities insofar as possible. In that regard, the current EMS system puts Québec one step ahead of several Canadian provinces. The 9-1-1 system is now operational in almost all inhabited regions. Semi-automated external monitor-defibrillators and the Combitube are also used across the province. A symptom-relief program including five medications (epinephrine, salbutamol, glucagon, nitroglycerine and aspirin) is already available in several regions, and especially to all *Urgences-santé* EMTs. Within the next eighteen months, Québec will have achieved, throughout its jurisdiction, a level of care equivalent to the Canadian competency profile of "primary care paramedic" [MSSS, 2004].

None of Québec's pre-hospital emergency services offer ALS, except for *Urgences-santé* as part of a pilot project described in Chapter 6. This level of care is provided by eighteen EMTs trained in ALS and working under the direct supervision of an on-scene physician.

5 SCIENTIFIC LITERATURE REVIEW

5.1 INTRODUCTION

As we have seen, the definition itself of advanced life support (ALS) has changed over time, and no specific definition meets with consensus. In fact, today's ALS practices may become the basic life support (BLS) practices of tomorrow. This section reviews the current state of evidence-based knowledge that will help assess the role of ALS in the different fields of pre-hospital emergency practice.

Judging the quality of evidence is not an easy task. However, it is generally recognized that randomized clinical trials (RCTs) provide the strongest scientific evidence. In this type of trial, subjects are randomly assigned to two groups: an experimental group, which receives the treatment, and a control group, which does not. Random subject-assignment ensures that observed differences are not induced by any form of selection bias. Yet very few research projects are based on RCTs because they are often more costly and difficult, if not impossible, to conduct for ethical reasons and because it is difficult to obtain patients' informed consent in emergency situations. These trials are even a greater challenge when carried out in environments like pre-hospital settings where environmental factors (e.g., lighting, temperature, confined spaces) and human factors make it difficult to recruit subjects.

Most of the literature contains studies comparing two groups of non-randomly assigned patients. In this type of study, subject selection may have influenced the results; hence, the quality of the evidence is judged to be less solid. These are called *observational studies* and they can be prospective or retrospective. They consist of either before–after studies or comparisons of two groups in which the study intervention is available only to some of the subjects.

The literature on pre-hospital emergency care contains very few RCTs. To wit, the Cochrane Collaboration, which publishes regularly updated systematic reviews of evidence emerging from RCTs, produced a report on the effectiveness of advanced trauma life support training for ambulance crews [Sethi et al., 2001]. Of the 2034 relevant articles, only one RCT was located, but it had too few cases (a mere 16 injured patients) for any conclusions to be drawn.

Methodologies other than RCTs must therefore be used to analyze scientific evidence, and the value of the arguments presented must be closely scrutinized to detect possible biases in the different studies.

Several years ago, Ontario decided to introduce a pre-hospital ALS program applied by paramedics. This level of care was introduced concomitantly with an assessment initiative that has captured the attention of the international scientific community. This research project called Ontario Prehospital Advanced Life Support (OPALS) is led by Dr. Ian Stiell in Ottawa. This is the largest study ever undertaken on ALS, in terms of both the number of patients involved and the type of study design used, a before–after non-randomized comparative trial. The OPALS group has a database on a total of over 30 000 patients. These data were compiled over a ten-year period (1994–2004) in seventeen urban and suburban communities in Ontario with populations ranging from 16 000 to 750 000.

Phase I of the study served as the baseline to measure the survival rate of cardiac-arrest victims in Ontario. Phase II evaluated the optimization of BLS, that is, improvements stemming from the availability of early cardiac defibrillation (within eight minutes) performed by first responders or by ambulance crews. Phase III served to assess

whether the addition of ALS[20] improved survival outcomes compared with optimized BLS services. To qualify for phase III, a community had to comply with minimum performance standards: defibrillation within eight minutes in 90% of the cases, with paramedics responding to 95% of patients within 11 minutes in 80% of the cases [Stiell et al., 2004; 1998]. The OPALS study has been the subject of several publications (especially on cardiac survival rates) and a fair number of abstracts and conference presentations. Although the OPALS study results are now known for the most part, other publications are expected in the months to come. Given the importance of this research, data derived from the OPALS study will be presented in a separate section at the end of each theme in this chapter.

For discussion purposes, the studies have been divided into five themes: cardiac arrest, other cardiac problems, respiratory problems, trauma, pediatrics, and other treatment avenues. Each theme, except for the last one which covers several topics, contains a section on the effectiveness of pre-hospital emergency care, a reference to the OPALS study, a discussion of the evidence and an evidence summary.

5.2 METHODOLOGY

A literature search was conducted through Medline (1966–2005), Embase (1980–2005), CINHAL (1982–2005) and the Cochrane Database of Systematic Reviews (Cochrane Library, No. 1, 2005). Search statements included the following keywords: (ALS OR advanced life support) AND (EMS OR emergency medical service OR paramedic OR paramedics OR prehospital OR pre-hospital OR out-of-hospital). Search results were aggregated, yielding a total of 1530 bibliographic references. This compilation was reduced to 204 articles by limiting the search results to clinical trials and the consensus documents of major organizations. All the references were evaluated for relevance by two of the authors of this report. Some of the articles cited as references were also hand-searched. Major publications known in the field of pre-hospital emergency care but not located by the search strategy were also used for the analysis.

Various Web sites were consulted, especially those of the following organizations: Nova Scotia's Emergency Health Services,[21] Ontario Prehospital Advanced Life Support (OPALS),[22] the National Association of EMS Physicians (NAEMSP),[23] the American College of Emergency Physicians (ACEP)[24] and the Center for Medical Education[25]. The literature search also retrieved some OPALS study results presented at major conferences and to be published in the coming months; their abstracts will be used for the purpose of the discussion here, given their importance to the issue at hand. The authors of the OPALS study were reached by telephone or e-mail for the purpose of obtaining information required to interpret some recent results.

5.3 CARDIAC ARREST

Sudden cardiac arrest is a dramatic event: the person loses consciousness, stops breathing, and lacks signs of effective blood circulation (absence of a detectable pulse). Without a rapid and well-orchestrated intervention, cardiac arrest is always fatal. Over the past forty years, different interventions have been proposed and combined under the name *chain of survival*. This chain is composed of different links: recognition of the signs of cardiac arrest and call to 9-1-1, bystander-initiated CPR, early defibrillation, and advanced life support [Cummins et al., 1991]. The chain has recently been expanded and now encompasses seven links to include the steps of prevention, early

20. In the OPALS study, advanced life support is defined as the use of endotracheal intubation and different intravenous medication protocols.

21. http://www.gov.ns.ca/health/ehs/default.htm.
22. http://www.ohri.ca/programs/clinical_epidemiology/opals/in_the_news.asp.
23. http://www.naemsp.org.
24. http://www.acep.org.
25. http://www.ccme.org.

recognition of signs and symptoms and early ALS (Figure 1), conferring a holistic approach to the management of myocardial infarction and cardiac arrest.

5.3.1 Effectiveness of the chain of survival

Except for King County, Washington, where the rate of survival to hospital discharge for cardiac-arrest patients is 10.2% [Ornato et al., 1990], the survival rate remains low in all North American cities. It reaches a median of 6.4%, according to a meta-analysis of 39 emergency medical services (EMS) systems published in 1996 [Nichol et al., 1996a].

The effectiveness of the first links in the chain of survival, including early call to 9-1-1, early CPR and early defibrillation, has been clearly established in the literature [Nichol et al., 1996a]. In fact, if a person is in ventricular fibrillation and a bystander is on the scene, that person's chance of survival to hospital discharge reaches 32.1% in King County [Rea et al., 2003], where nearly 60% of the population over the age of twelve knows how to perform CPR [Cobb et al., 1992].

Bystander intervention to reduce mortality from cardiac arrest should include not only CPR but early defibrillation as well. A public-access defibrillation approach was tried out in the Public Access Defibrillation (PAD) study. This trial included 993 community units, such as shopping malls, hotels, apartment complexes and recreational centres, for which had been developed a structured and monitored emergency-response system relying on the help of trained lay volunteers with no inherent duty to respond.

These community units were randomly assigned to two groups, depending on the type of training provided to the volunteers: the control group had learned how to perform CPR, and the experimental group knew how to perform CPR and automated defibrillation. A total of over 19 000 volunteers were retrained every three to six months during the three-year project. Early defibrillation performed by the experimental group significantly increased the rate of survival to hospital discharge of out-of-hospital cardiac-arrest victims (14.0% vs 23.4 %; $p = 0.03$; relative risk [RR] = 2.0: confidence interval [CI], 1.07 to 3.77) [Hallstrom et al., 2004].

Medical papers are very clear about the benefit of cardiac massage; and a recent resurgence of interest in this topic is apparent in the literature [Vaillancourt and Stiell, 2004; Stiell et al., 2003b; De Maio et al., 2001; Petrie et al., 2001]. Likewise, it is known that defibrillation must be performed early for it to be effective [Stiell et al., 1999b]. It is estimated that the probability of surviving from cardiac arrest and being discharged from hospital may double if a bystander initiates CPR on the scene [Valenzuela et al., 1997; Larsen et al., 1993]. When performed optimally, CPR is able to restore from 10% to 20% of normal cardiac output, and from 20% to 30% of normal cerebral blood flow. When performed during patient transport, CPR does not seem to be as effective. Sunde et al. [1997] demonstrated on a manikin that CPR is less effective when a patient is being moved than when it is administered on site. They measured the percentage of correctly performed compressions, according to position, frequency, depth and sequence in four different situations: at the scene of the event, on a stretcher carried horizontally, on a stretcher carried down the stairs, and in a moving ambulance. Results show a compression rate of 68% on site and 66% in the ambulance, compared with 57% while the patient is being carried horizontally and 32% while being carried down the stairs. A randomized clinical trial, recently presented at the annual conference of the National Association of EMS Physicians (NAEMSP), reached similar conclusions. According to the abstract, the rate of compressions performed correctly on a manikin rose to 54.4% if performed on the floor and 20.4% if the victim was being moved [Vogel et al., 2005].

FIGURE 1

The chain of survival

Permission to reproduce the Chain of Survival logo was kindly granted by the Heart and Stroke Foundation of Canada.

Defibrillation is also known to increase patient survival from cardiac arrest [Cummins et al., 1991]. Defibrillators are becoming available to the general public, mostly in airports, casinos and commercial aircraft [Page et al., 2000; Robertson, 2000; Valenzuela et al., 2000; Page et al., 1998; O'Rourke et al., 1997]. For defibrillation to be effective, however, it must be performed soon after collapse [Stiell et al., 1999b]. It is estimated that the survival rate drops by 3% (with CPR) and by 10% (without CPR) for every minute that defibrillation is delayed [ERC, 2000; Larsen et al., 1993]. Paradoxically, recent studies reveal that, in the case of prolonged cardiac arrest and ventricular fibrillation, the optimal strategy may consist in performing CPR for three minutes before defibrillation [Wik et al., 2003; Cobb et al., 1999].

In pre-hospital systems offering ALS care, resuscitation of cardiac-arrest patients is done on site, and patients are transported only once their circulation returns; failing which, resuscitative efforts can be terminated via on-line medical control. Out-of-hospital termination of resuscitative manoeuvres is clearly supported by major organizations such as the American Heart Association (AHA) and the National Association of EMS Physicians (NAEMSP) [Bailey et al., 2000]. This decision averts ambulance runs with sirens and flashing lights, which carry needlessly high risks of collision [Colwell et al., 1999].

5.3.2 Effectiveness of advanced life support

The effectiveness of the next link in the chain—advanced life support consisting of endotracheal intubation and intravenous drug therapy—is still under investigation [Nichol et al., 1999; 1996a; Cummins et al., 1991]. One of the difficulties involves distinguishing between the impact of early defibrillation and that of ALS, and to date there are few conclusive studies on the topic.

Two randomized, double-blind controlled trials have evaluated the role of amiodarone in the management of out-of-hospital cardiac arrest.

The survival rates of patients resistant to initial defibrillation were compared in the ARREST study (Amiodarone in Out-of-Hospital Resuscitation of Refractory Sustained Ventricular Tachycardia). A total of 504 patients were assigned to two groups: one received amiodarone and the other a placebo administered by paramedics in the pre-hospital setting [Kudenchuk et al., 1999]. The rate of survival to hospital admission was higher in patients given amiodarone, 44% vs 34% ($p = 0.03$; OR = 1.6). Yet no significant difference was observed in the rates of survival to hospital discharge.

The survival rates of patients resistant to initial defibrillation (347 patients) who received either amiodarone or lidocaine were compared in a randomized clinical trial

called ALIVE (Amiodarone vs Lidocaine in Prehospital Refractory Ventricular Fibrillation Evaluation). The rate of survival to hospital admission was higher in patients given amiodarone, 22.8%, compared with 12.0% for those given lidocaine ($p = 0.009$; OR = 2.2). The rate of survival to hospital discharge was 5% for the amiodarone group and 3% for the lidocaine group, but this difference is not significant ($p = 0.34$) [Dorian et al., 2002].

A recent European multicentre randomized trial of 1186 out-of-hospital cardiac-arrest patients compared the use of vasopressin with that of epinephrine. The overall survival of patients to hospital admission was 36.3% in the group treated with vasopressin and 31.2% in the group that received epinephrine ($p = 0.06$; OR = 0.8). The rate of survival to hospital discharge was the same for both groups, 9.9%. A subgroup analysis for initial arrhythmias showed that neither medication was superior to the other, except in the subgroup of patients with an initial asystole (n = 528). In that subgroup, the survival rate was higher in the vasopressin group than in the epinephrine group, 29% vs 20.3% for the rate of survival to admission ($p = 0.02$; OR = 0.6) and 4.7% vs 1.5% for the rate of survival to hospital discharge ($p = 0.04$; OR = 0.3) [Wenzel et al., 2004]. These results seem to indicate that pre-hospital intravenous therapy with a medication such as vasopressin may have a role to play in cardiac-arrest patients with asystole, but this hypothesis remains to be confirmed by other studies to counter the bias possibly induced by subgroup analysis.

It is worth mentioning that, even in the hospital setting, there is no scientific evidence that the medications that may be administered in ALS care improve the survival of cardiac-arrest patients [Stiell et al., 1995; Pepe et al., 1994]. In fact, at least one prospective study of 773 in-hospital cardiac-arrest patients reported an increase in initial mortality (recorded one hour after termination of CPR) after administration of medications following recommended protocols [Van Walraven et al., 1998].

In spite of this, on the basis of the results of two pre-hospital studies (including the ARREST study), the 2000 guidelines of the American Heart Association (AHA) recommend the use of amiodarone for patients presenting with ventricular fibrillation resistant to initial defibrillation. The AHA does indicate that this recommendation is based on arguments (evidence or opinions) that are less well established (Class IIb)[26] [AHA and ILCR, 2000a].

Another recommendation concerning the chain of survival as a whole, including early ALS, obtained the highest level of recommendation (Class I)[27] from the AHA in its 2004 guidelines [Antman et al., 2004]. As a point of information, in the Montréal region, the interval between arrival of an EMT crew at the bedside of a cardiac-arrest patient and arrival at the nearest hospital was 27 minutes on average for 703 patients transported in 2004, without ALS having been administered on site.[28]

5.3.3 OPALS and cardiac arrest

The optimization of BLS services between OPALS phases I and II had a pronounced effect: the proportion of patients who received early defibrillation (within eight minutes) rose from 76.7% to 92.5% ($p < 0.001$), and survival to hospital discharge after cardiac arrest rose from 3.9% to 5.2%, a relative increase of 33% ($p = 0.03$) [Stiell et al., 1999b].

In phase III of the project, 5638 patients from the seventeen study communities suffered cardiac arrest. Data collection took place during the 12 months before the addition of advanced life support (1391 patients)

26. According to the AHA, this recommendation is applicable to situations for which there is conflicting evidence and/or diverging opinions on the usefulness/efficacy of a procedure or treatment (Class II), but arguments in favour of the usefulness/efficacy are less well established (Class IIb).

27. Class I: The usefulness/efficacy of the procedure or treatment is supported by evidence and/or meets with general agreement.

28. Eric Lareau and Gisèle Ouimet, *Urgences-santé*, personal communication, March 2, 2005.

and during the 36 months after its introduction (4247 patients). Paramedics achieved a success rate of 94% for endotracheal intubation and 89% for intravenous access. When advanced care paramedics were involved, the rate of return of spontaneous circulation rose from 12.9% to 18% ($p < 0.001$) and the rate of survival to hospital admission increased from 10.9% to 14.6% ($p < 0.001$). There was no significant effect on the rate of survival to discharge, which was 5% before the paramedics came into play, and 5.1% after the introduction of ALS ($p = 0.83$) [Stiell et al., 2004].

5.3.4 Discussion of the evidence

The OPALS study is the largest and one of the most rigorous studies ever undertaken on the additional impact of ALS compared with BLS care that included early defibrillation in cardiac-arrest patients. Although it may not have the validity of a randomized trial, its non-randomized comparative design and the authors' efforts to eliminate the effects of other variables have helped make these study results the best evidence available to this day.

Some experts have put forward that the Ontario paramedics were relatively inexperienced at the beginning of the data-collection period, six months previously. A learning curve effect with respect to the techniques and protocols may have been a factor, but that is not very likely given that their success rates for intubation and intravenous injection are comparable to those achieved in older pre-hospital systems.

The interval before the introduction of advanced cardiac life support may have had an impact on the survival rates. At a recent conference, one of the authors of the study, Dr. Daniel Spaite, highlighted the fact that some systems have much shorter access times to ALS care than those in Ontario. In Tucson, Arizona, for example, 90% of cardiac-arrest patients have access to an ALS crew within 6.9 minutes. In the OPALS study, in 87% of the cases, the ALS crew responded to emergency calls within 11 minutes [Spaite, 2005]. The question of the effectiveness of early ALS systems needs further study.

5.3.5 Evidence summary

In light of current evidence, the addition of pre-hospital ALS care does not seem to influence the rate of survival to hospital discharge. The only documented effects are limited to better transient results, such as the return of a pulse and hospital admission. Some authors argue that an intermediate marker should be adopted—the rate of survival at 24 hours from cardiac arrest—which in their view would be a more appropriate measure for evaluating out-of-hospital resuscitation efforts [Wang et al., 2005]. This would help exclude the effects of complications and treatments that occur during hospital stays in intensive-care units, for which the pre-hospital system would not be held accountable. It is worth pointing out that there is no scientific evidence that the in-hospital administration of ALS medications effectively improves the survival of cardiac-arrest patients.

5.4 OTHER CARDIAC PROBLEMS

5.4.1 Delays in the management of acute stroke

Acute stroke requires a series of rapid interventions involving the entire pre-hospital and hospital chain, from the call to 9-1-1 all the way to thrombolysis or angioplasty. Since the early 1990s, considerable attention has been given to decreasing hospital delays in administering thrombolytic agents, based on the concept "time is muscle." Despite massive awareness campaigns, nearly two thirds of treatment delays are apparently caused by late calls to 9-1-1. The pre-hospital stage is estimated to account for barely 5% of the total time to definitive care, and the hospital stage between 25% and 33% [AHA and ILCR, 2000c].

Hospital delays are due to various factors: triage, recording and then interpreting the electrocardiogram (ECG), reaching a prognosis, and preparing the thrombolysis protocol or mobilizing the angioplasty team, as the case may be. Some studies have attempted to measure the impact of certain pre-hospital procedures on these delays.

5.4.2 Electrocardiograms (ECGs)

Performing pre-hospital ECGs would help reduce delays in a direct way by promptly obtaining ECG results, and in an indirect way by making early contact with the receiving hospital to alert the staff to the imminent arrival of a patient with acute coronary syndrome (ACS). Studies with varying levels of methodological rigour have examined this issue and seem to indicate that obtaining ECGs in the field may increase the number of thrombolyses and primary angioplasties performed, thereby significantly reducing treatment delays [NHAAP, 1998; Canto et al., 1997; Aufderheide et al., 1996; NHAAP, 1995; Foster et al., 1994; Aufderheide et al., 1992a; 1992b; Kereiakes et al., 1992; Karagounis et al., 1990; Kudenchuk et al., 1989; Pantridge et al., 1975]. Similarly, some studies have noted that ECG results can be relayed to the receiving hospital for the purpose of having the interpretation confirmed [Giovas et al., 1998; Weaver et al., 1990; Grim et al., 1987].

In light of these studies, the AHA issued a recommendation in 2004 that favoured, albeit with reservations, performing ECGs before hospital arrival in urban and suburban settings (Class IIa)[29] [Antman et al., 2004]. It also recommended that pre-hospital personnel trained in ALS interpret 12-lead ECGs for all patients suffering from suspected cardiac chest pain and transmit them to the receiving hospital or to a physician if the ECG reveals ST-segment elevation myocardial infarction (STEMI) (Class IIa). The American College of Emergency Physicians (ACEP), for its part, recommends that ECGs be performed in the pre-hospital setting [Brennan et al., 1999].

5.4.3 Pre-hospital thrombolysis

In an effort to discover how to reduce delays to definitive care for patients with suspected myocardial infarction, numerous randomized clinical trials have investigated the impact of pre-hospital thrombolysis [Steg et al., 2003; Morrow et al., 2002; Rosenberg et al., 2002; Rawles, 1997; Brouwer et al., 1996; Rawles, 1994; EMIPG, 1993; Weaver et al., 1993; Brugemann et al., 1992; GREAT Group, 1992; McAleer et al., 1992; BEPS Collaborative Group, 1991; Risenfors et al., 1991]. They all showed that treatment delays were shorter than those in receiving hospitals. One of these studies was a five-year follow-up that served to estimate that every 30-minute delay in administering a thrombolytic agent translates into an average life-expectancy reduction of one year [Rawles, 1997]. The rate of survival to hospital discharge among patients who received out-of-hospital thrombolysis seems higher than that among patients who received it only upon hospital arrival. Nevertheless, most of these trials did not have the statistical power required to make a small difference significant.

Morrison et al. [2000b] attempted to dispel this uncertainty by performing a meta-analysis of six randomized trials combining a total of 6434 patients. Their results showed that pre-hospital treatment reduced time to thrombolysis on the order of 58 minutes ($p = 0.007$), resulting in a relative reduction of mortality to hospital discharge on the order of 17% ($p = 0.03$; NNT[30] = 62).

When the AHA revised its practice guidelines in 2004, it recommended the pre-hospital administration of a thrombolytic agent by an on-scene physician or by a well-trained paramedic working in a well-

29. According to the AHA, this recommendation is applicable to situations for which there is conflicting evidence and/or diverging opinions on the usefulness/efficacy of a procedure or treatment (Class II), but the weight of evidence or opinion is in favour of its usefulness/efficacy (Class IIa).

30. Number needed to treat (NNT) is the number of patients who need to be treated to save one life.

organized pre-hospital EMS system that has crews with 12-lead ECGs in the field with transmission capability, on-line medical command, and an ongoing continuous quality-improvement program [Antman et al., 2004].

5.4.4 Patient transport to a cardiac centre

A Cochrane meta-analysis pooled ten randomized controlled trials (2573 patients) and reported a significant reduction in short-term mortality of 32% (CI, 5% to 50%) in patients treated with angioplasty compared with patients treated with a thrombolytic agent. The benefits emanating from angioplasty seem transient, however, given that this meta-analysis did not demonstrate that angioplasty was superior to thrombolysis at six months and at one year [Cucherat et al., 2003]. This meta-analysis is currently being updated to reflect recent literature on the topic. Another recently published meta-analysis of 23 randomized trials (7739 patients) shows that angioplasty is superior to thrombolysis: reduction in mortality (OR[31] = 0.73), reinfarction (OR = 0.35), stroke (OR = 0.46), hemorrhagic stroke (OR = 0.05), and results indicators combining death, reinfarction and stroke (OR = 0.53) [Keeley et al., 2003]. The advantages of primary angioplasty are statistically significant, both in the short term (4–6 weeks) and in the long term (6–18 months). Moreover, the differences in favour of angioplasty are consistent in the five studies comparing on-scene thrombolysis with transfer to a tertiary-care centre for primary angioplasty. Another meta-analysis of six randomized trials combining 3750 patients also showed that transfer to a tertiary-care centre for primary angioplasty is superior to on-scene thrombolysis, with a decrease at 30 days in the combined criteria (CC) of death, reinfarction and stroke (7.8% vs 13.5%; relative risk [RR] = 0.58; $p < 0.001$) [Dalby et al., 2003].

Since only a limited number of hospitals are able to perform angioplasty, pre-hospital use of 12-lead ECGs permits identification of myocardial infarction and direct transfer to a tertiary-care centre, which significantly reduces time to angioplasty. This strategy is being applied by a fair number of pre-hospital EMS systems in Canada and the United States.

When the AHA revised its practice guidelines in 2004, it recommended that all out-of-hospital patients who have cardiogenic shock or who present with contra-indications to thrombolytic treatment be taken immediately or transferred promptly to a cardiac centre with hemodynamics facilities capable of performing early revascularization, either by percutaneous angioplasty or by coronary artery bypass graft surgery within eighteen hours of onset of shock (Class I recommendation for patients under the age of 75, and Class IIa for patients aged 75 and over) [Antman et al., 2004].

A recent study based on a prospective observational registry with data collected from 106 hospitals in 14 countries suggests that caution should be exercised before the decision is made to routinely transfer patients to a cardiac centre [Van de Werf et al., 2005]. Outcomes were analyzed for 28,825 patients admitted to hospital with a presumed diagnosis of acute coronary syndrome (ACS). Most of the patients (77%) had been admitted to hospitals equipped with cardiac catheterization facilities, and as expected, the use of invasive interventions was more frequent among these patients than among those admitted to hospital without such facilities. Percutaneous coronary interventions were performed on 41% of the patients in the first group, compared with 3.9% in the second group ($p < 0.001$). The same was true for coronary artery bypass surgery, 7.1% vs 0.7% ($p < 0.001$). Notwithstanding these higher intervention rates, the survival rates of patients admitted to hospitals with catheterization laboratories were not higher. Mortality rates at six months had increased by 14% (RR = 1.14:

31. Odds ratio (OR), comparing the probability that an event will occur in one group rather than in another.

1.03 to 1.26). In addition, the rates of major bleeding (OR = 1.94: 1.57 to 2.39) and of stroke (OR = 1.53: 1.10 to 2.14) were higher than those in patients admitted to hospitals without catheterization laboratories. On the other hand, the risk of reinfarction after hospital discharge tended to be lower among patients initially admitted to hospitals with catheterization laboratories. The authors conclude that their analysis supports the current strategy of promptly directing patients with suspected ACS to the nearest hospital whether or not it has a catheterization laboratory, and they argue against the early routine transfer of these patients to tertiary-care hospitals equipped to perform these procedures.

5.4.5 Other advanced care

Pre-hospital use of cardioversion (electric conversion of symptomatic arrhythmia in patients with a cardiac pulse) has been investigated. A prospective study examined the use of cardioversion by a crew composed of paramedics and a physician in 86 cases of supraventricular tachycardia, including atrial fibrillation with rapid ventricular frequencies either accompanied by signs of instability or resistant to pharmacological treatment. Sinus cardiac rhythm was restored in all patients, and no complications were reported. The status of all the patients improved within 20 minutes of the cardioversion [Roth et al., 2003].

Pre-hospital administration of anti-arrhythmic drugs has been recommended for patients presenting with unstable arrhythmias, but this assumption has not been rigorously investigated. Only three small studies on the topic were found, and they are summarized below.

A retrospective case-series study on the pre-hospital administration of atropine to 131 patients presenting with bradycardia and hemodynamic instability reported a partial or complete response in 47.3% of the patients, with 2.3% of adverse effects attributable to atropine [Brady et al., 1999]. Given that this type of study design does not include a control group, it is impossible to determine the relative efficacy of atropine in this context.

A comparative retrospective observational study examined the impact of administering intravenous diltiazem to stabilize cardiac arrhythmia in patients presenting with atrial fibrillation and an accelerated ventricular response rate. There were no significant differences in the demographic and clinical characteristics of the two comparison groups: a group of 43 patients who had received diltiazem in 1999 and a control group of 27 patients who had not done so in 1998. Pre-hospital administration of diltiazem slowed patients' cardiac rhythms to 55 beats per minute on average, which corresponds to a relative reduction of 33.1% ($p < 0.001$); this reduction was 38 beats greater than the reduction documented in the control group. No pre-hospital treatment for complications, including hypotension, was reported [Wang et al., 2001].

Lastly, a before–after retrospective comparative study examined pre-hospital use of adenosine and its effects on the conversion rate of paroxysmal supraventricular tachycardia (PSVT). Seventy-four patients with PSVT before the adenosine protocol was introduced were compared with 137 patients after its introduction. The conversion rate prior to arrival at the hospital ED was higher in the group treated with adenosine (59% vs 32%; $p < 0.001$). On-scene times, however, were longer in this group (26 vs 19 minutes; $p < 0.001$) [Morrison et al., 2001].

5.4.6 OPALS and other cardiac problems

In OPALS phase III, the investigators studied a cohort of patients suffering from cardiac chest pain to determine the benefit of advanced life support for that category of patients. Despite the importance of these study results, the complete article has not yet been published, and the only data available so far come from one abstract [Stiell et al.,

2003a], various conference presentations [Spaite, 2005], and personal communication with the authors.[32]

In this study, 12,168 patients were evaluated in total, and 6380 were treated in the ALS phase. Final diagnoses for these patients were myocardial infarction (26.5%), angina (22%), undiagnosed chest pain (15%), congestive heart failure (7.5%), dysrhythmia (abnormal heart rhythm) (5%), respiratory problems (5.5%), gastrointestinal problems (3.5%), other cardiac problems (1%), anxiety (0.6%), and other diagnoses (13.5%) [Spaite, 2005; Stiell, 2004]. During their care, 14% (BLS group) and 18% (ALS group) of the patients suffered cardiac arrest witnessed by EMS crews. Pre-hospital treatment in the ALS group consisted of oxygen therapy (95%), sublingual nitroglycerine (59%), oral aspirin (50%), IV morphine (4.2%), IV fluid bolus of sodium chloride (NaCl) (3.5%), IV furosemide (1.8%), IV lidocaine (0.2%), IV atropine (0.3%) and IV adenosine (0.7%), along with endotracheal intubation (0.2%). Patients in the BLS group were treated with oxygen therapy (94%), aspirin (13%) and nitroglycerine (12%). In this cohort of patients, total mortality declined from 4.3% to 3.2%, a relative decrease of 28% ($p < 0.01$; NNT = 91) after the introduction of ALS care. Among the patients presenting with acute myocardial infarction, mortality fell from 13.1% to 8.5% after the introduction of ALS, a 35% decrease in relative risk ($p < 0.01$; NNT = 22). Among the patients diagnosed with angina, mortality decreased from 2.4% to 1.3%, but this reduction is not statistically significant ($p = 0.97$). The proportion of patients stating that their health had improved after pre-hospital care rose from 20.9% to 49.3% ($p < 0.0001$). In the patient subgroup presenting with myocardial infarction (768 patients), 18% were treated by ALS protocols, either intravenous therapy or endotracheal intubation. The authors estimated that 87 (NNT = 91) additional lives were saved per year, owing to the addition of ALS for all the study communities (overall population of roughly two million).

5.4.7 Discussion of the evidence

Thrombolysis and angioplasty are effective for the management of ST-segment acute elevation myocardial infarction (STEMI). It is also known that reducing treatment delays has a confirmed effect on the consequences of heart attack. In an effort to reduce these delays, a possible strategy to consider could be pre-hospital case recognition, but this would require the use of 12-lead ECGs. There seems to be a sufficient number of well-designed studies to confirm that it is feasible and safe to perform ECGs and to transmit them to an appropriate base hospital for medical interpretation. Rigorous studies have led to the conclusion that pre-hospital use of thrombolytic agents effectively reduces treatment delays, but the overall effect on mortality remains modest all in all.

As for the overall impact of advanced life support, which the OPALS study in Ontario is proposing to measure, current literature on the topic is still limited. Publication of the full OPALS study should shed greater light on the conditions liable to explain the effects reported. Moreover, it is impossible to know the extent to which documented improvements in the survival rates of cardiac chest pain patients are attributable to the two most commonly used medications, aspirin and nitroglycerine. These two medications are included in the symptom-relief program that is now part of BLS care. During the second half of the study, primary care paramedics (PCPs) in Ontario began to administer medications that do not require intravenous access, such as nitroglycerine and aspirin, as part of a symptom-relief program, as Québec is now doing. The administration rates of these medications by PCPs rose to 12% for nitroglycerine and 13% for aspirin. When we communicated with Dr. Stiell, he confirmed that an analysis would be conducted to compare the patient group treated by PCPs trained to administer nitroglycerine

32. Ian Stiell, MD, Senior Scientist, Clinical Epidemiology Unit, Loeb Health Research Institute, and principal investigator, OPALS study, Ottawa, Ontario, telephone communication, November 25, 2004.

and aspirin, with the group treated by ACPs. This comparison may help distinguish the effects of BLS medications from the effects of the other ALS treatments. Other than these specific effects, it is difficult to know how patient management by advanced care paramedics (ACPs) affects morbidity and mortality in patients presenting with myocardial infarction. It is presumed that a higher level of knowledge confers sounder judgement and permits better use of the same medications. Once again, the publication of the full article will probably bring answers to these questions.

5.4.8 Evidence summary

The current literature review shows that the addition of ALS may have a beneficial effect on survival from myocardial infarction, but some of the results remain open to discussion. The exact nature of the interventions that confer this advantage is even more difficult to determine with any accuracy, and the relative contribution to the reported benefits by these newly introduced BLS medications is still not known. The role of ECG interpretation or transmission is recognized. Thrombolysis also seems to have a role to play in pre-hospital care, but it requires a well-established patient-management system.

5.5 RESPIRATORY PROBLEMS

5.5.1 Patient assessment

It is estimated that roughly 100,000 patients with respiratory problems are transported by ambulance each year in Canada. In-hospital mortality of respiratory-distress patients transported by ambulance reaches 18% [Stiell et al., 1999c]. To administer the right treatment, paramedics must be able to identify the cause of patients' dyspnea (shortness of breath). In a retrospective study of 222 patients, paramedics correctly assessed the cause of the patients' dyspnea in 77% of the cases, and the level of agreement between the paramedics' initial assessments and the EMS physicians' assessments regarding the cardiac or non-cardiac origin of the problem was estimated to be 86% and 83% respectively. When the medical diagnoses included the 24 cases of dyspnea that had both cardiac and non-cardiac origins, however, the level of agreement was not as high: the paramedics treated seven (29%) cases as non-cardiac, thirteen (54%) as suspected cardiac, and four (13%) as having combined sources. The authors observed no significant differences in in-hospital mortality, intubation frequency or average length of hospital stay among the patients who had received differing pre-hospital diagnoses [Pozner et al., 2003].

5.5.2 Non-invasive ventilation

Four in-hospital randomized clinical trials have clearly demonstrated that non-invasive ventilation, such as CPAP (continuous positive airway pressure) and BiPAP (bilevel positive airway pressure), improves the management of patients with acute cardiac insufficiency [Gilligan et al., 2004; Lin et al., 1995; Bersten et al., 1991; Lin and Chiang, 1991; Rasanen et al., 1985]. At least two pre-hospital research studies have been conducted, including the non-randomized prospective comparative study by Craven et al. [2000]. In that study, which began with 71 enrolled patients but ended with only 62, BiPAP was used by a paramedic crew for 37 patients, whereas 25 subjects did not receive ventilation and served as controls. Improvements in patients status objectively measured as an average increase in blood oxygen saturation levels was higher than in the BiPAP group, 13.7% vs 6.7% ($p < 0.05$). On-scene time was not longer for the BiPAP patients (31.4 vs 31.2 minutes; $p = 0.93$). The trial did not have the power required to show a statistically significant difference in morbidity (length of hospital stay, rate of endotracheal intubations) or mortality. Only 7% of the patients (5 of the original 71) could not tolerate BiPAP, while 97% of the paramedics thought it was easy to use. According to the paramedics, the status of 97% of the patients who had been treated with BiPAP improved after the treatment.

A retrospective case-series study of 121 patients in Finland showed that their status improved after the use of CPAP by ALS crews that included a physician. Blood oxygen saturation rose from 77% to 90% ($p < 0.0001$) in the 116 patients who had received CPAP. Other hemodynamic parameters, such as respiratory rate, systolic blood pressure and heart rate, also improved after CPAP, compared with the control group [Kallio et al., 2003].

A randomized clinical trial on the benefit of CPAP is currently in progress in Nova Scotia.

Several pre-hospital EMS systems with ALS services have adopted CPAP (Europe, United States and Canada), but it could not be determined if some of the systems were using it strictly in the context of BLS care.

5.5.3 OPALS and respiratory problems

The primary objective of OPALS phase III was to determine if the addition of ALS would improve survival to hospital discharge in respiratory-distress patients. Despite the importance of the study results of this phase, the complete article has not yet been published, and the only data available to date come from an abstract [Stiell et al., 2002], various conference presentations [Spaite, 2005], and personal communication with the authors.[33] The methodology used to study the cohort of respiratory-distress patients was described in a published paper [Stiell et al., 1999c].

In the cohort of 8157 patients, the final diagnoses at hospital discharge were congestive heart failure (26%), exacerbation of chronic obstructive pulmonary disease (COPD) (19%), pneumonia (13.5%), asthma (7.5%), myocardial infarction (2.5%), bronchitis (4%), lung cancer (3.5%), congestive heart failure combined with COPD (1.5%), other respiratory problems (8%), other cardiovascular problems (4.5%), and other diagnoses (10%). The ALS treatments included nebulized salbutamol (54%), IV furosemide (15%), IV nitroglycerine (9%), IV morphine (1.5%), endotracheal intubation (1.7%) and bag-valve-mask (BVM) ventilation (2.9%). Total mortality to hospital discharge fell from 14.3% to 12.3% ($p < 0.001$; NNT = 50) after the introduction of ALS [Spaite, 2005].

If the different diagnosis subgroups are examined, a statistically significant reduction in mortality was documented only in patients diagnosed with congestive heart failure (1870 patients). In this subgroup, mortality declined from 15.1% to 11.0%, a relative reduction of 27.2% ($p < 0.01$; NNT = 25). These patients received the following treatments: salbutamol (47%), nitroglycerine (18%), furosemide (33%), morphine (4%), bag-mask-valve ventilation (4.2%) and endotracheal intubation (1.6%). No increase in mortality rates was associated with the addition of ALS in any subgroup.

After the addition of ALS, the percentage of patients showing improvement following their pre-hospital treatment rose from 23.8% to 45.9% ($p < 0.0001$). The rate of endotracheal intubations in hospital EDs decreased, from 4.8% to 2.6% ($p < 0.001$). In the subgroup of patients with congestive heart failure, the rate dropped from 7.7% to 3.7% ($p < 0.001$) after the introduction of ALS, for a relative decrease of 52%. The rate of aspirations measured objectively by chest x-ray was significantly lower, 1.8% vs 4.4% ($p < 0.001$). The hospitalization rate declined from 70.9% to 66.3% ($p < 0.0001$). The average hospital stay also declined, from 10.2 to 9.3 days ($p < 0.05$). Lastly, the percentage of patients with good neurological status at hospital discharge rose from 52.2% to 63.2% ($p < 0.0001$). The number of additional lives saved per year, owing to the introduction of ALS in all the study communities (overall population of roughly two million) was estimated to be 170 (NNT = 50).

33. Ian Stiell, MD, Senior Scientist, Clinical Epidemiology Unit, Loeb Health Research Institute, and principal investigator, OPALS study, Ottawa, Ontario, telephone communication, November 25, 2004.

5.5.4 Discussion of the evidence

New ventilation methods using positive pressure could prove interesting, but their impact on the most significant clinical indicators, such as survival or reduction of sequelae, has not yet been studied. The results of the Nova Scotia study, shortly to be made available, will likely help dispel the uncertainties surrounding this type of care.

In the OPALS study, improved survival rates in patients presenting with congestive heart failure seem impressive. Morbidity in survivors may also have been reduced. No bias appears to have been induced by the introduction of the symptom-relief program because only salbutamol is permitted, and this medication has a positive effect only on patients presenting with an asthma attack or exacerbation of COPD. From a cost-benefit perspective, the introduction of a range of ALS procedures seems promising, given that the number of patients who need to be treated to save a life (50 in this case) is smaller than that for patients in other cohorts. For the Québec health-care system, the sizeable reduction of one day of hospitalization could translate into substantial savings. As with the cohort of patients suffering from cardiac chest pain, however, the OPALS study design does not determine with any precision which medications would improve survival from congestive heart failure.

Other than these specific effects, it is difficult to know what impact patient management by advanced care paramedics has on the outcomes of patients presenting with congestive heart failure. It is also important to stress that the paramedics did not use non-invasive ventilation during the data-collection period, which reinforces the hypothesis that certain pharmacological interventions may have a beneficial effect on this group.

5.5.5 Evidence summary

Respiratory-distress patients are the OPALS study cohort that most benefited from pre-hospital ALS care. In this subgroup, the most substantial gain in survival was documented in patients with congestive heart failure.

Since the benefit of CPAP for treating patients in hospital EDs has been demonstrated, it would seem logical to apply it in the pre-hospital setting. Be that as it may, it would be prudent to wait for the results of other studies before the routine use of CPAP should be recommended. The pre-hospital EMS systems that administer this treatment do so by following ALS protocols, and it is not known if this technique is used by BLS personnel. The results of the now completed Nova Scotia study will be published shortly, and they will help clarify the benefit from CPAP in the pre-hospital setting.

5.6 TRAUMA

5.6.1 Concept of a trauma centre

In Canada, it is estimated that each year 10 000 Canadians are severely injured and a total of 22% of them die [Stiell et al., 1999c]. In trauma care, more often than not, the interval between the management of major trauma victims and their access to definitive care is critical, given that approximately 80% of deaths occur within the first minutes or hours of the trauma [Trunkey, 1983]. The concept of a tertiary trauma centre originated from this premise and has contributed to reducing intrahospital delays and mortality, especially in Québec, [Liberman et al., 2004b; Sampalis et al., 1999] by offering all the necessary specialized expertise under one roof (trauma care, neurosurgery, and vascular, thoracic, plastic and orthopedic surgery), thus avoiding

transfers that carry needless risks. For over twenty years, a heated debate between the proponents of two schools of thought has galvanized the medical literature on trauma care: the "scoop and run" approach (prompt evacuation) vs the "stay and play" approach (field stabilization) [Liberman et al., 2004a].

5.6.2 Treatment delays

A retrospective study published in 1996 triggered a polemic in the world of pre-hospital trauma care. It compared 4856 patients transported by the Los Angeles pre-hospital EMS system, with 926 patients transported by other means (bystanders, friends, police officers). The outcome took everyone by surprise by revealing a mortality rate of 9.3% in the group transported by the EMS system, and 4% in the other group ($p < 0.001$). Even after adjustments for the severity of the injury (as measured by the Injury Severity Score [ISS]), the difference remained significant ($p = 0.002$) [Demetriades et al., 1996]. Despite several limitations, including the important one of failing to provide transit times for the control group, this study struck like a bombshell in all North American pre-hospital EMS systems. It became critical to conduct other studies to refute or confirm these results.

In 1997, the issue of on-scene time with multitrauma victims resurfaced following the media outcry ignited by the death of Princess Diana in Paris, and this issue has been at the core of the most fiery debates in trauma care ever since. In 1999, a prospective study of 7103 patients with penetrating trauma indicated that with a quality-improvement program, on-scene times of over 20 minutes in the absence of special circumstances (i.e., without patient extrication) had been lowered from 4.1% (in 1993) to 1.5% (in 1997), and at the same time, the mortality rate had dropped from 5.1% to 0.8% [Eckstein and Alo, 1999]. In 2000, the same authors conducted a retrospective study of 9451 injured people and concluded that, although ALS could be performed without lengthening on-scene times, it did not increase survival rates. In the authors' view, these results do not support prolonging on-scene times to administer ALS, including endotracheal intubation, and all efforts should focus on reducing the time to evacuate patients to a trauma centre [Eckstein et al., 2000].

5.6.3 Overall advanced trauma care

To date, only one randomized clinical trial on overall advanced trauma care seems to have been conducted, but the number of subjects (a mere sixteen) is much too small for conclusions to be drawn [Nicholl et al., 1998].

In 2004, a Cochrane review examined all the studies judged to be the most robust (randomized clinical trials, quasi-randomized studies and before–after comparative studies) on the impact of pre-hospital advanced trauma life support [Sethi et al., 2001]. Of the 2034 identified studies, the only one to meet pre-defined inclusion criteria was the small randomized trial by Nicholl et al. [1998]. As a result, the report concludes that, despite the prevalence of this type of care in developed countries, there is no evidence of the efficacy of pre-hospital advanced trauma life support, and recommends that its use should not be promoted in settings outside randomized controlled trials.

In fact, the best evidence on this topic comes from a Québec group. A meta-analysis of studies relying on various methodologies and comparing BLS with ALS in trauma concluded that 1) on average (17 studies), ALS added five minutes to on-scene time ($p = 0.005$); and 2) ALS increased mortality (15 studies) ($OR^{34} = 2.59$) [Liberman et al., 2000].

In 2003, a multicentre retrospective analysis by the same authors examined the cases of 9405 severely injured patients who had been treated in three different pre-hospital systems: one with advanced care paramedics (Toronto), one with physicians providing

34. Odds ratio (OR), comparing the probability that an event (e.g., death) will occur in one group (ALS) rather than in another (BLS).

pre-hospital care (Montréal), and one with EMTs trained in BLS (Quebec City) [Liberman et al., 2003]. Results show that, even after adjustment for the severity of the trauma, mortality rates were significantly higher among patients who had received ALS than they were in the other two groups combined (29% vs 18%; $p = 0.001$; OR = 1.86). After statistical adjustment to control for the observed differences in the groups (age, mechanism of injury, body region injured and severity of the injury), mortality remained significantly higher in patients who had received ALS (OR = 1.21; $p = 0.01$).

5.6.4 Intubation of trauma patients

The need to ensure ventilation and to protect the airways of injured patients, especially those with traumatic brain injuries, has always been considered a priority objective in pre-hospital care.

At least two recent studies, a retrospective study of 852 patients [Murray et al., 2000] and a prospective study of 191 trauma patients [Bochicchio et al., 2003], appear to indicate that endotracheal intubation may in fact be associated with a higher mortality rate in victims with major traumatic brain injuries.

This negative outcome is apparently not linked to the choice of intubation method because it is also associated with rapid-sequence induction (RSI)[35] promoted in hospital EDs. Some studies have evaluated the effect of administering medications that facilitate endotracheal intubation (rapid-sequence induction) in patients with severe head injuries who score from 3 to 8 on the Glasgow Coma Scale. The first study of 114 patients is prospective. It reports an overall success rate of 99.1% for airway management (84.2% with an endotracheal tube and 14.9% with a Combitube), but on-scene times rose from 13 to 26 minutes when rapid-sequence induction was performed [Ochs et al., 2002]. Albeit interesting, this study provides no data on patient survival or on any other outcome measure. A second prospective study of 209 patients treated with RSI compared them with a control group of 627 patients matched for age, sex, mechanism of injury and severity. Results indicate that RSI is associated with increased mortality, which rose from 24.2% to 33.0% ($p < 0.05$), and decreased hospital discharge, whether authorized or not, which fell from 57.9% to 45.5% ($p < 0.01$) [Davis et al., 2003].

5.6.5 Pre-hospital management of hypovolemic shock

The massive loss of blood induced by trauma leads to a drop in blood pressure that may hinder the oxygenation essential to vital tissues and organs, especially the brain. Loss of blood volume may occur in two ways: either by external hemorrhaging in cases of penetrating injuries and open fractures, or by internal hemorrhaging in cases of blunt trauma. The question of whether fluids should be administered before the source of hemorrhage has been detected and corrected remains controversial.

The only intervention that has been studied in randomized clinical trials is the use of military anti-shock trousers (MAST pants). Initially introduced during the Vietnam war, the use of MAST subsequently spread to almost all pre-hospital EMS services. These inflatable pants were thought to compress the legs, thereby shunting the blood toward the brain, heart and lungs. Relevant studies [Bickell et al., 1991; Mattox et al., 1986; Bickell et al., 1985] have asserted that the effects of this procedure were either nil or harmful. A meta-analysis of randomized clinical trials conducted on this technique reported a negative effect, which was statistically significant [Dickinson and Roberts, 2000]. Since then, most pre-hospital EMS systems have stopped using this apparatus.

In hospitals, lost blood volume may be restored either with blood or, in emergency

35. Rapid-sequence induction (RSI): endotracheal intubation of patients with respiratory rates involving the administration of medications that induce coma and muscle paralysis. This technique, originally used in anesthesia, is now one of the techniques employed in hospital emergency departments.

situations, with replacement fluids such as colloid or crystalloid solutions. A Cochrane review also studied the effectiveness of different volumes and timing of fluid administration to conclude that there was no evidence to support their relative efficacy and that the effectiveness itself of fluid replacement remained uncertain [Kwan et al., 2003]. A recent literature review of the effectiveness of pre-hospital fluid replacement reveals that, out of four randomized clinical trials, three are of paltry methodological quality [Dretzke et al., 2004]. The authors conclude that the pre-hospital use of colloid or crystalloid solutions is probably harmful in cases of penetrating injuries, and that there is no evidence that it has beneficial effects in cases of blunt trauma.

5.6.6 OPALS and trauma

The aim of OPALS phase III was to examine the effects of advanced trauma life support. The study cohort included some 6000 severely injured patients. No publication is available yet. Only an interim analysis has recently been presented, and the results seem to indicate that ALS may not have a positive effect.

5.6.7 Evidence summary

No randomized clinical trial concludes on the real value of ALS for the pre-hospital management of trauma patients. To date, medical literature seems to indicate that the transportation of injured patients should not be delayed by pre-hospital ALS interventions. Can the increased mortality associated with ALS in trauma care be explained simply by prolonged on-scene times or by the harmful effects of the ALS procedures themselves? Several pre-hospital EMS systems still use advanced trauma life support for the management of trauma patients despite the lack of evidence supporting this practice.

5.7 PEDIATRIC ADVANCED LIFE SUPPORT

In pediatrics, few studies have been conducted on pre-hospital care chiefly because of the relatively small number of children requiring emergency care.

Endotracheal intubation is an exception, given that at least one randomized clinical trial has studied this topic. That trial included 830 patients aged 12 or younger who had received out-of-hospital artificial ventilation. The patients were randomized according to the day of the week (pseudo-randomization): one group received bag-valve-mask ventilation, the other endotracheal intubation. The rates of survival to discharge and neurological sequelae in the two groups were compared: documented results were very slightly unfavourable to endotracheal intubation, but the difference was not statistically significant. Of some concern was the fact that the paramedics' endotracheal-intubation success rate was barely 57%. Complications included 2%unrecognized esophageal intubations, 6% unrecognized tube dislodgement during transport, 8% recognized tube dislodgement during transport, 18% successful main stem intubations, and 24% intubations with tubes of the wrong size [Gausche et al., 2000]. Since the release of that study, several pre-hospital care systems have halted this practice with children.

In Pittsburgh, Pennsylvania, a retrospective study compared ALS and BLS provided over a thirteen-year period to 189 children presenting with cardiac arrest. The rate of survival to hospital discharge was 3.3% (5 out of 150) for the ALS group and 0% (0 out of 39) for the BLS group, but this difference is not statistically significant. The authors conclude that ALS does not improve survival to hospital discharge [Pitetti et al., 2002].

5.7.1 OPALS and pediatrics

In OPALS phase III, 1368 patients under the age of sixteen were recruited over a six-month period. The average age was eight. The study interventions included cardiac monitoring during transport (21%), establishing intravenous access (8.5%), administration of IV diazepam (0.9%) or IV morphine (0.8%), and endotracheal intubation (0.1%). After medical assessment in the hospital ED, 94.5% of the patients were discharged, 3.5% were hospitalized, 0.9% were admitted to an intensive-care unit, and 0.5% died. The authors conclude that most pediatric patients have minor illnesses, few advanced life support interventions are performed, and the vast majority of patients are discharged after ED assessment [Richard et al., 2003]. Despite the importance of this study, it is available only as an abstract so far.

5.7.2 Evidence summary

Very few studies have focused on pediatric advanced life support (PALS) because major problems are exceedingly rare. It is also recognized that ALS interventions such as endotracheal intubation and intravenous access are technically more difficult to apply with pediatric patients. It is therefore not very surprising that the success rate of these interventions is relatively low.

5.8 OTHER TREATMENT AVENUES

5.8.1 Convulsive seizures

A pre-hospital randomized clinical trial compared the pre-hospital use of lorazepam, diazepam and placebo to 205 status epilecticus patients presenting with convulsive seizures that were repetitive or prolonged (lasting over five minutes). Seizures had terminated upon arrival at the ED in more patients treated with intravenous lorazepam (59.1%) or diazepam (42.6%) than in patients given placebo (21.1%) ($p = 0.001$). Complications noted in the pre-hospital setting (hypotension, cardiac dysrhythmia or the need for a respiratory intervention) appeared to be greater in the placebo group, but the difference is not statistically significant ($p = 0.08$). There was no significant difference ($p = 0.39$) in the effects observed in hospital (duration of status epilepticus, new cardiopulmonary complications, reasons for discharge from the ED) and at hospital discharge (neurological status) [Alldredge et al., 2001]. The authors conclude that paramedic administration of benzodiazepines in the pre-hospital setting is effective and safe to stabilize status epilepticus in adult patients.

5.8.2 Hypoglycemia

Studies have examined the usefulness of the pre-hospital management of hypoglycemia accompanied by altered levels of consciousness. In Europe, a small randomized clinical trial of 14 patients presenting with severe hypoglycemia showed that symptom-recovery time was shorter in patients given intravenous dextrose (from 1 to 3 minutes) than in those given intramuscular glucagon (from 8 to 21 minutes) [Carstens and Sprehn, 1998]. Another prospective study compared the outcomes observed in 9 hypoglycemic patients (glucose level $\leq$ 4.0 mmol/L) given intramuscular glucagon (phase I) and in 19 patients given intravenous dextrose (phase II). Four patients were excluded, and five in the second group required intramuscular glucagon instead. Results also showed that the patients regained full consciousness more quickly in phase II (11 minutes) than in phase I (28 minutes) ($p < 0.005$). This gap increases if patients given dextrose (3.5 minutes) are compared with those given glucagon (17.5 minutes) [Howell and Guly, 1997].

5.8.3 Drug overdose

Treatment for drug overdose is usually limited because there are few antidotes and they are rarely used. The cornerstone of severe-overdose management is to support patients' vital functions, which sometimes

requires endotracheal intubation, intravenous fluid therapy and gastrointestinal decontamination.

The only pre-hospital therapeutic avenue examined is the administration of naloxone to treat overdoses from opioid agents (heroin, morphine and other narcotics). Opioid overdose leads to reduced consciousness and respiratory rates, which may cause different complications and death.

A retrospective study of 726 patients evaluated their response to intravenous or intramuscular naloxone administered by California paramedics. Results for the 609 patients who had vital signs (pulse, blood pressure) showed that 94% of them responded to naloxone within five minutes: documented outcomes included improved mental status (Glasgow Coma Score greater than or equal to 14/15) or respiration rate (greater than or equal to 10 respirations per minute). All treated patients were transported to a hospital, but only 2.7% of them were hospitalized after initial treatment [Sporer et al., 1996]. The study provides no mortality or morbidity outcomes.

A retrospective study of the San Diego pre-hospital EMS system was designed to evaluate the safety of paramedic administration of intravenous and/or intramuscular naloxone to heroin-overdose patients. Over a five-year period, 8366 patients had received naloxone. The authors examined the records of 998 patients who had refused transportation to hospital (against medical advice) after their status had improved. The researchers examined deaths attributable to opioid overdose within twelve hours of the initial call by consulting regional medical-examiner databases where all death records are compiled. They matched these records to the patients treated with naloxone by paramedics to establish a comparison between the two groups. Among the patients treated by paramedics, there were no deaths due to opioid overdose within twelve hours of the intervention. The authors mention that the fact of averting ambulance transport and emergency-department assessment has implications of interest to hospital EDs, which are already stretched to capacity [Vilke et al., 2003]. Owing to the type of study design used, patient morbidity could not be evaluated.

A few studies have examined the different routes of naloxone administration available in the pre-hospital setting. A Canadian prospective study of 196 opioid-overdose patients treated by Vancouver paramedics compared how patients' respiratory rates were affected by the speed of onset of intravenous (0.4 mg) versus subcutaneous (0.8 mg) naloxone. No clinical difference was observed, and the authors conclude that the subcutaneous route is an acceptable option when venous access is difficult to establish [Wanger et al., 1998]. A small prospective study of 30 patients in Denver showed that paramedic administration of intranasal naloxone is a safe, effective and rapid technique, which avoids the need to use needles with populations at risk of transmitting diseases such as hepatitis B, hepatitis C and the human immunodeficiency virus (HIV) [Barton et al., 2002].

A recent well-designed RCT compared the administration of intramuscular naloxone (2 mg) with that of intranasal naloxone (2 mg) by Australian paramedics. This study examined the cases of 155 patients presenting with suspected opioid overdose who had fewer than ten respirations per minute and who were not arousable. The primary outcome measure was the time required to regain a respiratory rate greater than ten respirations per minute. The mean response time was six minutes in the intramuscular group and eight minutes in the intranasal group ($p = 0.006$). The proportion of patients who achieved a respiratory rate greater than ten per minute within eight minutes of receiving naloxone rose to 82% for the intramuscular group and to 63% for the intranasal group ($p = 0.0173$; OR = 2.6: CI, 1.2 to 5.5). The proportion of patients who had adverse reactions, such as agitation and irritation, was 13% for those who received the naloxone intramuscularly and 2% for those who received it intranasally ($p = 0.0278$). The authors conclude that both

routes are effective but that intramuscular naloxone takes effect more quickly, and a second dose is required less often. They point out, however, that the intranasal route reduces the risk of injury to paramedic practitioners and the risk of exposure to viral diseases transmitted through handling the needles used for intramuscular injections. This procedure is thought to be practical and relatively safe to make more widely available [Kelly et al., 2005].

It is good to know that naloxone is now part of the enhanced symptom-relief program available to primary care paramedics in some Canadian provinces. As a point of information, between October 1999 and November 2000 in the Montréal area, 94 patients with severe heroin overdoses were transported by *Urgences-santé*.[36]

5.8.4 Pain management

Pain relief is another important component of emergency care and practice. It would therefore seem advisable to offer pain relief in the pre-hospital setting. Yet few pre-hospital EMS systems use analgesia protocols, except for ischemic chest pain [Paris, 1996, 85–90]. Some authors have coined the term *oligoanalgesia* to define the lack of acute-pain management for patients seen in hospital EDs [Wilson and Pendleton, 1989]. In cases where patient safety is not at risk, prompt analgesia should be regarded as the standard of care. Needless to say, there are important considerations to be taken into account before pharmacological interventions should be used: the risk of respiratory failure, loss of consciousness and drop in blood pressure, along with the restrictions governing controlled substances (narcotics). The advantage of narcotics is that it allows the use of an antagonist like naloxone in the event of adverse reactions. Pre-hospital analgesia may offer the benefit of faster pain relief.

A recent retrospective study of 104 patients who had isolated fractures or dislocations of the upper or lower extremities (including the hip) served to establish that the time to analgesia was significantly shorter (90 minutes) in the pre-hospital setting than in the hospital ED, 23.5 minutes vs 113.6 minutes respectively. The average time to analgesia was 75 minutes after hospital ED triage [Abbuhl and Reed, 2003].

A recent retrospective study evaluated the administration of morphine or meperidine to 124 adult patients presenting with hip or lower-extremity fractures [McEachin et al., 2002]. Results show that analgesia is underused in the pre-hospital setting, 18.3% received analgesia compared with 91.1% in the ED. Pre-hospital analgesia helped reduce total delays by 117.5 minutes (28.4 minutes on average vs 146 minutes after the ambulance crew's arrival at the scene of the accident) ($p < 0.001$), which seems to indicate that this strategy could be of benefit to patients. The authors point out that further research is needed to clarify how patient need and pre-hospital practices respectively influence the use of analgesia [McEachin et al., 2002].

According to a before–after prospective study (492 vs 471 patients), an analgesia protocol allowing paramedics to administer morphine without direct medical supervision may help reduce the time to analgesia without putting patient safety at risk [Fullerton-Gleason et al., 2002]. A retrospective study (211 doses administered to 131 patients) examined the use of fentanyl for analgesia in air-transported pediatric trauma victims (under the age of fifteen). No adverse effects were reported on vital signs (systolic blood pressure, heart rate and oxygen saturation), on hemodynamic functions or on respiratory functions [DeVellis et al., 1998].

Nalbuphine is a narcotic with agonist and antagonist effects and is therefore less likely to provoke respiratory depression. Unlike other narcotics, it is not a controlled substance, which makes it a molecule of interest to pre-hospital personnel. One study investigated its efficacy and safety. In that study, 116 patients were treated with nalbuphine by

36. Éric Lareau and Gisèle Ouimet, *Urgences-santé*, personal communication, March 2, 2005.

paramedics, and the mean pain score (on a visual analogue scale) fell from 8/10 to 3/10 ($p < 0.001$). No adverse effects were reported [Chambers and Guly, 1994]. In a British prospective study, paramedics treated 115 patients with low-dose nalbuphine (2.5 to 12.5 mg). Only two patients experienced nausea, and no adverse side effects were reported. Despite a mean reduction in pain of 3.97/10 ($p < 0.001$) on the visual analogue scale, adequate pain relief had not been achieved by 60% (CI, 50.9% to 68.5%) of the patients upon hospital arrival, according to pre-hospital criteria, and 43% (CI, 34% to 52%) had to be given further analgesia after admission. The authors conclude that, despite its safety profile, low-dose nalbuphine does not offer adequate pain control to a large proportion of patients [Woollard et al., 2002].

Nitrous oxide is the only analgesic and sedative agent that has been studied in the pre-hospital setting. It is administered as a 50/50 N_2O/O_2 mixture. Its onset and duration of action are from three to five minutes. In a Pittsburgh study combining more than 2700 patients over a sixteen-year period, pain was relieved in 80% of the cases [Paris, 1996, 85–90]. Few side effects were reported, and they were generally minor (e.g., nausea or vomiting in 10% to 15% of patients) [Blackburn and Vissers, 2000; Sacchetti et al., 1994]. A retrospective study of 200 subjects transported by ambulance in a rural area indicates that pain relief was achieved in 85% of the 120 patients whose cases were properly documented; only minor adverse effects were reported for the patients overall [Johnson and Atherton, 1991]. Another retrospective study of 240 subjects showed that 93.4% of patients treated by EMTs obtained partial or complete relief from pain [Donen et al., 1982]. Note that nitrous oxide is now part of the enhanced symptom-relief program available to primary care paramedics in some Canadian provinces.

For ethical reasons, it is unlikely that prospective studies with control groups will be carried out on this topic. The National Association of EMS Physicians (NAESMP) released a position statement on the pre-hospital use of analgesia [Alonso-Serra and Wesley, 2003]. The following recommendations are addressed to pre-hospital EMS services:

a) Mandatory assessment of both the presence and severity of pain.

b) Use of at least one reliable tool for the assessment of pain.

c) Indications and contra-indications for pre-hospital pain management.

d) Non-pharmacological interventions (reassuring communication to distract from pain, immobilization, ice, cushions and splints).

e) Pharmacological interventions (mophine, fentanyl, nalbuphine, nitrous oxide, ketamine, nonsteroidal anti-inflammatory drugs [NSAIDs]).

f) Mandatory patient monitoring and documentation before and after analgesic administration.

g) Transfer of relevant patient-care information to receiving hospital.

h) Quality improvement and close medical oversight.

5.8.5 Agitation management

Transporting agitated patients is a reality faced by all pre-hospital EMS systems. Pre-hospital personnel must frequently deal with agitated and combative people who nonetheless need medical care and transfer to a hospital. A thorough clinical assessment is necessary to detect whether the agitation is due to an underlying medical condition, such as hypoxia, hypoglycemia, drug or alcohol intoxication, stroke or head injury. Preventing injury both to patients and to paramedic personnel requires adhering to

protocols specifically designed for these situations and creating linkages with the law-enforcement and public-safety officials concerned. Pre-hospital agitation-management protocols may propose verbal-communication approaches to calm people who are agitated, violent or combative, as well as the use of physical or chemical restraints allowing for safe transportation and medical care. Applied optimally, this protocol may prevent injury to patients and crew, while allowing the crew to manage the health condition causing the agitation or resistance.

The use of physical restraints is not without risk, however, and may lead to severe complications such as patient asphyxia and death [Park et al., 2001; Hick et al., 1999; Roeggla et al., 1997; Stratton et al., 1995; Reay et al., 1992]. The primary aim of chemical restraint is to prevent complications associated with physical restraints. Complications include hyperkalemia, rhabdomyolysis (massive destruction of muscle cells that may lead to acute renal failure) and cardiac arrest, all of which may sometimes occur in patients who continue to struggle forcefully even after having been physically restrained.

The most common classes of medications used to manage agitation in hospital and pre-hospital emergency care are benzodiazepines and neuroleptics. More specifically, lorazepam and midazolam are the most widely used benzodiazepines, while haloperidol and droperidol are the most commonly used neuroleptics. A randomized, double-blind clinical trial of 46 patients compared the effect of 5 mg of intravenous droperidol with that of a placebo (a saline solution) to manage agitated patients in the pre-hospital setting [Rosen, 1997]. Paramedics measured each patient's state of agitation on a five-point scale before administering the droperidol or the placebo, and then every five and ten minutes thereafter. Within five minutes of administration, agitation levels dropped in 42% of the patients given droperidol and in 24% of those given the placebo ($p = 0.05$). Within ten minutes of administration, these reductions were 71% and 30% respectively ($p < 0.001$). The percentage of patients requiring sedation upon arrival at the ED rose to 13% in the group treated with droperidol and to 48% in the group that had received the placebo ($p = 0.01$). No major adverse effects were reported in the patients who received droperidol. Only one patient developed akathisia (a condition characterized by the inability to sit still and by extremely restless legs), a minor transient effect that may arise after administration of a neuroleptic agent.

Some studies have established that the onset of action of intramuscular droperidol is similar to that of intravenous droperidol [Thomas et al., 1992; Thomas, 1992; Cressman et al., 1973]. The intramuscular route seems the most logical choice for agitated patients because of the difficulty in establishing intravenous access without risking injury to both them and the paramedics. Another prospective study carried out in an urban setting examined 53 agitated patients who had been sedated with intramuscular droperidol (2.5 to 5 mg) by paramedics on physician order and under direct medical control. Results show that sedation was effective in 87% of the cases before hospital arrival. No major adverse effects were reported, and only one patient required supplemental oxygen after having received droperidol [Hick et al., 2001].

In the United States, the Food and Drug Administration (FDA) nonetheless issued a "black box" warning about the use of droperidol in the pre-hospital setting as a result of cardiovascular complications associated with arrhythmias. Nearly all of the reported cases seemed to have been caused by high-dose droperidol. Health Canada followed the FDA's warning and issued a safety alert regarding the use of droperidol [Health Canada, 2002]. Both organizations recommend performing a 12-lead electrocardiogram (ECG) to evaluate if a prolonged QT interval is present before droperidol administration and to continue monitoring after the treatment is completed. New atypical antipsychotic agents seem *a priori* safer, and

their use may become the standard of care in the years to come.

The use of benzodiazepines is less well documented in the literature on pre-hospital care. A randomized clinical trial of 202 patients compared the effects induced by lorazepam and droperidol administered in EDs, and results seem to indicate that droperidol controls agitation more quickly [Richards et al., 1998]. Another randomized clinical trial of 98 agitated psychotic patients seen in a hospital ED concluded that sedation was more effective in the group treated with a combination of lorazepam and haloperidol than in the group treated with either medication alone, and that the combination treatment did not produce additional adverse effects [Battaglia et al., 1997].

The American College of Emergency Physicians issued a policy statement supporting the use of physical and chemical restraints when required to guarantee the safety of patient and EMS staff [ACEP, 2001]. The National Association of EMS Physicians (NAEMSP) also issued a position statement on the management of agitated patients and recommends the use of medications such as neuroleptics and benzodiazepines or a combination of the two [Kupas and Wydro, 2002].

5.8.6 Acute stroke

In the United States, approximately half of the deaths linked to acute stroke occur before hospital arrival, and between 35% and 70% of patients presenting with stroke seem to access the health-care system via the pre-hospital EMS system [Kidwell et al., 2000; Barsan et al., 1993].

In its guidelines on pre-hospital ALS care, the American Heart Association refers to the concept of the *chain of recovery* from stroke. This concept is primarily based on 1) rapid identification of stroke signs and symptoms; 2) rapid administration of pre-hospital care; 3) rapid transport by ambulance with notification to the hospital of the patient's imminent arrival; and 4) rapid in-hospital diagnosis and treatment [AHA, 2000c]. The association with the chain of survival from cardiac arrest or acute myocardial infarction is largely attributable to the release of a study on cerebral thrombolysis showing that acute ischemic stroke left fewer sequelae when treatment was administered within three hours of the onset of symptoms [NINDS, 1995].

Despite the enthusiasm generated by this treatment, few patients prove to be potential candidates because of the brief thrombolysis time window (within three hours). Moreover, this procedure is offered only in tertiary-care centres that have specialists in neurology, radiology and neurosurgery (in the event of cerebral hemorrhage), computed tomography (CT) providing rapid brain imaging, and experts in CT interpretation.

To this day, the use of cerebral thrombolysis raises controversy [Caplan, 2004]. In 2001, the Canadian Association of Emergency Physicians (CAEP) published a position statement on this topic. It stipulated that further evidence was needed to support the widespread use of thrombolysis outside research settings [CAEP, 2001]. A more recent Cochrane review of the use of thrombolysis to treat ischemic stroke included 18 randomized clinical trials combining a total of over 5000 patients. This review, which included articles published as late as January 2003, concludes that current evidence does not support the widespread use of thrombolysis in routine clinical practice and that further studies are required to identify not only the patients most likely to benefit from treatment but also the best setting in which to administer it [Wardlaw et al., 2003]. Evidence indicates that rapid transport to a specialized stroke centre may improve clinical outcomes, whether or not cerebral thrombolysis is performed [Pepe et al., 1998; Pepe, 1997].

Activation of this sequence of interventions depends chiefly on the timely identification of stroke signs and symptoms by pre-hospital personnel [Schwamm et al., 2005]. Two scales for rapid stroke assessment have been developed and validated specifically for pre-hospital use: the Cincinnati Prehospital Stroke Scale [Kothari et al., 1999] and the Los

Angeles Prehospital Stroke Screen (LAPSS) [Kidwell et al., 2000]. The use of the LAPSS by paramedics in the field is the only one to have been studied prospectively. This study examined the cases of 206 patients presenting with acute neurological symptoms, 36 of whom were diagnosed in hospital with stroke. The 34 completed forms revealed that scale sensitivity and specificity were estimated to be 91% and 97%, while positive and negative predictive values were established at 86% and 98% respectively [Kidwell et al., 2000]. Given that the use of this screening scale by EMTs trained in BLS has never been evaluated, it is impossible to know if they would achieve the same results. The use of LAPSS does require measuring patients' blood glucose.

Another study of interest concerns 4413 pre-hospital assessments made by paramedics (ALS) or by EMTs (BLS), 96 of which led to a diagnosis of stroke. Analysis of the records of 86 of these patients indicates that 72% of them still had a diagnosis of stroke when they were discharged from hospital. In that study, 26% of the patients required ALS interventions. It is rather interesting to note that, although the patients treated by EMTs arrived at the hospital five minutes faster ($p = 0.004$), the time to physician evaluation was cut in half (10 minutes vs 20 minutes; $p = 0.02$), and CT scans were obtained 22 minutes sooner (47 minutes vs 69 minutes; $p = 0.04$) in the group of patients treated by the advanced care paramedics [Kothari et al., 1995].

Timely stroke recognition by pre-hospital personnel could also allow early administration of neuroprotective agents (thereby diminishing the effects of acute stroke). A recent study of 20 patients examined the effect of intravenous magnesium sulphate as a neuroprotective agent administered by paramedics in the pre-hospital setting. This pilot project served to establish that this agent was initiated 113 minutes ($p < 0.001$) sooner than for a historical cohort of patients treated with magnesium sulphate in hospital [Saver et al., 2004]. The value of magnesium sulphate as a neuroprotective agent is still controversial, and its use is not very widespread [Selco and Ovbiagele, 2004]. Further research is required to discover which neuroprotective agents would be most useful in the management of acute stroke.

The overall body of research clearly indicates that the clinical and scientific communities are actively gathering evidence in this field, and that they are on the way to developing innovations designed to optimize the chain of recovery in a context where it is believed that "time is neurons." Several reputable organizations have drafted position statements consistent with that view [Schwamm et al., 2005; Barsan and NINDS, 2002].

5.9 CONCLUSION

The question of the effectiveness of pre-hospital advanced life support (ALS) has not been clearly resolved over the past 30 years. The constant emergence of new technologies and knowledge makes it difficult to draw definitive conclusions. Yet some of these ALS procedures, such as pre-hospital cardiac defibrillation, have proven to be so effective that they have become BLS procedures, sustained by technological advances and validated treatment protocols. As stated previously, current ALS practices may become the BLS practices of tomorrow. Are they effective? The literature is divided over this question:

- It seems to support pre-hospital ALS interventions for the management of patients suffering from cardiac chest pain or respiratory distress.
- It seems neutral for cardiac-arrest patients, such that adding medication protocols to ALS does not improve patient survival to hospital discharge. It is worth mentioning that, even in hospitals, there is no scientific evidence that ALS medications effectively improve the survival of these patients.
- It seems to indicate that ALS may have adverse effects in severely injured patients and in children requiring endotracheal intubation.

- Other avenues of potential benefit but which have been the subject of fewer studies include the treatment of convulsive seizures, severe hypoglycemia and opioid intoxication; rapid screening of stroke patients; pain relief; and agitation management.

This report provides an overview of medical literature with varying degrees of methodological rigour in a field that is not very conducive to conducting randomized clinical trials. The reasons for this are twofold: 1) ALS is generally considered a standard of care in the settings where they are in place; and 2) obtaining informed consent is a factor that is becoming increasingly restrictive. Moreover, existing organizational models do not always lend themselves well to randomized clinical trials, an experimental design that is better suited to the study of single interventions. Other more appropriate types of experimental design have not yet been widely adopted by EMS researchers. Primary evidence therefore comes from non-randomized comparative studies. The forthcoming publication of the complete results obtained for all the cohorts in OPALS phase III, along with a cost-benefit analysis of pre-hospital ALS care, might provide other answers to questions that have been left in abeyance thus far. The fact remains that, despite its importance and particularly rigorous methodology, the OPALS study will still not be able to determine with any accuracy which part of advanced life support (procedures or medications) will prove to be of benefit.

6 FIELD EVALUATION OF ADVANCED LIFE SUPPORT AT URGENCES-SANTÉ

The infrastructure built by *Urgences-santé* is more highly developed than that found elsewhere in Québec. This organization has its own training centre, electronic databases on its clients and interventions, medical control and quality-assurance mechanisms. As such, *Urgences-santé* has been able to produce a number of analyses that have served to describe its client profile and to assess how it handles trauma-patient referrals. It was also the first to report to the *Collège des médecins du Québec* on its performance with semi-automated defibrillation and the Combitube.

Over the past twenty years, *Urgences-santé* has participated in several research projects culminating in publications, chiefly in trauma care [Liberman et al., 2003; Sampalis et al., 1999] and in cardiopulmonary resuscitation [Liberman et al., 1999; Lavoie, 1998]. Most of these studies [Liberman et al., 2004a; 2003; Sampalis et al., 1998; 1997; 1996; 1995; 1994; 1993; 1992] compared the outcomes of ALS and BLS care. Twelve other research projects are currently underway, although at different stages of development.[37] This research is mainly geared to evaluating the impact of having introduced (a) a symptom-relief program, (b) 12-lead ECGs performed by EMTs, and (c) devices that monitor endotracheal tube position (esophageal detector device and capnometry).

When the research project on the ALS care delivered by a cohort of EMTs was launched in the fall of 2001, *Urgences-santé* already had a research-oriented environment; and when it subsequently decided to evaluate this ALS project, it had prior experience in EMT training and in evaluating the quality of such procedures. An external advisory committee composed of members of the MSSS and the *Collège des médecins du Québec* was set up to observe the conduct of the field evaluation.

6.1 INITIAL PROJECT

Initially, the project was to study five ALS protocols: 1) endotracheal intubation; 2) use of Magill forceps to clear obstructed airways; 3) administration of vasopressin and amiodarone in the case of shockable cardiac arrhythmias; 4) administration of epinephrine and atropine in the case of shock-resistant cardiac arrhythmias; and 5) intravenous administration of dextrose in the case of severe hypoglycemia.

An evaluation project was submitted by an external consulting firm and approved by the advisory committee in April 2002.

The five ALS protocols were an integral part of the Regulation respecting the professional activities that may be engaged in within the framework of pre-hospital emergency services, adopted under Québec's Professional Code [*Office des professions du Québec*, 2003]. The research objective was therefore not to assess experimental care but to evaluate patient-care innovations in the field. Consequently, the project was not subject to the ethical rules governing research projects, and the need to obtain the study subjects' informed consent was also waived.

The project was to take place in four phases:

Phase I: Participant selection and didactic training (12 weeks).

Phase II: Practical training on a simulator manikin (12 weeks).

Phase III: Advanced life support procedures performed in the field by EMTs under direct physician supervision (6 months).

37. Eli Segal, MD, Research Co-ordinator, *Module de recherche*, and Gisèle Ouimet, Research Consultant, *Module de l'assurance de la qualité et de la formation clinique*, *Urgences-santé*, personal communication, March 7, 2005.

Phase IV: Advanced life support procedures performed by the EMTs under on-line medical supervision.

In an effort to adhere to the instructor-participant ratio in the didactic training sessions (phase I), to optimize each participant's use of the simulator manikin (phase II) and to offer participants sufficient exposure to clinical training under direct physician supervision (phase III), it was decided that a cohort of twenty EMTs would be the maximum group size. Training time was determined on the basis of models from other Canadian provinces, most of which offer a six-month didactic-training period. The clinical tutorial generally lasts from three to six months. Given an average 20-week field internship with clinical tutorial, it was estimated that each ALS crew of two EMTs could respond to roughly 200 calls, or 100 per EMT.

Urgences-santé uses Advanced Medical Priority Dispatch System (AMPDS) protocols and a computer-assisted dispatch system that helps determine the crew's estimated time of arrival. Prior data served to identify 30 call categories which in the past had most often required ALS care from *Urgences-santé* physicians.

The field evaluation was based on a quasi-experimental design. All the users corresponding to these 30 call categories were to be included in a prospective cohort that would have constituted the study population. The EMTs trained in ALS were to be assigned to these calls provided that their estimated time of arrival were within 12 minutes; otherwise, the central dispatcher would assign the usual BLS crew. The results obtained by the EMTs trained in ALS were to be compared with those of EMTs without such training, according to an intention-to-treat analysis. The study period was to take place during phase IV of the program and was to be spread out over one year. Each EMT trained in ALS was to team up with an EMT without this training, which would have provided a sufficient number of cases for all the protocols to be evaluated, except for the use of Magill forceps, which is too rare of an event.

During the project, however, changes were made to the *Urgences-santé* ALS program. These changes resulted in 1) a delay in the overall project; 2) the introduction of a six-month phase III-A during which ALS procedures were to be performed in the field by physicians observed by the EMTs (the initial phase III became phase III-B); 3) the requirement that two EMTs trained in ALS be present at all times; 4) the elimination of phase IV of the project; and 5) the impossibility of assigning crews by call category. Consequently, the exposure of the eighteen EMTs trained to apply ALS protocols was much more limited than originally anticipated, and the original study design of the research project had to be abandoned.

6.2 ACTUAL PROJECT

The eighteen EMTs (two of the original twenty had dropped out) attended didactic ALS training (phase I) from September to December 2001, and practical training on an enhanced simulator manikin (phase II) in the spring of 2001.

The clinical tutorial lasted from April 2002 to December 2003. During that time, ALS was taught either by physicians (phase III-A, April 2002 to June 2003) or by one of the EMTs under direct physician supervision (phase III-B, from June to December 2003). On board each vehicle were a physician and one or two EMTs trained in ALS. These crews were not assigned according to *Urgences-santé*'s routine dispatch protocols. Rather, they operated by self-assignment: the crew covering the call area checked the on-board terminal for the dispatch location and summary data (age, sex, call category) of each assignment. The physician on board would judge which calls the ALS crew would respond to.

A quality-assurance report on the protocols, the training and the safety of the ALS procedures was submitted by *Urgences-*

santé to the *Collège des médecins du Québec* and to the MSSS in February 2004 [*Urgences-santé* et al., 2003].

The research report prepared by the consulting firm [*Urgences-santé*, 2004] was released in August 2004. It was based on a comparison of two prospective cohorts: one consisting of patients treated by a physician or an EMT trained in ALS, and the other of patients treated exclusively by EMTs without ALS training. Four outcome measures were evaluated: 1) conversion of any abnormal heart rhythm to one that was defibrillated; 2) return of spontaneous circulation in the pre-hospital setting; 3) admission to hospital; and 4) survival to hospital discharge.

6.3 OBSERVED RESULTS

6.3.1 Quality and safety of the advanced life support procedures provided by the emergency medical technicians

Urgences-santé set up a quality-assurance program applied by the physicians who were part of the ALS crews [*Urgences-santé* et al., 2003]. During the 26 weeks that phase III-B lasted, the observed primary outcomes were the following:

- 92% of procedures without protocol deviation and 98% without major deviation (i.e., those that could have affected patient outcomes);
- an endotracheal-intubation success rate of 78% (the objective was 80%);
- only three patients had obstructed airways that needed clearing;
- 93% of procedures without major protocol deviation in the case of shockable arrhythmias, with an average of one case per EMT every five weeks;
- 97% of procedures without major protocol deviation in the case of shock-resistant cardiac arrhythmias, with an average of one case per EMT every two weeks;
- 100% of procedures without major protocol deviation in the case of hypoglycemia, with an average of one case per EMT every nine weeks.

6.3.2 Impact of advanced life support on cardiac arrest

Owing to the small number of cardiac events to be examined for the ALS impact study, only the cardiac-arrest results were analyzed, and the results from phases III-A and III-B were combined. A total of 1878 cardiac-arrest cases were analyzed, and ALS was available on site for 465 (24.8%) of these cases.

Two groups (patients treated with or without ALS care) were compared in relation to variables known to affect outcomes. Age, sex, bystander CPR and initial heart rate were well matched in both groups. A few more cardiac arrests were witnessed by *Urgences-santé* EMTs without ALS training, but there were fewer bystander-witnessed cases. Treatment times were obviously shorter with BLS than with ALS care. These factors are known to affect outcomes, and their potential impact was controlled for during analysis to eliminate all differences between the two groups.

Advanced life support care proved to be beneficial for two outcome indicators: 1) It increased the proportion of patients who went from a shock-resistant to a shockable rhythm (8.7% with ALS vs 3.6% with BLS; $p < 0.001$); and 2) it increased the proportion of patients who experienced a return of spontaneous circulation before hospital arrival (21.1% vs 8.5%; $p < 0.001$). Nevertheless, ALS affected neither the proportion of hospitalized patients (11.8% vs 13.3%; $p = 0.472$) nor the rates of survival to hospital discharge (3.0% vs 4.2%; $p = 0.331$). Even after the results were adjusted for other variables, the conclusions remained the same.

Overall, these study results match those obtained in the Ontario OPALS study and are consistent with those documented in the literature. This means that, in the case of cardiac arrest, ALS seems to provide better very short-term results (e.g., increased return of spontaneous circulation) but does not lead to improved survival to hospital discharge compared with BLS care.

7 ANALYTICAL FRAMEWORK FOR INTERPRETING THE SYSTEMATIC REVIEW IN LIGHT OF THE QUÉBEC CONTEXT

The effectiveness of pre-hospital EMS systems is based on the principle that medical care must be administered as quickly as possible if it is to be effective. In the case of trauma, ALS seems to be effective only when provided in the hospital setting. The aim then is to help patients reach that care as rapidly as possible. In this situation, except under special circumstances, the transportation of trauma patients should not be delayed by pre-hospital ALS interventions. Several studies have shown that transportation delays caused by ALS care increase mortality.

We have seen that in the case of cardiac arrest, ALS does not add significant benefits after optimization of defibrillation delays. In this situation, pre-hospital ALS care theoretically corresponds to in-hospital ALS care. Such results may raise doubts about the effectiveness of ALS care in hospitals. It is possible, however, that practice conditions differ in the two settings.

In an evidence-based approach, it is important to take into account contextual variables before research results can be extrapolated to other pre-hospital EMS systems, whether from region to region or country to country [MacFarlane, 2003; MacFarlane and Benn, 2003]. These contextual variables were addressed in the Dicaire report [MSSS, 2000]. Figure 2 on the following page provides a schematic diagram illustrating a set of factors likely to influence the technical effectiveness of the care provided for a particular clinical problem.

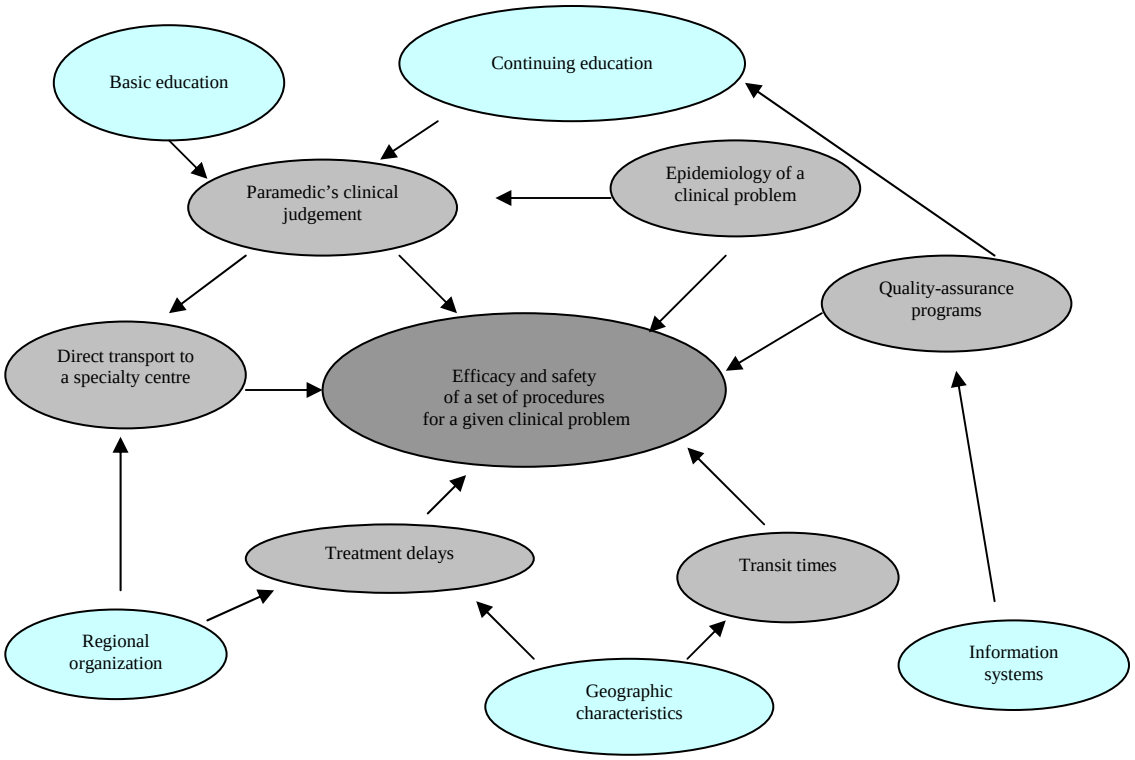
For example, OPALS phase III results show that a range of ALS procedures may reduce mortality in patients suffering cardiac chest pain [Stiell et al., 2003b]. The section in this report that analyzes these study results describes its interpretation limitations. These results are nevertheless very interesting, and their validity for Québec deserves careful scrutiny.

The OPALS study covers a series of urban and suburban pre-hospital EMS systems. Considering the longer transit times in rural areas, these systems may be more effective in urban and suburban rather than rural locales. Call volumes, which are most likely lower in rural areas, would tend to limit practitioners' practical exposure and thus their skill retention. This makes continuing-education and quality-assurance programs even more important there than in urban areas. Information systems are the cornerstones of quality-assurance programs. These systems are not highly developed in the areas outside the one covered by *Urgences-santé*.[38] If ALS is to be introduced, a factor to be taken into account is the capability of setting up quality-assurance and continuing-education programs tailored to each region.

38. Daniel Lefrançois, MD, Medical Director, *Direction adjointe des services préhospitaliers d'urgence, Ministère de la Santé et des Services sociaux*, December 2004 and January, 2005, and Wayne Smith, MD, Medical Director, *Services préhospitaliers d'urgence, Agence de développement de réseaux locaux de services de santé et de services sociaux de l'Estrie*, personal communication, January 25, 2005.

FIGURE 2

Figure 2 Contextual factors that influence the effectiveness of pre-hospital advanced life support care: Cardiac chest pain



According to the analysis in this report of the effectiveness of ALS for cardiac problems other than cardiac arrest, transferring certain patients to a tertiary-care centre rather than to the nearest hospital seems a promising avenue for reducing mortality due to myocardial infarction. Toward the end of OPALS phase III, some of the patients requiring ALS care were being transported directly to tertiary-care centres.[39] The small number of these patients makes it unlikely that this practice will modify the overall effectiveness measure, but it is a variable that must be considered in introducing ALS in other contexts.

The study interventions examined were administration of sublingual nitroglycerine (70%) and oral aspirin (67%). All the other medications were each administered to less than 10% of the patients, and it is unlikely that they were responsible for achieved outcomes. This ALS procedures apparently led to a decrease in overall mortality (from 4.3% to 3.2%) and in the mortality of patients with acute myocardial infarction (from 13.1% to 8.5%)[40] [Stiell et al., 2003a].

According to several experts, it is astonishing to observe such a major reduction stemming primarily from the use of aspirin and

39. Ian Stiell, MD, Senior Scientist, Clinical Epidemiology Unit, Loeb Health Research Institute, and principal investigator, OPALS study, Ottawa, Ontario, telephone communication, January 25, 2005.

40. The figures cited here on the use of these medications and on mortality differ somewhat from those in the abstract published in 2003. They correspond to the latest available analyses presented in January 2005. (Dr. Daniel Spaite's presentation to the National Association of EMS Physicians, January 14, 2005).

sublingual nitroglycerine. It seems likely that part of the benefit from ALS care documented in this study is due to the general effect that ALS training may have on clinical judgement.[41] In fact, better clinical judgement may enhance compliance with protocols and communication with the base hospital. These are hypotheses that will need to be validated by specific studies. In Québec, aspirin and sublingual nitroglycerine are already part of BLS protocols, which will be fully in use by 2006 (see the Health Minister's request in Appendix A). It is therefore difficult, if not impossible, to extrapolate OPALS cardiac chest pain results to Québec since the most commonly used medications are already or soon to be part of BLS services, and this is valid even if the full range of contextual factors shown in Figure 2 are disregarded.

According to the OPALS phase III results on reduced mortality in patients with respiratory problems, the decrease in mortality rates of patients with congestive heart failure is statistically significant (from 15.1% to 11.0%). Treatments included salbutamol (47%), furosemide (33%) and nitroglycerine (18%). The use of the other medications each accounted for less than 5% [Stiell et al., 2002].

These medications are not part of current BLS protocols in Québec. These preliminary results are highly significant, and their validity for Québec must be interpreted in light of the full range of contextual factors shown in Figure 2.

41. Ian Stiell, MD, Senior Scientist, Clinical Epidemiology Unit, Loeb Health Research Institute, and Brian Schwartz, MD, Director, Sunnybrook-Osler Centre for Prehospital Care, Toronto, and President, Canadian Relations Ad Hoc Committee, National Association of EMS Physicians (U.S.), personal communication.

8 DISCUSSION

In his request, the Minister of Health and Social Services asked that the report prepared by AETMIS address the following issues: a) the safety of ALS procedures applied in North American pre-hospital EMS systems; b) the effectiveness and cost-effectiveness of the practices that these systems offer target populations; c) the role of performance in the chain of survival as a factor independent of the medical procedures performed by EMTs trained in ALS or advanced care paramedics; and d) the optimal path for developing pre-hospital services in Québec, taking into account the importance to be given to each of the links in the chain of survival within the context of the system's overall efficiency with respect to the entire population (see Appendix A).

8.1 EVIDENCE-BASED RESULTS

In a system such as the one in Ontario where early defibrillation is performed by EMTs, the addition of ALS care does not improve patient survival. The same may be said of hospitals, given that there is no scientific evidence that the medications included in ALS protocols effectively improve survival from cardiac arrest.

Recent evidence confirms the importance of performance in the chain of survival in the case of cardiac arrest. The OPALS study is the largest and one of the most rigorous studies ever undertaken on the additional benefits of ALS compared with BLS, including early defibrillation in victims of cardiac arrest. That study clearly establishes that basic CPR and early defibrillation performed by first responders or EMTs significantly improve the survival of these patients. In a system such as the one in Ontario where early defibrillation is performed by EMTs, the addition of ALS care does not improve patient survival. This study concludes on the importance of training the general public in CPR and of early defibrillation performed by first responders [Stiell et al., 2004].

Despite the mitigated results of ALS care for cardiac-arrest patients, several factors must be taken into consideration in the overall assessment of its benefit. There is a theoretical advantage to administering ALS medications as early as possible, which means in the pre-hospital setting. Out-of-hospital termination of resuscitative manoeuvres, under certain conditions [Bailey et al., 2000], serves to avoid the needless risks involved in ambulance runs with sirens and flashing lights [Colwell et al., 1999]. Finally, as already mentioned, there is no evidence that in-hospital ALS care improves patient survival from cardiac arrest.

A systematic review of current evidence indicates that the transportation of trauma patients should not be delayed by pre-hospital ALS interventions. Québec's planning approach for pre-hospital services gave priority to developing the chain of survival as opposed to advanced pre-hospital medical care. This policy direction has enabled us to avoid duplicating the situation seen in many places where advanced trauma life support is still offered despite the relatively clear scientific verdict regarding its futility, if not its negative impact on survival.

Few pediatric studies have investigated the effectiveness of pediatric advanced life support (PALS) chiefly because of the relatively small number of children requiring emergency care. Endotracheal intubation is an exception, however. A randomized trial indicates that endotracheal intubation is difficult, if not dangerous, when it is part of ALS care administered by paramedics. Since the release of that study, several pre-hospital systems have halted that practice with children.

The overall body of evidence analyzed in this report also supports the conclusions reached in the Dicaire report, such that it is

not recommended to make the full spectrum of ALS care available in Québec's pre-hospital system [MSSS, 2000, 172–3]. The decision to introduce the entire range of ALS procedures as defined in the National Occupational Competency Profiles (NOCP) could nevertheless be driven by considerations such as workforce mobility and standardization or by the possibility of taking part in multicentre research studies on the effectiveness of these standards. That decision, however, is not at this moment supported by scientific evidence.

A certain number of interventions, especially in the case of cardiac problems (other than cardiac arrest) and respiratory distress, have significant potential for reducing mortality and morbidity. For example, in OPALS phase III, in-hospital mortality of patients with congestive heart failure fell from 15.1% to 11.0%, a relative reduction of 27.2%. These results have so far been released only in the form of abstracts. Congestive heart failure was the in-hospital diagnosis for 16.9% of the 8157 patients transported for respiratory distress [Spaite, 2005]. According to *Urgences-santé* data, 11.1% of all the patients it transported in 2003 had respiratory problems, as assessed by the EMTs, representing a total of 16 366 patients.[42] A certain number of deaths could be avoided, but this number can be estimated only within pilot projects on the use of ALS to treat respiratory distress in the context of Québec's pre-hospital emergency services.

An important factor to consider is how the training of practitioners performing a given technical procedure affects results. According to expert opinion, training plays a decisive role not only in applying protocols correctly but also in developing clinical judgement. As demonstrated in a U.S. field trial, the addition of an ALS protocol (endotracheal intubation) to the scope of practice of a group of basic EMTs did not allow them to achieve the same performance level reached by advanced care paramedics [Sayre et al., 1998]. The standards spelled out in the NOCP for paramedic practitioners propose a consistent model of fundamental knowledge corresponding to the different levels of occupational competency (see Chapter 3) [PAC, 2001].

8.2 FIELD EVALUATION RESULTS

The concept of advanced life support is variable and constantly evolving. Each country, if not each region, has its own definition. New procedures are regularly added to ALS care, while others shift from ALS to BLS care. As mentioned previously, the Combitube is a good example of a procedure that is routinely used in Québec as part of pre-hospital BLS care, while it is an ALS procedure elsewhere in North America. Establishing intravenous access to administer dextrose to hypoglycemic patients is another ALS procedure that is now part of BLS care in Alberta and in some regions of Ontario.[43]

Over the past few years, Québec has made a sustained effort to extend the chain of survival throughout its jurisdiction in a bid to limit regional inequities insofar as possible. That effort seems to have put Québec one step ahead of several other Canadian provinces. The 9-1-1 system is now operational in virtually all inhabited regions. Semi-automated external monitor-defibrillators and the Combitube have also been introduced throughout the province. A symptom-relief program, including epinephrine, salbutamol, glucagon, nitroglycerine and aspirin, is already in place in several regions and available in particular to all *Urgences-santé* EMTs. Over the next eighteen months, Québec will have achieved throughout its jurisdiction a practice level that corresponds to the Canadian profile of

42. Gisèle Ouimet, Research Consultant, *Module de l'assurance de la qualité et de la formation clinique, Urgences-santé*, personal communication, February 10, 2005.

43. Robert Burgess, ACP, AEMCA, Senior Manager, Division of Prehospital Care, Sunnybrook-Osler Centre for Prehospital Care, Toronto, Ontario, and Claude Desrosiers, Coordinator, *Module de l'assurance de la qualité et de la formation clinique, Urgences-santé*, personal communication, February 2005.

"primary care paramedic" [MSSS, 2004]. These achievements rank Québec among the best North American systems with regard to the breadth of available BLS care.

As far as training is concerned, the program currently being offered to new EMTs does not entirely match the requirements set out in the NOCP. In actual fact, however, the practice level of these EMTs will correspond to the PCP competency profile, even though their training doe not correspond to the Canadian benchmark, the NOCP. The basic training time of currently employed EMTs in Québec varies on the whole from 150 to 945 hours, although the MSSS information systems do not provide details on these differences in training.[44] Continuing-education initiatives have made it possible to put different BLS protocols into practice. Since new BLS procedures are expected to emerge over the next few years, this differing initial training may place limits on the existing system. Enhancing EMTs' foundation knowledge could in itself be advantageous in the short term.

The Montréal region nevertheless has the only pre-hospital EMS system offering ALS care as part of a pilot project (described in Chapter 6). This project involves the provision of advanced life support by 18 specially trained EMTs working under direct physician supervision.

While other Canadian provinces have opted to develop both BLS and ALS care, Québec has made rapid strides in expanding not only the scope but also the geographic range of BLS care. In fact, only Québec makes Combitube intubation routinely available as part of the BLS care it offers. The Dicaire report recommended not to make the full panoply of ALS care available in Québec's pre-hospital system [MSSS, 2000, 172–3] but to conduct field evaluations within structured, time-limited pilot projects under the supervision of the MSSS with the purpose of showing that ALS care offers clinical added value in terms of mortality and morbidity [MSSS, 2000].

Chapter 6 describes the field evaluation of the ALS project run by *Urgences-santé*, in accordance with the recommendations of the Dicaire report. This project could not be carried out as planned. Owing to a series of modifications to the ALS project, the exposure of the EMTs trained to apply ALS protocols was much more limited than anticipated, and as a result, the original study design had to be abandoned. It is beyond the scope of this report to examine the decision process that led to the various changes. Some of these decisions were examined as part of an MSSS administrative inquiry [2005]. Even though the project was not able to evaluate the effectiveness of the five protocols, it did allow eighteen EMTs, including six supervisors, to achieve the Canadian competency profile of advanced care paramedic. In addition, the quality-assurance program provided a satisfactory objective measure of the safety of these protocols.

Lastly, the training structure built by *Urgences-santé* may again be put to good use in response to future needs. Under an established regime and operating seven days a week, the training system could produce at the most two cohorts per year for a maximum of 20 participants per cohort, totalling 40 per year.[45]

8.3 ASSESSMENT LIMITATIONS

In line with the most current approaches today, this assessment relies on an evidence-based model that includes both scientific evidence and contextual information, as stated in the introduction.

44. Daniel Lefrançois, MD, Medical Director, *Direction adjointe des services préhospitaliers d'urgence, Ministère de la Santé et des Services sociaux,* e-mail communication, January 19, 2005.

45. Marcel Boucher, MD, Director, *Services professionnels et de l'assurance de la qualité, Corporation d'urgences-santé,* personal communication, March 3, 2005.

8.3.1 Scientific evidence

Several difficulties in the area of scientific evidence were encountered in this assessment, and a fair number of them were directly linked to the field of pre-hospital care. Four deserve mention: 1) the limited amount of evidence capable of yielding answers to all the Health Minister's questions; 2) the difficulty in isolating the effectiveness of ALS procedures; 3) the unsuitability of the effectiveness indicators measured in the studies examined; and 4) the lack of relevant economic evidence.

This assessment is based on a comprehensive literature search on the impact of pre-hospital ALS care. It must be admitted, however, that this field is particularly devoid of high-quality research. In fact, the most important and significant evidence for Québec stems from studies which results are available only as as scientific conference presentations and published abstracts. This refers in particular to the OPALS study, judged to be of high quality, although the *transferability* of the results (external validity) to Québec remains somewhat unclear for the reasons cited in Chapter 7. It needs to be recognized that the lack of evidence of the efficacy of the interventions does not mean that they are completely ineffective.

In evaluating the effectiveness of pre-hospital interventions, it is important to bear in mind that they are most often followed by clinical procedures performed in the emergency department, if not in the hospital itself, by other practitioners. As a result, any appraisal of the impact of this care is complicated by the fact that it must be linked to a cascade of medical or other procedures that follow pre-hospital care and whose effectiveness may or may not have been demonstrated. We naturally did our best to extract pre-hospital ALS procedures linked to in-hospital procedures, as well as their respective effectiveness, but this was not always possible. Some of the ALS procedures performed in hospital emergency departments are not supported by evidence. This situation, while not unique to the field of pre-hospital ALS care, must be taken into account and translated by selecting indicators capable of adequately measuring the effectiveness of the interventions in question.

The issue of effectiveness indicators is of vital importance in this context. In the case of cardiac arrest, for example, the actual effectiveness of pre-hospital measures is most often judged by the rate of survival to hospital discharge. Indicators prior to hospital discharge, such as post-treatment return of spontaneous circulation or rate of hospitalizations, are in fact more direct measures of pre-hospital care. Findings that show a rise in the proportion of patients experiencing a return of spontaneous circulation or in hospitalization rates following ALS care indicate that the treatment had positive effects. Admittedly, that in itself is not enough to prove the effectiveness of ALS care. That is why some EMS experts argue in favour of using intermediate outcome measures believed to be more appropriate, such as survival at 24 hours. The debate on outcome measures in pre-hospital emergency care is much broader than this, applies to overall health problems encountered in the pre-hospital environment, and has recently galvanized EMS researchers. They contend that the outcome measures that influence decisions on the organization of pre-hospital services are predominantly tied to mortality; and yet pre-hospital care covers a wide spectrum of services that produce a more diversified range of results that must be measured by suitable indicators [Osterwalder, 2004; MacFarlane and Benn, 2003; Maio et al., 1999]. For that reason, the U.S. group Emergency Medical Services Outcome Project refers to a range of outcomes divided into six categories: 1) improving survival; 2) reducing impaired physiology; 3) limiting disability; 4) alleviating discomfort such as pain, nausea and shortness of breath; 5) ensuring satisfaction with services rendered; and 6) ensuring cost-effectiveness. These endpoints are called the "6 Ds" of patient outcome: death, disease, disability, discomfort, dissatisfaction and destitution [Maio et al., 1999].

Given the paucity of economic evidence, it was not possible to produce analyses establishing the cost-effectiveness of different scenarios for developing pre-hospital services in Québec. These kinds of analyses depend on the quality of the evidence available not only on each link in the chain of survival but also on a set of procedures called *advanced life support*, and on ranges of procedures applicable to specific clinical problems or specific populations. Moreover, the lack of effective information systems in most parts of Québec is in itself a non-trivial limiting factor.

8.3.2 Contextual information

The time allowed to produce this assessment was limited by the urgency of the situation. As a result, we were unable to follow a structured and systematic approach to consulting key informants in the field, and to include a section documenting the results of that inquiry. We were able, however, to consult a number of selected EMS experts. We did so to gain a clearer picture of the context in which pre-hospital emergency care is practised in Québec, Canada and around the world. The experts we consulted were mostly practitioners in the pre-hospital and hospital environments (emergency physicians, EMTs, paramedics); medical directors of pre-hospital emergency services or of hospital emergency departments; regional and provincial co-ordinators of pre-hospital emergency services; and EMS researchers and clinical methodology experts. Although not entirely representative, these expert consultations allowed us to refine our recommendations so that they should be as realistic and accurate as possible in light of Québec's context and the field of pre-hospital care.

8.4 RESEARCH AVENUES

Current scientific evidence does not at this time allow us to point to an optimal route for developing pre-hospital services in Québec within the context of the system's overall efficiency. The evidence that is available does shed certain light on avenues for developing the chain of survival and pre-hospital ALS care.

The ability to make rational decisions about introducing ALS care requires well-established evidence of the efficacy and safety of the procedures involved. Rapidly evolving evidence of the effectiveness of in-hospital ALS techniques exerts pressure to use them in the pre-hospital setting. Discussions on the limitations of the OPALS study (chiefly the substudy on cardiac chest pain) clearly show that, in light of Québec's current context, there is a need to invest in major evaluative research initiatives if we want to introduce new procedures capable of improving pre-hospital care while maximizing its impact on the health of the entire Québec population. Such initiatives require that resources be earmarked for research in this field and also that several dozens of additional EMTs be trained in ALS, so that we might attain the exposure required to produce a statistical analysis of research outcomes and thus contribute to increasing the evidence needed to make planning decisions about the pre-hospital EMS system.

These resources cannot yield expected outcomes unless a certain number of conditions are met. Experience shows that training levels must be upgraded so that EMTs can master the new procedures that will be added to current BLS services. This additional training would also allow them to take part in research projects on BLS care.[46] Other key conditions for the success of this evaluative research include dynamic medical

46. Marcel Boucher, MD, Director, *Services professionnels et de l'assurance de la qualité, Corporation d'urgences-santé*, and Wayne Smith, MD, Medical Director, *Services préhospitaliers d'urgence, Agence de développement de réseaux locaux de services de santé et de services sociaux de l'Estrie*, personal communication.

supervision provided by physicians with expertise in emergency care, and the availability of effective information systems. *Urgences-santé* seems in many respects to be the ideal place to conduct field evaluations of new ALS techniques. Given the importance of organizational context in the provision of pre-hospital care in each of Québec's regions, it will also be necessary to sustain research efforts in both urban and rural settings.

The Dicaire report pointed out that the organization of pre-hospital services was entering a transitional phase toward an explicit evidence-based model [MSSS, 2000, 172–3]. In fact, the development of Québec's pre-hospital emergency systems was spearheaded by an expert committee that had worked without the benefit of a structured analysis of scientific evidence. What is more, there is often no evidence in support of certain procedures even though they may have great potential for reducing mortality and morbidity. A good example of this is the Combitube, which is now part of pre-hospital BLS care in Québec. Decisions on developing pre-hospital ALS care must strike a balance between scientific uncertainties and the advisability of introducing highly promising medical treatments.

It would seem advisable to pursue the transition that is already underway in the organization of pre-hospital services (especially with respect to introducing new BLS and ALS services) toward an explicit evidence-based model, as mentioned in the Dicaire report [MSSS, 2000, 172–3]. A firm determination to pursue this transition would increase the system's overall effectiveness and would place Québec at the forefront of such initiatives on an international scale.

9 CONCLUSIONS AND RECOMMENDATIONS

In his request, the Minister of Health and Social Services asked that the report prepared by AETMIS address four issues:

- the safety of the advanced life support (ALS) procedures applied in North American pre-hospital emergency medical services (EMS) systems;
- the effectiveness and efficiency of the practices that these systems offer target populations;
- the role of performance in the chain of survival as a factor independent of the medical procedures performed by EMTs trained in ALS or advanced care paramedics; and
- the optimal path for developing pre-hospital services in Québec, taking into account the importance to be given to each of the links in the chain of survival within the context of the system's overall efficiency with respect to the entire population.

This assessment is based on a review of relevant scientific literature and an analysis of developments in pre-hospital care, internationally, in Canada and in Québec, including their advanced life support training programs and practices.

Examination of the scientific evidence of the efficacy and safety of advanced life support led to four major findings:

- There is currently not enough solid evidence to support the widespread routine use of an advanced life support program throughout Québec.
- Preliminary evidence shows that advanced life support could be beneficial, especially in the case of respiratory distress or cardiac chest pain.
- The limited evidence that is available indicates that advanced life support is neither beneficial nor detrimental in terms of mortality or morbidity in patients experiencing non-traumatic cardiac arrest, yet the hypothesis that it might be beneficial in reducing morbidity and mortality has not yet been set aside and deserves further research.
- Evidence indicates that advanced life support is associated with adverse effects in certain circumstances, mainly the pre-hospital endotracheal intubation of young children and trauma management in general.

This evidence, combined with field data and contextual information, leads us to recommend that Québec should follow a reasoned approach to introducing pre-hospital advanced life support. This approach should be based on the vision of making optimal use of both the full range of pre-hospital services and the various links in the chain of survival. It is therefore recommended that specific measures be taken to expand advanced life support and to optimize pre-hospital basic life support, including cardiopulmonary resuscitation and cardiac defibrillation. It would also be advisable to implement measures of a more general nature that affect both basic and advanced life support care in the pre-hospital setting.

Reasoned approach to introducing pre-hospital advanced life support

The adoption of a reasoned approach to introducing pre-hospital advanced life support will respond to two issues linked to its implementation in Québec. The first issue concerns giving consideration to the scientific evidence and information gathered during this analysis. Our assessment shows that pre-hospital advanced life support care is a field particularly devoid of high-quality research. Yet, in spite of this lack of evidence, it must be acknowledged that simply because the efficacy of advanced life support procedures has not been demonstrated, it does not mean that they are ineffective.

Furthermore, our talks with international, Canadian and Québec experts revealed that our reflection on this matter must include the lessons drawn over the years from field experience in advanced life support, along with anticipated developments in this area. The second issue concerns translating all these data into coherent avenues to action tailored to the specific conditions in Québec as a whole and in its different regions.

By reasoned approach, we mean a gradual, reflective process designed to make optimal use of resources within the context of an innovation. This entails understanding its mode of operation in context, measuring its effects, and drawing conclusions about its transferability or applicability to other practice situations.

Recommendation 1: *It is recommended that the use of advanced life support in Québec be limited, for the time being and as an initial step, to pilot field projects.*

Rationale: The decision to immediately introduce the full range of advanced life support procedures as defined in the National Occupational Competency Profiles for Paramedic Practitioners could be driven by considerations such as workforce mobility and standardization, or yet again by the possibility and usefulness of taking part in multicentre research studies on the efficacy of these standards. That decision, however, is not at this moment supported by evidence. The potential for severe adverse effects tied to pre-hospital advanced trauma life support and the endotracheal intubation of children calls for caution. Data shedding light on these harmful effects were not available thirty years ago when these procedures were introduced into practice in other parts of the world. On the other hand, we cannot keep silent about the significant life-saving potential of pre-hospital advanced life support for patients with respiratory distress or cardiac chest pain. The Dicaire report understandably recommended not to make the full panoply of advanced life support available in Québec's pre-hospital system, but to conduct field evaluations within structured, time-limited pilot projects armed with an evaluation mechanism that would show that this type of care could offer clinical added value in terms of mortality and morbidity. The importance of the links between different contextual factors and the efficacy and safety of advanced life support calls for the establishment of pilot projects that will inform the effectiveness of this type of care in different settings in Québec. In fact, it would be important to launch these pilot projects as soon as possible so that the eighteen emergency medical technicians trained in ALS can maintain and make full use of the skills and competencies they have acquired and so that the entire Québec population can quickly benefit from the interventions that will have been proven to be effective.

Recommendation 2: *It is recommended that pilot projects be set up Québec with a view to assessing the effectiveness and efficiency of advanced life support protocols and to evaluating the organizational conditions required for their implementation, with priority being given to respiratory distress, chest pain and cardiac arrest. These projects, which may be carried out in any region of the province, must nevertheless meet the following conditions:*

a) They must be carried out in a pre-hospital emergency service capable of guaranteeing to the MSSS that it will comply with high standards with respect to both staff training and quality control of the procedures.

b) The pre-hospital service must offer rigorous medical control, whether online or on site, provided by physicians with expertise in emergency medicine and pre-hospital care.

c) The evaluation must be conducted under the scientific direction of a research group recognized for its independence and experience.

d) Given that evaluation of the impact of advanced life support will contribute to the advancement or application of knowledge in this field, it must be based on an experimental or a quasi-experimental study design approved by a research-granting agency or other recognized body.

e) The nature and scope of the project, the minimum standards of medical control to be observed and the reasons that would justify the premature termination of the pilot project shall be jointly determined by the MSSS, the *Collège des médecins du Québec*, pre-hospital emergency service authorities, and the researchers concerned.

f) The number of emergency medical technicians well trained in advanced life support shall be increased to obtain as quickly as possible the number of cases needed to guarantee the validity of the evaluation results.

g) Advanced life support protocols introduced shall explicitly exclude children and trauma patients for the time being.

h) The implementation of advanced life support protocols must be evaluated on an ongoing basis so that appropriate adjustments may be identified and put into effect.

Rationale: The Dicaire report recommended that certain advanced life support practices be implemented in certain regions of Québec capable of complying with specified implementation requirements. It also suggested that the introduction of advanced life support procedures should be subjected to objective scientific evaluation conducted over a reasonable period of time. The field evaluation of certain advanced life support protocols at *Urgences-santé* did not apply to patients with chest pain or respiratory distress, where the potential to save lives currently seems to be greatest. Despite the mitigated results of advanced life support procedures in the case of cardiac arrest, several factors urge us to view them as priorities in these pilot projects. We believe there is a need to define more valid outcome measures of the efficacy of advanced life support and to identify the ethical and organizational issues raised by the possibility of performing advanced cardiac-resuscitation procedures in a pre-hospital setting rather than in a hospital emergency department, clearly on condition that the quality of care would be the same as in a hospital. Pilot-project evaluation requires not only that resources be earmarked for research in this area but also that a sufficient number of EMTS receive training in ALS, in addition to the eighteen who have already completed their training, so as to give appropriate power to conduct a statistical analysis of the outcomes. Other key conditions for the success of this evaluative research include dynamic medical control provided by physicians with expertise in emergency care, and the availability of effective information systems. *Urgences-santé* seems in many respects to be the ideal place to conduct field evaluations of these new ALS techniques. Nevertheless, given the importance of organizational context in the provision of pre-hospital care in each of Québec's regions, it will also be necessary to sustain research efforts in both urban and rural settings.

Recommendation 3: *It is recommended that a research program be established that deals specifically with evaluating pre-hospital advanced life support, open to the entire research community of Québec, under the leadership of the MSSS.*

Rationale: It would be advisable to officially recognize this research area and to allocate budgets for it, if we want to obtain evidence that will be useful for Québec and that will contribute to enhancing the knowledge base in this field at an international level. A process for approving advanced life support protocols for treating suspected cardiac chest pain and respiratory distress that is recognized across Canada and by the *Collège des médecins* should be initiated in parallel with the implementation of the

research program. The research program itself should be methodologically rigorous and should take care to include research activities that meet regional needs. The development of a process for formalizing the evaluation criteria for these pilot projects, and an appeal to the entire scientific community of Québec, would appear to be two prerequisites for maximizing results.

Recommendation 4: *It is recommended that, to ensure throughout Québec a gradual introduction of proven pre-hospital advanced life support care that keeps pace with emerging evidence, a service-development plan be established that provides for the training of a sufficient number of emergency medical technicians capable of administering this care, and that sets out appropriate organizational conditions that would include building close partnerships between pre-hospital and hospital settings.*

Rationale: It is expected that over the next few years new evidence will emerge from the studies published by OPALS and other research groups. This evidence should allow the clear identification of proven advanced life support practices. Moreover, since the release of the Dicaire report, we now have the National Occupational Competency Profiles (NOCP) that provide benchmarks for paramedics working in Canada. Note, however, that increasing the number of EMTs trained in advanced life support will be restricted by the limited availability of teaching staff and material resources that are essential for this training. With a view to developing and maintaining competencies and fostering mutually beneficial collaboration, it would be desirable for Québec to follow the example of other Canadian provinces and build close working partnerships between pre-hospital and hospital settings. In that sense, we could conceivably establish a model along the lines of Ontario's base hospitals, especially in Québec's regions, which generate a lower volume of emergency calls than does the greater Montréal region. This would also allow certain regions to have direct on-line support provided by a base-hospital emergency physician. Finally, emergency medical technicians must be able to practise within organizational structures that support the delivery of high-quality services. These structures will need to be created or further developed.

Optimization of pre-hospital basic life support and the chain of survival

Recommendation 5: *It is recommended that the addition of new procedures to pre-hospital basic life support services be supported by evidence or by expert recognition that these new procedures have a significant potential for reducing mortality and morbidity.*

Rationale: The development of Québec's pre-hospital emergency system was spearheaded by an expert committee that had worked without the benefit of a structured analysis of scientific data. Even though there is often no scientific evidence for certain procedures, they may still have significant potential for reducing mortality and morbidity: this is case of the Combitube, which is now a standard part of pre-hospital BLS care in Québec. This is equally true for the five medications in the symptom-relief program, which was implemented both in Québec and in other provinces even before its effectiveness had been proven. Continuous quality improvement of pre-hospital care requires a reasoned approach to adapting the services to new evidence.

Recommendation 6: *It is recommended that the basic training provided to emergency medical technicians be enhanced so that competencies acquired through this training match those stipulated in the National Occupational Competency Profiles (NOCP) for primary-care paramedics.*

Rationale: Several procedures that were once considered part of ALS care now belong to BLS care, and today's pre-hospital ALS practices may very well become the BLS practices of tomorrow. A recent example of this trend is the fact that EMTs are

now authorized to administer five symptom-relief medications to patients, a procedure that used to be exclusively part of ALS care. Several factors argue in favour of enhancing the training of emergency medical technicians: the critical nature of situations requiring pre-hospital care; the complexity of the medical procedures performed; the technical support needed by EMTs trained in advanced life support; and their need to rely on both general and specific skills and competencies in the field. Experience shows that training levels must also be upgraded so that EMTs can master the new procedures that will be added to current pre-hospital BLS services. Furthermore, this extra training would allow them to take part in research projects on BLS care.

Recommendation 7: *It is recommended that measures be implemented to expand the general public's training in cardiopulmonary resuscitation (CPR) and to ensure that patients experiencing cardiac arrest have access to early defibrillation performed by first responders or bystanders.*

Rationale: Basic cardiopulmonary resuscitation and early defibrillation performed by bystanders (public access defibrillation programs), first responders or EMTs significantly improve the survival rate of cardiac-arrest victims. In the Ontario system, these procedures have effectively been linked to improved patient survival.

Establishment of other conditions required to optimize the full spectrum of pre-hospital emergency care in Québec

Recommendation 8: *It is recommended that the following be introduced throughout Québec: an enhanced continuing-education program; effective medical control; quality-assurance tools; and information systems, such as electronic databases to keep a record of the patients served, their particular health problems, the clinical procedures performed by pre-hospital personnel, and the immediate effects of these procedures.*

Rationale: The concept of medical control of pre-hospital care seems to exist in all countries, but in practice it may take the form of direct (on-line) medical support, delegated acts stipulated in standard protocols, or indirect medical support (off-line). Supervision to ensure the quality of the procedures is also a key element. Certain provincial regulations governing pre-hospital care dictate that quality-assurance mechanisms be set in place. These mechanisms can include mandatory continuing education, mandatory recertification, audit of certain procedures (similar to the quality control of physicians' professional practice) and a complaint-investigation system. Information systems are the cornerstones of quality-assurance programs. These systems are not highly developed in Québec's regions, however, apart from the area covered by *Urgences-santé*. It should be emphasized that continuing-education initiatives have helped enhance the competencies of the personnel already in place, but these efforts have varied from one region to another.

Recommendation 9: *It is recommended that a horizon-scanning system be established to actively monitor emerging evidence in the field of pre-hospital care.*

Rationale: Scientific data on all aspects of pre-hospital care should be monitored regularly and continuously so that we can identify procedures that should be part of ALS or BLS services. Structured mechanisms for tracking these data are to be determined. They should include operating procedures ensuring that data are subjected to rigorous and objective analysis. Expert committees on pre-hospital care that are part of recognized bodies such as the *Association des médecins d'urgence du Québec* (AMUQ) and the *Association des spécialistes en médecine d'urgence du Québec* (ASMUQ) could be involved in this process.

APPENDIX A REQUEST FROM THE MINISTER OF HEALTH AND SOCIAL SERVICES

(TRANSLATION OF THE ORIGINAL LETTER FROM THE HONOURABLE PHILIPPE COUILLARD)

November 11, 2004

Luc Deschênes, MD
President and CEO
A.E.T.M.I.S.
2021, avenue Union, bureau 1040
Montréal (Québec) H3A 2S9

Dear Dr. Deschênes:

Modern medicine is currently going through an adjustment period wherein its empirical and traditional practices are moving toward evidence-based practices. This direction is giving rise to approaches and protocols based on specific practice guidelines in the various fields of medicine. Pre-hospital emergency services are not excluded from this trend.

This type of emergency care, delivered within a very particular context, is organized in different models across the world. Several models, including the one favoured by the emergency medical services systems in the United States and other Canadian provinces, make use of a spectrum of highly complex medical procedures performed by health professionals other than physicians. These systems are often called advanced life support or ALS systems.

Québec, whose pre-hospital emergency system was consolidated only fifteen or so years ago, did not initially adopt the path of providing highly advanced medical care, preferring to start by establishing a solid systemic response structure founded on a well-orchestrated chain of survival. That chain consists of 9-1-1 call centres, health co-ordination centres, first-responder and ambulance services, and evacuation/reception centres.

Now that this chain of survival has been well defined, we must adopt a clearer definition of the scope of practice for each of the practitioners employed in this field, with the aim of determining the best practices to reduce the overall mortality and morbidity of the populations concerned. Over the next eighteen months, Québec will have achieved the Canadian practice level referred to as primary care paramedic. This level encompasses the clinical skills of cardiac defibrillation, Combitube intubation, and administration of five medications (epinephrine [for allergic reactions], salbutamol, glucagon, nitroglycerine and aspirin).

At this stage of development, it would seem opportune to raise certain questions about the practices applied by neighbouring pre-hospital systems. Recent literature seems perplexed about the advisability and safety of certain medical procedures and about the philosophy that led to the development of highly complex care practices (for example, pre-hospital rapid-sequence induction). Well-designed evidence-based studies on pre-hospital practices seem rare and are sometimes the topic of controversy.

Moreover, within the context of the questions currently being raised by the physicians of the *Corporation d'urgences-santé*, the Ministère would like your agency to examine current evidence and to prepare a report covering the following issues:

- The safety of advanced life support procedures applied in North American pre-hospital emergency medical services systems;
- The effectiveness and efficiency of the practices that these systems offer target populations;
- The role of performance of the chain of survival as a factor independent of the medical procedures performed by emergency medical technicians trained in advanced life support or by advanced care paramedics; and
- The optimal path for developing pre-hospital services in Québec, taking into account the importance to be given to each of the links in the chain of survival within the context of the system's overall efficiency with respect to the entire population.

I would very much appreciate receiving your report by the end of February 2005. I am certain that AETMIS can contribute to shedding light on this complex issue and support the Ministère in establishing a quality pre-hospital response system for the population.

Sincerely,

Philippe Couillard
Minister of Health and Social Services

APPENDIX B SEARCH STRATEGIES

Search strategy for section 3 (Practitioner Categories, Scopes of Practice and Training in Various Countries)

An Internet search was conducted that included the various sites of the health ministries of the provinces of Ontario, Alberta and Nova Scotia. The Web sites of the cities of Toronto, Edmonton, Calgary and Halifax were also accessed to locate information on the organization and duties of paramedics. Some Canadian sites that covered these topics (in the provinces concerned) were also explored.

Search statements

(ALS OR advanced life support OR paramedic* OR basic life support) AND (intervention* OR act OR acts OR competen* OR certification* OR practice* OR skill* OR level*) emergency medical services OR emergency management OR emergency health services.

REFERENCES

Abbuhl FB and Reed DB. Time to analgesia for patients with painful extremity injuries transported to the emergency department by ambulance. Prehosp Emerg Care 2003;7(4):445–7.

Agence d'évaluation des technologies et des modes d'intervention en santé (AETMIS). Letter to the Honourable Philippe Couillard from Dr. Luc Deschênes agreeing to prepare a report on pre-hospital emergency services. Montréal: AETMIS; 2004.

Alldredge BK, Gelb AM, Isaacs SM, Corry MD, Allen F, Ulrich S, et al. A comparison of lorazepam, diazepam, and placebo for the treatment of out-of-hospital status epilepticus. N Engl J Med 2001;345(9):631–7.

Alonso-Serra HM and Wesley K. Prehospital pain management. Prehosp Emerg Care 2003;7(4): 482–8.

American College of Emergency Physicians (ACEP). Use of patient restraints. ACEP Policy Statements. Policy No. 400119. Approved in April 2001. Available at: http://www.acep.org/1,680,0.html (accessed on March 22, 2005).

American College of Emergency Physicians (ACEP). Out-of-hospital 12-lead ECG. ACEP Policy Statements. Policy No. 400288. Approved in June 1999. Available at: http://www.acep.org/1,627,0.html (accessed on March 22, 2005).

American Heart Association (AHA) and International Liaison Committee on Resuscitation (ILCR). Guidelines 2000 for cardiopulmonary resuscitation and emergency cardiovascular care. Part 6: Advanced cardiovascular life support; Section 5: Pharmacology I: Agents for arrhythmias. Circulation 2000a;102(Suppl):I-112–28.

American Heart Association (AHA) and International Liaison Committee on Resuscitation (ILCR). Guidelines 2000 for cardiopulmonary resuscitation and emergency cardiovascular care. Part 7: The era of reperfusion; Section 1: Acute coronary syndromes (acute myocardial infarction). Circulation 2000b;102(Suppl):I-172–203.

American Heart Association (AHA) and International Liaison Committee on Resuscitation (ILCR). Guidelines 2000 for cardiopulmonary resuscitation and emergency cardiovascular care. Part 7: The era of reperfusion; Section 2: Acute stroke. Circulation 2000c;102 (Suppl):I-204–16.

Antman EM, Anbe DT, Armstrong PW, Bates ER, Green LA, Hand M, et al. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction—Executive summary: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to revise the 1999 guidelines for the management of patients with acute myocardial infarction). Circulation 2004;110(5): 588–636.

Association professionnelle des paramédics du Québec (APPQ). Création d'un ordre professionnel spécifique aux techniciens ambulanciers paramédics du Québec. APPQ; 2003.

Association professionnelle des paramédics du Québec (APPQ), Verreault D, Desrosiers C, Scalabrini S. Requête en constitution d'un ordre professionnel des techniciens ambulanciers-paramédics. Québec: APPQ; 2003.

Aufderheide TP, Kereiakes DJ, Weaver WD, Gibler WB, Simoons ML. Planning, implementation, and process monitoring for prehospital 12-lead ECG diagnostic programs. Prehospital Disaster Med 1996;11(3):162–71.

Aufderheide TP, Haselow WC, Hendley GE, Robinson NA, Armaganian L, Hargarten KM, et al. Feasibility of prehospital r-TPA therapy in chest pain patients. Ann Emerg Med 1992a;21(4):379–83.

Aufderheide TP, Hendley GE, Woo J, Lawrence S, Valley V, Teichman SL. A prospective evaluation of prehospital 12-lead ECG application in chest pain patients. J Electrocardiol 1992b;24(Suppl):8–13.

Aufderheide TP, Keelan MH, Hendley GE, Robinson N, Hastings T, Lewin R, et al. Milwaukee Prehospital Chest Pain Project—Phase I: Feasibility and accuracy of prehospital thrombolytic candidate selection. Am J Cardiol 1992c;69(12):991–6.

Bailey ED, Wydro GC, Cone DC. Termination of resuscitation in the prehospital setting for adult patients suffering nontraumatic cardiac arrest. National Association of EMS Physicians Standards and Clinical Practice Committee. Prehosp Emerg Care 2000;4(2):190–5.

Barsan WG and National Institute of Neurological Disorders and Stroke (NINDS). Improving the chain of recovery for acute stroke in your community: Preamble. Proceedings of a National symposium on rapid identification and treatment of acute stroke, 2002 December 12–13. Bethesda, MD: NINDS; 2002. Available at: http://accessible.ninds.nih.gov/news_and_events/proceedings/stroke_2002/acute_stroke_preamble_pr.htm.

Barsan WG, Brott TG, Broderick JP, Haley EC, Levy DE, Marler JR. Time of hospital presentation in patients with acute stroke. Arch Intern Med 1993;153(22):2558–61.

Barton ED, Ramos J, Colwell C, Benson J, Baily J, Dunn W. Intranasal administration of naloxone by paramedics. Prehosp Emerg Care 2002;6(1):54–8.

Battaglia J, Moss S, Rush J, Kang J, Mendoza R, Leedom L, et al. Haloperidol, lorazepam, or both for psychotic agitation? A multicenter, prospective, double-blind, emergency department study. Am J Emerg Med 1997;15(4):335–40.

BEPS Collaborative Group. Prehospital thrombolysis in acute myocardial infarction: The Belgian Eminase Prehospital Study (BEPS). BEPS Collaborative Group. Eur Heart J 1991;12(9): 965–7.

Bersten AD, Holt AW, Vedig AE, Skowronski GA, Baggoley CJ. Treatment of severe cardiogenic pulmonary edema with continuous positive airway pressure delivered by face mask. N Engl J Med 1991;325(26):1825–30.

Bickell WH, Bruttig SP, Millnamow GA, O'Benar J, Wade CE. The detrimental effects of intravenous crystalloid after aortotomy in swine. Surgery 1991;110(3):529–36.

Bickell WH, Pepe PE, Wyatt CH, Dedo WR, Applebaum DJ, Black CT, Mattox KL. Effect of antishock trousers on the trauma score: A prospective analysis in the urban setting. Ann Emerg Med 1985;14(3):218–22.

Black JJ and Davies GD. International EMS systems: United Kingdom. Resuscitation 2005;64(1): 21–9.

Blackburn P and Vissers R. Pharmacology of emergency department pain management and conscious sedation. Emerg Med Clin North Am 2000;18(4):803–27.

Bochicchio GV, Ilahi O, Joshi M, Bochicchio K, Scalea TM. Endotracheal intubation in the field does not improve outcome in trauma patients who present without an acutely lethal traumatic brain injury. J Trauma 2003;54(2):307–11.

Brady WJ, Swart G, DeBehnke DJ, Ma OJ, Aufderheide TP. The efficacy of atropine in the treatment of hemodynamically unstable bradycardia and atrioventricular block: Prehospital and emergency department considerations. Resuscitation 1999;41(1):47–55.

Brennan JA, Calkins AM, Baker EF, Heimbach LJ, Olsson DJ, Katz AA. Out-of-hospital 12-lead ECG. American College of Emergency Physicians; 1999. Available at: http://www.acep.org/webportal/PracticeResources/IssuesByCategory/EmergencyMedical Services/PREPOutofHospital12 LeadECG.htm (accessed on March 11, 2005).

Brouwer MA, Martin JS, Maynard C, Wirkus M, Litwin PE, Verheugt FW, Weaver WD. Influence of early prehospital thrombolysis on mortality and event-free survival (the Myocardial Infarction Triage and Intervention [MITI] randomized trial). Am J Cardiol 1996;78(5):497–502.

Brugemann J, van der Meer J, de Graeff PA, Takens LH, Lie KI. Logistical problems in prehospital thrombolysis. Eur Heart J 1992;13(6):787–8.

Canadian Association of Emergency Physicians (CAEP). Position statement on thrombolytic therapy for acute ischemic stroke. CJEM 2001;3(1). Available at: http://www.caep.ca/004.cjem-jcmu/004-00.cjem/vol-3.2001/v31-008.htm (accessed on March 18, 2005).

Canadian Health Services Research Foundation (CHSRF). What counts? Interpreting evidence-based decision-making for management and policy. Report of the 6th CHSRF Annual Invitational Workshop, Vancouver, British Columbia, March 11, 2004. Available at: http://www.chsrf.ca/knowledge_transfer/pdf/2004_workshop_report_e.pdf.

Canto JG, Rogers WJ, Bowlby LJ, French WJ, Pearce DJ, Weaver WD. The prehospital electrocardiogram in acute myocardial infarction: Is its full potential being realized? National Registry of Myocardial Infarction 2 Investigators. J Am Coll Cardiol 1997;29(3):498–505.

Caplan LR. Treatment of acute stroke: Still struggling. JAMA 2004;292(15):1883–5.

Carstens S and Sprehn M. Prehospital treatment of severe hypoglycaemia: A comparison of intramuscular glucagon and intravenous glucose. Prehospital Disaster Med 1998;13(2-4):44–50.

Chambers JA and Guly HR. Prehospital intravenous nalbuphine administered by paramedics. Resuscitation 1994;27(2):153–8.

Cobb LA, Fahrenbruch CE, Walsh TR, Copass MK, Olsufka M, Breskin M, Hallstrom AP. Influence of cardiopulmonary resuscitation prior to defibrillation in patients with out-of-hospital ventricular fibrillation. JAMA 1999;281(13):1182–8.

Cobb LA, Weaver WD, Fahrenbruch CE, Hallstrom AP, Copass MK. Community-based interventions for sudden cardiac death: Impact, limitations, and changes. Circulation 1992;85(Suppl 1):I-98–102.

Colwell CB, Pons P, Blanchet JH, Mangino C. Claims against a paramedic ambulance service: A ten-year experience. J Emerg Med 1999;17(6):999–1002.

Craven RA, Singletary N, Bosken L, Sewell E, Payne M, Lipsey R. Use of bilevel positive airway pressure in out-of-hospital patients. Acad Emerg Med 2000;7(9):1065–8.

Cressman WA, Plostnieks J, Johnson PC. Absorption, metabolism and excretion of droperidol by human subjects following intramuscular and intravenous administration. Anesthesiology 1973;38(4):363–9.

Cucherat M, Bonnefoy E, Tremeau G. Primary angioplasty versus intravenous thrombolysis for acute myocardial infarction. Cochrane Database Syst Rev 2003;(3):CD001560.

Cummins RO, Ornato JP, Thies WH, Pepe PE. Improving survival from sudden cardiac arrest: the “chain of survival” concept. A statement for health professionals from the Advanced Cardiac Life Support Subcommittee and the Emergency Cardiac Care Committee, American Heart Association. Circulation 1991;83(5):1832–47.

Dalby M, Bouzamondo A, Lechat P, Montalescot G. Transfer for primary angioplasty versus immediate thrombolysis in acute myocardial infarction: A meta-analysis. Circulation 2003;108(15):1809–14.

Davis DP, Hoyt DB, Ochs M, Fortlage D, Holbrook T, Marshall LK, Rosen P. The effect of paramedic rapid sequence intubation on outcome in patients with severe traumatic brain injury. J Trauma 2003;54(3):444–53.

De Maio VJ, Stiell IG, Spaite DW, Ward RE, Lyver MB, Field BJ, et al. CPR-only survivors of out-of-hospital cardiac arrest: Implications for out-of-hospital care and cardiac arrest research methodology. Ann Emerg Med 2001;37(6):602–8.

Demetriades D, Chan L, Cornwell E, Belzberg H, Berne TV, Asensio J, et al. Paramedic vs private transportation of trauma patients. Effect on outcome. Arch Surg 1996;131(2):133–8.

DeVellis P, Thomas SH, Wedel SK, Stein JP, Vinci RJ. Prehospital fentanyl analgesia in air-transported pediatric trauma patients. Pediatr Emerg Care 1998;14(5):321–3.

Dickinson K and Roberts I. Medical anti-shock trousers (pneumatic anti-shock garments) for circulatory support in patients with trauma. Cochrane Database Syst Rev 2000;(2):CD001856.

Donen N, Tweed WA, White D, Guttormson B, Enns J. Prehospital analgesia with Entonox. Can Anaesth Soc J 1982;29(3):275–9.

Dorian P, Cass D, Schwartz B, Cooper R, Gelaznikas R, Barr A. Amiodarone as compared with lidocaine for shock-resistant ventricular fibrillation. N Engl J Med 2002;346(12):884–90.

Dretzke J, Sandercock J, Bayliss S, Burls A. Clinical effectiveness and cost-effectiveness of prehospital intravenous fluids in trauma patients. Health Techn Assess 2004;8(23):1–103.

Eckstein M and Alo K. The effect of a quality improvement program on paramedic on-scene times for patients with penetrating trauma. Acad Emerg Med 1999;6(3):191–5.

Eckstein M, Chan L, Schneir A, Palmer R. Effect of prehospital advanced life support on outcomes of major trauma patients. J Trauma 2000;48(4):643–8.

Eisenberg MS, Hallstrom AP, Copass MK, Bergner L, Short F, Pierce J. Treatment of ventricular fibrillation. Emergency medical technician defibrillation and paramedic services. JAMA 1984;251(13):1723–6.

Eisenberg MS, Copass MK, Hallstrom AP, Blake B, Bergner L, Short FA, Cobb LA. Treatment of out-of-hospital cardiac arrests with rapid defibrillation by emergency medical technicians. N Engl J Med 1980;302(25):1379–83.

Eisenberg M, Bergner L, Hallstrom A. Paramedic programs and out-of-hospital cardiac arrest: I. Factors associated with successful resuscitation. Am J Public Health 1979;69(1):30–8.

European Myocardial Infarction Project Group (EMIPG). Prehospital thrombolytic therapy in patients with suspected acute myocardial infarction. N Engl J Med 1993;329(6):383–9.

European Resuscitation Council (ERC). Part 4: The automated defibrillator: Key link in the chain of survival. Resuscitation 2000;46(1–3):73–91.

Food and Drug Administration (FDA). Droperidol gets second-line, narrowed indication due to arrhythmia risk. F-D-C Reports, The Pink Sheet 2001 (December 10): 23.

Foster DB, Dufendach JH, Barkdoll CM, Mitchell BK. Prehospital recognition of AMI using independent nurse/paramedic 12-lead ECG evaluation: Impact on in-hospital times to thrombolysis in a rural community hospital. Am J Emerg Med 1994;12(1):25–31.

Fullerton-Gleason L, Crandall C, Sklar DP. Prehospital administration of morphine for isolated extremity injuries: A change in protocol reduces time to medication. Prehosp Emerg Care 2002;6(4):411–6.

Furlan A, Higashida R, Wechsler L, Gent M, Rowley H, Kase C, et al. Intra-arterial prourokinase for acute ischemic stroke. The PROACT II study: A randomized controlled trial. Prolyse in Acute Cerebral Thromboembolism. JAMA 1999;282:2003–11.

Gausche M, Lewis RJ, Stratton SJ, Haynes BE, Gunter CS, Goodrich SM, et al. Effect of out-of-hospital pediatric endotracheal intubation on survival and neurological outcome: A controlled clinical trial. JAMA 2000;283(6):783–90.

Gilligan P, Khan A, Shepherd M, Lumsden G, Kitching G, Taylor A, et al. SOCRATES 1 (Synopsis of Cochrane reviews applicable to emergency services). Emerg Med J 2004;21(5):584–5.

Giovas P, Papadoyannis D, Thomakos D, Papazachos G, Rallidis M, Soulis D, et al. Transmission of electrocardiograms from a moving ambulance. J Telemed Telecare 1998;4 (Suppl 1):5–7.

GREAT Group. Feasibility, safety, and efficacy of domiciliary thrombolysis by general practitioners: Grampian region early anistreplase trial. GREAT Group. BMJ 1992;305(6853): 548–53.

Grim P, Feldman T, Martin M, Donovan R, Nevins V, Childers RW. Cellular telephone transmission of 12-lead electrocardiograms from ambulance to hospital. Am J Cardiol 1987;60(8): 715–20.

Hallstrom AP, Ornato JP, Weisfeldt M, Travers A, Christenson J, McBurnie MA, et al. Public-access defibrillation and survival after out-of-hospital cardiac arrest. N Engl J Med 2004; 351(7):637–46.

Health Canada. Health Products and Food Branch. Cardiovascular toxicity with injectable droperidol; February 12, 2002. Available at: http://www.hc-sc.gc.ca/hpfb-dgpsa/tpd-dpt/droperidol_e.html (accessed on March 18, 2005).

Hick JL, Mahoney BD, Lappe M. Prehospital sedation with intramuscular droperidol: A one-year pilot. Prehosp Emerg Care 2001;5(4):391–4.

Hick JL, Smith SW, Lynch MT. Metabolic acidosis in restraint-associated cardiac arrest: A case series. Acad Emerg Med 1999;6(3):239–43.

Howell MA and Guly HR. A comparison of glucagon and glucose in prehospital hypoglycaemia. J Accid Emerg Med 1997;14(1):30–2.

Johnson JC and Atherton GL. Effectiveness of nitrous oxide in a rural EMS system. J Emerg Med 1991;9(1–2):45–53.

Kallio T, Kuisma M, Alaspaa A, Rosenberg PH. The use of prehospital continuous positive airway pressure treatment in presumed acute severe pulmonary edema. Prehosp Emerg Care 2003;7(2):209–13.

Karagounis L, Ipsen SK, Jessop MR, Gilmore KM, Valenti DA, Clawson JJ, et al. Impact of field-transmitted electrocardiography on time to in-hospital thrombolytic therapy in acute myocardial infarction. Am J Cardiol 1990;66(10):786–91.

Keeley EC and Grines CL. Primary percutaneous coronary intervention for every patient with ST-segment elevation myocardial infarction: What stands in the way? Ann Intern Med 2004;141(4):298–304.

Keeley EC, Boura JA, Grines CL. Primary angioplasty versus intravenous thrombolytic therapy for acute myocardial infarction: A quantitative review of 23 randomised trials. Lancet 2003;361(9351):13–20.

Kelly AM, Kerr D, Dietze P, Patrick I, Walker T, Koutsogiannis Z. Randomised trial of intranasal versus intramuscular naloxone in prehospital treatment for suspected opioid overdose. Med J Aust 2005;182(1):24–7.

Kereiakes DJ, Gibler WB, Martin LH, Pieper KS, Anderson LC. Relative importance of emergency medical system transport and the prehospital electrocardiogram on reducing hospital time delay to therapy for acute myocardial infarction: A preliminary report from the Cincinnati Heart Project. Am Heart J 1992;123(4 Pt 1):835–40.

Kidwell CS, Starkman S, Eckstein M, Weems K, Saver JL. Identifying stroke in the field. Prospective validation of the Los Angeles Prehospital Stroke Screen (LAPSS). Stroke 2000;31(1):71–6.

Kothari RU, Pancioli A, Liu T, Brott T, Broderick J. Cincinnati Prehospital Stroke Scale: Reproducibility and validity. Ann Emerg Med 1999;33(4):373–8.

Kothari R, Barsan W, Brott T, Broderick J, Ashbrock S. Frequency and accuracy of prehospital diagnosis of acute stroke. Stroke 1995;26(6):937–41.

Kudenchuk PJ, Cobb LA, Copass MK, Cummins RO, Doherty AM, Fahrenbruch CE, et al. Amiodarone for resuscitation after out-of-hospital cardiac arrest due to ventricular fibrillation. N Engl J Med 1999;341(12):871–8.

Kudenchuck P, Ho M, Litwin P, Martin J, Weaver W. Accuracy of a cardiologist vs computerized ECG analysis in selecting patients for out-of-hospital thrombolytic therapy. Circulation 1989;80(SII):II-354.

Kupas DF and Wydro GC. Patient restraint in emergency medical services systems. Prehosp Emerg Care 2002;6(3):340–5.

Kwan I, Bunn F, Roberts I. Timing and volume of fluid administration for patients with bleeding. Cochrane Database Syst Rev 2003;(3):CD002245.

Larsen MP, Eisenberg MS, Cummins RO, Hallstrom AP. Predicting survival from out-of-hospital cardiac arrest: A graphic model. Ann Emerg Med 1993;22(11):1652–8.

Lavoie A. Introduction de la défibrillation semi-automatique à Montréal. Urgence pratique 1998;31:49–52.

Liberman M, Branas C, Mulder D, Lavoie A, Sampalis J. Advanced versus basic life support in the prehospital setting: The controversy between the “scoop and run” and the “stay and play” approach to the care of the injured patient. Int J Disaster Med 2004a;2:1–9.

Liberman M, Mulder DS, Lavoie A, Sampalis JS. Implementation of a trauma care system: Evolution through evaluation. J Trauma 2004b;56(6):1330–5.

Liberman M, Mulder D, Lavoie A, Denis R, Sampalis JS. Multicenter Canadian study of prehospital trauma care. Ann Surg 2003;237(2):153–60.

Liberman M, Mulder D, Sampalis J. Advanced or basic life support for trauma: Meta-analysis and critical review of the literature. J Trauma 2000;49(4):584–99.

Liberman M, Lavoie A, Mulder D, Sampalis J. Cardiopulmonary resuscitation: Errors made by prehospital emergency medical personnel. Resuscitation 1999;42(1):47–55.

Lilja G. Section 1: Prehospital care; Emergency medical services. In: Tintinalli J, Kelen G, Stapczynski J. Emergency medicine: A comprehensive study guide. 6th ed. New York: McGraw-Hill; 2004.

Lin M, Yang YF, Chiang HT, Chang MS, Chiang BN, Cheitlin MD. Reappraisal of continuous positive airway pressure therapy in acute cardiogenic pulmonary edema. Short-term results and long-term follow-up. Chest 1995;107(5):1379–86.

Lin M and Chiang HT. The efficacy of early continuous positive airway pressure therapy in patients with acute cardiogenic pulmonary edema. J Formos Med Assoc 1991;90(8):736–43.

MacFarlane C. The advances and evidence base for prehospital care. Emerg Med J 2003;20(2):114-5.

MacFarlane C and Benn CA. Evaluation of emergency medical services systems: A classification to assist in determination of indicators. Emerg Med J 2003;20(2):188–91.

Maio RF, Garrison HG, Spaite DW, Desmond JS, Gregor MA, Cayten CG, et al. Emergency medical services outcomes project I (EMSOP I): Prioritizing conditions for outcomes research. Ann Emerg Med 1999;33(4):423–32.

Manz D. EMS scope of practice . . . and other perspectives. In: NAEMSP Annual Meeting, 2005. Naples, Florida. Available at: http://www.naemsp.org/ (accessed on March 16, 2005).

Marks MP, Marcellus M, Norbash AM, Steinberg G K, Tong D, Albers GW. Outcome of angioplasty for atherosclerotic intracranial stenosis. Stroke 1999;30:1065–9.

Mattox KL, Bickell WH, Pepe PE, Mangelsdorff AD. Prospective randomized evaluation of antishock MAST in post-traumatic hypotension. J Trauma 1986;26(9):779–86.

McAleer B, Ruane B, Burke E, Cathcart M, Costello A, Dalton G, et al. Prehospital thrombolysis in a rural community: Short- and long-term survival. Cardiovasc Drugs Ther 1992;6(4):369–72.

McEachin CC, McDermott JT, Swor R. Few emergency medical services patients with lower-extremity fractures receive prehospital analgesia. Prehosp Emerg Care 2002;6(4):406–10.

Ministère de la Santé et des Services sociaux (MSSS). Rapport d'inspection ministérielle. Report prepared by Bourque L, Fontaine M, Laliberté P and Tremblay J. Québec: MSSS, February 2005.

Ministère de la Santé et des Services sociaux (MSSS). Official request for report by the Honourable Philippe Couillard, Minister of Health and Social Services. Québec: MSSS; 2004.

Ministère de la Santé et des Services sociaux (MSSS). Urgences préhospitalières: un système à mettre en place. Report prepared by André Dicaire. Québec: MSSS; 2000.

Ministère de la Santé et des Services sociaux (MSSS). Services préhospitaliers d'urgence au Québec: chaque minute compte! Québec: MSSS; 1992.

Monosky K. The JEMS 2003 200-city survey. JEMS 2004;29(2):38-53.

Morrison LJ, Allan R, Vermeulen M, Dong SL, McCallum AL. Conversion rates for prehospital paroxysmal supraventricular tachycardia (PSVT) with the addition of adenosine: A before-and-after trial. Prehosp Emerg Care 2001;5(4):353–9.

Morrison LJ, Brooks S, Sawadsky BV, McDonald AC, Verbeek PR. Mortality and thrombolysis time intervals with prehospital 12-lead electrocardiogram and advance emergency department notification: A meta-analysis. Acad Emerg Med 2000a;7(5):479.

Morrison LJ, Verbeek PR, McDonald AC, Sawadsky BV, Cook DJ. Mortality and prehospital thrombolysis for acute myocardial infarction: A meta-analysis. JAMA 2000b;283(20): 2686–92.

Morrow DA, Antman EM, Sayah A, Schuhwerk KC, Giugliano RP, deLemos JA, et al. Evaluation of the time saved by prehospital initiation of reteplase for ST-elevation myocardial infarction: Results of the Early Retavase-Thrombolysis in Myocardial Infarction (ER-TIMI) 19 trial. J Am Coll Cardiol 2002;40(1):71–7.

Murray JA, Demetriades D, Berne TV, Stratton SJ, Cryer HG, Bongard F, et al. Prehospital intubation in patients with severe head injury. J Trauma 2000;49(6):1065–70.

National Heart Attack Alert Program (NHAAP). Access to timely and optimal care of patients with acute coronary syndromes—Community planning considerations: A report by the National Heart Attack Alert Program. J Thromb Thrombolysis 1998;6(1):19–46.

National Heart Attack Alert Program (NHAAP). Staffing and equipping emergency medical services systems: Rapid identification and treatment of acute myocardial infarction. National Heart Attack Alert Program Coordinating Committee, Access to Care Subcommittee. Am J Emerg Med 1995;13(1):58–66.

National Institute of Neurological Disorders and Stroke (NINDS). Tissue plasminogen activator for acute ischemic stroke. The National Institute of Neurological Disorders and Stroke rt-PA Stroke Study Group. N Engl J Med 1995;333(24):1581–7.

Nichol G, Stiell IG, Laupacis A, Pham B, De Maio VJ, Wells GA. A cumulative meta-analysis of the effectiveness of defibrillator-capable emergency medical services for victims of out-of-hospital cardiac arrest. Ann Emerg Med 1999;34(4 Pt 1):517–25.

Nichol G, Detsky AS, Stiell IG, O'Rourke K, Wells G, Laupacis A. Effectiveness of emergency medical services for victims of out-of-hospital cardiac arrest: A metaanalysis. Ann Emerg Med 1996a;27(6):700–10.

Nichol G, Laupacis A, Stiell IG, O'Rourke K, Anis A, Bolley H, Detsky AS. Cost-effectiveness analysis of potential improvements to emergency medical services for victims of out-of-hospital cardiac arrest. Ann Emerg Med 1996b;27(6):711–20.

Nicholl J, Hughes S, Dixon S, Turner J, Yates D. The costs and benefits of paramedic skills in prehospital trauma care. Health Technol Assess 1998;2(17):1–84.

Ochs M, Davis D, Hoyt D, Bailey D, Marshall L, Rosen P. Paramedic-performed rapid sequence intubation of patients with severe head injuries. Ann Emerg Med 2002;40(2):159–67.

Office des professions du Québec. Regulation respecting the professional activities that may be engaged in within the framework of pre-hospital emergency services. R.Q. c. C-26, r.155.6.

Ornato JP, Racht EM, Fitch JJ, Berry JF. The need for ALS in urban and suburban EMS systems. Ann Emerg Med 1990;19(12):1469–70.

O'Rourke MF, Donaldson E, Geddes JS. An airline cardiac arrest program. Circulation 1997;96(9):2849–53.

Osterwalder JJ. Insufficient quality of research on prehospital medical emergency care—Where are the major problems and solutions? Swiss Med Wkly 2004;134(27–28):389–94.

Page RL, Joglar JA, Kowal RC, Zagrodzky JD, Nelson LL, Ramaswamy K, et al. Use of automated external defibrillators by a U.S. airline. N Engl J Med 2000;343(17):1210–6.

Pantridge J, Webb S, Adgey A, Geddes J. The first hour after the onset of acute myocardial infarction. In: Yu PN, Goodwin JF. Progress in cardiology. Philadelphia, PA: Lea and Febiger; 1975: 173–8.

Pantridge JF and Geddes JS. A mobile intensive-care unit in the management of myocardial infarction. Lancet 1967;2(7510):271–3.

Paramedic Association of Canada (PAC). National Occupational Competency Profiles for Paramedic Practitioners. Kamloops, BC: PAC; 2001.

Paramedic Association of Canada (PAC) and Human Resources Development Canada (HRDC). National Occupational Competency Profiles for Paramedic Practitioners: Essential Skills Profile. Kamloops, BC: PAC and HRDC, June 2000.

Paris PM. Prehospital analgesia. In: Paris PM, Roth R, Vertile V. Prehospital medicine: The art of on-line medical command. St. Louis, MO: Mosby Lifetime; 1996.

Park KS, Korn CS, Henderson SO. Agitated delirium and sudden death: Two case reports. Prehosp Emerg Care 2001;5(2):214–6.

Pepe PE. The initial links in the chain of recovery for brain attack: Access, prehospital care, notification, and transport. Proceedings of a national symposium on rapid identification and treatment of acute stroke. Bethesda, MD: NINDS; 1997. Available at: http://www.ninds.nih.gov/news_and_events/proceedings/strokeworkshop.htm (accessed on March 18, 2005).

Pepe PE, Zachariah BS, Sayre MR, Floccare D. Ensuring the chain of recovery for stroke in your community. Acad Emerg Med 1998;5(4):352–8.

Pepe PE, Abramson NS, Brown CG. ACLS—Does it really work? Ann Emerg Med 1994;23(5):1037–41.

Petrie D, De Maio V, Stiell I, Dreyer J. Factors affecting survival after prehospital asystole cardiac arrest in a basic life support-defibrillation system. Can J Emerg Med 2001;3(3):186–92.

Pitetti R, Glustein JZ, Bhende MS. Prehospital care and outcome of pediatric out-of-hospital cardiac arrest. Prehosp Emerg Care 2002;6(3):283–90.

Pozner CN, Zane R, Nelson SJ, Levine M. International EMS systems: The United States—Past, present, and future. Resuscitation 2004;60(3):239–44.

Pozner CN, Levine M, Shapiro N, Hanrahan JP. Concordance of field and emergency department assessment in the prehospital management of patients with dyspnea. Prehosp Emerg Care 2003;7(4):440–4.

Rasanen J, Heikkila J, Downs J, Nikki P, Vaisanen I, Viitanen A. Continuous positive airway pressure by face mask in acute cardiogenic pulmonary edema. Am J Cardiol 1985;55(4): 296–300.

Rawles J. Halving of mortality at 1 year by domiciliary thrombolysis in the Grampian Region Early Anistreplase Trial (GREAT). J Am Coll Cardiol 1994;23(1):1–5.

Rawles JM. Quantification of the benefit of earlier thrombolytic therapy: Five-year results of the Grampian Region Early Anistreplase Trial (GREAT). J Am Coll Cardiol 1997;30(5): 1181–6.

Rea TD, Eisenberg MS, Becker LJ, Murray JA, Hearne T. Temporal trends in sudden cardiac arrest: A 25-year emergency medical services perspective. Circulation 2003;107(22): 2780–5.

Reay DT, Fligner CL, Stilwell AD, Arnold J. Positional asphyxia during law enforcement transport. Am J Forensic Med Pathol 1992;13(2):90–7.

Richard J, Stiell I, Osmond M, Nesbitt L, Beaudoin T. How are pediatric patients managed by EMS and what are their outcomes? Acad Emerg Med 2003;10(5):443.

Richards JR, Derlet RW, Duncan DR. Chemical restraint for the agitated patient in the emergency department: Lorazepam versus droperidol. J Emerg Med 1998;16(4):567–73.

Risenfors M, Gustavsson G, Ekstrom L, Hartford M, Herlitz J, Karlson BW, et al. Prehospital thrombolysis in suspected acute myocardial infarction: Results from the TEAHAT Study. J Intern Med Suppl 1991;734:3–10.

Robertson RM. Sudden death from cardiac arrest—Improving the odds. N Engl J Med 2000;343 (17):1259–60.

Roeggla M, Wagner A, Muellner M, Bur A, Roeggla H, Hirschl MM, et al. Cardiorespiratory consequences to hobble restraint. Wien Klin Wochenschr 1997;109(10):359–61.

Rosen CL, Ratliff AF, Wolfe RE, Branney SW, Roe EJ, Pons PT. The efficacy of intravenous droperidol in the prehospital setting. J Emerg Med 1997;15(1):13–17.

Rosenberg DG, Levin E, Lausell A, Brown A, Gardner J, Perez E, et al. Feasibility and timing of prehospital administration of reteplase in patients with acute myocardial infarction. J Thromb Thrombolysis 2002;13(3):147–53.

Roth A, Elkayam I, Shapira I, Sander J, Malov N, Kehati M, Golovner M. Effectiveness of prehospital synchronous direct-current cardioversion for supraventricular tachyarrhythmias causing unstable hemodynamic states. Am J Cardiol 2003;91(4):489–91.

Sacchetti A, Schafermeyer R, Geradi M, Graneto J, Fuerst RS, Cantor R, et al. Pediatric analgesia and sedation. Ann Emerg Med 1994;23(2):237–50.

Sampalis JS, Denis R, Lavoie A, Frechette P, Boukas S, Nikolis A, et al. Trauma care regionalization: A process-outcome evaluation. J Trauma 1999;46(4):565–81.

Sampalis J, Boukas S, Lavoie A, Fréchette P. Évaluation du rôle de la médication préhospitalière dans la prévention des décès. Urgence pratique 1998;28:58–60.

Sampalis JS, Tamim H, Denis R, Boukas S, Ruest SA, Nikolis A, et al. Ineffectiveness of on-site intravenous lines: Is prehospital time the culprit? J Trauma 1997;43(4):608–17.

Sampalis JS, Boukas S, Lavoie A, Nikolis A, Fréchette P, Brown R, et al. Preventable death evaluation of the appropriateness of the on-site trauma care provided by *Urgences-santé* physicians. J Trauma 1995;39(6):1029–35.

Sampalis JS, Tamim H, Nikolis A, Lavoie A, Williams JI. Predictive validity and internal consistency of the pre-hospital index measured on-site by physicians. Accid Anal Prev 1996;28(6):675–84.

Sampalis JS, Lavoie A, Salas M, Nikolis A, Williams JI. Determinants of on-scene time in injured patients treated by physicians at the site. Prehospital Disaster Med 1994;9(3):178–89.

Sampalis JS, Lavoie A, Williams JI, Mulder DS, Kalina M. Impact of on-site care, prehospital time, and level of in-hospital care on survival in severely injured patients. J Trauma 1993;34(2):252–61.

Sampalis JS, Lavoie A, Williams JI, Mulder DS, Kalina M. Standardized mortality ratio analysis on a sample of severely injured patients from a large Canadian city without regionalized trauma care. J Trauma 1992;33(2):205–12.

Saver JL, Kidwell C, Eckstein M, Starkman S. Prehospital neuroprotective therapy for acute stroke: Results of the Field Administration of Stroke Therapy-Magnesium (FAST-MAG) pilot trial. Stroke 2004;35(5):e106–8.

Sayre MR, Sakles JC, Mistler AF, Evans JL, Kramer AT, Pancioli AM. Field trial of endotracheal intubation by basic EMTs. Ann Emerg Med 1998;31(2):228–33.

Schwamm LH, Pancioli A, Acker JE, Goldstein LB, Zorowitz RD, Shephard TJ, et al. Recommendations for the establishment of stroke systems of care: Recommendations from the American Stroke Association's Task Force on the Development of Stroke Systems. Circulation 2005;111(8):1078–91.

Selco S and Ovbiagele B. Intravenous magnesium sulphate does not improve survival or disability outcomes in people with stroke. Evidence-based Healthcare 2004;8(4):227–9.

Sethi D, Kwan I, Kelly AM, Roberts I, Bunn F. Advanced trauma life support training for ambulance crews. Cochrane Database Syst Rev 2001;(2):CD003109.

Spaite, DW. OPALS study: What we've learned about EMS. In: NAEMSP Annual Meeting 2005. Naples, Florida; 2005.

Sporer KA, Firestone J, Isaacs SM. Out-of-hospital treatment of opioid overdoses in an urban setting. Acad Emerg Med 1996;3(7):660–7.

Stanton K, Alam HB, Rhee P, Llorente O, Kirkpatrick J, Koustova E. Human polymorphonuclear cell death after exposure to resuscitation fluids in vitro: Apoptosis versus necrosis. J Trauma 2003;54(6):1065–76.

Steg PG, Bonnefoy E, Chabaud S, Lapostolle F, Dubien PY, Cristofini P, et al. Impact of time to treatment on mortality after prehospital fibrinolysis or primary angioplasty: Data from the CAPTIM randomized clinical trial. Circulation 2003;108(23):2851–6.

Stiell, IG. Trials and tribulations of conducting the world's largest prehospital study: The OPALS trial. In: NAEMSP 2004 Annual Meeting, Tucson, Arizona. Available at: http://www.naemsp.org (accessed on March 20, 2005).

Stiell IG, Wells GA, Field B, Spaite DW, Nesbitt LP, De Maio VJ, et al. Advanced cardiac life support in out-of-hospital cardiac arrest. N Engl J Med 2004;351(7):647–56.

Stiell IG, Nesbitt L, Wells GA, Beaudoin T, Spaite DW, Brisson D, et al. Multicenter controlled clinical trial to evaluate the impact of advanced life support on out-of–hospital chest pain patients. Acad Emerg Med 2003a;10(5):501–2.

Stiell IG, Nichol G, Wells G, De Maio V, Nesbitt L, Blackburn J, Spaite D. Health-related quality of life is better for cardiac arrest survivors who received citizen cardiopulmonary resuscitation. Circulation 2003b;108(16):1939–44.

Stiell IG, Wells G, Spaite D, Nichol G, Nesbitt L, De Maio V, et al. Multicenter controlled clinical trial to evaluate the impact of advanced life support on out-of-hospital respiratory distress patients. Acad Emerg Med 2002;9(5):357.

Stiell IG, Wells GA, De Maio VJ, Spaite DW, Field BJ, Munkley DP, et al. Modifiable factors associated with improved cardiac arrest survival in a multicenter basic life support/defibrillation system: OPALS study phase I results. Ontario Prehospital Advanced Life Support. Ann Emerg Med 1999a;33(1):44–50.

Stiell IG, Wells GA, Field BJ, Spaite DW, De Maio VJ, Ward R, et al. Improved out-of-hospital cardiac arrest survival through the inexpensive optimization of an existing defibrillation program: OPALS study phase II. Ontario Prehospital Advanced Life Support. JAMA 1999b;281(13):1175–81.

Stiell IG, Wells GA, Spaite DW, Nichol G, O'Brien B, Munkley DP, et al. The Ontario Prehospital Advanced Life Support (OPALS) study, Part II: Rationale and methodology for

trauma and respiratory distress patients. OPALS study group. Ann Emerg Med 1999c;34 (2):256–62.

Stiell IG, Wells GA, Spaite DW, Lyver MB, Munkley DP, Field BJ, et al. The Ontario Prehospital Advanced Life Support (OPALS) study: Rationale and methodology for cardiac arrest patients. Ann Emerg Med 1998;32(2):180–90.

Stiell IG, Wells GA, Hebert PC, Laupacis A, Weitzman BN. Association of drug therapy with survival in cardiac arrest: Limited role of advanced cardiac life support drugs. Acad Emerg Med 1995;2(4):264–73.

Stratton SJ, Rogers C, Green K. Sudden death in individuals in hobble restraints during paramedic transport. Ann Emerg Med 1995;25(5):710–2.

Sunde K, Wik L, Steen PA. Quality of mechanical, manual standard and active compression-decompression CPR on the arrest site and during transport in a manikin model. Resuscitation 1997;34(3):235–42.

Symons P and Shuster M. International EMS systems: Canada. Resuscitation 2004;63(2):119–22.

Thomas H. Chemical restraint in the emergency department. Topics Emerg 1992;14:79-86.

Thomas H, Schwartz E, Petrilli R. Droperidol versus haloperidol for chemical restraint of agitated and combative patients. Ann Emerg Med 1992;21(4):407–13.

Thompson RG, Hallstrom AP, Cobb LA. Bystander-initiated cardiopulmonary resuscitation in the management of ventricular fibrillation. Ann Intern Med 1979;90(5):737–40.

Trunkey DD. Trauma. Accidental and intentional injuries account for more years of life lost in the U.S. than cancer and heart disease. Among the prescribed remedies are improved preventive efforts, speedier surgery and further research. Sci Am 1983;249(2):28–35.

Urgences-santé. Évaluation des soins préhospitaliers avancées durant la période de formation du personnel à Urgences-santé: Rapport final. Sainte-Thérèse, Québec: Corporation d'Urgences-santé; 2004.

Urgences-santé, Leibovici T, Boucher M, Desrosiers C. Rapport d'analyse des données recueillies du 23 juin au 19 décembre 2003. Sainte-Thérèse, QC: Urgences-santé; 2003.

Vaillancourt C and Stiell IG. Cardiac arrest care and emergency medical services in Canada. Can J Cardiol 2004;20(11):1081–90.

Valenzuela TD, Roe DJ, Nichol G, Clark LL, Spaite DW, Hardman RG. Outcomes of rapid defibrillation by security officers after cardiac arrest in casinos. N Engl J Med 2000;343(17):1206–9.

Valenzuela TD, Roe DJ, Cretin S, Spaite DW, Larsen MP. Estimating effectiveness of cardiac arrest interventions: A logistic regression survival model. Circulation 1997;96(10):3308–13.

Van de Werf F, Gore J, Avezum A, Gulba D, Goodman S, Budaj A, et al. Access to catherization facilities in patients admitted with acute coronary syndrome: Multinational registry study. BMJ 2005;330(7489):441–6.

Van Walraven C, Stiell IG, Wells GA, Hebert PC, Vandemheen K. Do advanced cardiac life support drugs increase resuscitation rates from in-hospital cardiac arrest? The OTAC Study Group. Ann Emerg Med 1998;32(5):544–53.

Vilke GM, Sloane C, Smith AM, Chan TC. Assessment for deaths in out-of-hospital heroin overdose patients treated with naloxone who refuse transport. Acad Emerg Med 2003;10 (8):8936.

Vogel DC, Kim J, Guimond G, Hostler DP, Wang HE, Menegazzi JJ. A randomized controlled comparison of cardiopulmonary resuscitation performed on the floor and on a moving ambulance stretcher. Prehosp Emerg Care 2005;9(1):105–6.

Wang HE, Hostler D, Min A, Callaway CW. Differential effects of prehospital interventions on short and long term survival after cardiac arrest. Prehosp Emerg Care 2005;9(1):105.

Wang HE, O'Connor RE, Megargel RE, Schnyder ME, Morrison DM, Barnes TA, Fitzkee A. The use of diltiazem for treating rapid atrial fibrillation in the out-of-hospital setting. Ann Emerg Med 2001;37(1):38–45.

Wanger K, Brough L, Macmillan I, Goulding J, MacPhail I, Christenson JM. Intravenous vs subcutaneous naloxone for out-of-hospital management of presumed opioid overdose. Acad Emerg Med 1998;5(4):293–9.

Wardlaw JM, del Zoppo G, Yamaguchi T. Thrombolysis for acute ischaemic stroke. Cochrane Database Syst Rev 2000;(2):CD000213.

Weaver WD, Cerqueira M, Hallstrom AP, Litwin PE, Martin JS, Kudenchuk PJ, Eisenberg M. Prehospital-initiated vs hospital-initiated thrombolytic therapy. The Myocardial Infarction Triage and Intervention Trial. JAMA 1993;270(10):1211–6.

Weaver WD, Eisenberg MS, Martin JS, Litwin PE, Shaeffer SM, Ho MT, et al. Myocardial Infarction Triage and Intervention Project—Phase I: Patient characteristics and feasibility of prehospital initiation of thrombolytic therapy. J Am Coll Cardiol 1990;15(5):925–31.

Weaver WD, Hill D, Fahrenbruch CE, Copass MK, Martin JS, Cobb LA, Hallstrom AP. Use of the automatic external defibrillator in the management of out-of-hospital cardiac arrest. N Engl J Med 1988;319(11):661–6.

Weaver WD, Cobb LA, Hallstrom AP, Copass MK, Ray R, Emery M, Fahrenbruch C. Considerations for improving survival from out-of-hospital cardiac arrest. Ann Emerg Med 1986;15(10):1181–6.

Wenzel V, Krismer AC, Arntz HR, Sitter H, Stadlbauer KH, Lindner KH. A comparison of vasopressin and epinephrine for out-of-hospital cardiopulmonary resuscitation. N Engl J Med 2004;350(2):105–13.

Wik L, Hansen TB, Fylling F, Steen T, Vaagenes P, Auestad BH, Steen PA. Delaying defibrillation to give basic cardiopulmonary resuscitation to patients with out-of-hospital ventricular fibrillation: A randomized trial. JAMA 2003;289(11):1389–95.

Wilson JE Pendleton JM. Oligoanalgesia in the emergency department. Am J Emerg Med 1989;7(6):620–3.

Woollard M, Jones T, Pitt K, Vetter N. Hitting them where it hurts? Low dose nalbuphine therapy. Emerg Med J 2002;19(6):565–70.

Agence d'évaluation des technologies et des modes d'intervention en santé

Québec