

**Annotated Bibliography of Critical Care Transport Safety Literature**  
**Russell D. MacDonald, MD MPH FRCPC<sup>1,2</sup>**  
**Jeffrey Singh, MD MSc FRCPC<sup>1,3</sup>**

<sup>1</sup>Research and Development, Orange Transport Medicine, Mississauga, Ontario, Canada

<sup>2</sup>Division of Emergency Medicine, Faculty of Medicine, University of Toronto, Toronto, Ontario, Canada

<sup>3</sup>Interdisciplinary Department of Critical Care Medicine, University of Toronto, Toronto, Ontario, Canada

Introduction and Scope of Work

The 1999 Institute of Medicine report "To Err is Human" emphasizes the need for increased attention to patient safety in healthcare. The report identified the emergency department as the most error-prone environment within the hospital. The report, however, does not discuss the emergency medical services (EMS) or air medical transport. In many cases, air medical transport systems provide the same advanced care to patients as an emergency department, but do so in a less well-controlled environment with no immediately available medical backup. There exists a knowledge gap regarding the lack of information on safety, errors, and adverse events in EMS and the need for research in this setting.

Safety in medical transport systems is inherently more complex because it combines the domains of the transport setting and patient safety. Loss of EMS aircraft are often high-profile, but adverse events in air medical transport, however, can be related to either delivery of patient care or aircraft operation, or the interaction between these two factors. From the patient's perspective, the delivery of patient care is more likely to result in mortality and morbidity when compared to an aviation incident.

To mitigate risk, delineate root causes, and improve patient safety in the transport medicine setting, it is necessary to understand the relevant medical and non-medical literature related to transport safety. This document contains a thorough and extensive review of the literature and provides an annotated bibliography that will serve as a key resource and reference repository for The Association of Air Medical Services, The MedEvac Foundation International, and its stakeholders.

Materials and Methods

We conducted a systematic review of the literature to identify pertinent issues in transport safety in the following domains: 1) ground critical care ambulance transport; 2) helicopter medical transport; 3) fixed wing medical transport; 4) human factor errors associated with medical transport; 5) medical errors and complications associated with medical transport; and 6) safety culture and safety management systems. An additional category, namely occupational health and safety, was included post-hoc because it provided a suitable descriptor to categorize some of the literature reviewed in this bibliography.

*Sources of literature and search methods*

Using established search methods (1), the Medline, EMBASE, CINAHL, and Cochrane Systematic Review databases, we searched all articles published between January 1, 1999

and June 30, 2009 to identify articles meeting our search strategies. The search strategies for the databases were designed in conjunction with and carried out by academic medical reference librarians skilled in information retrieval from the health care literature. We also carried out a manual search of reference lists and bibliographies of the identified materials to ensure we capture all relevant materials. We included materials published in languages other than English if a suitable translation is available or it could be interpreted by personal or industry contacts.

#### *Selection of literature for review*

Two investigators independently reviewed the titles for all retrieved material. If the title addresses one or more of the domains outlined above, the abstract was then be reviewed. The investigators reviewed full-text articles only for those materials where an abstract addressed a domain. Only those full-text articles identified by both investigators as meeting a domain were included in the final annotated bibliography. A blinded third-party with the requisite knowledge and experience in transport medicine will arbitrate in the event of non-agreement on a particular article between the two investigators. We present the inter-reviewer agreement for each step in the review process using the kappa ( $\kappa$ ) statistic.

Abstracts, letters, and comments that do not include original or new material will be excluded from the review process, as will any material with non-human subjects.

#### *Abstraction of data for annotation*

Two investigators independently abstracted the following information from each selected article meeting search criteria: domain, study design, service description, population examined, intervention and comparison (control) group, results, conclusions.

#### Results

The literature search strategies, including manual searches described in the methodology, yielded 13412 titles for initial review. Of these, there were 6600 duplicates. Removal of duplicates resulted in a total of 6812 unique titles for review. Of the 6812 titles identified as meeting one of more domains for this bibliography, the investigators agreed that 849 met criteria for abstract review. The measure of agreement between two independent reviewers was 0.80 (95% CI 0.78-0.82) for this step.

Investigator review of the abstracts identified 258 to undergo full-text review. The measure of agreement between two independent reviewers was 0.78 (95% CI 0.72-0.84) for this step. Of these, 167 met inclusion criteria for this review and were included in the final bibliography. The measure of agreement between two independent reviewers was 0.88 (95% CI 0.82-0.94) for this step.

Figure 1 is a comprehensive spreadsheet that includes all pertinent results from this review.

#### Limitations

The methodology used to conduct this systematic review is comprehensive and an accepted method to retrieve pertinent published materials. However, the investigators will not consider foreign language materials for which there is no English translation or

the material cannot be translated by a colleague or industry contact. This may limit inclusion of potentially relevant non-English material.

This study excludes abstracts of potentially relevant material that has not yet been published in full manuscript form. The investigators could review abstracts and programs from pertinent scientific meetings, assemblies, and symposia, identify relevant material, and contact the principle authors. However, including material that has not been subjected to the rigorous peer-review process required for publication of a full manuscript may include material later found to be less rigorously proven.