RURAL PATIENT TRANSPORT AND TRANSFER: FINDINGS FROM A REALIST REVIEW

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An Applied Policy Research Unit Review

Commissioned by the Rural and Remote Division of Family Practice

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Executive Summary

Overview

The transport of high acuity rural patients poses unique challenges to health planners in British Columbia. The province is characterized by varying topography and seasonal variations across diverse climatic zones. These elements result in challenging travel conditions by land, air, and sea. Many rural and remote communities therefore have difficulty accessing health care and emergency transport. This review consolidates international peer-reviewed literature on best practices for the transport of complex and acute rural patients, within the context of a jurisdictional review on how models have been implemented in jurisdictions comparable to BC.

A focus on rural transport in BC is timely. In 2015, a series of strategic directives were expressed in the Cross Sector Policy Discussion Papers issued by British Columbia's Ministry of Health, and specifically concentrated on BC Emergency Health Services (BCEHS)

> *… to ensure air ambulance resources and critical care paramedics are optimally located and deployed to deliver timely, quality patient care.* (Ministry of Health 2015, p. 27)

The Cross Sector Policy Discussion Papers also advise an expanded role for paramedics in community and hospital settings in order to bridge the low-incidence gap that creates inefficiencies when staffing only for emergency or interfacility transports in rural settings. These policy directives give rise to the need for a rigorous evidence base to inform practice.

This report, commissioned by the Rural and Remote Division of Family Practice[1] sets out to answer the question:

> *What are the best practice models for transferring medically complex rural patients to secondary/tertiary care?*

The capacity of rural hospitals, care teams, triage, and transport systems are health service challenges common across international jurisdictions. Nevertheless, an understanding of the local context is essential for effective policy development. This report aims to bridge international learning with the local context to provide an evidence-based road map for developing best practices for the care of medically complex patients in rural BC.

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1 The literature review was partially supported using unspent funds from a previous study of the High Acuity Response Team (HART)

A distinction is often made between initial emergency care and stabilization on one hand and definitive medical care on the other. Initial *emergency care* and *stabilization* are usually considered the domain of mobile EMS, the lower levels of the health care system (for example, clinics and smaller hospitals), and the emergency departments of any fixed facility. *Definitive care* is usually considered the domain of the hospital and of larger facilities, and implies the resolution of the condition needing treatment. However, the distinction is somewhat arbitrary; a more accurate approach is to view care as a continuum. Many of the elements of early care delivered in the course of emergency treatment, whether in the field or in fixed facilities, can be considered "definitive." For this reason, this report uses the phrase *secondary/tertiary care* instead of the more common *definitive care*.

Methods and Approach

This review uses a realist approach to identify "what works, for whom, in what circumstances, in what respects and how." This approach is intended to generate a detailed, practical, and sophisticated understanding of the contextual complexity that is needed when making policy and programming decisions (Pawson et al. 2005). A two-pronged search strategy was applied to respond to the research question, including (1) a review of the academic literature yielding 151 articles that met inclusion criteria and (2) a broad "grey literature" review of emergency transport systems across Canada and international jurisdictions of comparable circumstances. Key points from the jurisdictional review and the peer-reviewed academic literature are summarized below.

Jurisdictional Findings

The jurisdictional review yielded descriptions of models based loosely on either the "Anglo-American" or the "Franco-German" model of Emergency Medical Services (EMS) (Al-Shaqsi 2010). Although the models historically have been presented in a dichotomous way, in fact most contemporary EMS integrates aspects of each in their delivery of services. This review primarily refers to the attributes of each model. That is, one end of the continuum of emergency care options focuses on immediate patient retrieval for care at a higher-resourced location, while the other end emphasizes pre-hospital stabilization and early treatment on site. In practice, emergency transport systems draw upon elements of these and other models to suit local circumstances. Unique EMS combinations that have developed in discrete jurisdictions are detailed along with the applicability to the Canadian context.

Academic Search Findings

This review focuses on best *system* practices. The authors strategically organized data under the following headings, key points, and best practices:

Evidence Regarding Timing to Secondary Referral or Tertiary Care

- Survival benefit from helicopter transport has not been consistently supported by evidence for rural trauma patients at any level of trauma severity (Butler, Anwar and Willet 2010; Mann et al. 2002; McVey et al. 2010; Mitchell, Tallon and Sealy 2007; Ringburg et al. 2009; Rose et al. 2012; Shepherd et al. 2008).

- Systematic reviews suggest that the observed mortality improvements from helicopter use found in many case studies is actually a confound for better organized, coordinated, and prepared Emergency Medical Services (EMS) systems (Butler, Anwar and Willett 2010).

- Studies of time intervals show ground transport can be faster in some rural environments (Belway et al. 2008; Carr et al. 2006; Shepherd et al. 2008).

- Case studies indicate that guided quality improvement interventions can dramatically reduce both Helicopter Emergency Medical Services (HEMS) dispatch time and arrival time to secondary/tertiary care, by coordinating efforts to attend to improved pre-hospital triage and receiving centre arrival procedures (Aguirre et al. 2008; Blankenship et al. 2007; Pitta et al. 2010).

- Where HEMS suffers logistical challenges and is used as a backup to Advanced Life Support (ALS) qualified ground transport, the cost-benefit appears to be poor (Kurola et al. 2002).

- Contextual indicators for helicopter use include retrieval trips greater than 100 km (Shepherd et al. 2008), pre-hospital retrieval where ground transport cannot reach the patient (Artuso 2012), and privatized medical systems in which private health/hospital companies strive to expand the range of their services (Taylor et al. 2010).

Direct transport from the scene to specialist centres is found to reduce time to secondary/tertiary care for those rural patients who require specialist centres (Gleeson and Duckett 2005; Hill, Fowler and Nathens 2011; Pickering et al. 2015). However, this care must be interpreted from within a rural framework that recognizes that such care in critical patients may be achieved at the rural site, depending on the presenting condition, geography, and current weather. Rural hospitals must be brought into the triage conversation. In addition, transport and transfer services must be integrated into a single system.

- There is limited population data pointing to increased risk of mortality for those patients first taken to a local/rural hospital prior to transfer to a specialist centre (Garwe et al. 2011; Haas et al. 2012). Nevertheless, most data, including pooled analyses from systematic reviews, show no difference in outcomes based on transfer status (e.g. secondary/tertiary care at local hospital or after transfer to larger centre) (Hill, Fowler and Nathens 2011; Pickering et al. 2015).

- Levers for reducing mortality in rural areas may include improving networks of communication between primary and secondary/tertiary sites, using transfer guidelines, and supporting high quality networks of care

Evidence Regarding Equipment and Technology

- Medical equipment should be standardized across all phases of the medical transfer system, including the sending hospital, transport/transfer/EMS equipment, and the accepting hospital (Barratt 2012). Standardization would improve continuity of care and equipment familiarity.

- Where inappropriate or impossible to use the same equipment in rural and urban environments, equipment and technology should nevertheless be compatible throughout the transfer system (Barratt 2012).

- Telehealth systems have the capability of reducing inter-hospital transfer by improving interactive consultation to manage high complexity patients in rural hospitals (Duchesne et al. 2008).

- Telehealth has the potential to expand the capacities of lesser-resourced rural EMS systems in the event of high complexity cases (Charash et al. 2011; Giller 2009).

- Equipment needs for rural pre-hospital environments should be evaluated independently from equipment suitable for urban pre-hospital environments (Artuso 2012; Droogh et al. 2015).

Evidence Regarding Health Human Resources

- Early emergency interventions have the most patient impact in rural areas where transport times are longest and rural facilities are often poorly resourced.

- Specialist/advanced transport teams bring skills, equipment, and experience that may not be available in some rural hospital and clinic settings (Brayman et al. 2012).

- Specialist transport teams show patient benefit for inter-hospital transfer, including fewer iatrogenic incidents in-transit and better outcomes at the receiving hospital (Bellingan et al. 2000; Droogh et al. 2015).

Evidence Regarding Dispatch and Communication

- Single-call dispatch within a formalized network of patient transfer is necessary to support transfer efficiency toward better rural patient health and provider satisfaction (Aguirre et al. 2008; Ahl and Wold 2009; Newton and Fralic 2015).

- Required consultation with busy accepting facility specialists slows down transfer efforts and demands considerable time during high-stress events; evidence is needed regarding the efficacy of required consultations in regards to improved patient outcomes.

Responsibility for patient transfer decisions should result from collaborative processes between the on-site provider, receiving physician and transport physician. The transport physician should have a good understanding of the rural context. To support this activity, transport physicians require the operational capacity and authority to triage and organize multiple patient transfer requests that may occur at the same time. (e.g. BC Emergency Health Service Emergency Physician Online Service; Alberta's Shock Trauma Air Rescue Society Online Medical Control). If the local physician is not escorting the patient, direct oversight for clinical care provided *during the transport phase* lies with the transport physician.

Evidence Regarding Governance

- Patients have a preference to recover from illness or trauma in their home communities (Johnson 1999).

- Networks of transfer with integrated local network-level oversight improve quality of care, trust, teamwork, and decision making in collaboration with local providers (Droogh et al. 2015; Feazel et al. 2015; Helling, Davit and Edwards 2010; Hill and Harris 2008).

- Patients should be maintained in their local hospitals whenever possible for clinical, logistical, and socio-economic reasons (Droogh et al. 2015; Duchesne et al. 2008; Feazel et al. 2015; Sharpe et al. 2012).

- Data sharing is needed between sites and phases of care; transparency of data on transport outcomes and administrative data on transport system features will enable more thorough quality improvement efforts (Feazel et al. 2015; O'Meara 2005).

Conclusion and Recommendations

The recommendations arising out of the review of best practices in international models of transport for complex rural patients are proposed through a *rural-centric lens*. That is, suggestions for an evidence-based reorganization of the system are made around the needs of rural patients and by recognizing the essential role of rural providers. At a planning level, this requires the involvement of rural communities (patients, providers, and other key stakeholders) in discussions of restructuring patient transport in BC, recognizing the primacy of experience "at the coal-face." This involves system-level recommendations grounded in recognizing the crucial role of rural providers in providing critical care and in transport decision making. A further series of recommendations are made on supporting the capacity of rural sites and operational recommendations to facilitate system-wide communication. The final recommendations, based on best evidence reported in the literature, involve optimizing time to both critical interventions and secondary/tertiary care, appropriate health human resource skill levels for transports, recommendations supporting best practice use of equipment and technology, best dispatch practices and health human resource models. All of the recommendations are underscored by the need for a rurally-sensitive, system-wide, and transparent population-based quality improvement framework.

Glossary

Definitive vs. Secondary/Tertiary Care: "Definitive care" is commonly understood to refer to the advanced medical treatment a patient receives from specialists at hospitals and larger facilities, which results in the resolution of the condition. However, the term can have misleading connotations for rural patients, because such care often includes early life-saving interventions. Many of the elements of early care delivered in the course of emergency treatment, whether in the field or in fixed facilities, can be considered "definitive" in the sense of restoring immediate health. The alternative phrase "secondary/tertiary care" acknowledges that medical treatment occurs on a continuum; life-saving medical care is often the culmination of a series of efforts at resolving the condition needing treatment, and may not always require advanced facilities.

Inclusive / Exclusive Trauma System: American terms that roughly equate to regionalization. The premise of an exclusive system is that single trauma centres function independently, are served by private EMS companies, and must be asked for help on a necessarily ad hoc basis by other hospitals. An inclusive system allows inter-site protocols for triage and transfer as well as regional oversight and coordination. These terms are country-specific and not used in this report.

Regionalization: Regionalized care is a norm in emergency services in Canada and involves higher-resourced centres taking on higher-complexity cases. Where specific cases exceed the capacities of the local hospital – whether for lack of specialized equipment, specialist/subspecialist physicians, or other reasons – that patient can be moved to the higher-resourced facility. In essence, the population is cared for by the whole of the health care system.

Network [of care]: This is very similar to regionalization and inclusive trauma systems defined above. However, a specific network of care implies closeness among providers and staff between sites, as well as managerial oversight for a sub-regional component of the system. While regionalization focuses on balancing patient rights to care with efficient management of resources, networks of care are formal agreements to share protocols, training, mutual support, and ultimately patient responsibility by the hospitals and providers themselves.

Trauma Centre: A hospital that can treat major traumatic injuries. In the United States, Level I, II, III, and IV trauma centres represent different ranks of preparedness to manage various degrees of injury. This includes immediate availability of staff and services related to trauma at all times, and Emergency Department (ED) physicians with course certifications such as Advanced Trauma Life Support (ATLS). In all jurisdictions, those EDs with the planned capacity to provide care for the most severely injured and ill are called tertiary (or even quaternary) hospitals or Level I trauma centres.

Levels of Evidence: Typically used in systematic reviews with a positivist paradigm, levels of evidence correspond to the likelihood of subjective human bias present in the research design. There are many ways of reporting this ranked degree of evidence. In a typical I-VII scale, levels I-III are controlled trials with various rates of experimental/quasi-experimental designs, and level VII is opinion or expert commentary. In this report, the ranking system (where mentioned at all) borrows from the Canadian Task Force on the Periodic Health

Examination, which defined four levels: I – Evidence from at least one controlled trial; II1 – Evidence from at least one well designed cohort or case-control study; II2 – Comparisons between times and places with/without the intervention; III – Opinions of experts.

Pre-hospital / Inter-hospital: In idealized terms, "pre-hospital" refers to the period before patient arrival at the hospital for initial triage and care, while "inter-hospital" care is a distinct phase during which a patient is in transit between facilities. In reality, the clarity of these phases can be challenged by pre-/inter-hospital staff mix, EMS intercepts/rendezvous, auto-launch policies, and more. For the purposes of this review, pre-hospital care is the care received prior to arrival at any hospital facility, and inter-hospital care is care received during patient transfer from one hospital to another.

ISS: The Injury Severity Scale (ISS) is a derived scale from the Abbreviated Injury Scale (AIS) and is used for patients with multiple injuries or injuries to multiple parts of the body. Each injury is assigned an AIS score (1 to 6 where 6 is unsurvivable) and is allocated to a body part. The three most severe scores are squared and added together to create an ISS score, ranging from 0-75.

TRISS: The Trauma Score and Injury Severity Scale (TRISS) is a derived survival likelihood score that uses ISS as an input. TRISS was a major advance in trauma and emergency services literature. Starting with pooled data from 1982-1987 for the Major Trauma Outcomes Study (1990), TRISS combines data sharing across countries, health systems, and institutions to create a repository of trauma outcomes for research comparison.

Context and Background in British Columbia

The transport of high acuity rural patients poses unique challenges to health planners in British Columbia. The province is characterized by changing topography and seasonal variations across diverse climatic zones. These elements result in challenging travel conditions by land, air, and sea. Many rural and remote communities therefore have difficulty accessing health care and emergency transport. This is not a new problem; nor is it restricted to BC. Canadian and international jurisdictions including the United States, Australia, and Northern Europe must also contend with sparsely settled populations across diverse geographies affected by seasonal inclement weather. Local circumstances, however, give rise to the unique role of historical precedent and contemporary influence on emergency transport. In British Columbia this includes the system-wide challenges of physician recruitment and retention in rural and remote communities, the extensive closure of small primary care led surgical services, and the attendant withdrawal of maternity care. These factors all coincide with the move to a regionalized system of health care. By its very nature, regionalization has concentrated care into regional hubs to achieve higher procedural volume for assumed efficiencies. This makes travel for patients from the smaller sites inevitable and a robust transport system critical. British Columbia also contends with the legacy of the provincial transport system governed by BC Emergency Health Services (BCEHS). The BC Ambulance Services (BCAS) is the operational arm of BCEHS responsible for pre-hospital (911) and inter hospital transfers throughout the province. BCAS deploys a mix of air and ground resources to achieve its mandate.

Similar to other ambulance systems, there is a "rural-urban divide" in BC that plays out through the metropolitan concentration of both decision making and resource allocation. In BC, paramedics with the most advanced training are located in urban settings with the shortest transport time to secondary/tertiary care, whereas those with the most basic training are often tasked with the longest travel times. In addition, urban communities are resourced with full time paramedics while many rural ambulance stations are staffed by "on-call" personnel. The latter scenario has contributed to challenges with paramedic recruitment and retention in rural BC and has provided the rationale for the province's introduction of the Community Paramedicine program.[2]

When considered as a whole, the above contextual factors (i.e. regionalization of health services, challenging geography, and dichotomy of resources along rural-urban lines) have contributed to a gap in the clinical resources required to safely and effectively transfer medically complex patients over long distances to secondary/tertiary care. Not surprisingly, these phenomena have overextended rural healthcare resources (facilities and ambulance services). It is not uncommon for a local physician or nurse to end up assisting in the transport of patients receiving or likely to need advanced care. This results in more timely movement of critically ill patients but removes key resources from the local community for the duration of the transport and return trip. Although there are clear challenges to maintaining highly skilled personnel in areas likely to have a lower frequency of need for their advanced skills, there exists the potential to engage with rural sites to create a flexible approach to emergency transport to meet the needs of distinct regions and communities.

Several specialized transport program initiatives have been introduced in BC to support rural healthcare (e.g. BCAS Critical Care Paramedic program and the Interior Health Authority's High Acuity Response Team) whereas other Health Authorities continue to rely on nurse-physician assisted transports. While it is recognized that these

initiatives have helped improve access to services for rural citizens, the challenge remains that there is variability in approach depending on the patient's location in rural BC.

The need for a rurally responsive system was clearly identified by Wilkinson and Bluman (et al. 2015) in their *Rural Emergency Medical Needs Assessment* report. Based on in-depth focus groups with rural physicians, they identified a gap in understanding between the system-level planning and the realities of skills, knowledge, and abilities of rural physicians. This gap has led to the systematic exclusion of rural physicians in planning for and carrying out patient transports. Yet as on-the-ground practitioners, rural physicians have the in-depth knowledge of the relevant patient, geographical, and local health resource circumstances. This critical information includes the social supports and constraints that could affect a given patient's outcomes if transferred to another community; variable road and climatic conditions that distant dispatchers are unaware of; and the time-sensitive availability of local ambulance crews.

All of these issues have contributed to strained relationships between local care providers and the organizations (Regional Health Authorities and BCAS). Rural health care providers feel frustrated with the clinical gap in transport care provision and in particular, with the protracted and often difficult process(es) required to arrange transfer of patients.

These issues have been consolidated through the strategic directives expressed in the Cross Sector Policy Discussion Papers (2015) issued by British Columbia's Ministry of Health, and specifically concentrated on BC Emergency Health Services (BCEHS)

> *… to ensure air ambulance resources and critical care paramedics are optimally located and deployed to deliver timely, quality patient care.* (Ministry of Health 2015, p. 27)

The Cross Sector Policy Discussion Papers also advise an expanded role for paramedics in community and hospital settings in order to bridge the low-incidence gap that creates inefficiencies when staffing only for emergency or interfacility transports in rural settings. These policy directives are a productive and welcome addition to an area of health care that has been under-appreciated and lacking attention.

A robust model of rural generalism underscores optimal population health, and such systems rely on the triage and transport of those who need secondary/tertiary care. Designing a system for meeting the health care needs of rural populations can also involve further supporting local care to make transport less likely, such as developing the interprofessional capacity of health care teams to meet critical care needs in rural settings. Solutions may at times involve assistance from advanced care teams who provide on-site support without transporting the patient, and these care teams may be assisted by telehealth links with regional or tertiary specialists. Solutions may also involve an appreciation for the expanded capacity for communities supporting rural generalist physicians with enhanced surgical (GPESS) and anaesthetic skills. General practitioners with enhanced skills are common throughout BC and Canada. Increased support for GPESS would be beneficial. This demands reframing the model for meeting the emergency acute care needs of rural populations from a default systems position of transport to the next level of care when necessary, to thoughtful consideration of the skill sets available or required to support more care locally. Evidence suggests this latter approach is likely to yield the best patient outcomes.

The drive to re-envision patient transport in BC is in part motivated by a perception of inadequacies in the existing system to meet the health care needs of rural people and communities. The current potential for system improvement has been created through the policy directives set out in the Ministry of Health's *Setting Priorities for the BC Health Care System* (2014), and reinforced through pivotal cross sector discussion papers, namely *Delivering a Patient-Centred, High Performing and Sustainable Health System in BC: A Call to Build Consensus and Take Action* (2015); *Primary and Community Care in BC: A Strategic Policy Framework* (2015); and *Rural Health Services in BC: A Policy Framework to Provide a System of Quality Care* (2015).

It is crucial to base the search for local solutions on existing data relating to system performance, while giving particular attention to how services meet rural needs, and contextualizing that data within the particular environment of rural BC. The key questions to ask of a patient transport system are: "Are we serving the right patients, at the right time, in the right place?" This question strikes at the heart of the issue of integrated and sustainable rural health care. It demands an examination of who is presenting to rural Emergency Departments, whether or not they need to be there, at that time, and if they could have received care in a different setting. Considering the appropriateness of ED admissions sheds light on the availability of local resources, such as family physicians. Understanding transfers allows an evaluation of patterns of care and the effectiveness of health care networks that support triage through the system. Sound answers to these questions rely on open and transparent data from rural hospitals, referral sites and BCEHS. Transparency and sharing of data is essential for effective system planning and continuous quality improvement.

This report's commissioner, the Rural and Remote Division of Family Practice supports rural physicians from a number of communities across British Columbia to be involved in improving health services through collaborative partnerships at local, regional and provincial levels. Patient transport has been identified by its members and other rural physicians as one of the highest priorities relating to rural health services. This priority is reinforced by the Rural Emergency Needs Assessment (2015) produced by the Rural Continuing Professional Development unit in the Faculty of Medicine at the University of British Columbia. Key findings of the needs assessment include the identification of barriers to patient transfer to secondary or tertiary levels of care reported by rural physicians, which are exacerbated by fragmented communication between the rural sites and the BC Patient Transport Network (BCPTN). Similarly, the Health Authorities are responsible for ensuring that their rural citizens have timely access to secondary/tertiary care. It is for this reason that the Interior Health Authority of BC created the High Acuity Response Team (HART). The HART initiative works in conjunction with BCAS to more directly meet complex transport needs over an expansive and sparsely populated geography.

The commissioner identified a priority of the present report to understand the international context and best practices for rural patient transport, in order to contribute to decisions regarding the most appropriate response to rural transport needs. This review was in response to prioritizing the evidence-based needs of both organizations. The guiding question,

> *What are the best practice models for transferring medically complex rural patients to secondary/tertiary care?*

orientates readers towards the existing literature exploring models for rural patient transport, and specifically in models that have been applied to jurisdictions with a health services context similar to that of BC. The present review fills an evidence gap in current policy and planning, and has the potential to inform strategic planning for rural patient transport in BC.

The *capacity* of rural hospitals, care teams, triage, and transport systems is a health service challenge common across international jurisdictions. Nevertheless, an understanding of the local context is essential for effective policy development. This report aims to bridge international learning with the local context to provide an evidence-based road map for developing best practices for the care of medically complex rural patients in British Columbia.

Patient Transport in British Columbia

British Columbia covers an area of 944,735 square kilometres that include mountain ranges, coastlines and water-bound communities. Diverse geography and variable climatic conditions (including heavy rainfall and snow) make travel and emergency transport difficult. Emergency transport services and coordination is provided by BC Emergency Health Services (BCEHS), which oversees the BC Patient Transfer Network (BCPTN), Trauma Services BC, and BC Ambulance Services (BCAS). Taken together, their responsibilities include pre-hospital scene support, emergency 911 response, and interfacility transport. The air ambulance division, in particular, is staffed by Critical Care (CCPs) and Infant Transport Team (ITT) paramedics. These specialized clinicians respond to rural and remote communities by rotary and fixed wing aircraft as climatic conditions and topographical challenges permit. When required, BCEHS have the opportunity to enlist the support of Alberta's Shock Trauma Air Rescue Society (STARS) to support the helicopter transport of patients in eastern BC to the closest tertiary care facility in neighbouring Alberta. BCAS is one of the largest emergency transport systems in North America, with over 3,600 paramedics. In 2014-15, BCAS used 585 vehicles from 183 ambulance stations and 5 aircraft bases. These vehicles travelled nearly 23 million kilometres. [2 3]

System responses to the discrete needs of rural communities have led to the Interior Health Authority initiating the High Acuity Response Team (HART). This is a mobile team of Registered Nurses and Registered Respiratory Therapists who are dispatched to rural sites from adjacent regional centres for interfacility transport and site

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2 BCEHS (British Columbia Emergency Health Services). Ambulance Stations and Facilities [Fact Sheet, Internet]. Vancouver (BC): Provincial Health Services Authority; August 2015b [cited 2016 Oct 17]. Available from: http://www.bcehs.ca/about-site/Documents/factsheets/201508-ambulance-stations-facilities-fact-sheet.pdf

3 BCEHS (British Columbia Emergency Health Services). 2015-2018 BCEHS Strategic Plan [Strategic Plan, Internet]. Victoria (BC): BCEHS; 2015c [cited 2016 Oct 17]. 8 p. Available from: http://www.bcehs.ca/about-site/Documents/2015-2018-strategic-plan.pdf

support. The program addresses the need for complex and high acuity patient escort with resources external to rural communities, while bypassing the potential drain on resources when local medical or nursing staff need to accompany patient transport.

Limitations

The primary limitation of research about emergency transport systems in rural environments is sample size. High acuity events are surrounded by excessive contextual "noise" that limit the value of statistical measurement. Further, high acuity events can involve concurrent emergency systems that do not share a governance or evaluation structure, such as police or Search And Rescue (SAR) volunteers. While the majority of the present research in emergency transport uses quantitative measures of positive outcomes (e.g. survival, ICU days), small samples make generalizability difficult to assess. As well, there is a lack of literature focusing on service improvement (Browning Carmo et al. 2008).

By necessity, much of the research reviewed in this paper is of a retrospective and observational design, often using single-centre audits of data. While these approaches are not in themselves problematic, they represent a "weak" quality of evidence by conventional standards.

From a realist perspective, a primary methodological concern is the artificial construction of a start and end point of care, which is used in observational design to better isolate the variables, cases, or system features of interest. This often means "framing out" both what rural facilities do well – by excluding cases where people are successfully treated at a rural hospital – and the specific challenges of rural medicine, such as longer pre-hospital times.

Droogh (et al. 2015) note that non-standard severity scoring and confounds from efforts at stabilization actually make it impossible to compare transferred patients with non-transferred patients. Meanwhile, adverse events during transport are reported in the literature as between 3% and 75% based on different conceptions of adverse events (Droogh et al. 2015). A standardized way of evaluating the outcomes of transferred and non-transferred patients is required in order to provide clear analysis of the health benefits of that care.

Moreover, much of the existing literature lacks a rural patient lens, potentially giving readers the false impression that rural hospitals are simply waiting areas for more advanced care. Such a framing adds to the concern of rural people that researchers, policy-makers, specialist physicians, and trauma specialists – all of whom are more likely to be urban-based professionals – lack awareness of both the unique challenges of rural health service delivery and the strengths of the generalist model used in rural health care.

A review of this literature also exposes an important and persistent publication bias. That is, case study and case report evidence is almost entirely about the positive aspects of the program in question. Further, those programs that are not meeting their mandate successfully or sustainably do not appear in the literature. This review seeks to compare "best" practice models, and such a comparison would benefit from evidence regarding the problems as well as successes of emergency transport models. However, this bias does not limit the value of the review's findings, as it ultimately hopes to learn from the most successful programs and models. Most importantly for overcoming this bias, the realist approach used in this review includes careful attention to context. A critical approach to where, how, and why programs are successful helps to reduce the impact of the publication bias.

A limitation of this particular review is the exclusion of articles not published in English. This does create a potential bias toward excluding reviews of emergency care models that emphasize pre-hospital stabilization and early treatment on site. The size of this bias (with regard to the number of resources missed) is unknown. At the same time, considerably shorter distances to care and greater density in even rural-designated parts of continental Europe strain the relevance of the literature describing such models to British Columbia. Careful attention has been given to those remaining English language publications that discuss models that emphasize pre-hospital stabilization and early treatment on site, in order to understand its applicability to the Canadian context.

One of the key challenges in reviewing emergency health services literature is the case-level clinical diversity. While many high acuity trauma patients requiring surgery have a clear need for immediate tertiary care, those suffering STEMI events, strokes, less severe trauma, and a myriad of other high acuity events can have less clear clinical indicators and less clear transport needs. When reviewing academic material, these varied illness- and event-specific needs are often conflicting rather than synergizing, and may not be known or stated by the authors.

In a positivist systematic review (where quantified study findings are directly compared), these conflicting contexts can lead to uncertain results (Barratt 2012; Belway et al. 2006; Butler, Anwar and Willett 2010; Droogh et al. 2015; Fan et al. 2005). This realist review is focused on providing value to service planners and health service researchers and decision makers for understanding the complex real world requirements of rural and remote emergency transport services. Therefore, it minimizes the specific statistical benefit of a given system feature, and emphasizes disentangling the service model requirements from clinical indications of appropriate care.

Methods and Approach

Realist Approach

This review uses a realist approach. A realist approach considers the mechanisms of high quality outcomes within their rich context to identify what works, for whom, in what circumstances, in what respects, and how. Traditional efforts at synthesizing research take the form of systematic reviews and meta-analysis. In these approaches, the unit of analysis is the (usually weighted) evidence from each carefully selected study, taken in aggregate with the intention of providing a clear answer to a narrowly defined question. This approach can be highly effective for determining the relative merits of a controlled clinical intervention. However, in health services, the success of an intervention is contingent on a variety of complex factors, both social and structural. A realist approach is intended to generate a detailed, practical and sophisticated understanding of that complexity so it can be considered when making policy and programming decisions (Pawson et al. 2005).

Applying a context-mechanism-outcomes model, the research team, in collaboration with experts from the commissioning bodies, developed a hypothesis of how emergency transport systems best function in rural environments to achieve good outcomes, and then tested that hypothesis using data found in the international literature. Consistent with a realist approach, rather than confirming or not confirming the hypothesis, the model was iteratively amended to provide a rich description of how the system can best meet its objectives (safe, satisfactory, and cost-effective care). Fundamentally, the realist approach requires that the system is contextualized in real world possibilities and vulnerable to influences of change could not have been anticipated.

Context, Mechanism, Outcomes (CMO)

The purpose of a CMO (Context-Mechanism-Outcomes) model is to create a hypothesis regarding how real world, complex phenomena function, with the goal of identifying the mechanisms that lead to desired outcomes, and the contexts to which those mechanisms are best suited. Taken together, this is the program theory of a complex health services intervention (rural patient transport), aimed at providing a nuanced understanding of how a system works to produce good outcomes and how to foster the best possible support for that system in the specific context of British Columbia.

This review hopes to identify *which mechanisms work at what levels of the systems to produce clinically, socially, and culturally safe care for rural and remote patients, their families, and their communities*. This review considers transport models for implementation in British Columbia. As such, it gives greater weight to possible and plausible mechanisms appropriate to the geographical and health services context of BC.

The Context of Rural Patient Transport

The context of rural patient transport includes fiscal, logistical, and efficiency constraints that have led to the centralization of services in high levels of care in dense urban areas. While centralization is appropriate in urban areas, it becomes a service constraint for people from rural and remote areas, because these patients must travel when they need more specialized services for medically complex acute conditions.

Tensions define a system that often relies on ad hoc clinical and logistical decision making to access the most appropriate level of patient care. The cost, difficulty, and political will for maintaining the competence and confidence of rural providers for complex events is in tension with the cost and difficulty of transporting medically complex, often time-sensitive patient presentations to centralized care. The need for highly trained paramedics to deliver care in the rural pre-hospital setting is in tension with the challenges of system cost and provider recruitment and retention in areas with a lower volume of emergency calls. Universal rapid access to higher resourced centres is in tension with the need to support and respect rural hospitals that successfully treat the majority of acute and non-acute events in their community. If all patients were immediately sent to the referral centre, this would create further tensions through ED overcrowding. These debates must take place within a context that recognizes the capacity of small rural hospitals to attend to many urgent health care situations.

This review aims to add clarity to these issues by developing a patient and community-centred model of rural transport and transfer. Rural patients clearly prefer local care whenever possible, and evidence from other areas of care shows improved population outcomes accompanies access to local care. From a patient perspective, there is a strong imperative to find creative solutions to sustaining critical care in the rural pre-hospital environment. This includes maintaining patients in rural hospital sites whenever possible, and bringing the expertise of critical care and transport specialists to the rural patient rather than bringing the patient to the expertise.

A high quality patient-centred rural transport system would integrate transport professionals into hospital operations. It would include a defined system of telehealth, connecting rural hospitals and regional referral centres for both diagnostics/triage and care. Such a system would recognize the continuum of the patient journey from pre-hospital contact through care at secondary/tertiary hospitals. Finally, it would ensure the accurate dispatch of the right resources at the right time, which would improve efficiency at both a system level and outcomes at a patient level.

The continuation of a single-payer, public system of acute transport is vital to maintaining access to care for rural British Columbians. This allows for the centralized, coordinated dispatch of appropriate services with medical oversight that is the hallmark of high quality transport and transfer systems worldwide.

The Mechanisms of Good Outcomes

The expected mechanisms of good outcomes include:

- Efficient, single-call dispatch
- Excellent interfacility and interprofessional communication
- Respect between sites, players, and professions
- Centralized oversight and coordination
- Interprofessional collaboration and team work
- Interprofessional, team, regional and/or network based Continuing Medical Education (CME) and Continuous Quality Improvement (CQI)
- Shared equipment between transport vehicles and hospital sites
- Hospital integration of critical care transport professionals
- Ground transport “backup” even when air transport is indicated
- Dispatch of appropriate levels of expertise for pre-hospital care
- Active collection and transparency of data

- Population-based benchmarks

Outcome Measures

Clinical outcomes in emergency transport studies are primarily focused on mortality, Intensive Care Unit (ICU) days, and length of hospital stay. This is often due to a sourcing bias found in much of the literature, whereby researchers collect data retrospectively from urban referral hospitals. As well, limitations have been noted in standardized records between pre-hospital, rural hospital, and referral hospital professionals, preventing retrospective tracking of patient outcome measures at each stage of care.

Some qualitative research exists regarding the acceptability and suitability of care outside the local community from a patient perspective. It is hoped this data will provide an understanding of the expectations of care for medically complex events among rural people and their families.

Outcomes of interest will include measures of:

- Accurate and efficient referral and transfer to secondary and tertiary care (quickly sending the right people to the care they need)
- Triple Aim markers (patient outcomes, satisfaction with care, and cost efficiency)
- Sustainability of models
- Geographic coverage
- Relative ability to keep patients in rural settings where clinically possible/appropriate
- Applicability to the BC context (where air transport is difficult and ground transport can involve significant distance)

Search Structure and Results

A two-pronged search strategy was applied to respond to the research question: (1) a review of the academic literature and (2) a broad “grey literature” review of emergency transport systems across Canada and comparable international jurisdictions.

Academic Literature Search

The search for academic literature involved several iterative attempts to appropriately balance sensitivity with specificity. Terms related to recreational accidents in rural areas (which appear primarily under the MeSH heading “Wounds and Injuries”), models of care and service delivery, organizational structures, and policy were all explored. As well, a variety of terms related to emergency medical services, trauma, and ambulance vehicles were trialled.

Table 1 (below) reflects a high sensitivity search structure focused around the core concepts of the research question. The combination of terms was as follows: (rural terms) AND (high complexity care terms) AND (transport/transfer terms).

This final search was executed in September 2015 using MEDLINE, PubMed, CINAHL, and EBM Reviews (which includes seven Cochrane libraries). Subsequent additional searches for “rendezvous” or “intercept” literature did not reveal new material.

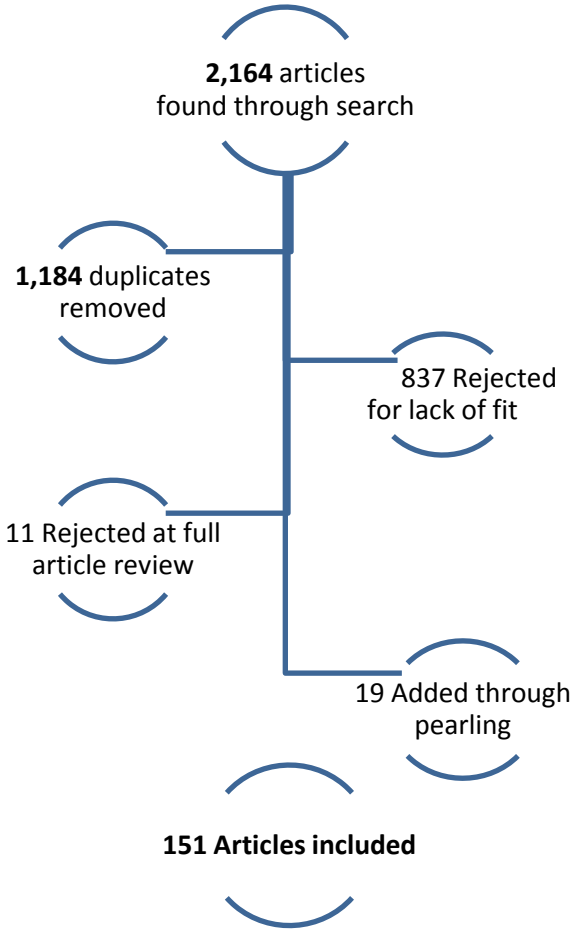
Table 1: Search Terms

Concept	Terms	Reasoning and Commentary
Rural	Keywords: rural remote MeSH: Rural Health services Rural Health Hospitals, Rural	The most sensitive terms were sought and are reflected to the left. "Remote" is a keyword that is also found in non-rural literature (e.g. remote monitoring literature), leading to some unmitigated loss in specificity.
High Complexity Care	Keywords: emergencies critically ill critically injured MeSH: Emergencies Critical Care Critical Illness Critical Care Nursing	Acuity-specific terms were trialled initially but it was found that medical and academic vernacular diverge on this point. Instead, terms were furnished that effectively limit "rural" and "transport" to avoid literature on service planning of rural transport for diagnostic and care for people without such local services.
Transport / Transfer	Keywords: transportation of patients patient transport patient transfer transfer of patients interfacility transport interfacility transfer MeSH: Transportation of Patients (Exp) Patient Transfer	In the study of health services, transportation and transfer are seen as distinct. Moreover, the field of transport/transfer is seen as an independent phase and/or field of medicine. These search terms effectively balance specificity and sensitivity in an attempt to capture data from all parts of this field.

Only articles written in English about developed settings were included. In keeping with the realist review tradition, no exclusions were made based on research design. Evidence from a variety of perspectives and methods yield a richer overall understanding of the system and its levers. As such, this review includes expert opinion, case study data, cohort data (mostly retrospectively designed), and some randomized trials of course of care and systematic reviews. Quality of evidence was considered according to research design rigor and the coherency of the results.

Specific focus on case mix excludes:

- STEMI timing CQI literature
- System efforts at better PCI Centre access
- Case reviews / EMS professional development literature
- Intra-hospital communication literature
- Case mix of EMS transport patients
- Factors in decision making regarding ground or air transport
- Patterns of transport use (e.g. frequency of use of EMS vs. private vehicle)
- System design literature regarding where to have services vs. transport (e.g. ERCP services developed in Northern Ontario, where ERCP was found to be 3x the population average and were previously flown to Manitoba)
- Developing nation literature



Jurisdictional Review

A jurisdictional review of emergency transport services was undertaken to describe models of care and their implementation in varying health systems across different countries and regions. The goal of the review was not to be exhaustive, but to provide a window into the current state of emergency transport models as they have developed in advanced health care systems. The jurisdictional review provided the opportunity for a flexible methodology to be applied to sourcing information, including grey literature review, interviewing key informants from EMS organizations, and mapping global models of EMS by limiting searches to specific countries and regions that provided examples for program implementation in British Columbia.

The jurisdictional review was completed in three iterations. The strategy developed over time as new information emerged and report commissioner provided feedback.

Iteration 1

In the first search iteration, the Canadian jurisdiction was described as well as countries with rural populations and similar health systems to Canada: Australia, Norway, and Scotland. Understanding Canadian emergency transport systems provided insight on how to create a framework of inquiry around what models could reasonably be applied to the healthcare system in BC, and what models could provide opportunities for learning due to contrast. Program evaluations and reports were sought for EMS systems in these countries, two interviews were completed with program leads for the Canadian programs Shock Trauma Air Rescue Society (STARS) and ORNGE (not an acronym), and regional EMS systems were mapped for each country.

Structural program descriptions were searched for on websites of programs that were publicly available. Additional data yielded from websites included annual reports, program evaluations, and clinical guidelines. Two program leads from non-profit models, STARS and ORNGE, were also interviewed as a starting place to understand how the alternative models might integrate with a provincial health system. Interviews focused on logistical and structural descriptions of the interviewees' service, for example, dispatch processes, staffing, and transport vehicle fleet.

Iteration 2

A regional search was performed in the second jurisdictional review iteration. It is important to note that European Union countries operate under a different health system organization. Emergency programs can be run by a municipality, making it untenable to collate a list of programs given the sheer number (i.e., Germany alone has over 300 municipalities). A larger systems view was taken by way of a limited review of academic literature organized by the two EMS models on opposite ends of the spectrum: the "Anglo-American" model that emphasizes immediate patient retrieval for care at a higher-resourced location, and the "Franco-German" model that favours pre-hospital stabilization with early treatment on site. Articles that highlighted the functioning of emergency transport systems within specific countries were reviewed.

Iteration 3

The commissioner reviewed the results from Iteration 2 and requested further information on emergency transport systems that have made attempts to operate under the two models emphasizing either "immediate patient retrieval for care at a higher-resourced location" or "pre-hospital critical intervention and early treatment on site." They specifically requested cases where elements of "early treatment on site" models have been added to "immediate patient retrieval" models in order to broaden the range of emergency response available in a multitude of contexts. The British Association of Immediate Care Schemes (BASICS) was added to the review of STARS and ORNGE in Canada.

Findings

The findings from the jurisdictional review and the peer-reviewed academic literature are presented sequentially below. The jurisdictional review provides a pragmatic description of emergency transport models in settings comparable to British Columbia. The literature often highlights two organizational extremes in transport models, sometimes referred to in the historically relevant yet outdated terms of "Anglo-American" and "Franco-German." In practice, most EMS, emergency transport systems today integrate aspects of each in their delivery of services. Contemporary "hybrid" models may be heuristically represented as existing along a continuum of emergency care options, rather than the clear dichotomy sometimes suggested. One end of the continuum focuses on immediate patient retrieval for care at a higher-resourced location, while the other end emphasizes pre-hospital or local facility critical intervention. As documented in the literature, there are numerous arrangements in between, with unique responses to factors such as timing, dispatch, equipment and technology, human health resources, and governance.

While this review primarily refers to the attributes of each EMS model, the following section briefly describes the "Anglo-American" and "Franco-German" labels that provide the historical backdrop that informs contemporary models of care. It then turns to hybrid models with a focus on Canada.

Jurisdictional Findings

Historically, Emergency Medical Service (EMS) systems developed in relative isolation from one another, often in response to the various strengths and weaknesses of the pre-existing hospital system of a given jurisdiction.[4] Broadly, contrasting service models are identified by shared features. The "Anglo-American" model is sometimes more colloquially described as a "scoop and run"; in rhetorical contrast, the "Franco-German" model has a descriptive moniker of "stay and play" (Al-Shaqsi 2010). Both approaches have the same goal of delivering emergency care for trauma and life-threatening illnesses (Al-Shaqsi 2010), and both models meet the criteria for trauma care services identified by the World Health Organization (Sasser et al. 2005).

Table 2: Features of Anglo-American and Franco-German EMS Models
(reproduced from Al-Shaqsi [2000])

	Anglo-American Model	**Franco-German Model**
Location of patients	Few treated on scene; more transported to hospitals	More treated on scene; few transported to hospitals
Provider of care	Paramedics with medical oversight	Medical doctors supported by paramedics
Main motive	Brings the patient to the hospital	Brings the hospital to the patient

4 See Appendix B for country-specific details on EMS service models.

Destination for transported patients	Direct transport to EDs	Direct transport to hospital wards, i.e.: bypassing EDs
Overarching organization	EMS is part of public safety organization	EMS is part of public health organization

Hybrid Models

Hybrid models are increasingly developing around the world. The UK supports the use of EMS systems in urgent primary and social care to reduce conveyance to overcrowded EDs, based on findings from the Bradley Report (Department of Health 2005), which found that only 10% of patients making an emergency call actually had a life-threatening emergency. The development of new pre-hospital professionals with the capacity to discharge from the scene, deliver basic medications and treatments, and make independent triage decisions were developed in the UK to address the majority of emergency service calls for issues of mental health, older people who had experienced a fall, and patients with a chronic illness that had a sub-acute onset of symptoms.

In Canada, a broad disparity remains between urban and rural EMS service provision. Canada has a variety of funding and service delivery models represented across the country's 13 EMS systems; delivery is not federally administered. The majority of systems are heavily subsidized by provincial, regional, or municipal governments with some cost to the patient. Within these structures, EMS can be either "free standing" and part of public safety agencies, or hospital-based with some privately run services available.

In general, paramedic practitioners deliver EMS in the field in Canada. According to the Paramedic Association of Canada (PAC), paramedic roles can be classified into four categories of progressively advanced skill, or National Occupation Competency Profiles (NOCP): Emergency Medical Responder (EMR), Primary Care Paramedic (PCP), Advanced Care Paramedic (ACP), and a Critical Care Paramedic (CCP).

Urban areas benefit from specialty care hospitals where it is possible to enact bypass protocols, and transport patients to the closest hospital with the most appropriate level or type of care. In rural areas, a patient is typically transported as quickly as possible to the closest hospital and then transported again to the most appropriate level of care based on presenting conditions. Symons and Shuster (2004) emphasize that despite improvements in Canada's EMS system over the past 15 years, the benefits have not been significant outside of urban regions. This need is often obscured by a lack of data-sharing infrastructure across jurisdictions.

A problem inherent in a system like Canada's that transports all EMS patients to Emergency Departments is over-crowding. Symons and Shuster (2004) highlight the cascading effect this issue has on improving the problem: the health care system must pledge resources to processing patients through overcrowded EDs at the expense of resourcing effective responses to emergency calls (CAEP and NENA 2003).

As discussed in the academic search findings to follow, patients injured in a rural setting have greater mortality rates (Bell et al. 2012; Fatovich et al. 2011). Distance to care and remoteness both play a role. At the same time, urban emergency systems are often the best staffed, best equipped, and most highly trained. Rural Canadian EMS systems face the continued challenges of efficiency and effectiveness in managing lower frequency of high acuity events at remote recreation sites, resource-extraction work sites, Aboriginal reserve communities, and isolated island, mountain, and northern communities. We must move towards patient-centred models of care that attend the specific challenges of geography and demography in BC and Canada in general.

Academic Search Findings

Other reviews on patient transport have used multiple clinical headings (Brown et al. 2012) that carefully separate case-specific findings. However, this review focuses on *system* best practices rather than clinical ones. Although this review aims to identify which interventions work for whom under what circumstances, similar levers of effective systems of care appear in the transport of all ill and injured patients. This broader consideration underlies the structure of the findings to follow.

Data was extracted according to the central decision making issues of emergency transport health service planning. The micro-level questions asked of each academic resource included: Where should the patient go? Which mode of transport should be used? Who should accompany the patient? Those are necessarily tied to meso-level questions that concern institutions and organizations, such as who decides, on what basis, and how conflict is resolved between professionals and sites with competing perspectives on optimal patient care. Finally, the macro-level features of the system were also examined, guided by considering the coordination system, the oversight system, and the integration of the transport system in to the general health care system.

Data associated with each question were reframed as headings discussed in each of the following sections:

1. Timing to Secondary/Tertiary Care
2. Equipment and Technology
3. Human Health Resources (HHR) (including credentials, training and scope of practice)
4. Dispatch and Communication
5. Clinical and Administrative Governance

A core finding of this review is the importance of transport system coordination, and it reoccurs throughout each section. This must involve collaboration between clinical guidelines, protocols, training, and dispatch centres with clinical authority. Each of these represents efforts to reduce delays in dispatch, improve communication, manage clinical variation, and create team- and system-based accountability. As such, it is not surprising that those single-payer health systems where transport oversight is integrated into the broader health system have the greatest success at these coordinating efforts. This high level finding is foundational to the literature reviewed.
Many of the specific protocols, guidelines, innovations, and improvements in emergency transport for rural people are covered in the sections to follow.

Timing to Secondary/Tertiary Care

Perhaps the most central feature of the academic literature on EMS transport is that of time to necessary care for optimal patient outcomes. Common medical sense dictates that the time to care in the event of major trauma, infarction, sepsis, and stroke, as well as major burns and some obstetrical complications, can make a substantial difference in both survival and recovery. In each of these cases, the adage, “time is tissue” is often repeated.

While time to necessary care for optimal patient outcomes is important to the purpose, design, and measurement of EMS systems around the world, the academic literature is thoroughly uncertain as to the critical variables of

timing. Debates continue on issues ranging from the mode of transport to decision making. Are air or ground transport vehicles best? What is the appropriate destination for pre-hospital transport? That is, should the nearest hospital be bypassed so a patient accesses more suitable specialist care sooner? Under what conditions, clinical or otherwise, is this appropriate? Who decides? Even pre-hospital, on-scene interventions are debated. Furthermore, as few factors regarding emergency health care can be controlled, there is limited academic evidence that directly ties time to care and mortality or morbidity. The "golden hour" of maximum appropriate time for trauma and emergency care is noted to be largely unsubstantiated (Carr et al. 2006).

Although there is a lack of strong evidence to define the precise clinical impact of time to emergency services, *distance* to services is a known problem for rural patients. This review acknowledges the importance of timely care in the event of high acuity and medically complex injury and illness. However, the well-intentioned efforts of many of the health systems reviewed below to reduce the time from injury to secondary/tertiary care has, in fact, lengthened time to care and/or raised EMS costs without any consequent improvement in care outcomes. In this context of improving patient outcomes while maintaining cost responsibility, best practices for reducing time to necessary care are addressed below.

TRISS-Based Analysis

Many studies in this review seek to determine the effectiveness of a given transport model through an analysis based on the Trauma Score and Injury Severity Scale (TRISS). TRISS analysis offers a particular type of insight, but suffers from validity issues such as reliable consistency among raters.

Some trauma events may have greater TRISS agreement than others. One study found good predictive value in a field-assigned TRISS score for traumatic brain injury (Davis et al. 2006), while another found an inability of the metric to account for multiple traumas to the same body part or those suffering low falls (Cayten et al. 1991). The score has only been validated for non-intubated and non-paralyzed patients, with ad hoc adjustments made to scores for those patients arriving at an ED after pre-hospital intubation (Voskresensky et al. 2009).

Flowers, Sloan and Zoltie (1994) found extreme variations in the recording of injury severity scores between professionals in a small study of 16 patients and 15 observers. Exact score match was observed in 28% of cases, and agreement over severity "bands" was found in just 50% of cases. This included a maximum "expected survival" variation from 0.01% to 90% for some patients. Demetriades (et al. 1998) examined misclassification of TRISS among 5,445 trauma patients in an urban trauma centre, and found the metric was especially inaccurate for those with ISS scores >20 who had suffered falls, multiple traumas, in-hospital complications, or pre-hospital distress (resulting in misclassifcation rates in a quarter to a third of cases). The authors concluded, "[i]n its present form TRISS has no useful role in major urban trauma centres. Its use should be seriously reconsidered, if not abandoned" (Demetriades et al. 1998, p. 379).

While the academic and medical communities continue to work to improve TRISS data accuracy, the most fundamental limitation of severe trauma system case studies – sample size – has not been overcome. While pooled data from across the world has improved the sample size present in the TRISS database, the use of a few to a few hundred observed high-risk cases in most level-II2 (case study) transport literature nevertheless means a low likelihood of repeatable or generalizable results.

Air Transport Or Ground Transport?

Key Points

- Survival benefit from helicopter transport has not been consistently supported for rural trauma patients at any level of trauma severity (Butler, Anwar and Willet 2010; Mann et al. 2002; McVey et al. 2010; Mitchell, Tallon and Sealy 2007; Ringburg et al. 2009; Rose et al. 2012; Shepherd et al. 2008).

- Systematic reviews suggest that the observed mortality improvements from helicopter use found in many case studies is actually a confound for better organized, coordinated and prepared EMS systems (Butler, Anwar and Willett 2010).

- Studies of time-intervals show ground transport can be faster in some rural environments (Belway et al. 2008; Carr et al. 2006; Shepherd et al. 2008).

- Case studies indicate that guided quality improvement interventions can dramatically reduce both Helicopter Emergency Medical Services (HEMS) dispatch time and arrival time to secondary/tertiary care, by coordinating efforts to attend to improved pre-hospital triage and receiving centre arrival procedures (Aguirre et al. 2008; Blankenship et al. 2007; Pitta et al. 2010).

- Where HEMS suffers logistical challenges and is used as a backup to Advanced Life Support (ALS) qualified ground transport, the cost-benefit appears to be poor (Kurola et al. 2002).

- Contextual indicators for helicopter use include retrieval trips greater than 100 km (Shepherd et al. 2008), pre-hospital retrieval where ground transport cannot reach the patient (Artuso 2012), and in privatized medical systems in which private health/hospital companies strive to expand the range of their services (Taylor et al. 2010).

One of the core considerations in the timing of transport to secondary/tertiary care is the mode of transport. This has led to comparison studies of ground versus air vehicles, mainly helicopters. In all cases of transport and transfer, helicopter use must be understood in the context of a given EMS system. In some systems, HEMS is used for the highest acuity patients (Mitchell, Tallon and Sealy 2007; McVey et al. 2010). In others, helicopter transport is used to cover the furthest distances (Shepherd et al. 2008). HEMS is sometimes used to bypass local hospitals and transport directly from the scene to Level I Trauma Centres or other highly resourced hospitals.

Two population-based studies from Nova Scotia compare ground EMS to HEMS. Nova Scotia has a single Level 1 trauma centre that serves over 900,000 people on an island roughly 55,000 square kilometres.

Mitchell, Tallon and Sealy (2007) applied TRISS-based expectations and found improved outcomes for HEMS relative to ground EMS. However, a much higher proportion of ground-based missions were for pre-hospital retrieval, and trauma from falls accounted for the entire difference in services. A follow-up study by McVey (et al. 2010) instead compared those patients transported by HEMS and those who were indicated for HEMS but had to be transported by ground because of aviation restrictions. One of the few quasi-experimental designs in the field, McVey (et al. 2010) found that ground EMS achieved TRISS-based expectations, but HEMS still provided a relative outcomes advantage of 5.61 fewer deaths per 1,000 transports. Similar pre-hospital time for each comparison

group implies few logistical problems. It is important to note that when comparing ground EMS to HEMS, the researchers were also looking at different staffing mixes. Nova Scotia's LifeFlight system uses Critical Care Paramedics, while their ground ambulances use a mixture of volunteers, BLS-trained, ALS-trained and Critical Care paramedics.

Another uniquely designed study examined a rural inter-hospital transfer service in the three years before and after abruptly losing its flight capacity due to a helicopter crash. Mann (et al. 2002) found a dramatic (4-fold) increase in risk of mortality in the periphery hospitals, concomitant with fewer inter-hospital transfer initiations for major trauma and longer transfer times associated with ground transport (average 2 hours 07 minutes pre-, 3 hours 10 minutes post-crash). The authors leave an intentional one-year gap in data collection immediately after the crash to avoid obvious bias from systemic mal-coordination. However, the authors fail to note important contextual details that could potentially confound their findings, including the level of paramedics involved in pre- and post-crash transports, and how and from where transfer vehicles/staff are dispatched.

Two recent systematic reviews on the mortality impact of helicopter use in pre-hospital emergency transport underline the importance of both context, and rural-specific data. Case study data on privately funded flight services predominates both of these systematic reviews. There is a greater likelihood of publication from those services exceeding TRISS-based expectations. Findings do not necessarily mean that *all* helicopter transport is faster or improves outcomes, especially as rural specific data is rare.

Ringburg (et al. 2009) examined 16 studies that exclusively sought to measure HEMS success using a TRISS-based, "predicted mortality" comparison. While five of the included studies used a ground EMS comparison group from the same health system, no study had controlled or randomized conditions (15 case studies and 1 level II study which randomized only whether a physician was present in the HEMS crew). Ringburg (et al. 2009) argue that the results demonstrate the general clinical value of helicopter use in pre-hospital transport, while noting a considerable variation on outcomes due to the unique EMS systems examined in each study.

A second systematic review on the same topic included all population-based studies on the mortality benefit of helicopter use in exclusively pre-hospital transport (Butler, Anwar and Willett 2010). Of 23 included studies, 14 found a statistically significant benefit. Eighteen of the studies were case studies with level III evidence, five were level II, and just one study examined rural outcomes separately from urban. Again, considerable variation in EMS systems was found. The authors concluded, "[i]t is likely that pre-hospital EMS services, operating in different trauma systems, with different terrain and geographical arrangements of hospital facilities, will come to different conclusions about the appropriate need for [helicopter use]" (Butler, Anwar and Willet 2010, p. 700). Most critically, Butler, Anwar and Willet (2010) warn that the mode of transport is often a confound in case studies for better organized, coordinated and prepared EMS systems, programs, or personnel. Kurola (et al. 2002) supports this notion, finding that access to ALS paramedics in rural Finland – whether the paramedics were air- or ground-based – was beneficial to more patients than actual air transport.

A large retrospective chart review of all rural patient transports to an urban Level I trauma centre showed no survival benefit for helicopter use over ground transport, and suggested questions about the appropriate use of costly helicopter transport (Rose et al. 2012). During the two-year study period (2007-2008), a total of 1,443 rural patients were transported to the centre by ground and 1,028 by helicopter. Patients were grouped into three categories depending on their Injury Severity Scores (ISS), which can vary from 0 to 75. The group with the least

severe injuries ranged from 0 to 10, the group with moderate scores ranged from 11 to 30 and then the most severe injury group were those with a score greater than 30. Patients in the low ISS group had no survival benefit and a shorter average transport distance compared to 1,039 similarly low severity patients transferred by ground (Rose et al. 2012). In those with an ISS score of 11-30, helicopter transport was associated with more mortality and, again, shorter average transport distance for both scene-to-centre transports and inter-hospital transfers. Though few in number, those with an ISS score >30 had higher mortality (57% survival rate) when transported by air than ground (69% survival rate) (Rose et al. 2012). As above, human error in ISS-scoring may account for survival difference. Patient acuity could also play a role: the high severity score group had a relatively wider classification of 31-75, and patients with higher acuity tend to be transported by air. Regardless, the cost-effectiveness of using helicopters for short distance, low-severity transport and transfer is questionable.

Carr (et al. 2006) conducted a meta-analysis of 49 observational studies consisting of 155,179 trauma patients from 20 states over 30 years. Researchers found longer average time intervals (activation, response, on-scene, and transport) for helicopter ambulance than urban, suburban, or even rural ground ambulance. As well, while EMS systems effectively reduced pre-hospital times for ground ambulances over the last 30 years, pre-hospital care intervals lengthened from time period one (1975-1989) to period two (1990-2005) for helicopter ambulances (Carr et al. 2006). As above, these numbers may reflect a difference in training and expectation for pre-hospital interventions and/or the use of helicopter EMS teams for especially remote or difficult to extricate patients.

A direct comparison between air and ground EMS services in New South Wales, Australia, between 2004-2006 found that in transport trips of <100 km , HEMS either did not offer time savings (50-100 km) or were slower than ground transport (<50 km). Only in the constructed category of >100 km did HEMS offer reduced time to care according to Shepherd's (et al. 2008) retrospective chart audit.

Cost-effectiveness of HEMS

In one study on the cost-effectiveness of helicopter use in a primarily rural environment, the infrequency of completed missions meant substantial costs with few benefits. Kurola (et al. 2002) examined rural and remote Eastern Finland, which shares some characteristics with rural and remote British Columbia, including air transport difficulties due to weather and geography. These difficulties, combined with the use of ALS-staffed ground ambulances, meant there was a very low rate of need for HEMS. Specifically, of 588 HEMS missions, just 25 were completed by HEMS (40% cancellation rate, 14% BLS-appropriate, 31% ALS ground transport used). In 61% of cases, ground transport arrived first. Of those 25 completed air transports, case reviews suggested three patients benefited solely from helicopter transport and two benefited from both ALS-trained paramedics and air transport, at a cost of 28,444 euros per beneficial mission (Kurola et al. 2002).

The cancellation rate in Eastern Finland is considerably higher than found in some other parts of world. For example, in New South Wales, Australia, the cancellation rate was 18%, equally due to death at the scene and lower-than-expected severity (Shepherd et al. 2008). In Kurola's (et al. 2002) study, cancellation was higher in part because of ALS-trained paramedics staffing the ground ambulances, and in part because of more geographic and climatic challenges to flight.

Cost-effectiveness data is also deeply context dependent. In a systematic review of cost-benefit literature, Taylor (et al. 2010) found cost figures from the UK alone varied by a factor of 21, suggesting widely different methods of

both service and measurement. Taylor (et al. 2010) note that HEMS is demonstrably an integral part of financial sustainability for private health centres/systems by widening the patient range for high complexity patients. However, in public systems, trauma has more mixed results with regard to benefits, with costs that are as much as 7-10 times higher than ground transport (Taylor et al. 2010).

Best Practices Identified

- Simultaneous ground transport dispatch for HEMS calls in places with geographic/climatic challenges to flight (Kurola et al. 2002). Approach reducing EMS activation and dispatch times from a QI perspective, including developing guideline-driven protocols for coordinated "auto-launch" at patient transfer initiation.

- Guidelines for triage, dispatch, communication, and transport can reduce HEMS time to secondary/tertiary care (Aguirre et al. 2008; Blankenship et al. 2007; Pitta et al. 2010). While Droogh (et al. 2015) cites literature finding a modest time-savings by helicopter between centrally located specialist ground and air teams, the authors are quick to point out that no high quality studies have been able to link modest transport time differences to patient outcomes. It is important to note that benefit may exist even though practical and ethical barriers prevent the collection of appropriately powered evidence.

Direct Transport to Urban Facility Or Inter-Hospital Transfer

Key Points

- Direct transport from the scene to specialist centres is found to reduce time to secondary/tertiary care for those rural patients who require specialist services.

- There is limited population data pointing to increased risk of mortality for those patients first taken to a local/rural hospital prior to transfer to a specialist centre (Garwe et al. 2011; Haas et al. 2012).

- Most data, including pooled analyses from systematic reviews, show no difference in outcomes based on transfer status (e.g. secondary/tertiary care at local hospital or after transfer to larger centre) (Hill, Fowler and Nathans 2011; Pickering et al 2015).

- Levers for reducing mortality in rural areas may include improving networks of communication between primary and secondary/tertiary sites, using transfer guidelines, and supporting high quality networks of care

The value of a regionalized trauma network for major trauma survival is well established (Droogh et al. 2015; Hill, Fowler and Nathens 2011; Pickering et al. 2015; Utter et al. 2006). The survival benefit of treating medically complex and high acuity patients in the appropriately resourced hospital is also undisputed (Garwe et al. 2010).

However, there persists a system level question about where those suffering potentially medically complex injuries or illnesses should be taken after retrieval from scene. While time to secondary/tertiary care is found to be consistently longer for those patients taken to their local hospital before transfer for more complex care (Garwe et

al. 2011; Gleeson and Duckett 2005; Haas et al. 2012; Hill, Fowler and Nathens 2011; Pickering et al. 2015), the impact of this delay on clinical outcomes is widely disputed.

Evidence regarding this question has historically suffered from considerable limitations. A reliance on hospital deaths for evaluation (Mann et al. 1999), retrospective observational designs (Hill, Fowler and Nathens 2011), and a lack of information on distances to care or between care sites (Pickering et al. 2015) all undermine the applicability of the data for policy planning. In particular, the common practice in observational studies to exclude those cases not transferred away from rural sites both limits the meaningfulness of the data and impacts the perception of rural hospitals, incorrectly framing them as simply a stop along the patient journey toward more complex care.

A strong example of this is the frequent recommendation for reduced non-therapeutic imaging and testing at rural sites prior to referral and transfer (Garwe et al. 2011). When examining exclusively those patients who were eventually transferred to an urban facility, these interventions may appear costly, time-consuming and ultimately unnecessary. In the many cases of non-transfer – even for severe trauma and other emergency events – these non-therapeutic interventions become necessary and appropriate. Though rarely captured in studies on hospital bypass, most rural patients are treated effectively and recover fully in their home communities without having to leave for higher resourced referral centres. Rates of transfer in the event of severe trauma naturally vary according to the capabilities of the sending hospital, but the literature indicates they can be as low as one-third from a non-trauma designated Australian ED (Gleeson and Duckett 2005).

The repetition of non-therapeutic interventions prior to and after transfer still represents an inefficiency of communication. Hill, Fowler and Nathens (2011) found five studies from the United States which each reported higher costs of care for transferred patients compared to those transported directly to a trauma centre. However, a sole Canadian study involving rural patients exclusively found higher transport but not higher total costs for transferred patients (Cummings and O'Keefe 2000). Recommendations from the literature include shared imaging and patient records, improved inter-site trust and communication and protocol-driven patient transfer.

Equally problematic in the study noted above is the exclusion of those patients who die at their local hospital without transfer to a major centre. These deaths may bias studies that examine mortality using single-site, referral centre data (Rivara et al. 2008). In fact, only one study was able to capture deaths in the ED before hospital admittance at each of the rural sending and urban receiving sites (Haas et al. 2012), finding much higher rates of ED death in non-trauma centres.

Haas (et al. 2012) is one of three population-based studies found in this review. Through a retrospective observational design, the authors examined severely injured motor vehicle occupants in Ontario to find that direct transport to a designated trauma centre resulted in an approximate mortality improvement of 40% (24 hour mortality OR=0.58; 95% CI 0.41-0.84; 48 hour mortality OR=0.68; 95% CI 0.48-0.96). The study, however, contends that patient-level factors related to the probability of death should be equivalent across regions with substantially different rates of transfer. Two critical factors in evaluating rural transport are missing from this analysis: distance to care and EMS capability. In fact, distance to secondary/tertiary care and the appropriate resources to support expedient and effective transport *do* impact mortality for rural patients, and may be at the heart of why rural people continue to experience higher rates of mortality than urban patients (Bell et al. 2012; Fatovich et al. 2011; Mullins et al. 2002).

Clinical indication necessarily plays a role in triage directly to a referral trauma centre (Haas et al. 2012), but Gleeson and Duckett (2005) found that the bypass decision was rarely based on the capability of the local hospital to manage a particular patient. Rather, rural paramedics sought to avoid additional time out of the community (Gleeson and Duckett 2005) and/or had limited training and equipment to care for severely injured patients (Feazel et al. 2015; Garwe et al. 2011; Helling, Davit and Edwards 2010).

Another population study, this time from Oklahoma, clarifies the potential for avoidable mortality from direct transport. Garwe (et al. 2011) conducted an exceptionally rigorous study by controlling for many of the factors in decision to bypass (including time of day, distance, and injury severity), as well as factors of mortality (such as distance, time since injury, demographic and co-morbidity factors. They found that mortality within two weeks was 2.7 times more likely for patients who had been indirectly transferred to secondary/tertiary care from another hospital. The authors acknowledge a series of system problems that may account for some of the difference in outcomes. First, 61% of patients transferred from another hospital received pre-hospital care from BLS paramedics (Garwe et al. 2011). As those included in the study were necessarily those with severe injury, the authors note that many of these patients may have been clinically indicated for hospital bypass, but triage and stabilization required a higher level of on-scene care, or the resources of the local hospital. Furthermore, Oklahoma does not require trauma life support training at small hospitals, and the authors note that a lack of standardized protocols for transfer may have created undue delays (Garwe et al. 2011). Garwe and group (2011) acknowledge that in rural settings with limited EMS capability, transport to the nearest hospital may simply be necessary and urges educational interventions for small hospitals as well as standardized protocols for transfer. Garwe (et al. 2011) only included patients who reached the Level I trauma centre, framing out the relative success/non-success of rural hospitals managing patients without transfer.

Helling, Davit and Edwards (2010) found that airway management in the local hospital prior to transfer improved outcomes for severe trauma patients in Pennsylvania. Researchers compared 2,388 patients transported directly with 529 patients transferred to a Level I TC, and found that care in rural hospitals prior to transfer augmented and/or improved good outcomes (Helling, Davit and Edwards 2010). Those who were transferred had lower mortality, no difference in complications, no clinical difference in physiological parameters, lower incidence of required operative procedures, shorter length of stay in ICU and hospital, and no difference in discharge performance scores (Helling, Davit and Edwards 2010).

The final population-based study covered in this review is from British Columbia and provides a unique analysis. Bell (et al. 2012) examined severe burn patients – often excluded in trauma studies – transferred to Vancouver General or Royal Jubilee burn units from 2001-2006. After adjustment for clinical covariates (including burn severity), transfer status (direct versus indirect) was not associated with any difference in mortality or hospital length of stay (Bell et al. 2012). Bell (et al. 2012) includes an examination of airway management, an important variable which is not often considered in other studies. Roughly 60% of those patients transferred from another hospital had been intubated, while just 35% of those receiving direct transport to the burn unit had been intubated in the pre-hospital environment. The dispatch of BLS-trained paramedics (both EMR and more commonly PCP) to a scene in rural BC is common, and would necessitate transport to the nearest hospital for advanced airway management as this is beyond the capacity of BLS training.

Bell (et al. 2012) revealed two important factors that may offer some further insight into the findings of improved mortality of patients transported to secondary/tertiary care in the above studies. First, those with a rural site of injury did experience a higher rate of mortality regardless of direct transport or indirect transfer (RR: 1.22, 95% 1.0-1.48). Second, much higher mortality in the burn unit among intubated patients (RR 5.1; 95% CI 2.24-11.83) is argued to be a result of mortality that was inevitable but otherwise delayed due to rapid access to necessary care.

As with the debate above regarding the value of air or ground transport, contextual differences can become causal differences in both population level and case study level observational studies examining direct and indirect transport to urban referral facilities. Helling, Davit and Edwards (2010) found improved outcomes for those transferred from small hospitals after severe trauma, including lower mortality (not statistically significant), no difference in complications, no clinical difference in physiological parameters, lower incidence of required operative interventions, shorter length of stay (not statistically significant), and no difference in discharge performance scores. Rogers (et al. 1999) found no mortality difference in Vermont patients initially stabilized in rural hospitals before transfer to a major trauma centre, finding instead that injury severity and age significantly contributed to mortality. Veenema and Rodewald (1995) found that the stabilization and triage of rural severe trauma victims by Level III EDs met national mortality standards outlined in the Major Trauma Study in Wayne County, New York. At a larger scale, Rivara (et al. 2010) also found no difference in mortality within 50 days for direct or indirect transport using data from the National Study on Cost and Outcome of Trauma, which included 18 trauma centres.

Falcone (et al. 1998), however, found considerable difference in preventable deaths among those receiving air transports in Ohio in 1996. Importantly, the system described by Falcone (et al. 1998) is a non-regionalized system, where 536 separate EMS systems – some staffed exclusively by volunteers and each with separate protocols, procedures and medical direction – service a mostly rural area of roughly 25,000 square miles (65,000 square kilometres). While this particular study found six potentially preventable deaths among indirect transfers from rural hospitals (compared to one in direct transport), the average age of those patients was 73 (range 53-90), and the system-level reason for these preventable deaths could not be determined from all of the contextual influences. Examining literature on direct and indirect air transport, Falcone (et al. 1998) found very mixed results from around the United States, with only pediatric studies showing a trend toward improved outcomes from direct transport – arguably because of limited resources in rural areas. Falcone's (et al. 1998) study and literature review reflects the very significant contextual differences, and differences in opportunities for care, captured in studies that draw data from trauma centre registries in non-regionalized systems. Young (et al. 1998) struggles with many of the same issues in Virginia, offering little insight into whether direct transport to a trauma centre or improvements in rural hospitals and rural EMS are more likely to reduce mortality for rural people.

Systematic reviews in this area reached many of the same conclusions. Hill, Fowler and Nathens (2011) included 14 studies in a systematic review (some of which are discussed above) and 31 studies in a pooled analysis of mortality outcomes, concluding that there was no difference in length of hospital stay and no pooled difference in mortality among rural populations (rural subgroup pooled OR=0.94; 95% CI 0.77–1; total pooled OR= 1.06; 95% CI 0.90–1.25). They caution, however, that significant heterogeneity in setting and research design challenges the validity of quantitatively pooling results.

A second systematic review examined 19 severe trauma studies and a further 11 studies of head injury specifically (Pickering et al. 2015). Each systematic review covered 13 of the same studies but differed on a total of 32

included studies. Pickering's (et al. 2015) analysis of 30 studies involved more than 50,000 patients and also found no difference in clinical outcomes due to transfer status for severe trauma or moderate-to-severe head injury. Just five studies were argued by Pickering (et al. 2015) to account for all patients initially taken to a non-specialist centre – thus avoiding survivor bias – and adjusted for age and injury severity. Meta-analysis of these five studies also showed no difference in mortality between those directly transported to a specialist centre and those first taken to a non-specialist centre. Nevertheless, the authors again caution that heterogeneity between studies necessitates future research with comprehensive data collection, prospective designs and a wider range of both potential confounders and relevant outcomes beyond mortality.

Best Practices Identified

- Triage of even severely injured patients to local hospitals for stabilization and potential referral and transfer appears safe; equivocal data suggests equivalent outcomes.

- High quality networks of care with formalized, protocol-driven referral processes are needed.

- In the case of long transport times for severely injured/ill patients, advanced care positively impacts survival.

Equipment and Technology

Key Points

- Medical equipment should be standardized across all phases of the medical transfer system, including the sending hospital, transport/transfer/EMS equipment, and the accepting hospital. Standardization would improve continuity of care and equipment familiarity.

- Where inappropriate or impossible to use the same equipment in rural and urban environments, equipment and technology should nevertheless be compatible throughout the transfer system.

- Telehealth systems have the capability of reducing inter-hospital transfer by improving interactive consultation to manage high complexity patients in rural hospitals.

- Telehealth has the potential to expand the capacities of lesser-resourced rural EMS systems in the event of high complexity cases.

- Equipment for rural pre-hospital environments should be evaluated independently from equipment suitable for urban pre-hospital environments.

Telehealth

The rapid changes in telehealth technology and capacity necessitate frequent evaluation for potential use in rural health services and rural EMS services. The opportunity for virtual consultation to support rural patients in high

complexity and emergency events includes reducing time to interventions usually performed in secondary/tertiary facilities (such as PCI) and the recognition and management of severe trauma.

Telemedicine is currently being employed in both the pre-hospital and rural hospital environments in an effort to bring specialist and sub-specialist expertise into lesser-resourced care settings. Ethical and technical challenges have hampered the development of its use and study.

Woollard (et al. 2005) randomized suspected cardiac patients for consideration of pre-hospital thrombolytic agents in the rural UK. Using the continuous transmission of pre-hospital ECG and vital signs, cardiologists made the decision to provide thrombolytics en route, which was then compared to the decision for thrombolysis upon hospital arrival. No pre-hospital thrombolytic agents were provided and instead the time of treatment and appropriateness of clinical decision making were analyzed. While Woollard (et al. 2005) found that the average reduction in time to intervention was 55 minutes for rural patients; only 21 of 213 patients from the telemedicine group actually required thrombolytic intervention upon hospital arrival; and just three of those 21 were indicated for intervention in the pre-hospital environment. The authors concluded that while the reduction in time to intervention was substantial, the rarity of the event may not be worth the significant investment in training, equipment, and decision making oversight necessary for the implementation and wider use of pre-hospital thrombolytic agents.

In contrast, Kleinrok (et al. 2014) favourably described the use of similar telemetry data in Poland in the triage of suspected ST segment elevation myocardial infarction (STEMI) patients directly to PCI-enabled centres. Their case report highlights the potential value of extending specialist decision making into pre-hospital environments without the additional training and certification plausibly necessary for pre-hospital professionals to provide advanced cardiac intervention themselves. Similar systems in Illinois (Aguirre et al. 2008) and Minnesota (Pitta et al. 2010) found that STEMI diagnosis in the pre-hospital environment using transmission of ECG data can reduce total “door-to-balloon” time by an average of 20 minutes for rural patients.

Small numbers of high complexity cases is a central problem in organizing emergency health services for rural populations. One Australian system underscores how telehealth might be integrated into existing rural referral infrastructure. The Queensland Emergency Medical System Coordination Centre (QCC) is responsible for the clinical coordination and transfer of patients in Queensland, Australia. Of the 6,460 transfers specifically coordinated through QCC’s Townsville location during Sharpe’s (et al. 2012) one-year study, just 51 used telehealth, of which nine instances were during active patient resuscitations. In these instances, telehealth was used in a way analogous to an “autolaunch” policy, in which the same physician coordinator liaising with the retrieval team was also virtually present in the rural sending site during resuscitation and provided support according to guidelines intended to maintain the authority of the rural team. Comments from both referring physicians and medical coordinators indicate the value of this practice, with noted benefits including: the medical coordinator was able to gather information useful for retrieval team handover; expertise in emergency care and updated care procedures was offered by the coordinator to primary care providers who may have limited experience in emergency medicine (e.g. junior medical staff); and the coordinator was able to reassure the local team to reduce the stress and strain of emergent events (Sharpe et al. 2012).

When used on a broader scale, a similar in-hospital telemedicine system was shown to radically reduce patient transfer and trauma costs in Mississippi. Duchesne (et al. 2008) analyzed the value of telehealth intervention for triage and screening for possible transfer to Mississippi's only Level I trauma centre. Of the average 3,500 trauma activations per year in the trauma centre, 60% are for transferred patients from smaller community hospitals. A 2.5 year pre-telemedicine (trauma patient n=351) and 2.5 year post-telemedicine (n=463) retrospective review found that the trauma transfer rate fell from 100%, with an average ISS score of 10, to 11% with an average ISS score of 18. Higher mortality in the trauma centre (7.8% post- vs. 4.8% pre-) reflects a lower likelihood of survival in the higher-severity patient population, while only one death was recorded in local hospitals post-telemedicine (Duchesne et al. 2008).

Though the retrospective, observational design of this study (like many in this review) cannot provide definitive evidence regarding quality of care and care outcomes, the substantial reduction in patient transfer was shown by Duchesne (et al. 2008) to reduce trauma care costs from $7.63 million in the pre-telemedicine period to $1.13 million in the post- period. As it is not a population level study, the off-set of costs to rural hospitals is not captured. Nevertheless, reduced use of the EMS transport system and advanced trauma professionals for lower-severity trauma cases will likely yield system-wide savings.

In pre-hospital environments, telemedicine can be used to bring the diagnostic and treatment capability of even rare subspecialists into the rural scene. In California, one of America's 50 neuro-vascular surgeons uses telemedicine (including communications and robotic assessments) to remotely assess patients for possible transfer (Giller 2009). This sub-specialist also helped develop pre-hospital and inter-hospital protocols and medication interventions used by CALSTAR (California Shock Trauma Air Rescue) to treat stroke, cerebral aneurysms, and arteriovenous malformations.

The same ability exists to bring the diagnosis and treatment expertise of trauma surgeon specialists into moving rural ambulances. Using a simulated patient unit, Charash (et al. 2011) compared the outcomes of BLS[5] EMT response with radio contact to medical control according to standard (non-consultative) protocol to the outcomes of BLS EMT response with video tele-link to a trauma physician. All participants were blinded to scenarios, and physicians were further blinded to the training of the paramedics. Among the telemedicine-enabled (TM) group, 22 of 24 simulated runs with potential patient demise resulted in normalization of vital signs. In 16 non-TM runs, all 16 simulated patients died (reduced mortality from 100% to 8%). Using telemedicine support, the BLS paramedic group was able to perform needle thoracostomy and pericardiocentesis, and delivered intravenous mannitol.

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5 Charash (et al. 2011) describe these paramedics as "intermediate" level EMTs. Their listed scope of practice is very similar to BC's Primary Care Paramedic, a BLS level of training. Importantly, their scope does not include intubation, needle thoracostomy, or pericardiocentrisis.

This study used a small sample of professionals (20 EMTs and 12 physicians) and a pre-existing inter-hospital telemedicine structure (FAST STAR) designed to give rural physicians 24-hour access to trauma surgeon consultation.

The test ambulance was equipped with a touch-screen workstation and two fixed cameras on the ceiling with adjustable pan/tilt/zoom that could be controlled from either end of the telecom links. Audio was via wireless Bluetooth headset rather than open speakers. The physician consultant workstation was pre-existing, and included dual monitors with access to camera feeds, logged and scrollable ECG, and vital sign data and ambulance GPS. The physician could "telestrate" by drawing on the ambulance touch screen using remote mouse control. The authors noted that the data intensity of the arrangement and potential "drops" in coverage from a rural environment threatens the viability of the model.

An ethical justice question is whether the potential improvement of a very small number of patient outcomes is worth the capital and training investment required for the realization of telemedicine's potential for complex rural patients in pre-hospital environments. Since 2005, the concept of telemedicine has moved beyond patient telemetry for the indication of intervention, to virtually bringing specialists into rural settings. The value of "live" telemedicine is shown above to include more accurate and appropriate triage decisions, more accurate recognition and treatment of highly complex injuries and illnesses, reduced crowding at referral sites, and consequent system cost savings. As well, Rokos (et al. 2010) note the potential value of supporting rural hospitals to maintain clinical confidence, which may further reduce unnecessary transfers independently of active telehealth support. At a policy level, this is in direct contrast to protocol-driven efforts at expediting patient transport out of rural environments, which intentionally results in over-triage and centralizing system resource use in specialist units.

In each case reviewed above, the value of the technology is leveraged through existing systems. This requires technological capacity, a commitment to health human resources to staff it, and the inter-site collaboration to make it functional. Integrating virtual consultation into existing transfer networks can substantially improve high acuity rural transport and transfer system outcomes and efficiencies.

Pre-hospital Equipment

A systematic review of critical care transfer quality repeatedly noted the lack of standardized equipment across the phases of patient care as a barrier to high quality care (Barratt 2012). There exists considerable opportunity for time and cost savings in transfer, as well as reduced provider frustration and patient morbidity, from having compatible equipment between rural sending hospitals, transfer and retrieval teams, and urban accepting hospitals. Deficiencies in equipment provision for, and equipment failure during, critically ill patient transfer were also reoccurring issues noted in the quality evaluation literature (Barratt 2012), which lead to adverse incidents during transfer.

At the same time, standardizing the equipment available to pre-hospital providers may not result in improved outcomes in every case. Rural EMS systems are shown to benefit from the context specific evaluation of pre-hospital equipment and supplies, including consideration of climatic and geographic challenges, longer pre-hospital times and lower frequency of critical patients.

Droogh et al's (2005) evidence review on transferring critically ill patients included five studies discussing necessary equipment. This includes equipment for the continuation of normal critical care (monitoring, ventilation, medication), transfer-specific items (gas supply, batteries) and incident management tools (defibrillator, chest tubes). An ICU monitor able to display electrocardiography, several pressure curves, capnography and oxygen saturation, a ventilator (preferably an ICU ventilator), airway management tools, arterial and central venous lines and various applicable medications are all stated as "advised." Droogh et al. (2015) also suggest that transfer trolleys – larger than the standard ambulance stretcher – carry all the equipment and that critical care transport use oversized ambulances that allow access to the patient from all sides.

A somewhat older paper from Australia (Cable 1994) details the equipment carried by the Tamworth Base Hospital Retrieval Service in the North West Region for remote retrieval. Equipment included a standard "Thomas" pack; a drug box; an oxylog ventilator; a propaq monitor with ECG, NIBP, Pulse Oximeter, and invasive pressure monitor; a Syringe pump; a "Lifepack" defibrillator; and a cellular telephone.

Importantly, some of the supply needs of rural pre-hospital and interfacility transfer differ from those in urban environments. In the arctic and sub-arctic environment of Alaska, pre-hospital professionals must employ specialized shielding for IV bags and tubing to prevent freezing, sleds for patient extrication, and protocols related to hypothermia (Artuso 2012). A letter by Gillon and Kibar (2012) discusses the difficulty of accessing blood products in rural environments, especially fresh frozen plasma. Gillon and Kibar (2012) argue for the potential effectiveness of freeze-dried factor preparations (fibrinogen concentrate and prothrombin complex concentrate) that are easier to store, transport, and deliver. However, evidence for their effectiveness currently exists only in developing nations and must be considered and tested in a developed nation setting.

The Royal Flying Doctor Service (RFDS) in Australia uses "medical chests" in rural locations to reduce unnecessary flights and transfers as well as overcome some of the resource challenges faced by rural and remote settings. There are 2,600 such medical chests in remote health clinics and rural hospitals around Australia, created and stocked by the RFDS. Consequently, the coordinating centre has an awareness of what is available on site, and can instruct local medical professions of what to use, how, and when (Jones and Langford 2015).

Best Practices Identified

- Compatibility of equipment between all phases of patient care is paramount.
- Formalized transfer networks must be established to leverage technological efficiencies.
- Equipment to be used by rural pre-hospital professionals must be considered from a rural, low-volume perspective.

Health Human Resources

Key Points

- Early emergency interventions have the most patient impact in rural areas where transport times are longest and rural facilities have less resources.

Definitive Care

The term "definitive care" can have misleading connotations for rural patients. In the event of suspected STEMI or stroke, expedited transport to, or communication with, PCI-enabled centres or neurosurgical units respectively may be the best way to shorten time to secondary/tertiary care. In trauma, the course of care is often less clear.

Many assume that direct transport to a tertiary surgical centre is the fastest route to "definitive care," as these units provide some of the most advanced care available. While time to "restorative care" was the most critical variable in survival in a meta-analysis of urban trauma patients (Liberman, Mulder, and Sampalis 2000), this care does not necessarily happen at highly resourced trauma facilities. As Somers (1999) points out, failure to ensure an adequate airway for transit will assuredly result in early death, and as such this care can often include early life-saving interventions. Taken further, "definitive care" is likely to be the culmination of a series of efforts at restoration, and may not require a tertiary unit.

In fact, for most rural trauma patients, advanced facilities will not be necessary. For those suffering severe trauma in a site with limited scope of care, reaching advanced facilities alive typically requires early, stabilizing interventions in the rural environment. Consequently, the system plan for these patients cannot simply include the "where" of secondary/tertiary care, but must attend carefully to "how" and "by whom."

- Specialist/advanced transport teams bring skills, equipment, and experience that may not be available in some rural hospital and clinic settings.

- Specialist transport teams show patient benefit for inter-hospital transfer, including fewer iatrogenic incidents in-transit and better outcomes at the receiving hospital.

The consideration of health human resources for rural patient transport and transfer in the event of high complexity and/or high acuity emergency events has many facets. A contentious debate in the basic intention of pre-hospital medical systems – that is, should EMS focus on immediate patient retrieval for care at a higher-resourced location, or pre-hospital critical care interventions and early treatment on site– has inspired numerous comparative studies on the value of ALS-level pre-hospital personnel. However, this literature is almost entirely from urban environments.

Urban-based research has shown that advanced pre-hospital care may have no benefit (Isenberg and Bissel 2005; Stiell et al. 2008), and may even increase mortality cases of severe trauma (Liberman et al. 2003; Stiell et al. 2008), especially with very short average pre-hospital times of less than 10 minutes (McNicholl 1994) or less than 15 minutes (Liberman, Mulder, and Sampalis 2000). The causal premise of this research is that BLS-level "immediate retrieval" systems deliver patients to tertiary units more quickly than do ALS-level paramedics, who average more time on-scene but are not delivering the care and restorative interventions that are usually attained in secondary/tertiary facilities (Liberman, Mulder and Sampalis 2000).
These large, high quality urban-based studies note their own limited relevance for rural patients who, without advanced pre-hospital intervention, may have long transport times to a local ED for airway management, intravenous therapy, pharmacological intervention, and stabilization, and who could face further transfer time to secondary/tertiary care (Isenberg and Bissel 2005; Liberman, Mulder, and Sampalis 2000; Liberman et al. 2003; Smith and Conn 2009; Stiell et al. 2008). Nevertheless, these studies underscore a core contradiction in the academic study of EMS health human resource models: Those with the longest pre-hospital times, least access to advanced medical care, and worst outcomes by injury site are also the

least likely to have ALS-level pre-hospital or inter-site services, while those with pre-hospital times of under 30 minutes to a local tertiary centre are the most likely to have advanced pre-hospital services available despite limited evidence of cumulative patient benefit.

This contradiction is typically explained by referring to practical, system, and efficiency issues. Lower call volumes in rural communities and less advanced interventions create a challenge to locating ALS-trained and critical care pre-hospital personnel. It is more costly to the system, there are difficulties with recruitment and retention, and it is difficult to keep skills up-to-date. These issues are common to the maintenance of all rural medical services.

In attempting to overcome these practical challenges while addressing the above contradiction, various health systems have employed physicians in rural pre-hospital environments, expanded the role of paramedics to include hospital-based roles and deliver primary care and triage in the community, and separated inter-hospital transfer from pre-hospital transport structures.

The current literature on each of these innovations is reviewed below.

Physicians in the Pre-hospital Environment

Physician involvement in pre-hospital care has a long history, including the Royal Flying Doctor Service started in Australia in 1928. However, the value of physician pre-hospital care remains uncertain. This sub-section reviews the potential benefits of physician-led pre-hospital care.

The deployment of physicians in pre-hospital and inter-hospital environments is most common in European contexts where paramedics have a limited scope of practice. For example, Caldow (et al. 2005) demonstrated the need for rapid sequence intubation or tube thoracostomy among severely injured rural patients in Scotland – skills not available to Scottish paramedics or rural GPs. Thus, the authors suggest, rapid intubation skills and not necessarily physicians are needed in patient transport/transfer.

Deployment of physicians for advanced intervention is a valuable resource. The financial implications of this are unknown. It could be measured in terms of accuracy of deployment: Was it the right resource at the right time, or could a lower cost intervention have been just as effective? It could also be measured in terms of usefulness. That is, how do the abilities of physicians add benefit to on-scene care? Somers (1999) discusses the potential deployment of physicians in Australian rural and remote pre-hospital settings to overcome the limited availability of advanced care pre-hospital professionals. The benefits are listed by Somers (1999) include the abilities to: "(i) provide definitive care early; (ii) ensure appropriate 'aggressive' resuscitation is commenced promptly; (iii) triage to appropriate hospitals rather than routine bypass; and (iv) determine which victims do require 'scoop and run'" (p. 106).

It is important to realize, however, that the skills of benefit – not necessarily the professional designation – are the mechanism of improving pre-hospital care. For example, based on a retrospective chart review, Kurola (et al. 2002) found that rural Finnish patients benefited most from the availability of ALS-level skills.

An interview with a STARS administrator indicated that there have been "growing pains" integrating physicians into what has been traditionally viewed as "paramedic work." STARS's physicians occasionally accompany the nurse-paramedic team on critical transfers. This has resulted in some interprofessional tensions. The source of

the tension is rooted in the perception of some paramedics that physicians do not provide a value-add to patient care in the out-of-hospital environment (i.e. paramedics have the clinical scope of practice and experience to provide advanced life support interventions such as intubation and initiation of hemodynamic monitoring in the field).
A study of the most effective physician provider by type was done by Chesters (2014), who found consistent results in on-scene intubation by anaesthesiologists, emergency medicine specialists, and GPs. Research from Norway suggests that very few patients benefit from specialist physician involvement. Hotvedt and Kristiansen (2000) argue that GPs can manage a large majority of life-saving, high complexity missions for a Norwegian rural helicopter ambulance service, but a flight anaesthesiologist would have a "substantial" health benefit for a few patients, including the difference between mortality/non-mortality in specific rare cases. This is echoed by Nielsen (et al. 2002), who states that among a widely scattered Northern Norwegian population, with an annual ambulance mission rate of 114 per 100,000 people, 95% of cases did not require an anaesthesiologist. In other words, just six cases per year required an anaesthesiologist in Northern Norway.

Given the international data, the use of physicians in pre-hospital environments should be considered a potential adjunct alongside other advanced pre-hospital care, and their deployment should be flexible. However, as many pre-hospital interventions require physician instructions – including some medication use, fluid therapy, the use of thrombolytic agents, and more depending on service area – the need for physician involvement, oversight and clinical governance is clear. Their presence in the pre-hospital and inter-hospital environment is often used to improve the autonomy of care teams when immediate access to such clinical decision support is not realistic, available, or codified in the transport system.

When physician oversight and consultation is immediately and meaningfully available, non-physicians can successfully support severely injured and ill patients. The following section discusses additional efforts to provide greater decision making autonomy to pre-hospital professionals.

Expanded Role for Pre-hospital Professionals

There is an important academic distinction to be made between expanded scope and expanded role for pre-hospital professionals. Academic literature regarding the expanded scope of pre-hospital professionals is most often framed by the effort of some health systems to reduce conveyance to the ED by EMS. Tohira (et al. 2014) refers to "new pre-hospital professionals," specifically in cases where Emergency Care Practitioners (EmCP) and Paramedic Practitioners (PP) in the UK and Extended Care Paramedics (ECP) in Canada, New Zealand, and Australia were introduced to reduce ED crowding. In each case, the new pre-hospital professional had an expanded scope of clinical practice for assessment, triage, and treatment. These new skills included treating minor illness and injury, such as suturing, ordering imaging, and prescribing some medications. Most critically, these new pre-hospital professionals had the capacity to discharge patients from the scene without conveyance to an ED.

As with other advanced pre-hospital care, new pre-hospital professionals are much more common in urban environments. The impact on patient outcomes is uncertain. A recent meta-analysis and systematic review found that while these programs did reduce ED trips as intended, there is no clear framework for evaluating the appropriateness of their decision making or the safety to patients (Tohira et al. 2014).

The expanded role of paramedics in rural care environments is somewhat different. An expanded role responds to the challenge of low-frequency rural EMS services by engaging advanced paramedics in more than emergency response. This can include an expanded scope and the use of a multiple-option decision point (MODP) model (O'Meara et al. 2006), in which on-scene discharge or referral can be used instead of conveyance to an ED. However, this expanded role can also involve increasing the use of rural EMS services through community engagement (Stirling et al. 2007), extending primary care roles (O'Meara et al. 2006), and involving transport personnel in hospital duties (Brayman et al. 2012; Cunningham 1999; Gentry 2002).

Expanding the role of rural paramedics creates more opportunities to utilize their skills and training, while also bringing needed emergency competencies into rural communities. In case studies from Australia, memoranda of understanding between hospital and EMS organizations required a selection process designed to identify paramedics who have a strong interest in supporting patient care activities in a rural hospital setting. Successful applicants were willing to grow their position and invest in the rural health system and community, and they were expected to be strong team players with an ethos of interprofessional respect and learning (O'Meara et al. 2006). The scope of practice for these expanded role paramedics include emergency response, community first aid education and other emergency preparedness training, assisting hospital staff with triage and intravenous cannulation, extending primary care to remote settings by treating people in their homes, and training hospital staff in emergency procedures (O'Meara et al. 2006). In a comprehensive report to the Council of Ambulance Authorities in Australia, O'Meara (et al. 2006) discuss the inter-organizational cooperation efforts required for expanding the role of paramedics, highlighting the ways these organizations can strengthen each other and rural care. For example, in South Australia, Bordertown began involving paramedics in hospital duties. In the context of a labour shortage, the hospital leveraged existing community paramedic staff into patient care activities. This initiative reduced the financial burden to the hospital and ambulance service, and provided paramedics with an opportunity to maintain advanced clinical skills in a low call volume area. In this model, the paramedic was still able to access physician medical oversight through the ambulance system when faced with hospital tasks outside the typical paramedic scope. In this way, the relative financial strength of one organization and the well-organized consultation system of the other were leveraged to create better patient care and rural staff emergency preparedness.

Though paramedics with hospital duties are not common in Canada, the involvement of hospital personnel in transport has a long history. Cox-Kerrigan and Ritz (1984) wrote about Canada's first flying hospital team, which was a group of seven RNs stationed in the industry city of Fort McMurray, which had a largely itinerant population of roughly 31,000 at the time. Cunningham (1999) reports on the organic development of the Medevac transportation system in the Yukon, noting the use of flight nurses with advanced cardiac life support (ACLS), basic trauma life support (BTLS), and advanced airway management skills in a "floating" role at Whitehorse General Hospital.

Significantly, there is a conceptual reversal in this structure compared with much of the literature reviewed above in the section on Timing to Secondary/Tertiary Care. Rather than a system intended to optimize pre-hospital, on-scene triage and care in the delivery of a patient to secondary/tertiary care, transport systems that use hospital staff are largely framed by the concept of "bringing the hospital out." This is not to be confused with a "stay and play" model in which on-scene intervention is balanced against the need for timely conveyance to a hospital setting. Instead, "bringing the hospital out" is a model of care intended to maintain patients in rural settings,

support rather than duplicate existing services and reduce historic and industrial relations barriers between phases of care.

In parts of Canada and many other jurisdictions, pre-hospital EMS systems are increasingly divorced from interfacility transfer systems, which have largely existed under much less regulation and thus have been fertile areas for organic innovation (but this is currently not the case in BC).

Inter-Hospital Transfer Health Human Resources

Rural hospitals face particular organizational challenges in the event of transferring a patient with a medically complex and/or high acuity injury or illness. Without formalized agreements and systems for patient transfer, rural physicians in one Australian hospital were found to average 4.7 phone calls totalling nearly one hour to arrange patient transfers (Barratt 2012). Moreover, it is common practice in BC and many other jurisdictions to send rural nurses or doctors with the ambulance to the accepting hospital, leaving the rural hospital without critical staff for long periods of time (Brayman et al. 2012).

Critically, academic evidence suggests that the decision to transfer is very rarely based on factors at the patient level, such as stability and likelihood of adverse events in transport (Barratt 2012; Fan et al. 2005; Feazel et al. 2015). Instead, the decision for transfer is more typically based on the availability of suitable personnel in the rural site (Barratt 2012), and clinical confidence, provider experience, and support (Fan et al. 2005). While this issue is more carefully discussed in the section on Clinical Governance, the impact of the practical considerations for transfer can be seen in the literature on patient transfer.

A comparative UK study by Bellingan (et al. 2000) made an international impact early in the development of specialist retrieval teams deployed from high-volume, highly resourced urban sites to retrieve a patient from a rural hospital for transfer to an urban facility. This retrospective cohort study compared 168 interfacility transfers by a specialist team to 91 matched transfers by standard emergency ambulance with a medical escort provided by the referring hospital. The study found substantial differences in outcomes, with a statistically significant decreased in the likelihood of arriving severely acidotic (50% reduction) or hypotensive (70% reduction), and lower mortality within six hours of arrival for the specialist care group. Bellingan (et al. 2000) also emphasized care standard issues: 5% of referring rural ICUs could not provide transport ventilators, 18% of transfers did not include the ability to monitor blood pressure invasively, and 38% did not include the ability to monitor central venous pressures.

The iatrogenic risk of patient transfer is alluded to in these numbers, but not well studied, especially among already stabilized patients (Fan et al. 2005). Feazel (et al. 2015) reports on two studies that place deterioration during transfer at 5.1-6.5%, noting that distance is a significant predictor of complications and deterioration. Droogh et al. (2015) found more frequent issues when measuring “incidents” during transport, however. The frequency of cardiovascular events (hypo/hypertension, brady/tachycardias, and arrhythmias) varies in the literature from 6-24%, while respiratory events were found to occur in 0-15% of transports (Droogh et al. 2015). Equipment failure accounts for as much as 46% of all incidents, and occur during 9-36% of transports (Droogh et al. 2015). Most critically, the frequency of equipment failure was consistently lower among specialist transport teams.

A systematic review comparing specialist to non-specialist transport teams for inter-hospital transport reported on six cohort studies (n=4,534 patients) with weak but suggestive results (Belway et al. 2006). Belway et al's. (2006) main finding is the need for more rigorous research in the area of interfacility transport. They noted that only one of their selected studies matched cohorts or adjusted for severity, and that the same study was the only one to report outcomes at the receiving hospital (this study was Bellingan et al. 2000 cited above). While no conclusive results regarding the mortality or morbidity change between specialist and generalist transfer teams could be found in their review, Belway et al. (2006) point to early pediatric literature for an example of in-transit benefits. The present review agrees with Belway (et al's. (2006) findings that there are consistent in-transit benefits of transfer provided by specialized staff for paediatric patients. Importantly, the mechanism of improved outcomes is not only the benefit of experience and training with a specialized population, but also fewer equipment problems and failures (Barry and Ralston 1994; Edge et al. 1994) – something that reoccurs in the literature for all patient populations.

As the data on specialist teams is not of high quality, determining the ideal retrieval team composition is typically a matter addressed by health service planners based on local expectations, provider availability, industrial relations considerations, and more. In Bellingan's (et al. 2000) study, the specialist team was composed of a tertiary-based physician intensivist, an RN, a driver, and a medical physics technician, all whom were trained in transfer of ICU patients. They used a "mobile ICU" with an ambulance equipped to the ICU standards of all-around stretcher access, piped oxygen and air, nitric oxide, mechanical ventilation, suction, 220-V power supply, and multi-channel monitoring (Bellingan et al. 2000). In Belway et al's. (2006) review, all six of the cohort studies involved the use of nurse-physician transport teams.

As noted above, physician involvement in care outside the hospital allows for greater autonomy in decision making for both triage and treatment. However, other modes of clinical governance are found in the literature, including using transport-experienced physicians in dispatch to perform triage and clinical decision support (Aguirre et al. 2008; Brayman et al. 2012; Cunningham 1999; Droogh et al. 2015), clinical oversight by the accepting physician (Ahl and Wold 2009; Giller 2009), and pre-written physician order sets (Brayman et al. 2012). In each case of absent physician oversight, the most common team structure is that of an RN or flight nurse and a paramedic at the advanced care level. As well, critical care paramedic teams (in ORNGE) and RN/respiratory therapist teams (in HART) are currently used in Canada.

Shared duties between transport and intensive or critical care hospital departments improve interprofessional respect, learning, and communication (O'Meara et al. 2006). Just as critically, individual practitioners are able to develop and maintain critical care skills, including central line placement and monitoring (Gentry 2002). The primary advantage to rural patients, hospitals, and communities, though, is the broad set of critical care skills and experience brought to rural sites by specialist retrieval teams (Brayman et al. 2012).

Volunteerism

There is a body of literature on the role of volunteerism in rural medical transport schemes (Asthana and Halliday 2004; O'Meara et al. 2006). For non-acute patients, volunteer transportation is a common community response to a lack or loss of local primary and diagnostic services. Unfortunately, these volunteer driver organizations have questionable longevity even when they succeed in initial community recruitment (Sherwood and Lewis 2000). In dealing with acute, high complexity patients, volunteer EMS services also struggle with retention, largely because

of volunteer emotional trauma and stress (Essex and Benz Scott 2008). Volunteer-based systems especially persist in the rural United States, and in other increasingly private-interest driven health systems, because low-volume EMS systems are not typically revenue generating for proprietary ambulance companies (Busko 2008). In this way, volunteer systems are better understood as community-level responses to "service deserts."

Volunteer-based systems are not ideal for the health of patients or volunteer providers, regardless of the altruistic community spirit underlying them or their necessity in service deserts. Acute patient transport should not depend on volunteer services in rural communities because there will be significant gaps in coverage. This review is aimed at providing rural British Columbians a common standard of care that brings the best chance of a long, healthy life after acute injury or illness within the frame of responsible system planning. Volunteer services are not likely to lead to better outcomes for high complexity rural patients, and cannot be expected to provide widespread, dependable coverage to British Columbia's many rural and remote recreational areas, work sites, and communities. As such, they are not reviewed herein.

Best Practices Identified

- Rural patients with severe injury/illness are the most likely to benefit from advanced intervention skills during initial pre-hospital transport and inter-hospital transfer, and can be served by a wide variety of skilled health professionals.

- Specialist inter-hospital retrieval teams should be used to extend the capacities of high- resource centres to rural hospitals and maintain patients in their home communities where possible, or be used in patient transfer when required.

- Expanded roles for patient transport professionals can provide value to the hospital system, rural patients, rural communities, and more.

- "Ideal" health human resources (HHR) configurations in patient transport and transfer are those which fit local needs most effectively, including availability and value to other parts of the health system.

Dispatch and Communication

Key Points

- Single-call dispatch within a formalized network of patient transfer is necessary to support transfer efficiency toward better rural patient health and provider satisfaction.

- Required consultation with busy accepting facility specialists slows down transfer efforts and demands considerable time during high-stress events; evidence is needed regarding the efficacy of required consultations in regards to improved patient outcomes.

- Dispatch agents should ideally be transport physicians with the medical authority to assume patient responsibility and offer clinical support, as well as the operational capacity to initiate and organize patient transfer while understanding the rural context.

Dispatch and communication are not necessarily linked in the conception of rural EMS systems employed in this review. Communication is widely recognized as a core component of all functioning teams and organizations, both within the health field and beyond. There is no doubt that effective communication is a mechanism of good quality care. It has been written about extensively in relation to intra-hospital communication, interprofessional communication, communication for leadership, "hand over" communication, and more.

For this review, communication will be limited to inter-organizational and interfacility communication. Moreover, interpersonal communication skills will not be discussed. Instead, effective pathways for communication structures will be the focus in this section, with particular attention being paid to dispatch structures.

Dispatch is a critical part of all EMS systems and can occur in one or more phases. Pre-hospital EMS dispatch is typically managed through 911 type emergency response systems, representing the historical connection of ambulance to fire and police services. The creation of private, public-private, regional, and institutional patient retrieval, transfer and transport teams around the world has led to rapid innovation and experimentation in both pre-hospital and patient transfer dispatch systems. Coordination, collaboration, and communication between traditional ambulance systems staffed by pre-hospital professionals, and parallel retrieval systems often staffed by medical professionals, are a regular feature of current patient transport schemes. This is most visible in interfacility patient transfer, where less strict regulation combines with concerted efforts at regionalization and networked structures of patient care, potentially generating a variety of solutions to the same challenge.

Interfacility Transfer Dispatch

For rural physicians, organizing a patient transfer can be difficult, frustrating and time-consuming. Barratt (2012) found in a review of literature that rural physicians averaged 4.7 phone calls and nearly one hour of effort to arrange a patient transfer. From every perspective, such an organizational burden on physicians is costly to the system, stressful for professionals, and dangerous to patients who face increased time to secondary/tertiary care. For example, redundant questioning of physicians can negatively affect patient care by diverting their attention away from the critically ill patients they are actively caring for. This is more pronounced in rural settings where there may be only one physician and nurse on duty to care for a critically ill or injured patient.

An example comes from rural Scotland (Caldow et al. 2005), where a non-formalized system of inter-hospital transfer requires the rural physician to call the ICU of the accepting hospital directly. This is sometimes colloquially referred to as "bed shopping." Once an accepting unit is found, a retrieval team is organized from available and appropriate hospital staff at the receiving hospital, and a mode of transport is arranged through the Scottish ambulance service "Airdesk."

Flexibility in the staff used for retrieval is an important characteristic of efficient retrieval systems (Barker and Ross 2014), and could be listed as a possible advantage of this model. However, without formal structures of interfacility transfer in place, staff may be inappropriately used for other rural services (Cunningham 1999).

Moreover, at the moment of contacting the Airdesk, at least three separate institutions are involved. The Airdesk manages all air ambulance resources, but may have to liaise with the military for nearby and available aircraft (a fourth institution), and/or with ground ambulance services when they are needed between airports/helipads and hospitals (a fifth institution).

There is ubiquitous agreement in the literature that best practice includes "single-call" dispatch and defined networks of patient transfer to reduce the organizing burden at the moment of the emergency. Single call dispatch can be broadly defined as the ability of a physician at a referring hospital to make a single call to a dispatch centre in order to access clinical decision making support and/or activate the transfer protocol. However, the concept of "single-call" is not homogenous in practice. Operationally, single-call dispatch falls into three types:

1. Facilitated Consultation
2. Dispatcher as Coordinator
3. Co-Located Services

An example of each type will be briefly discussed below for clarity, followed by a broader discussion of the value and impact of each of these models.

Facilitated Consultation

In Facilitated Consultation, a rural physician calls a central dispatch line, which then facilitates a conference with the appropriate specialist. Ahl and Wold (2009) report on a specialty stroke transport team in Colorado, where 52 of 64 counties are rural or frontier (less than six people per square mile), 50 counties are health care shortage areas, and 20 have no hospital at all. The specialty stroke team is a private service extension of a hospital-based stroke team. In Colorado, transfer dispatch is managed over a dedicated line that is "single-call" for the referring physician. The dispatcher is an employee of the private transport company and facilitates a conference between referring and accepting physicians, suggesting the stroke transport team specifically based on an algorithm.

Although this system reduces both "bed shopping" and retrieval team coordination by rural physicians, significant challenges persist. First, the referring physician has a dedicated number to call but will not necessarily spend less time away from direct patient care. By the nature of the system, referring physicians must repeat the patient information to the dispatcher to find the appropriate accepting site and specialist, and then again to that specialist. In addition, the referring physician must wait for the dispatcher to connect with an accepting facility, effectively adding a "middle man" to calling an accepting facility directly and asking for a specialist. Second, the dispatch professional does not have the ability or purview to make clinical decisions, and so can only respond to administrative realities such as a "full" or "empty" ICU bed, even if the reality is more nuanced from the perspective of a medical professional with the ability to move patients to other wards. Lastly, in a Facilitated Consultation dispatch system, the locus of decision making is moved away from the team immediately treating the patient to a decision-support algorithm. Furthermore, the accepting physician is told of the patient's clinical condition with a potentially limited understanding of the context of that rural site (e.g. their available equipment, staffing issues, geographical constraints).

Dispatcher as Coordinator

A more common form of single-call dispatch uses the dispatcher as the coordinating agent. Typically, the dispatcher is an emergency medicine physician with particular training, experience, and/or emphasis on transport. The dispatch agent, then, can offer consultation when necessary. The transport physician first accepts a call from a referring physician, and then organizes retrieval and accepting site services to support the needs of the particular patient.

The Albertan STARS organization is celebrated for this feature of their transfer services. Each of the six STARS bases has a transport physician on 24 hours per day to make care and resource decisions including which aircraft to deploy. The transport physician can accept a patient on behalf of a rural physician colleague, and then call the accepting physician to brief them on the incoming case. In this model, the "bed shopping," retrieval team organization, and accepting site briefing is all done by the transport physician. This allows the referring physician to continue patient care, and does not task accepting physicians with administrative decision making or coordination (e.g. bed management). As part of the Patient Transport Network, BC has introduced a similar service called Emergency Physician Online Support (EPOS). EPOS physicians provide clinical support for paramedics on the ground and during interfacility patient transfers, focusing on areas without immediate access to high-level critical care.

Co-Located Services

In a study of major US trauma centres, Newton and Fralic (2015) found that centres with centralized transfer call reception, bed management coordination and transport team dispatch were the most efficient and successful. In a Canadian context with regionalized care, this may appear similar to the "bed shopping" scenario described by Caldow (et al. 2005) in Scotland. Indeed, the system is largely an early effort at regionalization and the formalization of patient transfer. As this evolution is happening at a moment of difficulty in other patient referral and transport systems, though, the lessons from the Co-Location Service context are illuminating.

For US trauma systems, multiple private agencies may be involved in patient transfer, including two possibly independent hospitals, a private air transport system, and a separate ground transport system. In each case, no individual institution knows the status of all others at a given time. In the event of co-location, the accepting facility is also the dispatch centre, effectively centralizing data relevant to patient transfer, including retrieval team/vehicle status and bed allocation.

Most important to this system is the genuine "single call" dispatch for referring facilities. In other systems, Newton and Fralic (2015) found that the clinical report was repeated by the referring physician as many as five times in a normal transfer. In the case of co-location, that clinical report is given just one time to the accepting hospital, who then selects and informs the transport team and alerts the appropriate specialist staff.

One strong example of this comes from the STAT Heart Program in rural Illinois. Aguirre (et al. 2008) described a dedicated line for the referring physician that connects to a dispatch office located at the accepting site. The call itself immediately initiates transfer protocols and the dispatch operator is able to use an "alpha" page to ready the accepting cardiologist, cardiac cath lab personnel, coronary care unit staff, and admitting offices.

Over the last fifteen years, British Columbia has moved away from this type of system as it has significant limitations. Co-locating such services allows for immediate access to a decision maker at the accepting site and allows that decision maker to make a more decisive resource analysis and decision. These features are argued by Newton and Fralic (2015) to reduce referring physician call times. However, the responsibility for finding an accepting unit still falls on the referring physician, and as discussed in the introduction of this section, the time and effort commitment of rural staff to "shop" for an accepting bed can be onerous and disadvantageous.

Best Model of Single-Call Dispatch

The academic literature reviewed did not clearly separate transfer protocols from consultation protocols. In fact, all of the systems discussed above use the same "single call" terminology to refer to both.

Some organizations clearly put these two support features together. In this case, rural physicians must consult before requesting transfer, must spend more time on the phone despite having a high complexity and high-needs patient, and must wait for the appropriate specialist in the accepting facility to become available. At the same time, the accepting physician is expected to consider facility-level issues of bed usage, staffing levels, and other logistical concerns of transfer while also managing their own patient load and consulting with the rural site.

Other "single-call" systems allow the rural physician to choose whether to initiate consultation or transfer. The decision of when to use each likely holds many of the same ad hoc features noted in the decision to transfer, such as rural site capacities and physician confidence (Droogh et al. 2015; Fan et al. 2005; Feazel et al. 2015). No study currently exists describing how rural physicians choose. Further, no studies currently exist to measure the rate of transfer among patients who might have been maintained in their rural community, or on the effect of mandatory/voluntary consultation on clinical confidence and patient transfer.

Arguably, CQI and CME efforts may be more effective interventions to improve rural-to-urban patient transport decisions if these are found suspect in a given system. In the event of an emergency injury or illness, or the deterioration of a patient, consultation and transfer are important tools of the treating physician. Nevertheless, each process should be separate to improve the efficiency and value of both.

Best Practices Identified

- Dispatch agents should ideally be transport physicians with the medical authority to assume patient responsibility during transfer and offer clinical support as well as the operational capacity to initiate and organize patient transfer.

- Referring physicians should not be required to repeat a clinical report multiple times to different parties in order to initiate transfer.

- Referring physicians should not be responsible for the process of "bed shopping".

Governance

Key Points

- Patients have a preference to recover from illness or trauma in their home communities.
- Networks of transfer with integrated local network-level oversight improve quality of care, trust, teamwork, and decision making in collaboration with local doctors.
- Patients should be maintained in their local hospitals whenever possible for clinical, logistical, and socio-economic reasons.
- Data sharing is needed between sites and phases of care; transparency of data on transport outcomes and administrative data on transport system features will enable more thorough quality improvement efforts.

A critical challenge in organizing EMS systems is clinical and administrative governance. EMS systems require medical oversight at every stage, including training, protocol development, CQI, resource planning, continuing education, and clinical care (Bukso 2008). Canada has various oversight and performance standards groups involved in EMS care, from national certification bodies, to provincial quality standards organizations, to sub-provincial and regional resource planning authorities. Regional oversight is a standard of high quality health systems but can result in an urban-centric governance lens given the population and professional density of large urban centres.

This section focuses on best practices of governance for rural transport and transfer systems, beginning with patient-centred care and continuing through care network oversight, health information sharing, the value of supporting rural sites, and the need for high quality data.

Patient Preference

The event of transporting or transferring a rural patient to an urban facility can be emotionally challenging for everyone involved. Emergency situations are inherently stressful. It is essential that patient preferences are considered. This includes considering issues around cultural safety in the decision-making process.
As in other types of care, rural patients express their priority for high quality and comprehensive emergency healthcare. Interviews with rural patients from Iowa found they more strongly preferred transfer as the risk for adverse events increased (Mohr et al. 2016). However, some of those same patients expressed a reversal of this pattern at the thought of death. As one participant said, “[i]f I knew I [was]… going to die, I would rather die [at my local hospital] where my friends and family will be” (quoted in Mohr et al. 2016, p. 30).

When patients express a priority of survival over immediate social support, the act of patient transfer can still induce anxiety and stress. Johnson (1999) found that patients experienced anxiety about moving from the familiar to the unfamiliar and at the prospect of being separated from family. Participants experienced in-transit anxiety about issues such as who would look after their children and where their loved ones were, and Johnson (1999) noted that greater distances exacerbated their sense of isolation. Further, patients were uncomfortable at the impersonal nature of the experience, from seeing many health professionals in the metropolitan centre, to

confusion over the acuity of their illness/injury when urban hospitals spent less time with them (Johnson 1999). Perhaps most concerning from a governance perspective was the confusion patients felt at discharge planning. Urban sites often use early discharge to improve bed efficiency and reduce costs, but for rural patients transferred to the urban site, follow-up appointments and out-patient therapies were often not feasible.

Feazel (et al. 2015) argue that transferring rural patients back to their local sites for recovery could improve patient perception of care and reduce confusion, anxiety, and non-compliance. These include patients with various critical conditions.

Browning Carmo (et al. 2008) argues that communication is at the core of patient satisfaction. Parent feedback from NETS (New South Wales Neonatal and Peds Transport Service) expressed the need to travel with their child or know why they could not, and to receive a phone call to notify them of their child's status after transfer. Pediatric transfers reveal the stress and strain of transfer from the perspective of those left behind. It is assumable that many other families would appreciate similar levels of communication when their loved ones are moved to another community after a major incident.

Formalizing Networks of Transport and Transfer

Regional oversight of transport and transfer systems is necessary to ensure the maintenance of quality standards and consistent medical oversight. However, these large frameworks of care often overlook the local needs of rural transfer networks. Droogh et al. (2015) describe the value of formalized critical care transfer networks developed in the UK, where each network has a lead clinician and manager responsible for developing transfer pathways and protocols. In this case, the system is managed from an "on-the-ground" perspective of formalizing how and where patients go from a local network level.

The identification and formalization of local networks of emergency care and transfer also enables greater cooperation between sites. The Australian Royal Flying Doctor Service uses "field days" of shared training and treatment opportunities between rural and referral sites to improve knowledge, relationships, and protocols (Hill and Harris 2008). Helling, Davit, and Edwards (2010) describe the need for a Rural Trauma Team Development Course aimed at training, relationship building, and confidence improvement, especially for those not formally trained or appropriately resourced for severe trauma management.

Droogh et al. (2015) note a clear point of patient responsibility "hand off" as a further best practice of formalizing such networks. This moment needs to be clear to all team members and formalized in clear guidelines and protocols.

The literature shows that formalized clinical decision rules and standard indicators for transfer function as a decision aid in reducing "door-to-balloon" times for suspected STEMI patients (Aguirre et al. 2008; Pitta et al. 2010); improve inter-personal, inter-site, and interprofessional trust (Barratt 2012); and improve appropriate selection of transport personnel in systems with flexibility (Feazel et al. 2015).

Health Information Exchange

A repeated issue in patient transfer is accurate patient information. Rural physicians are often asked to repeat their clinical report multiple times when arranging their patient transfer. Both referral and discharge information is

critical to continuity of care and reduced repetition in diagnostic care. Newton and Fralic (2015) note electronic health records (EHRs) as a solution for which rural physicians in the United States remain hopeful. However, the presence of EHRs does not necessarily constitute efficient health information exchange, as discrete proprietary systems and firewalls between care sites plague many jurisdictions, including BC.

Instead, shared EHRs must be considered as a potential tool for improving both interpersonal and interfacility communication, as well as reducing human error, record duplication, and repeated tests and admissions. These EHRs must work well for physicians, nurses, paramedics, dispatchers, and admissions personnel alike. They must also be sharable with primary care professionals who may be involved in follow-up care or have previously noted critical co-morbidities in a patient's medical history.

Avoiding Patient Transfer

The iatrogenic risk of patient transfer was discussed in the earlier section on Inter-Hospital Transfer HHR. HHR Patient degeneration has been found to occur in between 5.1-6.5% of cases and medical "incidents" to occur in between 3% and 70% of patient transports, depending on the definition of incident and the transport system under consideration (Droogh et al. 2015).

Concurrently, EMS systems also face the reality of provider danger, despite the routine nature of both ground and air transport. Feazel (et al. 2015) found a traffic-related mortality rate among ambulance workers of 9.6 per 100,000 per year in the United States. In 2008, the rate of rotor wing ambulance crew mortalities was estimated at 164 fatalities per 100,000 HEMS crew members (Feazel et al. 2015). These rates are likely higher in rural and remote areas with inclement weather, difficult patient extrication, and longer driving and flight times.

These deleterious realities of patient transport and transfer confront the lack of evidence- or resource-based indicators for patient transfer. Telehealth solutions are increasingly available and affordable, and there continues to be a need for strong rural services that support the health and healthcare needs of communities and address the unavoidable risks involved in patient transfer. In this context, best practice is very likely to support patients at their rural sites as often as possible. This may include sending hospital-based, critical care-trained transport staff from urban sites to rural sites in order to support the patient (Brayman et al. 2012); using standardized equipment caches or "chests" (Jones and Langford 2015) and facility transport checklists; and bringing "virtual" specialists into rural EDs (Sharpe et al. 2012) to avoid moving patients as often as possible.

Good Data

Although access to transport data is crucial and the academic literature includes a number of systematic reviews, there is a lack of consistency and quality in both administrative and research data (Barratt 2012; Belway et al. 2006; Butler, Anwar and Willett 2010; Carr et al. 2006; Droogh et al. 2015; Evans et al. 2014; Hains et al. 2010; Hill, Fowler and Nathens 2011; Fan et al. 2005; Feazel et al. 2015; Pickering et al. 2015; Taylor et al. 2010; Tohira et al. 2014).

Best practice includes a clinical record that indicates clinical status before, during, and after transport/transfer, as well as other environmental and clinical factors of the pre-hospital engagement or inter-hospital transfer. As well, measures of disability, length of hospital stay, patient satisfaction, and cost must supplement mortality as a variable of interest, particularly as necessarily small samples can make such a crude measure difficult to assess and

analyze. Better research data would improve the understating of best practices in all facets of patient transport and transfer.

Administrative data is also problematic, making the job of planners and policy makers very difficult. O'Meara (2005) studied ambulance service performance frameworks and found that traditional use of response times is wholly inadequate for understanding complex modern transport systems. Below is a reproduction of O'Meara's (2005) suggested generic performance framework for ambulance services.

Table 3: Potential Performance Framework for Ambulance Services
(reproduced from O'Meara [2005])

Dimensions	Structures	Processes	Outcomes
Effectiveness	Equipment Staff skills	Response times Resuscitations Interventions	Mortality Survival
Appropriateness	Staff configuration Staff level Evidence base	Research activities Time at scene	New knowledge Adverse events
Safety	Monitoring system	Safety procedures Quality of care	Accreditation Complications
Capability	Appropriate staff Equipment	Clinical practice guidelines and standards Preparedness for a disaster	Impaired physiology Alleviation of discomfort
Continuity	Sustainability Teamwork	Coordination Collaboration	Limitation of disability Accurate information
Accessibility and Equity	Time to cases Distance to cases	Resource allocation processes	Utilization rates Availability Demand for Services
Acceptability	Public participation Ethical standards	Respect for patient autonomy Accountability	Satisfaction Complaints
Efficiency	Staff to case ratios	Rostering systems	Affordability Cost-Effectiveness

Best Practices Identified

- Maintain rural patients in rural hospitals when possible.

- Develop and use guidelines to support patient-centred transfer decision making with the goal of reducing the ad hoc nature of transfers.

- Develop and use support services for rural practitioners and sites to reduce non-clinical reasons for transfer such as low clinical confidence, gaps in on-call or on-duty rotations for qualified staff, or lack of specific equipment.

- Improve research and administrative data on patient transport and transfer to improve service quality and generate innovation.

Conclusion and Recommendations

The recommendations arising out of the review of best practices in international models of transport for complex rural patients are proposed through a *rural-centric lens*. That is, suggestions for an evidence-based reorganization of the system are made around the needs of rural patients, and by recognizing the essential role of rural providers. At a planning level, this requires involving rural communities (patients, providers, and other key stakeholders) in discussions of restructuring patient transport in BC, recognizing the primacy of experience "at the coal-face." This involves the following system-level recommendations:

1. A provincial commitment to facilitating high-level discussions between representatives of BCEHS, regional Health Authorities, the Joint Standing Committee on Rural Issues and provider or professional groups with a rural mandate, including the Doctors of BC, the Rural Coordination Centre of BC, the Rural and Remote Division of Family Practice and other rural Divisions of Family Practice.

2. Recognizing the central role of rural providers in making decisions around
    a. the need for transport;
    b. the severity of need; and
    c. the contextual influencing factors (weather, local availability of transport teams, availability of hospital services such as laboratory and x-ray, limitations on transport such as daylight hours only transport locations, and experience and comfort of the sending provider).

3. Supporting the capacity of local, interprofessional care teams to maintain care of complex patients by
    a. increased Continuing Professional Development (CPD) through local interprofessional education;
    b. The support of on-site critical care and transport teams from regional centres; and real-time telehealth linkages to specialist centres as required.

4. Supporting rural generalist physicians, including those with Enhanced Surgical and Anaesthetic Skills, to manage trauma locally as appropriate to patient condition and the capacity of the provider team. When needed, this team should be linked to, and supported by, tertiary trauma centres.

5. Improving and streamlining communications between care providers in rural sites and BCEHS
    a. when initiating transfer requests; and
    b. when transport is delayed or diverted
6. Providing enhanced clinical support (e.g. Telehealth consultation, or in-person nursing support from referral centres) to avoid unnecessary transfers to secondary/tertiary care.

7. Reducing transfer time.
    a. Simultaneous dispatch of air and ground transport at the time that the call is logged when there may be geographic, weather or other challenges to flight.
    b. Support for en-route rendezvous between different modalities of transport.

8. As evidence suggests a negative impact of BLS-level paramedics in long transport times for severely injured or ill patients, consider alternative models of providing a higher level of paramedic care to rural communities including
    a. assessing the feasibility of integrating ALS paramedics into hospital services to assist with the care of critically unwell patients and/or to complement BLS paramedics along with rural hospital based transport nurses to be deployed for transport on an "as needed" basis;
    b. investigating other models supporting the presence of ALS paramedics in rural areas
    c. looking at outreach models for ALS paramedics from regional centres

9. There should be compatibility of equipment between sites and in transport modalities. This may be facilitated by provincial guidelines and a standardized transport equipment protocol.

10. The potential for the utility of telehealth links to support both the transport and local management of high complex and high acuity patients should be explored. This should be evaluated and implemented through a series of demonstration projects and a scaling up of the most effective models.

11. The expansion of existing pilot projects implementing the use of specialized inter-hospital teams to extend the capacities of highly resourced centres out to rural hospitals, and maintain patients in their home communities where possible; or to be used in patient transfer when required.

12. As per the direction set in the policy framework in British Columbia, paramedics should be integrated in to rural hospital systems and communities. This will maximize efficiency in a low-volume transport setting and increase the critical human resource capacity at under-resourced sites. This will require recognizing the need to attend to industrial issues between some of the professions.

13. Patient transfer decisions should result from collaborative processes between the on-site provider, receiving physician and transport physician. The transport physician should have a good understanding of the rural context. The transport physician should provide medical oversight to the transport team during the transport phase if the patient is no longer in the care of an escorting sending physician.

14. Transport initiation should be streamlined for efficiency, recognizing the critical clinical role of the referring provider both with the transferring patient and in the care of other patients. Referring providers should not be required to repeat a clinical report multiple times to different parties in order to initiate transfer.

15. Lines of communication back to rural sites should be systematically maintained after transport, alerting the referring site to the course of care and outcome of the transferred patient.

16. System-wide administrative data on patient transport frequency, conditions, and outcomes must be made available to all levels of the system from rural to regional referral and tertiary sites in order to foster a culture of Continuous Quality Improvement.

17. Data must be continuously reviewed and shared to allow system correction where needed.

18. A rigorous, systematic study of rural patients, providers and administrators experience of transport in BC should be undertaken.

In summary, this realist review has identified and documented evidence to support best practices across a range of dimensions of care related to the transport of emergency patients form rural environments. If implemented, the recommendations listed above will greatly enhance the care of high acuity rural patients in British Columbia and establish a system that will support continuous quality improvement and best practices. In addition, these recommendations will lead to the enhanced capacity to meet patient needs through the sustainability of rural emergency services and the attendant benefits accrued, such as increased capacity to recruit and retain new providers. Supporting high complexity rural patients requires supporting rural services to care for them and to arrange effective, timely transfer when needed.

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Appendix A: Annotated Bibliography

Bibliographic reference	Setting	Objective	Context	Study Design	Main Findings
Aguirre FV, Varghese JJ, Kelley MP, Lam W, Lucore CL, Gill JB, Page L, Turner L, Davis C, Mikell FL. Rural interhospital transfer of ST-Elevation myocardial infarction patients for percutaneous coronary revascularization: the Stat Heart Program. Circulation. 2008;117(9):1145-52.	Rural Illinois, USA	Evaluates 'Stat Heart Program' efforts to reduce interhospital transfer time for suspected STEMI events.	• 230 consecutive presumed STEMI patients 2005-2007 • 6 STEMI referral facilities and 2 STEMI-accepting hospitals • Guideline-based STEMI reperfusion protocol introduced to improve uniformity in treatment and transfer strategies • Program designed around ACC Door-to-Balloon initiative strategies • Single call by referring physician to operator via dedicated phone line and simultaneous pager notification to the accepting cardiologist, cardiac cath lab personnel, coronary care unit staff and admitting	Observational retrospective cohort study	• Protocol improved time to PCI intervention at accepting hospital: 12% and 58% of patients achieving a time of <90 and <120 minutes, respectively • Of 230 presumed STEMI patients, 188 (82%) confirmed STEMI, of which 164 (87%), 8 (4%), and 16 (9%) were treated with the PCI, contraindication, and fibrinolytic protocols, respectively. • The cumulative in-hospital and 30-day composite of death, reinfarction, and stroke occurred in 4.8% and 5.9% of the alternative-diagnosed and STEMI-

			offices activated by the operator (located at the accepting hospital) • Full-dose fibrinolytic therapy was used as 'back up' perfusion strategy in the event of weather delays in transfer		confirmed patient subgroups, respectively • While 69% of patients were transferred by helicopter with a lower median travel time (26 minutes vs. 31), the decision to departure time was longer for air transport (median 37minutes vs. 24), and backup ground transportation was used for 24 (10%) of patients because of weather. • Diagnosis in the prehospital environment using ECG can reduce total door-to-balloon time by 20 minutes
Ahl E, Wold R. Defining and developing a specialty stroke transport team. Air Med J. 2009;28(3):133-38.	Colorado, USA	Describes the development of a specialty stroke transport team as part of a larger private air transport company	• 52 of 64 counties are rural or frontier (less than 6 people/sq mile), 50 are health care shortage areas and 20 of 64 have no hospital at all • Four bases currently operated • Team comprised of all flight nurses and	Case Report	• Intra-organizational support through on-going education, collaboration and communication between the administrative and executive bodies and clinicians is the key to the success of a specialized team • Organizational focus has

			works as an arm of urban hospital-based stroke team • Staff certified in National Institute of Health Stroke Scale and completed four NIHSS assessments mentored by a neurologist • Continuing education opportunities were organized and competency levels were created – 8 hours/year of CME was the required for 'competency', 8-12 for 'proficiency' and greater than 12 hours/year was required to be a mentor		led to a 5-fold increase in amount of stroke education given to flight nurses between 2005-2008 • Conference between referring and accepting physicians takes place over dedicated line and is guided by private transport company dispatcher, who can suggest the stroke team based on an algorithm • Advantages noted include the greater resources brought to rural hospitals for more expedient intervention (e.g. t-PA)
Artuso, CE. Rural trauma challenges in Alaska. Crit Care Nurs Clin of North Am. 2012 Dec; 24(4):593-600.	Remote Alaska, USA	Discusses the challenges of prehospital care in the remote and northern recreation, living and work areas of Alaska	• Considerable challenges include frigid temperatures that freeze iv fluids, extreme distances between towns, lack of information about the scene, accessibility and extrication difficulties	Case Report	• Snowshoes, snowmobiles and helicopters all used to access scenes • On-scene special equipment frequently needed includes sleds, thermal blankets,

			from many scenes, poor cellular coverage and low-resource health centres. • Medical crews responding to rural trauma are composed of a pilot, flight nurse and paramedic or a pilot and two flight nurses		shielding for IV fluid bags and tubing. • On-scene protocols include not removing clothing until other warming measures can be assured and attending to hypothermia as a common co-event to trauma • Critical care air transport teams are valuable in the rural and remote settings in part because they bring capacities not necessarily available at local health sites (usually health clinics), including needle or tube thoracostomy, rapid intubation, central lines, portable laboratory testing and pericardiocentesis
Asthana S, Halliday J. What can rural agencies do to address the additional costs of rural services? A typology of rural service innovation. Health Soc Care Community. 2004	Rural 'Health Action Zone' (innovation sphere), UK	Suggestions of organizing health systems to optimize rural advantage	• Health Action Zones were created to allow for local service innovations to be monitored, evaluated and potentially scaled-up • Not transport or high-	Non-systematic Literature review; Review of evaluations from a Health Action Zone	• In transport specifically, volunteer-based community first responders are noted as a necessary innovation related to professional-

Nov;12(6):457–65.			acuity/high-complexity specific, thus much of the paper was not extracted.		substitution where rural areas cannot support or attract better trained options • In patient transport, volunteer-based low-acuity transport of the elderly and disadvantaged has been formalized and connected across the UK and referral facilities are using 'block booking' – that is, booking patients from a certain geographic zone all together – to allow for bus or other collective transport schemes
Atkin C, Freedman I, Rosenfeld JV, Fitzgerald M, Kossmann T. The evolution of an integrated state trauma system in Victoria, Australia. Injury. 2005 Nov;36(11):1277–87.	Victoria State, Australia	To describe the development of an integrated trauma system	• Most Victorian trauma occurs in the large capital city of Melbourne but there is a higher per capita incidence of trauma in rural areas. • Authors argue this is due to increased travel distances, greater exposure to roads of lower standard and longer journeys at high speed	Case Description	• Regional system of stratified care developed, such that Primary Injury Services were created in remote and isolated areas, Urgent Care Services were developed in small, rural towns and Regional Trauma Centres were created to serve as a regional focus for

			(highway driving) • Efforts were made at trauma reduction/prevention programs with success • In 1999, ~1,800 major trauma cases in state, of which 1,000-1,200 were of ISS >15 • Ministry Taskforce and Departmental Working Group on Emergency and Trauma Services were created in 1997 with mandate to examine the unique challenges of trauma in isolated rural environments to better match State resources with patient needs • Taskforce used principle of: ‘‘the right patient to the right hospital in the shortest time’’		definitive trauma care and/or patient transfer to the highest resourced urban Trauma Centers (1 peds, 2 adult) • Urgent Care Services and Primary Injury services mostly provide resuscitation and stabilization of major trauma patients prior to early transfer to a higher level centre • The Primary Injury services may be designated for bypass so that major trauma patients may be trans-ported directly to the urban trauma centre or Regional Trauma Centre from the injury scene. • Regional Consultative Committees on Emergency and Critical Care Services (RCCECCS) were oversee the clinical functioning of the Regional Trauma Services and assist regional hospitals in

					coordinating system activities such as education, research and quality improvement. The RCCECCS also liaise with interstate bodies to develop referral strategies for border regions. • Clinical guidelines developed to indicate "major" trauma cases in prehospital environment, and further protocols developed for treatment, including early notification of trauma network for immediate preparations for patient arrival and possible transfer • By-pass guidelines (major trauma indicators met plus <30 mins from referral centre indicates by-pass).
Barker CL, Ross M. Paediatric aeromedical retrievals in the 'Top End' of the Northern Territory. Aust J of Rural Health. 2014	Remote Top End of Northern Territory, Australia	Examine the use and value of aeromedical retrieval for paediatric patients from remote	• All patients 0-16 years transported in one year period 2012-2013 (n=789) • Predominantly Aboriginal	Case Study	• Most patients found to have infectious cause for transport • Of 789 flight missions,

Feb;22(1):29–32.		environment	population in remote area with noted social and structural health disadvantages • Rates of A strep and consequent rheumatic fever among Northern Territory Aboriginal population are highest in the world • Urban base		25 required 'high-dependency' care. Most (15) of those were newborns. All 25 under 1 year old. • Small numbers make a specific high-dependency unit or specific paediatric service nonviable • Flexibility in retrieval staff is necessary • Relationship/team building focused on referral hospital specialist to aeromedical retrieval team relations • This includes orientation of paediatricians to aircraft and equipment available, as well as shared mortality/morbidity meetings and education sessions

Barratt, H. Critical care transfer quality 2000-2009: systematic review to inform the ICS guidelines for transport of the critically ill adult (3rd Ed). JISC. 2012 Oct;13(4):309-13.	Multiple	Systematic review undertaken to inform UK Intensive Care Society's Guidelines for Transport of the Critically Ill Adult	• Review not rural specific, but findings show relevance to rural environments • Review examines 38 studies of inter-hospital transfer • Review focused on transfer literature, the bulk of which concerns improving transfer quality • Literature gathered from developed nations • Data on number of transfers in a health system are very difficult to find as most academic literature is using hospital-level data from a single referral centre	Systematic Review	• Overarching theme is the need for appropriate accompanying staff, standardized equipment across all phases of care and appropriate documentation • Findings show weak compliance with transfer protocols in UK, Ireland and Switzerland, particularly with 'out of hours' and weekend transfers • Found serious adverse events occurred in between 20-31% of transfers (depending on setting), and complications occurred in as many as 68% of transfers • Most involve equipment failures, lack of patient stabilization before transfer and transfer delays • Increasingly sophisticated transport systems do not necessarily improve

					quality of transfers • Decision to transfer found to be inherently *ad hoc* and based more on the availability of suitable personnel and facilities rather than patient-level factors such as stability and likelihood of adverse event in transport • The lack of standardized indicators for transfer is argued to be part of the frequently reported difficulty in organizing a transfer as physicians must use personal relationships and their own time to find an accepting physician/hospital • Australian data pointed to an average of 4.7 phone calls per patient with a mean time to transfer acceptance of one hour

Bell N, Simons R, Hameed SM, Schuurman N, Wheeler S. Does direct transport to provincial burn centres improve outcomes? A spatial epidemiology of severe burn injury in British Columbia, 2001-2006. Can J of Surg. 2012 Apr;55(2):110-16.	BC, Canada	Compares outcomes for severe burn victims transported directly to provincial burn centres against those first taken to a local hospital	• In BC, transports of severely injured patients organized through BCAS and the critical care transport team • Data collected from three places to create population-level data: British Columbia Trauma Registry used for adult patients (age ≥ 18 yr) referred or transported directly to the Vancouver General Hospital and Royal Jubilee Hospital burn centres between Jan. 1, 2001, and Mar. 31, 2006; Coroner service database used to identify prehospital, in-transit and other-site deaths; place of injury identified through linkage with census records • Helicopters are primarily used to transfer patients over distances of less than 300 km, and fixed-wing aircraft are used for transport over greater distances, but flight	Retrospective observational design using population-level data	• After controlling for patient and injury characteristics, direct transport to burn centres (VGH and Royal Jubilee) did not improve Relative Risk of in-facility death compared to indirect transfer • Indirect transport did not increase risk of in-facility death (RR 1.32, 95% CI 0.54–3.22) or length of hospital stay (RR 0.96, 95% CI 0.65–1.42) • Rural injury site was associated with an increased risk of mortality from burns (RR: 1.22, 95% 1.0 – 1.48) regardless of direct transfer or indirect • Intubation prior to transfer is discussed as a lesser understood confounder: 60% of delayed transfer patients were intubated vs. 35% of direct transfer patients. Death at the

			transport is restricted in the province by geography, weather and time of day		burn centre among delayed transfer patients (unadjusted RR 5.51; 95% CI 2.24-11.83) may actually reflect prolonged life due to more rapid airway management
Bellingan, G, Olivier T, Batson S, Webb AR. Comparison of a specialist retrieval team with current United Kingdom practice for the transport of critically ill patients. ICM. 2000 May;26(6):740–44.	University College London Hospitals, UK	Compares specialist transport personnel against standard course of care	• Article compares 168 specialist team transfers to 91 comparable transfers by standard emergency ambulance with medical escort provided by referring hospital • No difference in demographic or severity of illness in groups • No transfers were delayed or cancelled • 65% intervention group patients and 68% regular course of care patients were transferred from district general hospitals (rest from other specialist or teaching hospitals) • Article appears at early stage of specialist retrieval team	Retrospective comparative cohort study	• Statistically significant decrease in the likelihood of arriving severely acidotic (50% reduction) or hypotensive (70%) occurred among those receiving specialist transport care • 4 deaths occurred among the 91 standard care patients within 6h of arrival, vs. just 1 of 168 specialist transport patients • Among deaths, those occurring to regular course of care patients had longer average distance to care (20.5km vs 9km mean)

			development in UK: most transfers overseen by junior doctors often in their first 6 months of anaesthesia training; 5% of ICUs could not provide transport ventilators; 18% of transfers could not monitor blood pressure invasively and 38% could not monitor central venous pressures		
Belway D, Dodek PM, Keenan SP, Norena M, Wong H. The role of transport intervals in outcomes for critically ill patients who are transferred to referral centers. J Crit Care. 2008;23:287-94.	BC, Canada	Sought to determine the association between transport intervals and patient outcomes, including ICU and hospital length of stay and mortality at the receiving hospital	• All adult patient transfer patients admitted to an ICU or CCU in 1999 (n=1,930) • Examined three transport intervals: 1. Time from initial call to the dispatch office to arrival of paramedics at sending hospital 2. Time from arrival of paramedics at sending hospital to departing from sending hospital 3. Time from departure at sending hospital to arrival at receiving hospital	Retrospective cohort study	• Unexpected finding that longer time from call to paramedic arrival was found to result in shorter ICU/CCU stays among priority 1 air transfers • As well, more time spent by paramedics at the referring hospital reduced total length of hospital stay for survivors of priority 1 air transfers • The authors contend it may be due to greater stabilization efforts by staff at the referring hospital. This better

					preparation may be reducing complications (e.g. complications from sepsis). • As expected, longer actual transport time was associated with longer ICU/CCU stays for survivors • Ground transport was found to have the shortest intervals at each stage (call to paramedic arrival, arrival to departure, time in transit)
Belway D, Henderson W, Keenan SP, Levy AR, Dodek PM. Do specialist transport personnel improve hospital outcome in critically ill patients transferred to higher centers? A systematic review. J of Crit Care. 2006 Mar;21:8-17.	Multiple	Examines outcomes of specialist transport teams for interhospital transfer	• Six cohort studies included (n=4,534 transfers), making it the largest systematic review in the area • Many of the relevant studies did not report hospital outcome. These studies (though not included in the formal systematic review) report improvements to outcomes while in-transit.	Systematic Review	• Only one study indicated improved outcomes at the receiving hospital when specialist transport personnel were used. • A lack of matched samples, controls of injury/illness severity and clear inclusion criteria for transport cases limit findings in five of the six included studies – all of the five that show no benefit

					• As well, death and length of stay may require large sample sizes (beyond what may ever be possible in high-complexity care). Thus, the authors suggest studies must begin including disability and rehabilitation measures, patient satisfaction, and long-term functional status.
Borst GM, Davies SW, Waibel BH, Leonard KL, Rinehart SM, Newell MA, Goettler CE, Bard MR, Poulin NR, Toschlog. When birds can't fly: an analysis of interfacility ground transport using advanced life support when helicopter emergency medical service is unavailable. J Trauma Acute Care Surg. 2014 Aug;77(2):331-37.	North Carolina, USA	Compared interfacility transfers to a Level I Trauma Centre by HEMS to those by ALS ground crews.	• Patients involved in interhospital transfer to a Level I trauma centre between 2008-2012 listed in the National Trauma Registry of the American College of Surgeons were stratified by transport vehicle (helicopter vs. ground transport) • HEMS n=2,190; Ground n=223 • Importantly, this study aimed to control for interfacility transfer team training by using only those patients indicated for air transport but	Retrospective Chart Review	• Cohorts were well matched with no differences found in demographics, injury severity, hospital length of stay or complications • Median time to definitive care was much shorter for HEMS (150 minutes) vs. ground (255 mins) • However, outcomes were equivalent between transport groups at both a descriptive and statistical level despite this longer interfacility

			transported by ALS ground crews because weather precluded flight		transfer time. • Time sensitive outcomes (including hypotension, transfusion requirements, ICU admission, need for surgery and surgery type within 24 hours) were similar between groups • Overall outcomes (including ICU length of stay, ventilator requirements, complications and overall mortality) were also similar between groups. • In logistic regression, those transferred by ground showed a slight (but not statistically significant) mortality advantage (adjusted OR of 0.902 (95% CI, 0.45Y1.8; p =0.77). • Authors conclude, “despite providing shorter time to definitive care, HEMS did not confer a survival benefit over ground

					transport for interfacility transport of injured patients in our large, rural trauma system." (335) • Authors suggest that certain subsets of patients may still benefit, but most likely benefit from prehospital professional training and expertise, rather than mode of transport.
Brayman C, Hobbs B, Hill W, Watson DL, Kaus R, Lamont S, Horkoff Tavis, Stubbings M, Moss R, Takeuchi L. ICU Without Walls — Interprofessional High Acuity Response Teams (HARTs) improve access to higher level of care in rural and remote communities. CJRT. 2012 Nov;48(4):14-19.	BC, Canada	Examines and describes HART in the Interior Health Authority of BC	• This health authority has a population over 750,000 and a mountainous land mass the size of Oregon state. • BCAS provides basic life support ambulance attendants for rural areas, while a provincial flight team staffed by critical care paramedics support with longer distance transfers • Frequent geographic and weather problems make flight difficult • Medically complex patients often require a	Case Study	• HART program uses emergency/ICU RN and a registered respiratory therapist (RRT) deployed from an urban setting using ground ambulances provided by BCAS and driven by BLS drivers. • When not deployed, HART clinicians work in base hospitals in critical care areas and make 'rapid responses' under HART designation to dangerous EWS scores, major trauma and code blue activations.

			higher level of care during long transports than basic life support crews can provide, so rural physicians and nurses have historically left their community to transfer with patients. • Long transport times require transport professionals with experience in critical care and considerable independence.		• RRTs are deployed based on joint determination by HART RN and a transport physician using guidelines. • Standardized tools, equipment, medications kits, and pre-printed physician order set to allow nurses and RTTs to perform “by order” interventions. • These supplement rural physician orders and system-wide guidelines. • A transport physicians is available 24/7 for further clinical consultation and medical directions. • HART RNs and RTTs are encouraged to take the same courses to improve skill and knowledge sharing interprofessionally. • A University in the area with an RTT program has been engaged to support advanced airway training.

Brown BS, Pogue KA, William E, Hatfield J, Thomas M, Arthur A, Thomas SH. Helicopter EMS Transport Outcomes Literature: Annotated Review of Articles Published 2007–2011. Emerg Med Int. 2012;2012:1-21.	Multiple	To determine the outcomes of HEMS services around the world	• Updating two previous annotated bibliographies on key outcomes-based research in the field of HEMS services. New literature spans 2007-2011.	Literature Review	• Annotates 26 HEMS articles separated into 8 clinical areas: Airway; Cardiac; Costs and Benefits; Drowning; Neurosurgery; Pediatrics;Trauma-Scene Transport; Trauma-Scene and Interfacility; Trauma Interfacility • Of these, 7 reviewed articles included rural-specific considerations • 6 of these 7 relevant articles had been captured in our initial search and these annotations were used as a secondary reliability exercise and an opportunity to place rural-specific findings in a broader context.
Browning Carmo KA, Williams K, West M, Berry A. A quality audit of the service delivered by the NSW Neonatal and Paediatric Transport Service. JPCH. 2008 May;44(5):253-72.	New South Wales, Australia	Review of satisfaction of parents of transferred pediatric patients under NETS program, as well as satisfaction of referring and receiving physicians	• At NETS (NSW Neonatal and Peds Transport Service), single call dispatch from referring hospital with clinical coordinator connecting to retrieval consultant and thereon to necessary	Case Study	• Parent feedback included the need to travel with their child or know why they could not and receive a phone call to notify them of the child's status after transfer.

			(sub)specialists at the preferred referral facility. • When retrieval indicated, NETS makes arrangements for transport vehicle/team as well as receiving hospital bed. • Retrieval team includes intensive care nurse and a doctor. • Data is kept on patient status (vital signs) throughout journey. Data is reviewed internally and is also used in NSW incident monitoring and review.		• Receiving physicians appreciated conference structure of NETS referral for understanding when patients could not be accommodated • Receiving physicians frequently indicated that patients were more sick than indicated during transfer request
Butler DP, Anwar I, Willett K. Is It the H or the EMS in HEMS that has an impact on trauma patient mortality? A systematic review of the evidence. Emerg Med J. 2010;27(9):692-701.	Multiple	Reviews all population-based studies which evaluate the impact of helicopter transport on trauma patient mortality	• Included 23 eligible studies. • 22 studies urban.	Systematic Review	• 14 demonstrated significant improvement in trauma mortality. • Mostly level III evidence, no randomization. • Importantly notes that we have to consider the capabilities of EMS team and system separately from the mode of transport. • Only one study examined rural

					(Arizona), which was a study that found ground medical transport to have better mortality outcomes.
Cable GG. Retrieval principles for rural GPs. Aust J Rural Health. 1994 Aug;2(4):47-52.	North West Region, Australia	Overview of clinical and practical considerations for how to stabilize a patient in a rural hospital for retrieval	• Short description of Tamworth Base Hospital Retrieval Service in the remote areas of the North West Region of Australia includes equipment list. • This service uses doctors from base hospital on 24-hour on call shifts and an Emergency Medicine Consultant is available 24 hours a day to offer advice regarding retrievals to both referring and retrieval doctors.	Expert Opinion	• Equipment carried: Standard 'Thomas' pack; drug box; oxylog ventilator; propaq monitor with ECG, NIBP, Pulse Oximeter, invasive pressure monitor; Syringe pump; 'Lifepack' defribrillator; Cellular telephone.
Caldow SJ, Parke TRJ, Graham CA, Munro PT. Aeromedical retrieval to a university hospital emergency department in Scotland. Emerg Med J. 2005 Jan;22(1):53-55.	Scotland	Considers the clinical challenges and potential benefits of a hypothetical system of formalized advanced ambulance care.	• Scottish air paramedics are trained in intubation without drugs and needle thoracentesis but not anaesthetic drugs or formal thoracostomy • Cites literature arguing the addition of physicians to prehospital services saves lives	Case Study	• This article describes a non-formalized inter-hospital transfer program in which rural physicians phone the accepting hospital directly to arrange transfer with an ICU consultant • At that point, a retrieval team is organized from

					available and appropriate hospital staff at the receiving hospital and a mode of transport is arranged through the Scottish ambulance service 'airdesk'. • This 'airdesk' manages all air ambulance resources and may even liase with the military for aircraft • Ground ambulance is needed between airports/helipads and hospitals. • Common factors among ten studied rural retrievals were reduced consciousness and an at-risk airway requiring rapid sequence intubation or tube thoracostomy – skills not available to Scottish paramedics or rural GPs. • Thus, authors allude, rapid intubation skills and not necessarily physicians are needed in

					patient transport/transfer.
Carr BG, Caplan JM, Pryor JP, Branas CC. A meta-analysis of prehospital care times for trauma. Prehospital Emergency Care. 2006 Mar;10(2):198-206.	United States (National Scope)	Sought information on national prehospital times to definitive care.	• N=155,179 trauma patients from 20 states from 49 observational studies over 30 years. • Article notes that the mortality/morbidity effect of response time intervals in trauma are unclear as the literature differently grades trauma. • Further, the 'golden hour' is unsubstantiated in the published literature. Evidence exists showing decreased on-scene time can lead to improved outcomes and also exists showing that aggressive, out-of-hospital resuscitation and stabilization may do better but require longer on-scene times.	Meta-Analysis	• Analysis found that helicopter ambulance time intervals (activation, response, on-scene and transport) were significantly longer on average than urban, suburban or even rural ground ambulances. • As well, total prehospital care time intervals for helicopter ambulances increased from time period 1 (1975-1989) to period 2 (1990-2005), while ground ambulance times (including for rural) decreased over time. • As well, on-scene time decreased for all modalities between time periods. • Rural ground ambulance overall average time was over 57 minutes in

					period 1, down to 42.5 minutes in period 2 with on-scene time accounting for most of the change.
Charash WE, Caputo MP, Clark H, Callas PW, Rogers FB, Crookes BA. Alborg MS, Ricci MA. Telemedicine to a moving ambulance improves outcome after trauma in simulated patients. J Trauma. 2011 Jul;71(1):49-55.	United States	Evaluated the impact of telemedicine (TM) to a moving ambulance on outcomes in simulated trauma patients.	• Patient simulator study (METI HPS unit, 33 year old standard male template used) • Small sample – 20 EMTs, 12 physicians offering consultation • Uses video telemedicine system called FAST STAR. Based on inter-hospital telemedicine system that gives rural docs 24 hour access to trauma surgeon consultation. • Ambulance is equipped with a touch-screen workstation and two fixed cameras on the ceiling with adjustable pan/tilt/zoom that can be controlled from either end of the telecoms links. Audio is via wireless Bluetooth headset. • Video is sent over five cellular modems, and a	Patient Simulator Study; Prospective, hypothetical	• In TM group, 22 of 24 simulated runs with potential demise resulted in normalization of vital signs. • In 16 non-TM runs, all 16 simulated patients died. (Reduced mortality of 100% to 8%). • Using TM, paramedic group was able to perform needle thoracostomy and pericardiocentesis and deliver intravenous mannitol. • Recognition and treatment of tension pneumothorax, impending herniation (closed head injury scenario) and on-going hemorrhage was similar between TM and non-TM, with TM group

			6th is used for bidirectional audio and monitor information (ECG, HR, resp rate, BP and pulse oximetry). All information is sent in encrypted packets over internet • Physician consult workstation is dual-monitor and can access cameras, logged and scrollable ECG and vital sign data and ambulance GPS. Physician can 'telestrate' by drawing on ambulance touch screen using remote mouse control. • Study used 'intermediate' EMTs – able to obtain IV access but scope does not include intubation, needle thoracostomy or pericardiocentrisis. This level is similar to BC's Primary Care Paramedic commonly found in rural. • In Telemedicine (TM) group, used telemed link, in non-TM group, could		having more consistent success. • In pericardial tamponade (profound tachycardia and hypotension following on-going hemorrhage simulation), 92% of TM group identified jugular distention and recognized tamponade, while just 13% of non-TM group did. 38% of Non-TM group administered 2nd fluid bolus compared to 100% of TM group.

			only radio with medical control according to standard protocol (non-consultative) • Physicians were blinded to both trauma scenario and paramedic scope of practice, paramedics blinded to scenario.		
Chesters A, Keefe N, Mauger J, Lockey D. Prehospital anaesthesia performed in a rural and suburban air ambulance service staffed by a physician and paramedic: a 16-month review of practice. Emerg Med J. 2014 Jan;31(1):65-68.	UK	To describe success of use of prehospital intubation procedures by physicians staffing an air ambulance service	• All rapid sequence intubation between October 2010 and January 2012 by East Anglican Air Ambulance • The team was activated 1, 156 times and attended 763 cases. A total of 88 RSIs. • Procedures already tested in an urban environment, study reports on first 16 months of protocol use in suburban and rural	Retrospective chart review	• 16 month review which found no failures among 88 rapid sequence intubations in the prehospital environment. All but 2 were completed by Registrar or Consultant Anesths/Emerg Med specialists. Other 2 by GP.
Corfield AR, Thomas L, Inglis A, Hearns S. A rural emergency medical retrieval service: the first year. Emerg Med J. 2006 Sept;23(9):679-83.	Rural West Scotland	Describes the first year of an emergency medical retrieval service to service remote Scotland	• The NHS Argyll & Clyde Health board area is geographically extensive with numerous inhabited islands. Much of its population live in remote locations far from an emergency department	Case Study	• EMRS attended 40 patients • 34 were transferred by the EMRS; 2 were deemed not to require transfer; 3 died within 4hours of arrival; 1 patient died in

			and specialist hospital care • A retrieval service (EMRS) was established in October 2004 to provide rapid access to critical care for 32, 700 patients living in remote parts of the health board area served by five remote community hospitals • A national paediatric retrieval service already exists • Consultants in emergency medicine, intensive care, or anaesthesia staff the retrieval service together with a flight paramedic from the Scottish Ambulance Services • Study of first 12 months of EMRS		prehospital environment • In addition, consult was given on a further 21 patients • 21 of 40 attended patients required RSI and ventilation; 1 patient had complications from RSI • Of 34 transferred patients, 2 died within 24hours of referral facility arrival • ISS calculated for trauma patients (n=17), with 76% (13) scoring >15. Median score was 23. • TISS scores for all 34 patients, 26 (79%) >10; median score was also 23. • Median SAPS II score of 27 measured patients = 24; Median APACHE II scores of 33 measured patients = 11. • Authors contend that severity of injury/illness demonstrates the need for such an urban retrieval service to

					support rural and remote health services to ensure equity of access to advanced health care
Cox-Kerrigan K, Ritz K. These nurses have wings! Fort McMurray's Flying Hospital is the only one of its kind in Canada. Can Nurse. 1984;80(9):12.	Northern Alberta, Canada	Disseminate early model of flying nurse-based EMS	• First flying nurse program in Canada • Started when Fort McMurray held a mostly itinerant population of ~31,000 [Not listed in article]	Editorial Case Report	• 7 nurse rotation of specialized critical transport nurses intended to move away from 'first available nurse' model in critical care transport • 12 hour shifts provide 24-hour air ambulance service • Ground time spent in various hospital rotations in referral hospital in Fort McMurray, most often critical care • Rely on specialized training and experience of nurses to prepare themselves for the role, including what to wear • 30 minute mobilization; averages 42 medivacs/month, including interfacility transfer to Edmonton

					and Calgary • Given the age of the program and editorial nature of the article, specifics are not generalizable
Cummings G, O'Keefe G. Scene disposition and mode of transport following rural trauma: a prospective cohort study comparing patient costs. J Emerg Med. 2000 Apr;18(3):349-54.	Alberta, Canada	Compares patient costs of direct transport to a trauma centre to those incurred through transport to a rural hospital first.	• Of 128 injured patients from 1994-1996 to arrive at the tertiary centre by ambulance within 24hour of injury, 23 were excluded for use of fixed wing aircraft, urban injury site, or lack of actual admission to the trauma centre • 105 remaining patients considered ,of which 52 were transported from the scene to a rural hospital and 53 were transported directly to the trauma centre • Authors did not include rural hospital costs or overhead costs (eg. the helicopter lease was listed as nearly $1.4million but was not included in patient costs)	Comparative cohort study	• Those taken directly had a higher average ISS score (19 vs. 12) but not difference in mortality • Average total cost for the whole cohort was $5,570 per patient, ranging from $3,874 to $11,643 based on length of stay (0 days to 101 days; average 6 days) • Lower transport costs found in direct transport group (avg: $826; range $559-1,132) vs. indirect transfer (avg. $1,219; range $898-1,556). • Hospital costs, however, were higher. • Consequently, the total costs were very similar between groups (non statistically significant difference): avg $5,435 among direct transport

					(range $3,508-12,885) vs. avg. $5,748 for indirect (range $4,342-9,500) • As well, ground transport patients had lower transport costs (and lower total costs) regardless of direct or indirect transport • Authors argue that because transfer by a helicopter after prehospital transport to a rural centre is more expensive than direct scene-to-trauma centre helicopter transport, cost efficiency is on the side of direct transport. Their own data is equivocal on this point.
Cunningham VL. The evolution of the Yukon Medevac Program in an environment of fiscal restraint. CMAJ. 1999 Dec;161(12):1559-62.	Yukon, Canada	Editorial history of the development of the Yukon Medevac program for rural, remote and very remote northern service	• Yukon is vast area of 483 350 km2 with just 32,000 inhabitants (24,000 of those in Whitehorse). • Two hospitals in territory: 4-bed cottage hospital in Watson Lake; the 52-bed Whitehorse General Hospital	Case Report	• Poor response times due to ad hoc staffing; retrieval services were not required of hospital staff and no dedicated team existed. When medevac was requested, the hospital had to find a willing nurse or a

			• The Whitehorse General Hospital offers the services provided by general and family practitioners, a general surgeon, a pediatrician and an obstetrician-gynecologist. No CT-scan services. The referral centres for Whitehorse General Hospital are in Vancouver and Edmonton, approximately 2,500 km • Ground ambulance covered communities within 175km radius of Whitehorse; Clear need for air transport • Formal air transfer started in 1998; prior to that, all air transports were done on an ad hoc basis without dedicated air carrier, staff, or even protocols or guidelines. • Audit in 1995 found the system lacking; retrieval times of over 5 hours for critically ill patients, problems with consistency		willing physician • Yukon government agreed to first fund medevac missions by paying nurses and physicians for them • Later, added 4.5 “floating” medevac nurses who would work in the hospital but act as first medevac responders • However, short staffing in this hospital meant these nurses had difficulty getting away from their duties. • Extra-territorial transfers were staffed on an ad hoc basis as well until a review found untrained and unqualified staff were involved. • In 1998, Yukon hired three ¼ time flight nurses to run the medevac system. As well, 6 physicians are rostered for emergency retrieval services and can be paid for such

			and quality in standards, training, protocols and procedures • In 1998, 207 intraterritorial missions and 110 extraterritorial missions flown		missions. • Protocols were adopted from the Keewatin Air transport group in Manitoba. • In 1997, two dedicated aircraft (pressurized with suitable equipment and pilot) contracted.
Droogh JM, Smit M, Absalom AR, Ligtenberg JJ, Zijlstra JG. Transferring the critically ill patient: are we there yet? Crit Care. 2015 Feb;19(1):62.	Multiple	Literature review on the organization and safety of transfers for critically ill adults.	• Examines the widely variable numbers on incidents during transport. These range from 3-75% in the literature based on various definitions of 'incident.' • The most common medically adverse events are cardiovascular or respiratory. • Cardiovascular events (hypo-/hypertension, brady-/tachycardias and arrhythmias) vary in the literature from 6-24%. • Respiratory events occur in 0-15% of transports.	Literature Review	• Most critically, equipment failure accounts for as much as 46% of all incidents, and occur during 9-36% of transports. • Specialized teams have been shown to reduce equipment failure incidence rates. • Factors associated with reduced incidents are "good crew skills/teamwork, checking equipment and the patient, patient monitors and good interpersonal communication." (3). • Specialized transport teams are also celebrated in the

					literature for their capacity to provide critical care skills to facilities, both urban and rural, when not performing a transport. • Best evidence currently suggests mode of transport does not affect outcome.
Duchesne JC, Kyle A, Simmons J, Islam S, Schmieg RE, Olivier J, McSwain NE. Impact of telemedicine upon rural trauma care. J Trauma. 2008 Jan;64(1):92-98.	Mississippi, USA	Analyzes outcomes before (pre-TM) and after (post-TM) implementation of telemedicine in the management of rural trauma patients initially treated at local community hospitals before trauma center transfer.	• Level I Trauma Centre; 3,500 trauma activations /year, 60% of which are transferred from community hospitals • Introduction of telehealth intervention for triage, screening among EMS and later among local community hospitals that are part of trauma network • 2.5 year retro analysis of pre-TM era (where local hospitals performing initial evaluation without assistance from the trauma centre) (n=351); and 2.5 year retro analysis of post-TM era (n=463) • TM involved dual video	Retrospective Chart Review	• With TM involvement, transfer rate fell from 100% at mean ISS of 10 to 11% at mean ISS of 18 (more appropriate transfer) • Higher TC mortality rate (7.8% post vs. 4.8% pre) reflects lower survival likelihood of transferred patient population. 1 death in local hospital post-TM. • Trauma centre hospital costs: pre- $7.63M, post- $1.13M

			cameras with remote control capability by TC operator • NPs with ATLS certification at local site begin by pressing 'On' to connect local camera into sustained bridge call, allowing TC doctors to monitor emergency room. If/when the NP needs a consult, he or she can press 'Consult' or 'Stat' depending on severity		
Edge WE, Kanter RK, Weigle CG, Walsh RF. Reduction of morbidity in interhospital transport by specialized pediatric staff. Crit Care Med. 1994 Jul;22(7):1186-91.	New York, USA	Compared the occurrence of morbidity during high-risk interhospital transport in two types of transport systems: specialized tertiary center-based vs. nonspecialized, referring hospital-based.	• Concurrent, prospective study of two like pediatric ICUs with different transport teams in Syracuse and Albany, New York. • 141 total high-risk patient transports going to one of two units • Captured two types of in-transport problems: observable clinical signs of deterioration and 'adverse events' such as loss of intravenous access, endotracheal tube complications or	Prospective comparative cohort study	• Adverse events occurred in one (2%) of 49 transports by the specialized team and 18 (20%) of 92 transports by nonspecialized personnel ($p<0.05$) • Physiologic deterioration was similar in the two groups occurring in five (11%) of 47 specialized team transports and 11 (12%) of 92 transports by the nonspecialized team • Findings suggest that specialized teams

			equipment failure/exhaustion		reduce equipment problems.
Evans R, McGovern R, Birch J, Newbury-Birch D. Which extended paramedic skills are making an impact in emergency care and can be related to the UK paramedic system? A systematic review of the literature. Emerg Med J. 2014;31:594-603.	UK	Sought to discover which extended paramedic skills are necessary for effective reduction of ED conveyance	• Aimed at finding paramedic skills which may reduce ED conveyance and extend primary care to the community through paramedics/EMS • UK health system is targeting reduced ED conveyance as a spending efficiency as well as care appropriateness measure • 19 included articles: 14 articles considering paramedic assessment and management skills; 2 on paramedic safeguarding skills; 2 health education; and 1 health information article	Systematic Review	• Evidence not strong enough to guide policy yet; primarily descriptive • Recommends further research to include: EMS trial register to improve research knowledge sharing; centralized database of ambulance and emergency patient data using a common reporting template; adopt systems perspective to assess the impact of all system actors • Further evidence needed in: paramedics working with GPs; paramedic referrals to non-EDs; Paramedics assessing and managing acute minor injuries in the elderly (or other higher risk populations).

Falcone RE, Herron H, Werman H, Bonta M. Air medical transport of the injured patient: scene versus referring hospital. Air Med J. 1998;17(4):161-65.	Rural Ohio, USA	Examined air transports, comparing direct from scene and interhopsital air transport for severely injured.	• In 1996, 25,000 sq miles of service area in Ohio, covered by 536 separate EMS programs each with their own protocols, procedures and medical direction. Some staffed by volunteers • All patients within 30 minutes ground transport to an emergency department.	Retrospective review	• Patients with indirect transport to a referral centre included 6 potentially preventable deaths, all in patients between the ages of 53 and 90 (average age=73). Among those transported directly, just one potentially preventable death (to a 24 year old) due to prolonged extrication from the scene. • Authors review similar literature in air transport to find very mixed results from around the United States, with pediatric studies tending to show improved outcomes for direct transport and otherwise no understandable pattern to observational study outcomes. • This reflects the very significant contextual differences in each place of study as well as the small samples prone to

					bias from rare mortality events.
Fan E, MacDonald RD, Adhikari NK, Scales DC, Wax RS, Stewart TE, Ferguson ND. Outcomes of interfacility critical care adult patient transport: a systematic review. Crit Care. 2005 Feb;10(1):R6.	Multiple	Systematic review of adverse events in the transport of intubated and mechanically ventilated adult patients.	• 2 USA studies; 1 Finnish; 1 French; 1 German	Systematic Review	• Only 5 studies (245 patients) included with heterogeneous indicators. • Pre-transport status was only recorded in two studies (one by SOFA score, the other by blood gas), and only one reported severity of illness on accepting hospital arrival (APACHE score). • The critical value of this review is to show that the safety of interfacility transfer is not well studied in this patient population. Thus, the decision to transfer has little empirical backing and remains a decision by the referring physician based on the clinical experience, expertise and available support.

Fatovich DM, Phillips M, Jacobs IG, Langford SA. Major trauma patients transferred from rural and remote Western Australia by the Royal Flying Doctor Service. J Trauma. 2011;71(6):1816-20.	Western Australia	Studies the effect of distance and remoteness on patients transferred by the Royal Flying Doctors Service	• Trauma Registry and RFDS database linked for data from 1997-2006 • 1,328 major trauma transfers to Perth in that period • The variables of interest included demographic data, cause, remoteness location of the trauma, distance flown, ISS, outcome data, and time data • Western Australia is a state with an area of 2.5 million km2 and a population of 2 million people with one major metropolitan area (Perth) of 1.4 million. • The only tertiary hospitals in the state are in Perth. Transferring trauma patients for definitive care over distances of up to 2,500 km is required • Remoteness defined by Accessibility/ Remoteness Index of Australia (ARIA) • Major trauma defined as >15 ISS	Retrospective review	• After adjusting for ISS, age, and time, the risk of death increases as remoteness increases: outer regional odds ratio (OR), 2.25 (95% CI, 0.58–8.79); remote, 4.03 (95% CI 1.04–15.62); and very remote, 4.69 (95% CI, 1.23–17.84). • Risk increases by 87% for each 1,000 km (OR, 1.87; 95% CI, 1.007–3.48; p< 0.05) flown. Despite long retrieval times, there were no deaths in flight. • Remoteness, as measured by the ARIA, is more important than distance, in the risk of death. • The 'Golden Hour' is irrelevant in rural and remote trauma

			• Mean transfer time was 11.6 hours. The median ISS was 25, and there were no differences within the ARIA classes for cause and injury patterns.		
Feazel L, Schlichting AB, Bell GR, Shane DM, Ahmed A, Faine B, Nugent A, Mohr NM. Achieving regionalization through rural interhospital transfer. Am J Emerg Med. 2015 Sept;33(9):1-9.	Iowa, USA	Aims to identify strategies that should be considered for development of regionalized emergency health care systems.		Literature Review	• Discusses the potential value of clinical decision rules to support the decision to transfer. • Found that clinical decision rules have been tested successfully in the selection of appropriate transport personnel for specific missions: • In two studies, brief 15-20 minute training sessions improved pre-transfer triage and appropriate transport personnel selection. However, both studies came from urban environments. • Discusses the value of health information exchanges (such as shared EHRs) for improving interpersonal and interfacility

					communication and reducing repeated tests and repeated admissions. • Back transfer is argued by the authors to be safe for many hemodynamically stable unstable angina, non-STEMI, STEMI patients after uncomplicated angiography and PCI. • Transfer back to a rural hospital for monitoring could improve patient perceptions of care, which are found to depend significantly on the proximity of care to home. • The mortality rate for ambulance workers estimated at 9.6 fatalities per 100,000 emergency medical services (EMS) workers per year due to traffic accidents. • The mortality rate for rotor wing ambulance crew has increased in

					recent years, being estimated at 164 fatalities per 100,000 helicopter EMS crewmembers in 2008
Garwe T, Cowan LD, Neas BR, Sacra JC, Albrecht RM. Directness of transport of major trauma patients to a level I trauma center: a propensity-adjusted survival analysis of the impact on short-term mortality. J Trauma. 2011 May;70(5):1118-27.	Oklahoma, USA	Study compared mortality for those taken directly to Level1 Trauma Centre (TC) and those transferred to Level 1 TC	• EMS, Trauma and hospital registries all linked. Thus, equivalent of population data. However, patients were included only if they reached the Level 1 TC, so rural hospitals are still framed out. Oklahoma is a mostly rural state with just one Level I trauma centre. • Used propensity weighting for decision for direct transport (time of day, distance, injury severity, etc.). Also used multi-variable regression to control for distance, time since injury and other factors. • 1,998 patients treated at the Level I Trauma Centre from 2006-2007; 600 transferred from smaller facilities, the rest directly transported	Retrospective cohort study	• Found increased risk of mortality among transferred patients: Hazard Ratio of 2.7 (CI 95% 1.31-5.6) in 2-week mortality (only sig. finding) • No difference in patient length of stay, even after adjustment • Excellent study, very well organized, very high quality data for this field • Some issues the authors acknowledge in assigning blame within the system include: ○ 61% of transfers were of patients who were initially transported by BLS services – some of these patients perhaps should have been sent directly to the TC, but triage

					and stabilization were required at the local hospital; ○ long distances to central services would remove EMS providers from their local area, which may influence decision making about transport; ○ prehospital EMS providers could initiate air transport or critical care teams for direct transfer (or, arguably, to rendezvous at local hospital); ○ trauma life support training is not mandated in Oklahoma, meaning that severity may not have been recognized at small hospitals; ○ lack of standard protocols for trauma and/or transfer may have created undue

					delays. • Authors conclude that in rural areas with limited EMS services, transport to local facilities may be necessary. Educational interventions and standardized protocols would reduce time to transport and time to definitive care for those in need of highly resourced centres. • Analysis: the frequent focus on reducing non-therapeutic testing is a red herring. It appears unnecessary and costly in those patients who are transported, but would appear appropriate in the diagnosis and treatment of a patient who was not transferred. Rural hospitals do treat people, and so the use of imaging is understandable. However, greater awareness of injury

					severity and the use of standardized protocols may still reduce unnecessary testing.
Garwe T, Cowan LD, Neas B, Cathey T, Danford BC, Greenawalt P. Survival benefit of transfer to tertiary trauma centers for major trauma patients initially presenting to nontertiary trauma centers. Aca Emerg Med. 2010 Nov;17(11):1223-32.	Oklahoma, USA	Evaluates mortality differences for patients initially presenting to nontertiary trauma centers in a predominantly rural region and later transferred to a tertiary centre	• 104 nontertiary trauma centres (Level III or IV) • Outcome of interest was 30-day mortality, defined as death at either the nontertiary trauma center or the tertiary trauma center within 30 days of first arrival • Included data on mode of transport (EMS vs non EMS) but did not perform analysis on this variable • - Transfer guidelines exist in Oklahoma, but were found to not be applied consistently.	Retrospective Cohort study	• Crude mortality was lower for patients transferred to tertiary trauma centers compared to those remaining at nontertiary trauma facilities (hazard ratio=0.59 (95% CI 0.48-0.72). - After adjusting for the propensity to be transferred, ISS, presence of severe head injury, and age, transfer to a tertiary trauma center was associated with a significantly lower 30-day mortality (HR = 0.38; 95% CI = 0.30-0.50) compared to admission and treatment at a nontertiary trauma center. • Observed survival benefit was similar for patients transferred to a Level I trauma center

					(HR = 0.36; 95% CI = 0.2-0.4) and those transferred to a Level II center (HR = 0.45; 95% CI = 0.33-0.61). • Found that decision to transfer was not based on clinical indicators, including age (older patients less likely to be transferred) and insurance status (those without insurance more likely to be transferred).
Gentry G. Decade of care in the air for MedLink AIR. Air Med J. 2002 Mar-Apr;21(2):24-27.	Wisconsin, USA	Describes MEDLINK services in Wisconsin	• Important service to support volunteer-based EMS systems in rural Wisconsin • Can be activated by police, fire or EMS personnel (volunteer or otherwise) to attend a scene • In response to a survey, marketing and rural education programs are planned to improve awareness of the service	Editorial Case Report	• The flight nurses share positions in the hospital: 25% of their time is spent assigned to the coronary care unit, ICU, or neonatal/pediatric ICU. Thus, flight nurses can offer invasive services in flight, such as central line placement and monitoring with an intra-aortic balloon pump. • Flight paramedics also regularly spend time assisting in the ED and with ground ambulance

					services. • Medical directors ensure protocols are continuously updated with the help of specialists in each area of MEDLINK care • “No longer are we just fo- cusing on what’s happening once a pa- tient arrives in the hospital. This system is now all encompassing, from the in- jury scene to rehabilitation or discharge. It is an all-inclusive system that stan- dardizes care and procedures.” (26)
Gill M. From the Central Valley to the Sierras: Air Med Team. Air Med J. 2001 Jan-Feb;20(1):22-24.	California, USA	Describes California Air Med Team service	• 6 years in the Sierra mountains and valley • 4,200 accident free missions and 1,900 patient transports since 1994 • Pilots average 7000 hours experience • Nurses and paramedics each average over 10 years experience	Editorial Case Report	• Nurses are given addi- tional training in central line, arterial line, and chest tube insertion, as well as intra-aortic balloon pump and neonatal isolette management. • All crew members are required to maintain certification in ACLS, PALS, NRP, ENPC, and

					BTLS/PHTLS. Nurses also are required to hold TNCC, FNATC, and either CCRN or CFRN recognition. • Ride-along program allows people (including current medical professionals) with a genuine interest in air medicine to spend a 12-hour day with the flight crew, sharing both the routine chores and the intensity that comes with an activation
Giller CR. CALSTAR – committed to another 25 years of safe and secure patient transports. Air Med J. 2009 Sep-Oct;28(5):237-41.	California, USA	Describes California Shock Trauma Air Rescue service	• 40,000 patient transports in 25 years • 250 employees dedicated exclusively to patient transport • Pilots have min. 3000 hours flying time • Diverse ecology served by 12 different bases in State • CALSTAR nurses have 3-5+ years experience in critical care • Connected with Dr. Alois Zauner, one of only 50 neurovascular surgeons in	Editorial Case Report	• CALSTAR advocates for auto-launch protocols with regular EMS crews • "The guiding principles of CALSTAR's Quality Improvement Program are: ○ Quality improvement is everyone's responsibility. ○ Quality/value cannot be demonstrated unless we define it, measure it, analyze

			America • Helped develop stroke and neurovascular protocols and his centre is a referral and consultation unit for CALSTAR Santa Maria “flagship” base • CALSTAR has developed a field STEMI protocol that is not discussed in detail		it, and reward it. ○ All outcomes are defined with the patient in mind. ○ Clinical practice should be guided by published evidence. ○ Quality data is to be used for improvement and prevention, not criticism or punishment. ○ We must continually ask, “Why do we do what we do and how can we do it better?” ○ Quality improvement practice must embrace the mission statement and core values of the company.”

Gillon SA, Kibar CR. Major haemorrhage in rural Australia: time for a novel solution to a unique problem? Med J Aust. 2012 Mar;196(4):242-43.	Australia	Discusses need for new blood products in rural prehospital environments	• In survey of rural transport services, Australian services reported difficulty accessing blood products. Only three of seven responding services had immediate access to PRBC, although all could obtain it within 45 minutes. None could obtain FFP without delaying departure, and only four (of 7) had access within 45 minutes • As logistical difficulties with storage and preparation render FFP impractical in remote Australia, alternative sources of coagulation factors must be explored	Editorial	• Suggests replacing FFP with freeze-dried factor preparations (fibrinogen concentrate and prothrombin complex concentrate). These are easier to store, transport and deliver, and may be safer and more efficacious than FFP • Data on freeze-dried factor preparations come from developing countries with limited access to blood products and its applicability to developed nation systems has been questioned. It may be highly applicable to remote and regional areas where FFP is scarce.
Gleeson P, Duckett S. Modeling the emergency ambulance pass-by of small rural hospitals in Victoria, Australia. J Rural Health. 2005 Jan;21(4):367-71.	Victoria, Australia	Aims to quantify the ambulance pass-by of local small rural hospitals and identify the factors that influence its occurrence.	• For rural paramedics, they are often expected to do both the initial transport and the potential patient transfer. • In the latter case, paramedics can be taken out of their community	Retrospective Review	• Found a very strong correlation between interfacility transfer and by-pass rate (r2=0.97). That is, the facilities that transfer patients the most often are also those that paramedics

			for extended periods.		most frequently choose to by-pass. • Paramedics appear to be making decisions to by-pass based on a personal risk-reward basis to reduce time outside the community or the time tied up with a single case. • Key to reducing by-pass may actually be to reduce inter-site transfer.
Haas B, Stukel TA, Gomez D, Zagorski B, De Mestral C, Sharma SV, Rubenfeld GD, Nathens AB. The mortality benefit of direct trauma center transport in a regional trauma system: a population-based analysis. J Trauma Acute Care Surg. 2012 May;72(6):1510-15.	Ontario, Canada	Compares mortality for MVAs between direct transport to a trauma centre and indirect referral through a rural hospital	• MVAs resulting in major trauma studied in Ontario. • 6,431 cases between 2002-2010; 45% triaged from the scene directly the trauma centre. • Data is strong and includes ED death before admittance. However, does not include prehospital death. • Uses an instrumental variable analysis, which is arguably inappropriate. Authors use county-level (regional) rate of transfer as the instrument	Population-based retrospective cohort study	• Found direct transport to TC improved mortality by 40%. 24 hour mortality OR=0.58 (95% CI .41-.84); 48 hour motality OR 0.68 (CI .48-.96). • However, distance to care is not discussed at all in the study and is a major influence on both outcome and rate of transfer. Thus, arguably, remoteness from TC and transfer capability/time to care is a confounder of rate of transfer as

			variable. The concept means the authors believe the rate of transfer to a Level I TC is not directly related to mortality. Instead, they believe care in a TC is related to mortality and that rate of transfer to that TC should be correlated with improved health only if that hypothesis is true. • Further, they contend that patient-level factors related to the probability of death should be equivalent across regions with substantially different rates of transfer, and thus the rate of transfer is an independent intervention – in this case, with an observed difference in mortality.		well as rate of mortality, thus implying that rate of transfer is not an instrumental variable. • As well, instrument variables are typically used in social policy analysis. For example, the effect of harmful substance tax rates on population health. In that instance, the instrument (taxation) and outcome (health) are not directly related. In this case, as transfer to a Trauma Centre can be clinically indicated, it is very likely an inappropriate instrument as it is directly related to likelihood of survival and survival.

Hains IM, Marks A, Georgiou A, Westbrook JI. Non-emergency patient transport: what are the quality and safety issues? A systematic review. Int J Qual Health Care. 2010;23(1):68-75.	Multiple	Examines the factors associated with the quality and safety of non-emergency transport services.	• 12 articles from 7 countries (USA, Europe, Australia and Jamaica) published between 1990 and 2009. • Examines transport of patients between hospitals, rehabilitation services, nursing homes and patients' homes. • Centralization and specialization means growing patient transport needs and costs. In 2007/08, Australia spent $A2 Billion on patient transport, an annual increase of 8.5% • Non-emergency patients still often have serious and/or chronic illness and have definite needs with regard to appropriate staff, equipment, and support during transport. • Non-emergency patient transport still poses risk to patients • All studies addressed factors associated with the transfer process such	Systematic Review	• Efficiency, communication and appropriateness were the themes of good quality transport • Poor efficiency may result in increased hospital costs, longer hospital stays and patient anxiety • Good communication requires better documentation of patient information as well as better communication when organizing between facilities • Ambulance transfer of non-emergent patients is often unnecessary and should be addressed through guidelines.

			as communication, appropriateness of personnel, time to arrange transfers, and the safety and efficiency of the process. • Outcomes were measured in just one study (finding that higher risk patients had higher mortality than lower risk patients)		
Helling TS, Davit F, Edwards K. First echelon hospital care before trauma center transfer in a rural trauma system: does it affect outcome? J Trauma. 2010;69(6):1362-66.	Pennsylvania, USA	Compared those transferred to Level I Trauma Centre in Pennsylvania with direct transport	• 2,388 patients were transported directly and 529 were transferred 2003-2008 to the level I trauma centre • Incorporated age, sex, mechanism of injury (penetrating or blunt), Abbreviated Injury Scale (AIS) score, injury severity score (ISS), severe traumatic brain injury (TBI; Glasgow Coma Scale [GCS] score ?9), trauma-injury severity score probability of survival (derived from revised trauma score, ISS, age, and mechanism of injury), and comorbidity as	Retrospective observational chart review	• Found that care in rural hospitals (usually (55%) airway management) prior to transfer augmented/improved good outcomes. • Those who were transferred had lower mortality (no sig.), no difference in complications, no clinical difference in physiological parameters, had lower incidence of required operative procedures, shorter length of stay in ICU and hospital (no sig.) and no difference in discharge performance

			controlling variables • Better data than most: Used the physiologic parameters, such as systolic blood pressure (SBP), heart rate, GCS score, and shock on arrival at the Level I TC, time from injury to definitive (Level I) care, mortality, hospital length of stay (LOS), intensive care unit LOS, complications, number of operative procedures within the first 6 hours of arrival at the Level I TC, discharge disposition (home, rehabilitation or transitional care, skilled nursing facility, or other acute care hospital), and functional status on discharge from the Level I TC as outcome measures (dependent variables)		scores. • These equivalencies despite considerably longer times to trauma centre care (rural = 5.3 hours avg, +/- 3.8 hours; direct 1.6 hours +/- 3 hours).
Hill AD, Fowler RA, Nathens AB. Impact of interhospital transfer on outcomes for trauma patients: a systematic review. J Trauma. 2011 Dec;71(6):1885-1900;	Multiple	Compared direct transport to interhospital transfer patients	• 14 studies included in systematic review, 34 observational studies used in pooled meta-analysis.	Systematic Review and a Pooled Meta-Analysis	• No difference in length of stay or mortality found in pooled analysis (pooled mortality OR 1.06 (95% CI 0.90, 1.25).

discussion 1901.			• 8 studies were rural specific, some others were urban or mixed sub-urban/rural		• Conclude that there was no difference in length of hospital stay and no pooled difference in mortality among rural-specific populations either (rural subgroup pooled OR=0.94; 95% CI 0.77–1). • Authors caution that significant heterogeneity in setting and research design challenge the validity of quantitatively pooling results. • Found five studies from the United States which each reported higher costs of care for transferred patients rather than those transported directly to a Trauma Centre
Hill K, Harris N. Royal Flying Doctor Service 'field days': a move towards more comprehensive primary health care. Aust J Rural Health. 2008 Oct;16(5):308-12.	North Queensland, Australia	Examines the RFDS 'field day' program and its effect on community capacity to offer primary care in remote communities	• Field day program is the use of shared training and treatment opportunities as a capacity building opportunity for remote sites and a communication building opportunity between	Qualitative Case Study	• 'Field Days' by Royal Flying Doctor Service found to improve knowledge transfer and relationships in remote Queensland communities with primary health services

			sites. • Organized by the RFDS Promotions Officer • Days are used as shared CME for professionals, but also community health education. • People travel to specific place where a morning session focuses on education for community health priorities and the afternoon session is a shared clinic day between local providers and RFDS physicians • Topics have included preventing farm accidents, stress management, chronic disease prevention and management, fitness, nutrition and emergency preparedness. • Interviews with field day participants used		• Specifically, participants identified improvements in three of the four theoretical areas of capacity building: Network Partnerships; Knowledge transfer; Problem solving. • Authors found no improvement in the fourth identified pillar of capacity building – infrastructure development – which may limit sustainability of the practices learned through the program • Field Days help move communities toward a public health/primary care model of integrating community health needs with other community assets and needs.
Hotvedt R, Kristiansen IS. Doctor-staffed ambulance helicopters: to what extent can the general practitioner replace the anaesthesiologist? BJGP. 2000	Norway	Examines whether GPs could have provided the same level of care to patients who had a health benefit from	• 41 patients identified who had live-saving interventions from a rural helicopter ambulance services over a two-year	Retrospective chart audit	• In 17 of 29 cases, GP panel unanimously agreed that a GP could be reasonably expected to carry out the

Jan;50(450):41-42.		anaesthesiologists aboard a rural helicopter ambulance	period • A panel of three anaesthesiologists reviewed these cases to identify 29 who received critical physician intervention in the pre-hospital environment. • - Further, a panel of 5 GPs with between 8 and 13 years rural experience and familiarity with the helicopter service was convened to review each of the 29 patients in detail to indicate whether a GP could be expected to carry out the intervention used and offer insight into how many current GPs could do so		intervention, with 50-100% of GPs estimated by the panel to be currently able to do so depending on the case • 11 of 29 were unanimously agreed to be beyond the reasonable scope of a GP. These cases mostly involved the drugs suxamethonium, ephedrine, and dopamine. • 96% of estimated life gain from the two-year helicopter program was achieved from just 9 of the 41 patients with life saving transports. Three of those 9 were among the group of 11 that GPs indicated they could or should not reasonably be expected to care for. • - Thus, authors argue that a flight anaesthesiologist was critical in providing substantial health benefit to 3 patients

					over two years with estimated life year gain of 66, 27, and 9 years respectively.
Hotvedt R, Thoner J, Almdahl SM, Bjorsvik G, Berge L, Sparr T, Ytre-Arne K, Kristiansen IS, Forde OH, Magnus AC, Mamen K. Which groups of patients benefit from helicopter evacuation? Lancet. 1996 May;347(9012):1362.	Norway	Explores the benefit of helicopter transport for a scattered rural, northern population	• Two years of data from a rural helicopter ambulance service examined (1989-1990) (n=370 patients) • Based at University Hospital of Tromso in northern Norway • Helicopter staffed by a pilot, a paramedic, and an anaesthetist. Some times an obstetrician, paediatrician, or nurse is included • Study excludes flights without a doctor • Air transport only used outside the city. • Catchment area is 26,000 km2 with a scattered rural population of 80,000 • Most distant point is 130 km (45 mins flying one way • Two expert panels, one for those under 15 and pregnant women and	Retrospective modified Delphi study	• On average, patients arrived 69 minutes earlier by helicopter than expected to arrive by ground • Of 370 patients, 283 were determined by the anaesthetists who prepared the case-reports to have received no additional health benefit from helicopter lift compared with what would have been obtained with a ground ambulance • Of 90 considered by expert panels, a further 49 were unanimously considered to have not received additional health benefit from the helicopter lift • Thus, 89% of 370 transported patients would have done just as well with a ground

			panel 2 for all other patients • Panel 1 consisted of an anaesthetist, a paediatrician, an obstetrician, a general practitioner, and an epidemiologist • Panel 2 included an anaesthetist, a surgeon, an internist, a general practitioner, and an epidemiologist.		ambulance in retrospect. • The remaining 41 were believed to have received a health benefit by at least one panel member with an estimated benefit of 290.6 life-years. • 96% of the total number of life-years gained was achieved in nine patients, six of whom were aged below 7 (four were aged 0-7 months). • The life-year-gain per adult patient with cardiovascular disease was 0.54.
Iirola TT, Laaksonen MI, Vahlberg TJ, Palve HK. Effect of physician-staffed helicopter emergency medical service on blunt trauma patient survival and prehospital care. Eur J Emerg Med. 2006 Dec;13(6):335-39.	Finland	Assesses the immediate and long-term effect of a helicopter emergency physician giving advanced life support on-scene compared with conventional load and go	• 81 blunt trauma patients treated by physician-staffed HEMS, compared to 77 treated before the HEMS service was offered • Retro chart audit plus a questionnaire to survivors three years after trauma • Expected to find more aggressive prehospital interventions by physicians and likely longer prehospital times	Retrospective comparative cohort study	• Found anticipated 'aggressive' interventions (including medications, intubation and cannulation) • No added delay to hospital • Despite finding expected treatment and no added delay, still no clinical difference in outcomes among mostly urban and peri-urban Finnish

					patients. • Authors cite a 'trend' toward lower survival in physician-treated group (at p=0.65). • No difference in 3-year outcomes among survivors • Authors pay little attention to distance, however descriptive analysis shows that physician HEMS treated patients averaged 30 kms to hospital, while those in the control averaged 17km • May be that HEMS services expanded geographic coverage of high quality care and/or that rural patients benefited from prehospital interventions while the control group was more predominantly urban and thus arrived at tertiary care more quickly.

Jarvis CM. Aviation nursing in the Western Australian Kimberley. Aust J Rural Health. 1995 April;3(2):68-71.	Western Australia	Describes role of flight nurse in the Western Australia chapter of the Royal Flying Doctors Service	• Doctors accompany flights in only 10% of cases (despite name)
			• Flight nursing described as 'remote' nursing, as one nurse may be looking after up to 4 patients at 28,000 ft
			• Doctor escorts are mandatory for all ventilated and multiple trauma patients, sick neonates and children.
			• A police officer accompanies flights with violent psychiatric patients.
			• Due to the changes in barometric pressures at altitude, flight crews have to be aware of the consequences of decreased partial pressure of oxygen, expansion of trapped gases in patients and equipment, decreases in temperature and alterations to the moisture con- tent of the air.
				Descriptive Case Report	• Flight nurses have to have RN and Midwife certification
					• Recruitment of nurses can be difficult because:
					  ○ Must have 5 years' experience
					  ○ Some bases are in remote areas
					  ○ Must work alone most often
					• Average length of flight nurse service is 4-5 years
					• Required equipment and staffing decisions made at initial RFDS call
					• Patients are stabilized at local site before departure. Treatment may include: i.v. therapy (at least two wide bore cannula *in situ* for all critical patients), intubation: insertion of a nasogastric tube, chest drains with heimlich valves attached: catheters, splints and more.

Johnson K. Ground critical care transport: a lifesaving intervention. Crit Care Nurse. 2006;26(5):148-147.	West Virginia, USA	Describes Critical Care transport Teams.	• CCT teams function as a mobile ICU and must be capable of providing many of the services offered in a level I trauma center or a tertiary care cardiac center. • "it should be the goal of any CCT program to exceed the care being given at an outlying facility." (77) • Goal of patient transport is changing from simply 'survival' to maximizing the chance at a full recovery	Editorial	• Ground transport teams are necessary for the many cases in which flight cannot be accomplished, and when deployed, should have the capacity to function independently for 2-4 hours of transport time • Notes the importance of jurisdictional networks of care • CCT teams must be capable of advanced airway intervention such as rapid sequence intubation, surgical cricothyrotomy, escharotomies, and endotracheal intubation. • They should also have ongoing skill evaluations and training to ensure that patients receive the required level of critical care
Johnson P. Rural people's experience of critical illness involving inter-hospital transportation: a qualitative study. Aust Crit Care.	New South Wales, Australia	Explores the experiences of a group of people from rural NSW with a critical illness that necessitated their transfer by air	• Unstructured interviews in patient homes started with the prompt: "Tell me what it was like to experience a critical	Qualitative case study	• Patients experience anxiety about transport, confusion about the acuity of the illness, alienation in the large

1999;12(1):12-16.		ambulance to a metropolitan critical care unit	illness that also required you to undergo air-ambulance transfer to a metropolitan hospital." • 10 respondents • Patient transfer, transport and critical care guidelines appropriately emphasize the physiological outcomes of patients. However, a holistic approach would improve experiences		metropolitan hospitals and further confusion with regard to discharge planning • Authors argue that health care and nursing in particular are 'caring' professions at their essence, and so providers should be sensitive to the anxiety and confusion transfer can cause patients
Jones JB, Leicht M, Dula DJ. A 10-Year experience in the use of air medical transport for medical scene calls. Air Med J. 1998 Jan-Mar;17(1):2-7.	Pennsylvania, USA	Evaluates the use of air medical setvices in response to medical scene calls for transport to tertiary care in the rural setting. Methods:	• Review of all medical scene calls by an air medical service between 1986-1995 covering (a mostly rural) 100-mile radius around a tertiary centre • ALS services almost universal through ground or air. • Air service included a nurse/paramedic crew, with resident physician accompaniment on request • 8,106 flight missions occurred in ten year period, of which 100 per	Retrospective chart audit	• 115 procedures done for 85 patients, including central line placement, cardiac resuscitation, rapid sequence endotracheal intubation, and defibrillation • Authors believe that air transport was justified in 71% of reviewed cases, however only 53% were indicated for transfer to a tertiary centre • Evacuation of a rural patient from the scene was a very small proportion of cases for this flight team

			scene calls • 85 of these 100 had available charts and met the criteria of Emergency Medicine patients • Most commonly these were for cardiac events (n=30)		• Authors believe cardiac patients did not receive a health benefit from the service in these cases • Authors argue that rural sites should be given guidelines on appropriate HEMS use to improve efficiency of service for their area
Jones R, Langford S. Australia's flying doctors. How the world's largest aeromedical response service provides effective patient retrieval in the Outback [Alternative title: Australia's Royal Flying Doctor Service is the World's Largest Aeromedical Response Service]. JEMS. 2015;40(4):39-43.	Australia (national)	Describes the success of the Royal Flying Doctors Service for rural and remote care	• RFDS had an average of 148 patient transports per day (54,705 annually), 44 fly- or drive-in remote health clinics per day (16,096 clinic days per year) and 225 telehealth consultations per day (82,305 per year) • 67 aircraft – fixed wing teams comprised of a physician and a nurse (Anesth or emerg doc; Emerg or critical care nurse); On rotary aircraft teams, doctor and paramedic used. • Royal Flying Doctor Service uses fixed wing aircraft beyond 130miles	Case Description	• Royal Flying Doctors have strategies to reduce unnecessary flights/transfers, including 2,600 'medical chests' with equipment and medications. The coordinating centre, then, has an awareness of what is available in the remote site and can instruct the local medical professional on what to use, how and when. • "The outcomes of RFDS telehealth vary from providing reassurance to a patient or their caregiver, providing

			from an urban centre because it allows larger teams and more equipment "in order to extend hospital-level care to the patient" • Telehealth expected to grow from radios, phones and sattelite phones to audio-visual media and computerized interactions		guided care to a patient, launching a medical team to attend the patient on scene, or undertaking an aeromedical evacuation. The timely use of telehealth and medical chest resources is often sufficient to sustain a patient while aeromedical retrieval is launched until medical care can reach the patient."
Judge, T. LifeFlight of Maine: the gift of trust. Air Med J. 2009 Jan-Feb;28(1):22-25.	Maine, USA	Describes LifeFlight HEMS service	• LifeFlight claims to be a medical company, rather than a medical transportation company. • Goal is to 'bring hospital to the patient' • Most of state is rural (80% by land mass) and flight can be challenged by practical issues • Infrastructure was costly to create, including helipads, fuel farms and more. Required state money as well as state-wide relationships with	Editorial	• Uses medical directorship at each of the State's three trauma centres • Also uses a 15-specialist Clinical Practice Committee to maintain updated protocols and training • LifeFlight is also a lever of change in other concurrent systems, developing a traumatic brain injury protocol and then helping other EMS and hospital staff to

			airports, hospitals and more. • Early crash was blamed on VFR (visual flight) being engulfed in poor weather and running out of fuel • Operated as a stand-alone business unit responsible for own budget • Has enjoyed funding from charity, state public dollars, and corporate owners for infrastruture and more.		bring it online throughout the state • Instrument based flight (IFR) was implemented as a necessary part of care in rural and geographically challenging areas. • IFR is costly and typically only used in commercial and urban flight vehicles, but has made LifeFlight viable all year in all areas of the state • IFR requires more training for pilots as well as more equipment for aircraft
Kapasi H, Kelly L, Morgan J. Thrombolysis in the air. Air-ambulance paramedics flying to remote communities treat patients before hospitalization. Can Fam Physician 2000 Jun;46:1313-19.	Sioux Lookout Health District, Canada	Describes current pilot project for delivering thromboyltics to remote First Nations patients during transport to hospital	• "Time is muscle" for acute MI • Program designed to optimize door-to-needle time for delivery of thombolysis in the event of acute MI to First Nations people in the remote Northwestern Ontario • In 1995, streptokinase added to to the "B list" of drugs: drugs paramedics	Editorial	• MI diagnosis made by on-call physician at Sioux Lookout base hospital based on faxed ECG (among other factors) • Upon diagnosis, paramedics adhere to guidelines: continuous cardiac monitor; establishing two saline intravenous lines; drawing blood for complete blood count,

			could administer under physicians' orders. Reteplase since been added as well • For MI events in remote northern Ontario, air ambulances are dispatched with full resuscitation equipment and two critical care flight paramedics, whose training includes advanced emergency courses (Advanced Cardiac Life Support [ACLS], Advanced Trauma Life Support, Perinatal Advanced Life Support, Neonatal Advanced Life Support, and Advanced Life Support in Obstetrics) and ongoing mandatory continuing medical education (CME) programs • Rural delivery of thrombolytics difficult. Previously, cost of medications and ACLS paramedics were restricted from providing		electrolyte, blood urea nitrogen, glucose, and enzymes levels, and pro-thrombin time (PT)/partial thromboplastin time (PTT); and then administering thrombolytics. • So far, only ten patients treated in pilot. All survived to hospital.

			the correct therapies		
Kleinrok A, Placzkiewicz DT, Puźniak M, Dabrowski P, Adamczyk T. Electrocardiogram teletransmission and teleconsultation: essential elements of the organization of medical care for patients with ST segment elevation myocardial infarction: a single centre experience. Kardiol Pol. 2014;72(4):345-54.	Poland	Examines time to PCI intervals after beginning to use prehospital ECG teletransmission for STEMI evaluation	• System created to have first medical contact of suspected STEMI patient included teletransmission of ECG to single PCI-capable centre to be read by the on-call cardiologist. • In the event of a STEMI confirmation, cardiologist coordinates hospital preparations for the arrival of the STEMI patient, including notifying the ER and cath lab.	Case Report	• Primary PCI was performed within 90 min after first medical contact in 14.0% of patients in 2006 and in 30.6% of patients in 2010 (+118%), and within 120 min in 55% and 62.2% of patients, respectively • Patient transfer time to the cardiac catheterization laboratory remained unchanged (55 vs. 60 min), as was the patient-related delay (162 vs. 150 min). • While patient and transfer time delays were not minimized, hospital-based delays were.
Koschel MJ. Air medical transport at its Peak-AirLife of Greeley. Air Med J. 2002 Jul-Aug;21(4):22-25.	Colorado, USA	Describes AirLife of Greenley, a private HEMS service	• Serves northeastern Colorado, Wyoming and Nebraska; mostly rural and remote	Editorial	• Small team/service of just 20 total medics and nurses • Paramedics and nurses

			• 20-years of service with over 10,000 missions flown • 57% scene calls • Only specialty flights are OB flights, staffed by a flight nurse and OB resident • Neonatal transport not accepted		are required to meet minimum clinical times in the ICU, cardiac catheter laboratory, pediatric unit, and the labor deck throughout the year. • In addition, team members must meet annual CAMTS-required education in altitude physiology, survival training, hazmat, extrication, and safety. • Certifications are maintained in ACLS, ATLS, PALS, NRP, BLS, and IABP monitoring. • A minimum number of skills also are documented for cricothyrotomy, intubations, intraosseous lines, chest decompressions, and chest tube insertions
Kurola J, Wangel M, Uusar A, Ruokonen E. Paramedic helicopter emergency service in rural Finland – do benefits justify the cost? Acta Anaesthesiol	Finland	Investigates whether the patient benefit of an HEMS service in rural Finland is due to early ALS procedures performed	• All missions in 1999 (n=588) in Eastern rural Finland • Physicians part of HEMS in other parts of Finland. In		• Of 588 HEMS missions, just 25 were completed by HEMS (40% cancellation rate, 10% on-scene death, 14%

Scand. 2002 Aug;46(7):779-84.		on-scene, or due to rapid transport of patients to definitive care, and the cost of the service.	Eastern Finland, HEMS staffed by ALS-equivalent paramedics • HEMS provides both EMS and SAR services, but 90% of the missions are medical emergency flights. • The service area of HEMS is 31,400 km2 and it covers 300,000 inhabitants within 30min of flying time. • 4 hospitals in catchment area and 3 EMS bases • Ground and air dispatch is simultaneous. Ground transport rarely has ALS capability • In 61% of cases, ground transport arrived first (by median time 7mins) • 206 patients needed ALS level actions		BLS-appropriate, 31% ALS ground transport used) • Of those 25 completed air transports, case reviews suggest 3 patients benefited solely from helicopter transport and 2 benefited from ALS and air transport at a cost of 28,444 euros per beneficial mission. • 17 of 25 we assessed to be inappropriate/unnecessary • Annual cost of HEMS in 1999 was 1.28M euros, or 2,176 euros per mission. However, only 25 of 588 missions were completed by ALS HEMS service, and reviewers indicated only 5 of those had patient benefit. • Estimated cost of beneficial ALS missions (ground and air) was 28,444 euros per beneficial mission.

					• Air transports were by far the most expensive, at est. 256,000 euros per beneficial mission. • High rate of patient need for ALS services, but very few benefited from air transport at a very high service cost
Mackie B, Kellett U, Mitchell M, Tonge A. The experiences of rural and remote families involved in an inter-hospital transfer to a tertiary ICU: a hermeneutic study. Aust Crit Care. 2014 Nov;27(4):177-82.	Queensland, Australia	To gain an understanding of rural and remote critical care families' experiences during an inter-hospital transfer to a tertiary ICU.	• 130 patients were admitted to the ICU via interhospital transfer between March-November 2012, of which 56 were from rural or remote Queensland. • ICU operated 25 beds and admitted adult patients for specialist cardiothoracic, spinal, trauma, neurological, medical or general surgical care. • The ICU had an open visiting policy for families • The hospital and ICU provide families with information on local accommodation, counselling and financial support.	Qualitative Case Study	• Describes four modes of being among participants: confused, engaged, vulnerable or resilient. • Confused associated with: Feeling unsupported, a need for information and a sense of panic • Engaged associated with: being able to say goodbye, a focus on the injured patient/loved one, actively seeking information • Vulnerable associated with: sense of shock, increased stress, trauma, financial burden, and threatened breakdown of the family

			• Prompts for unstructured interviews with family members included: “What circumstances lead up to your relative’s accident and the need for transfer to the metropolitan ICU?”; Can you recall one moment during the IHT period that stood out for you?”; “How were you involve in the IHT process?” • Follow up interview was 2-10 weeks post event • 14 interviews		• Resiliency associated with: holding it together, sense of support, life goes on attitude
Mann NC, Pinkney KA, Price DD, Rowland D, Arthur M, Hedges JR, Mullins RJ. Injury mortality following the loss of air medical support for rural interhospital transport. Aca Emerg Med. 2002 Jul;9(7):694-98.	Oregon, USA	Evaluates variation in mortality among interfacility transfers three years before and after discontinuation of a rural rotor-wing transport service	• Natural experiment opportunity • HEMS crash led to discontinuation of service in one region allowing for a before/after comparison for rural inter-site transport • Study also uses a comparison region with continued HEMS service • Compared two study hospitals located outside a city, more than 20 miles from another hospital and	Retrospective cohort analysis	• After crash, found 4-fold increase in risk of mortality • Fewer interhospital transfers occurred post-service for major trauma and longer transfer times associated with ground transport (avg. 2:07 pre, 3:10 post). • Missing contextual details – including level of paramedics involved, how and from where transfer vehicles/staff

			with fewer than 50 total beds • Used three years before and after crash but waited one year after crash to begin collecting data to avoid obvious bias during re-organization period. • Comparison community had 38% transfer rate of 6 study years, versus 20% in test community		are dispatched, how is dispatch initiated and more – leave us very uncertain as to the cause of increased mortality.
Martin DK. Spirit of Marshfield: celebrating 10 years of critical care transport excellence. Air Med J. 2004 Jan-Feb;23(1):20-23.	Wisconsin, USA	Describes medical air and ground ambulance service for rural area	• Service based at 504-bed hospital and 350-physician medical service in a community of 20,000 which serves as a regional referral and tertiary unit • Catchment within a 150-mile radius of Marshfield and occasionally beyond • ALS ground service added in 1994 • Does not stack calls • Provides scene calls, intercepts, transfers and seaches	Editorial	• Nurses average 18 years of critical care experience, and paramedics average 10 years of previous clinical expertise. • Medical crewmembers are cross-trained, allowing vehicle staffing flexibility • 4 full-time pilots with more than 5000 hours each and 2 dedicated helicopter-specific Airframe and Powerplant mechanics. • NICU specialty team • Volunteer rural EMS teams can call for

					intercepts to ground ALS service
McGregor J, Hanlon N, Emmons S, Voaklander D, Kelly K. If all ambulances could fly: putting provincial standards of emergency care access to the test in Northern British Columbia. Can J Rural Med. 2005;10(3):163-68.	BC, Canada	Examines whether standards of emergency care access established by Government are being met in Northern BC	• Uses 2 GIS methods to determine access within intended time intervals related to the 'golden hour' of trauma care	Demographic analysis	• Found that BC Ministry initially used 'as the crow flies' distances to determine access, without reference the to lack of roads, seasonal barriers and other geographic features that limit rural and remote access to major centres • As well, accounts for only one direction of travel, despite EMS services often coming from the larger centre for retrieval • The results of the straight-line distance analysis indicated that 18,222 people in Northern BC, or 6.4% of the population in 2001, live farther than 1 hour from emergency care • Using shortest distances on existing roads, as many as 30,332 people

					(or 10.7%) living in Northern BC are more than one-hour of ground transport to emergency services
McMonagle MP, Flabouris A, Parr M, Sugrue M. Reducing time to urgent surgery by transporting resources to the trauma patient. ANZ J Surg. 2007 Apr;77(4):241-46.	New South Wales, Australia	Considers the circumstances and frequency of inter-hospital transfer for urgent surgical intervention	• Reviews all trauma patients who were transferred between hospitals between 1999-2003 conducted by NRMA CareFlight • In NSW, interhospital transportation of critically ill patients is organized through a central retrieval unit, which tasks stand-alone specialist retrieval services. The NRMA CareFlight is one of the retrieval services • NRMA staffed by paramedical ambulance officer and doctor using road, fixed-wing and helicopter vehicles. The doctors are either specialists or senior trainees from anaesthesia, emergency medicine or intensive care • 4,124 inter-hospital	Retrospective chart review	• 749 interhospital trauma patient transfers • 511 (68%) were categorized as urgent and 64% of which were rural based. • Three (0.4%) patients had a surgically supported retrieval response and had an urgent surgical procedure carried out before patient transportation, each of which showed clear benefit. • Authors argue that consideration should be made for bringing surgical services to the patient, rather than the patient to surgical services

			patient transfers over 5 year period, 749 (18.2%) trauma related. 230 (31% categorized as immediate and 281 (37.5%) as urgent		
McNicholl BP. The golden hour and prehospital trauma care. Injury. 1994 May;25(4):251-54.	Northern Ireland	To determine how many major trauma patients would benefit from ALS-level prehospital care	• Prehospital transport to 12 hospitals for an area of approx. 1million people • All (n=239) patients with ISS score >15 to reach hospital alive 1990-91 • To get a sample as large as 239, all urban and rural patients had to be included, and 179 of those were within 10 minutes of definitive care	Prospective study	• McNicholl found that ALS paramedics would be beneficial in fewer than major trauma cases per year in all of Northern Ireland • Of those with greater than 10 minutes of travel time (n=60), only half were deemed to require ALS services while others who did not arrive alive at the hospital were posited by the author to have potentially benefited from then-rare ALS services. • Despite initial findings that no one within 10 minutes of definitive care would benefit from ALS services, the author did not investigate where those who would benefit originated

					• With prehospital times as high as 119 minutes recorded in the study, it seems plausible (though as yet unsubstantiated) that distance to services was a major indicator for the need for higher-trained prehospital professionals.
Mitchell AD, Tallon JM, Sealy B. Air versus ground transport of major trauma patients to a tertiary trauma centre: a province-wide comparison using TRISS analysis. Can J Surg. 2007 Apr;50(2):129-33.	Nova Scotia, Canada	Compares outcomes of adult blunt trauma patients transported to a single tertiary trauma centre (TTC) by helicopter emergency medical service (HEMS) versus those transported by ground ambulance.	• TRISS analysis comparing outcomes of major (ISS at least 12) blunt trauma patients transported by ground EMS or HEMS province wide between 1998-2002 (n=791). • Median ISS for HEMS = 25, ground =20. • Only 16% of 237 HEMS transports were from the prehospital scene compared to 56% of scene transports by ground. • Provincially integrated system with one central communications and • dispatch centre for both ground and air ambulance transport	Retrospective database review; population data	• Compared to TRISS-predicted survival, HEMS transport resulted in an expected 64 saved lives per 1,000 transports. • In contrast, ground transfer was associated with 24 unexpected deaths per 1,000 transports relative to TRISS-predicted rates. • However, exclusion of falls eliminated this negative outcome. • Further, the analysis includes both prehospital transport and interfacility transfer. It is likely that a much greater proportion of scene transports by

					ground impacts these numbers that otherwise strongly favour HEMS transport.
Mohr NM, Wong TS, Faine B, Schlichting A, Noack J, Ahmed A. 2016. Discordance between patient and clinician experiences and priorities in rural interhospital transfer: a mixed methods study. J Rural Health. 2016;32(1):25-34.	Iowa, USA	Examines patient and provider priorities in transfer, as well as expectations of priorities	• 79 patients and 40 physicians participated • Patient transfer is an interplay of provider and patient priorities, medical indications, and values of care • Patient interviews were used to ask priorities, experiences and preferences • Provider surveys used to examine reasons for initiating transfer and their perception of patient priorities	Mixed-method case study	• Most patient study participants (70%) felt that they participated meaningfully in the decision to transfer, and most acknowledged some input in the transfer decision and selection of a destination (62%) • Those who felt without this involvement were vociferous • Rural patients preferred transfer more strongly as the risk for adverse events increased • However, some of those same patients expressed a reversal of this pattern at the thought of death. Said one participant, “[i]f I knew I [were]… going to die, I would rather die [at my local hospital] where my friends and family will be”

					(participant quoted in Mohr et al. 2016, 30). • Providers over estimated how much patients would prioritize proximity to home for care, as well as desire to be cared for by a personal physician • Physicians under estimated desire for comprehensive care • Patients typically respond this way in priority studies, noting a preference for home care unless indicated that transfer would reduce or relieve the threat of death or disability
Morrison LJ, Brooks S, Sawadsky B, McDonald A, Verbeek PR. Prehospital 12-lead electrocardiography impact on acute myocardial infarction treatment times and mortality: a systematic review. Acad Emerg Med. 2006 Jan;13(1):84-89.	Multiple	Systematic review to consider whether mortality or treatment time intervals improved with use of pre-hospital ECG (PHECG) when compared with standard care.	• 5 included studies • The inclusion criteria: 1) compared PHECG and advance hospital notification with standard EMS care among patients with suspected AMI and 2) evaluated an on-scene time interval, time to fibrinolysis, or all-cause	Systematic Review and Meta-analysis	• PHECG and advance ED notification increased the weighted mean on-scene time by 1.2 minutes (95% CI = 0.84 - 3.2). • The weighted mean door-to-needle interval was shortened by 36.1 minutes (95% CI = 9.3-

			mortality as the study outcome. • Excluded non-English publications (because of cost constraints), letters, reviews, and editorials.		63.0: range of means, 22–48 minutes vs. 50–97 minutes). • One study reported all-cause mortality, with a statistically nonsignificant reduction from 15.6% to 8.4%.
Newton SM, Fralic M. Interhospital transfer center model: components, themes, and design elements. Air Med J. 2015 Jul-Aug;34(4):207-12.	Multiple	To describe the characteristics and procedures of trauma centre transfer systems	• Non participant observation at 10 tertiary centres receving patient transfers • Transfer systems are vari-able in structure and process and are described in the literature as being fragmented, complex, and difficult to navigate	Qualitative Observational Case Study	• Found greater efficiency in those systems that co-located their three primary functions: primary transfer answering system; bed management system; dispatch. • This arrangement allowed rural, referring physicians to reduce repeating the clinical case – they told it once to the single operator at the answering centre, who then was able to coordinate beds and dispatch as well as communicate needs with intake and appropriate hospital units

Nielsen EW, Ulvik A, Carlsen AW, Rannestad B. When is an anesthesiologist needed in a helicopter emergency medical service in northern Norway? Acta Anaesthesiol Scand. 2002 Aug;46(7):785-88.	Bodø, Norway	Assesses what proportion of ambulance missions carried out by the rescue helicopter in Bodo, northern Norway, delivered advanced medical treatment needing the skills of an anesthesiologist	• Bodo is a northern city of 40,000 and is the base for HEMS services for a widely scattered population of 190,000, mainly along the coast • Max flying time of 1 h and 20min (approximately 290km) from the city of Bodø. • The 40,000 inhabitants of the city use the faster responding ground ambulance. The helicopter usually lands on dedicated helipads or football grounds, picking up patients attended by the local general practitioner in a ground ambulance • Analyzed records from 1988 and 1990-1998 (n=2,078 missions; 2,1,66 patients) • Interhospital and search and rescue were not included • National air transport comes to Norway in 1988		• 107 (5%) patients noted to require anesthesiologist • "In our rural area, with a widely scattered population, 95% of patients received medical treatment not requiring an anesthesiologist. A selective use of the anesthesiologist seems indicated. " • 45 of the 107 patients survived to discharge from hospital, amongst whom 28 had received intravenous nitroglycerin for angina or suspected myocardial infarction

O'Meara P, Walker J, Fahey C, Pedler D, Tourle V, Wray D, Mulholland P, Jennings P, Davis KP. The rural and regional paramedic: moving beyond emergency response - Report to the Council of Ambulance Authorities Inc. [Internet]. Bathurst, New South Wales: Charles Sturt University; 2006 Mar [cited Jun 16] 74p. Available from: http://dro.deakin.edu.au/eserv/DU:30048588/pedler-ruralandregional-2006.pdf	Australia	Report to the Council of Ambulance Authorities in Australia on expanding the scope of paramedics	• In case studies from Australia, memoranda of understanding between hospital and EMS organizations, exceptional paramedics willing to grow their position and invest in the rural health system and community and strong teamwork based on inter-professional respect and learning was required for success	Case Study	• Expanding the role of rural paramedics creates more opportunities to utilize the skills and training while bringing needed emergency skills into rural communities. • The scope of practice for these expanded role paramedics include: emergency response; community first aid education and other emergency preparedness training; assisting hospital staff with triage and cannulation; extending primary care to remote settings by treating people in their homes and training hospital staff in emergency procedures • Inter-agency coordination can improve capacity of whole heath system: For example, in South Australia, where Bordertown began

					involving paramedics in hospital duties, payment from a hospital with chronic staff shortages reduced the financial burden to the ambulance service of having advanced personnel in a low call volume area, while the paramedic was still able to access physician medical oversight through the ambulance system when faced with hospital tasks outside the typical paramedic scope. In this way, the relative financial strength of one organization and the well-organized consultation system of the other were leveraged to create better patient care and rural staff emergency preparedness.
Sharpe K, Elcock M, Aitken P, Furyk J. The use of telehealth to assist remote hospital	Queensland, Australia	Evaluated the use of telehealth for patients who had suffered a	• Telehealth used in local site resus; Medical retrieval coordination	Case Study	• Both rural physicians and medical coordinators had

resuscitation and aeromedical retrieval tasking: a 12-month case review. J Telemed Telecare. 2012 Jul;18(5):260-66.		cardiac or respiratory arrest, and were medically coordinated from the Queensland coordination hub at Townsville	centre offers TM while also dispatching retrieval team • Medical coordinator from Queensland Coordination Centre is virtually present in room but has guidelines to allow local team leader to manage patient, offering support/help when asked or noticing a problem • Importantly, telehealth did not delay retrieval team dispatch. • Analogous to 'auto launch' policy, in which air or ground transport team and medical crew are activated based on limited scene information and can be stopped and returned if necessary • Sample (51 uses of telehealth in a year, just 9 for resus, 8 included in study) much too small to make claims about patient outcomes		positive feedback about telehealth: comments included that medical coordinator was able to gather information useful for retrieval team handover; offer expertise in emergency care and updated care procedures to primary care providers who may have limited experience in emergency medicine (e.g. junior medical staff); re-assure local team to reduce stress and strain of emergent events; useful for transfer coordination.

Shepherd MV, Trethewy CE, Kennedy J, Davis L. 2008. Helicopter use in rural trauma. Emerg Med Australas. 2008 Dec;20(6):494-99.	New South Wales, Australia	Sought to examine potential time savings of HEMS and outcome advantages with physician-staffed transport	• New England Rescue Helicopter Service uses non-physician transport staff with pre-hospital trained physicians available based on expected scene requirements	Retrospective Chart Review	• In constructed categories of <50km, 50-100km and >100 km, HEMS offered a time saving in only those cases with >100km to care • Within 100km, HEMS did not offer time savings or were slower (<50km). • Physician deployment had no association with ISS score or outcomes, indicating either or both unclear scene requirements and rare need for physicians on-scene • "In well-resourced areas, deploying helicopters with doctors has little impact on hospital services. In rural areas, with limited critical care reserve, unnecessary missions are a potentially dangerous burden. Furthermore, the low mortality of the cohort in the present paper… suggests that in

					this region at least, the routine deployment of doctors is not warranted. Our data (70% of patients transported with ISS < 15) does not justify such resource use. Perhaps the priority for future prospective research lies in improving the sensitivity of the dispatch protocols for doctors, rather than retrospectively validating their inclusion in all missions.”
Smith R, Conn AK. Prehospital care – scoop and run or stay and play? Injury. 2009 Nov;40 Suppl 4:S23-26.	Multiple; USA focus	Discusses literature on the value of ALS and BLS level prehospital care for an American emergency system	• Discusses ‘stay and play’ advanced interventions in contrast to ‘scoop and run’ basic interventions for use in a paramilitary American emergency system that would connect ambulance services with police and fire	Literature Review	• Authors argue that services above the BLS level have not been shown to improve outcomes, with shorter prehospital times associated with better outcomes. However, these findings are largely specific to urban prehospital environments and the authors note that in rural environments,

					there may be a need for advanced techniques. • Authors discuss the 'advanced care paradox' that ALS paramedics are more common in urban areas with short prehospital times and advanced care immediately available, while rural areas are commonly staffed by BLS paramedics despite long prehospital times to lesser resourced hospital units
Taylor CB, Stevenson M, Jan S, Middleton PM, Fitzharris M, Myburgh JA. A systematic review of the costs and benefits of helicopter emergency medical services. Injury. 2010 Jan;41(1):10-20.	Multiple	A systematic review of economic evaluations of HEMS, in order to determine the economic cost of HEMS and the associated patient-centered benefit	• The inclusion criteria consisted of English language articles that estimated both the costs and outcomes of a HEMS and fulfilled pre-specified criteria in relation to a cost analysis, cost–minimisation, cost–effectiveness or cost–benefit evaluation • 15 studies included	Systematic Review	• Cost-benefit analysis of HEMS is Very context and case-mix specific • In user-pay systems, HEMS is shown to be an integral part of financial sustainability by widening the patient range of the hospital/health centre. • Cost figures from the UK alone vary by a factor of 21, suggesting widely different accepted methods of service and

					measurement. • Trauma has deeply mixed results with regard to benefit, with most studies showing little or no patient benefit and costs that are as much as 7-10 times higher than ground transport. • In non-trauma (cardiac, stroke and obstetric), most data points to a positive cost-benefit ratio. However, again, contextual differences make this difficult to generalize meaningfully. • Five studies showed HEMS to be a more expensive transport alternative without an associated benefit • Eight studies provided cost–effectiveness ratios of $3292 and $2227 per life year saved for trauma, $3258 per life saved and $7138 and $12,022 per quality adjusted life year for

					non-trauma and $30,365 and $91,478 per beneficial mission for non-specific patient populations
Woollard M, Pitt K, Hayward AJ, Taylor NC. Limited benefits of ambulance telemetry in delivering early thrombolysis: a randomised controlled trial. Emerge Med J. 2005;22:209-15.	Rural UK	Evaluates the potential of a continuous telemetry system linking rural ambulances to a coronary care unit to reduce call to thrombolysis times	• RCT in which decision to provide thrombolytic agents was made based on prehospital 12-lead ECG and other readings sent to cardiologists and compared to decision to provide thrombolytic agents upon unit arrival (no actual prehospital thrombolysis)	Randomized Controlled Trial	• Average potential reduction in time to thrombolytic agents was 55 minutes • 21/213 of those randomized to TM group eventually received thrombolysis. Of these, 3/21 received prehospital (TM-based) recommendations for thrombolysis. • Authors argue that while it may have reduced time to intervention, it would have done so in a very small number of patients and may not be worth the significant investment in training, equipment and decision-making oversight.

Appendix B: Jurisdictional Review

The Anglo-American Model in Canada

Symons and Shuster (2004) provide an excellent overview of the Emergency Medicine Services (EMS) with Canada. Unless otherwise cited, the points highlighted here come from their 2004 overview.
Canada has a variety of funding and service delivery models represented across the country's 13 Emergency Medical Service (EMS) systems, as delivery is not federally administered. The majority of systems are heavily subsidized by provincial, regional, or municipal governments with some cost to the patient. Within these structures, the EMS services can be "free-standing," part of public safety agencies, or hospital-based with some privately run services available.

In general, the EMS is delivered in the field by paramedic practitioners. According to the Paramedic Association of Canada (PAC), paramedic roles can be classified into four categories of progressively advanced skill, or National Occupation Competency Profiles (NOCP): Emergency Medical Responder (EMR), Primary Care Paramedic (PCP), Advanced Care Paramedic (ACP), and Critical Care Paramedic (CCP).

Emergency Medical Responders may be the primary responders in rural areas. They have basic qualifications (e.g. provincial driver's license), and are equipped with simple basic life support skills such as cardiopulmonary resuscitation (CPR) with oxygen. EMRs do not perform any invasive interventions; nor do they maintain intravenous (IV) therapy or give medications.

Primary Care Paramedics are skilled in simple invasive procedures such as blood glucose monitoring and IV access. They are trained to administer a limited number of medications. PCPs also provide cardiac monitoring using 3-lead configurations and are trained in the use of Automatic External Defibrillators (AED).

Advanced Care Paramedics undertake an in-depth study of injury and of disease processes as well as learning advanced interventions, including non-drug-assisted airway management (tracheal intubation), electrocardiogram (ECG) (3-lead) interpretation, appropriate electrical therapy (defibrillation, cardioversion, transthoracic pacing), needle thoracostomy, and IV and intraosseous drug administration. They can administer all, or most, first-line ACLS drugs and certain antiemetics, antibiotics, bronchodilators, adrenergic and cholinergic agonists/antagonists, uterotonics, tocolytics, poison antidotes, and neutralizing agents.

Critical Care Paramedics build on the ACP education and training. In addition to the ACP skills, they are trained in recording 12-lead ECGs, anaesthesia/paralysis-assisted airway management, urinary catheterization, and the monitoring and transport of patients with chest tubes or arterial lines. CCPs are also trained to interpret lab and X-ray results.

Canada struggles with uneven EMS delivery across urban and rural areas. The rural population is widely scattered over a variety of challenging geographies. Urban areas benefit from specialty care hospitals where it is possible to enact bypass protocols and transport patients to the closest hospital with the most appropriate level of care. In rural areas, a patient is typically transported as quickly as possible to the closest hospital and then transported again to the most appropriate level of care based on presenting conditions. Symons and Shuster (2004) highlight that, despite improvements in Canada's EMS system over the past 15 years, lingering issues of long response and transport times for rural populations indicate that benefits have not been significantly shared beyond urban regions. This need is often obscured by a lack of data sharing infrastructure across jurisdictions.

Over-crowing is a problem inherent in a system like Canada's, which transports all EMS patients to the Emergency Department. Symons and Shuster (2004) point out the cascading effect this issue has on improving the problem: the health care system must pledge resources to processing patients through overcrowded EDs at the expense of resourcing effective responses to emergency calls (CAEP and NENA 2003).

The Anglo-American Model of the United Kingdom

Black and Davies (2005) provide a comprehensive overview of the EMS system in the UK. Their work is presented throughout the following section.

The population of the United Kingdom (England: 83%, Scotland: 8.6%, Wales: 4.9%, Northern Ireland: 3%) and visitors to the United Kingdom are provided with EMS through the National Health Service (NHS).In addition to ambulance service, there are a number of other ways to access medical care and advice in the UK, including: NHS Direct, which provides information on how to access services over the phone or internet; primary care, minor injury centres, and high street walk-in centres; and EDs. Advice from NHS Direct is given by senior nurses who can recommend self-care, divert a call to primary care, or arrange emergency department transport via the ambulance service when necessary. The ambulance service dispatch can divert non-emergency calls to NHS Direct.

The ambulance service control centre is staffed by a non-physician control room officer, who may have some clinical care experience. The ambulance service staffs vehicles and aircrafts with paramedics and technicians. Physician-staffed aircrafts are available through the London air service. Efforts are underway to increase physician staffing of other air ambulance services.

Some areas in the UK are covered by the British Association for Immediate Medical Care Schemes (BASICS), whereby physicians can be mobilized by control room staff to provide additional clinical support. These are primary care physicians with additional training in pre-hospital care. Mobile Medical Teams (MMTs) may also be available from a nearby hospital ED. The team may include an ED physician, nurse, and anaesthesiologist depending on availability and need. These teams often take additional time to mobilize and have limited experience outside of the hospital.

Pre-hospital bypass policies in the UK are rare; protocol is to transport patients to the nearest ED. This means that there are frequent inter-hospital transfers to the appropriate level of care after an initial ED assessment. Black and Davies (2005) note that patients needing time-sensitive critical care may have worsened outcomes due to this delay.

In the UK system, negative outcomes in rural areas are exacerbated by a lack of suitably trained physicians involved in pre-hospital critical care. This is because the pre-hospital phase of care for rural patients is relatively longer than for urban patients. Negative outcomes are compounded by the scarcity of cases and attendant skill retention issue that a paramedic may experience. Black and Davies (2005) note that District General Hospitals in the UK on average see one patient a week with an injury severity score (ISS) of >15. This means that even ED trauma teams and surgical teams may have a lack of exposure to the cases necessary to keep their skills up. To address this issue, recommendations towards regionally based hospital facilities, retrieval services, and inter-hospital transfer services that are well-integrated with current ambulance services are being actualized.

The Bradley Report

In 2004, the Department of Health in the United Kingdom invited Peter Bradley, Chief Executive of London Ambulance Service NHS Trust to lead a strategic review of NHS ambulance services in England (Department of Health 2005). The review focused on transforming ambulance services from a primary focus on resuscitation, trauma and acute care towards taking healthcare to the patient within their community. This was underscored by the finding that only 10% of patients making an emergency call actually had a life-threatening emergency. The remainder of calls were urgent primary and social care needs including mental health, older people who had experienced a fall, and patients with a chronic illness that had a sub-acute onset of symptoms.

By the time the review took place, change had already started. Ambulance services were moving away from the traditional approach and towards being embedded in urgent care. This meant activities such as providing primary care outside of typical operating hours and referring patients to other healthcare services via a standardization in how emergency calls were prioritized.

Telephone-based assessment, delivered via the ambulance services, was also increasingly supported by evidence of its safety, cost-effectiveness, and patient satisfaction (Dale et al. 2004). The report recommends that the call service should be further developed so that the patient only has to tell their story once and any advice given forms part of their care record.

The report specifically highlights "clinical support and governance arrangements in ambulance control rooms" (Department of Health 2005, p.11) as an area for improvement. The service has seen an over-categorization of life-threatening calls. The report attributed this to control room operators erring on the side of caution when they are unsure of what resource to dispatch. The result of this uncertainty is that many patients who make an emergency call are taken to the hospital when alternatives would suffice, for example, receiving advice, assessment, diagnosis, treatment and/or care closer to home or over the phone. The report explains that there is now more scope than there traditionally was for ambulance services to be flexible in the types of responses provided: Local health economies need to look at commissioning and funding of urgent care as a whole to establish how far current models of service provision should continue and where they need to change. For example, currently 77% of emergency calls result in an emergency patient journey, mostly to A&E (Accident and Emergency Department). Of those patients, surveys indicate that around 40% are admitted while at least 50% of these could be cared for at the scene or in the community. Achieving this would require changes in ambulance skill mix and better ambulance services access to community facilities and health and social care professionals (Department of Health 2005, p.13).

The report goes on to elucidate that this issue equates to at least 1 million patients per year being unnecessarily taken to the Accident and Emergency Department (A&E) when these patients would better benefit from receiving advice and treatment closer to their home or on scene.

When a patient does need transport, it is recommended that more options are made available rather than taking them to the A&E, for example, walk-in centres, minor injury units, out of hours primary care centres, or referrals directly to social and mental health services. This means all services need clear and standardized criteria for accepting patients. When appropriate, patients should be referred directly to those centres at point of call. It is suggested that having greater clinical decision making during the telephone call would support these changes.

These recommendations represent a shift in the traditional view of ambulance services as simply an emergency care transport service towards an out-of-hospital mobile health resource that is the response hub for coordinating out of hospital care. A transformed system would ensure that the right care is provided the first time and that this is standard across the country.

There is an ongoing shift in the NHS towards community-based primary and secondary care services. Whether they need urgent or planned care, patients should increasingly receive advice, assessment, diagnosis, treatment and care in or close to their homes, particularly in rural areas

where there may be a greater difficulty accessing traditional secondary care services. As a mobile health resource, able to provide increasing range of assessment, treatment and diagnostic services, the ambulance service should be playing a greater role in providing care closer to home (Department of Health 2005, p.13).

The Franco-German Model in France

Adnet and Lapostolle (2004) provide an excellent overview of the EMS system in France. Their work is summarized in the following.
Physician-delivered pre-hospital care is a long-standing protocol going back to 1955 in France. The current system, the Service d'Aide Médicale d'Urgence (SAMU) is "two-tiered." The first level offers basic life support (BLS) services via fire department ambulances, and the second level offers advanced life support (ALS) via ambulance staffed by physicians. The dispatching centre is also staffed by physicians who determine the appropriate level of response and can give instruction over the phone.

The options for response include:

- Ambulances staffed by emergency medical technicians (EMT)
- Fire-fighters with basic life support skills (including AEDs)
- A general practice physician by private vehicle;
- A mobile intensive care unit (MICU) or a helicopter if available

MICUs are distributed across bases called Service Mobile d'Urgence et de Réanimation (SMUR). In 2004, there were over 300 SMUR bases each housing one or more MICUs. An MICU is typically staffed by a senior emergency physician, a nurse, or a nurse anaesthesiologist, and sometimes a medical student. The average time between call and arrival is 15 minutes or less (Adnet et al. 1998; Plaisance et al. 1997). The physician dispatcher goes on to determine the destination of the patient and keeps track of bed availability at the available destinations.

Resource management is key in a system that provides such advanced pre-hospital care and is achieved by making physicians central to dispatch. Patients immediately receive and benefit from an appropriate level of care, and specialized teams intervene only when necessary as determined by the dispatching physician. Hospital bypass is determined based on patient needs and thereby avoids unnecessary inter-hospital transport.

The Franco-German Model in Germany

Roessler and Zuan (2006) provide a system-level overview of EMS in Germany in the journal of Resuscitation. Their work is summarized below.

EMS is delivered by legislation in the 16 federal states of Germany and united under the law that every person has the right to receive help, if necessary by an emergency physician, at any time of the day. EMS services are efficiently organized to follow this law. Every region is obliged to guarantee a person can be reached by an ambulance or emergency physician within 10-15 minutes of calling for services. The Helicopter Emergency Medical Services (HEMS) provides helicopter ambulance service, with each station having a mission range of 50 km.

The dispatching system is staffed by a paramedic with special training who operates out of the emergency ambulance control centre. Many of these control centres are integrated to coordinate EMS, non-emergency ambulance transport, and the fire brigade.

The dispatching paramedic uses the following criteria to mobilize an emergency physician:

- suspicion of acute impairment of vital functions
- loss of consciousness
- serious external bleeding
- chest pain
- shortness of breath
- stroke, new onset paresis/paralysis
- seizures
- accidents with a high likelihood of major trauma (i.e. high speed road traffic accident [RTA] entrapped person after RTA, RTA involving pedestrian/biker, falls over a certain height)
- accidents involving children
- birth

The emergency physician can be transported to the scene by going with the ambulance or rendezvousing in a rapid response car without patient transport. A physician can be available for the next call more rapidly when they do not participate in patient transport. Helicopters are used extensively for rural areas, and are on the scene before ambulances in up to 40% of cases.

The clinical expertise of the physician in the field means that they can provide ALS when needed, refer the patient to the appropriate hospital (thereby bypassing the closest one if necessary), and deal with minor cases on scene, thereby avoiding hospital admission all together. Every region is required to have a lead emergency physician to coordinate the EMS response for major incidents.

There are three qualification levels for non-physician ambulance personnel, generally corresponding to the number of hours of training received:

1. “Rettungshelfer” (RH)
    a. Receive 240 hours of training: 160 h classroom training and 80 h practical training in a hospital
    b. Focus on resuscitation and emergency medicine
    c. Are mostly found as unpaid volunteers at public events or on ambulances for non-emergency transport

2. “Rettungssanitater” (RS)
    a. Trained for 520 hours: 160 h classroom, 160 h in-hospital, and 160 h practical training on an emergency ambulance

3. “Rettungsassistent” (RA)
    a. Trained for 2 years, with formal qualification required
    b. 1200 h of theoretical and practical training in the first year, 1600 h of ambulance service apprenticeship in the second year

Most German states require that an emergency ambulance is staffed with at least with one experienced RS and preferably two RAs.

None of the non-physician ambulance personnel are formally authorized to deliver ALS procedures, such as administering medication, establishing IV access, defibrillation, or performing tracheal intubation. However, when a physician cannot attend on-scene quickly enough, it is accepted practice that an RS or RA performs these procedures. This practice comes with “emergency competence” conditions, where not performing the procedure is life threatening and when the RS or RA has been trained in the procedure. Accepted procedures are:

- defibrillation
- peripheral venous access
- tracheal intubation without muscle relaxants
- anaesthetic agents
- infusion of crystalloid solutions (e.g. isotonic NaCl, Ringer’s Lactate)
- administration of certain drugs (e.g. glucose, epinephrine, diazepam, inhaled ß2-adrenergic drugs, nitrate spray)

Drawbacks to Germany’s EMS system include difficulty retaining qualified emergency physicians in what some view as unfavourable working conditions, and difficulty managing this resource-intensive system in the face of health care cost cutting.

Current EMS Systems in Canada

The Shock Trauma Air Rescue Service (STARS)

The Shock Trauma Air Rescue Service (STARS) is a not-for-profit emergency transport service that comprehensively spans Alberta, Saskatchewan, and Manitoba, as well as the north-eastern part of British Columbia. STARS receives 24% of its funding from provincial governments, and the rest through charitable fundraising and income from servicing sites of the oil and gas industry. The service has six bases across three provinces (AB, SK, MB), eleven fixed wing aircrafts that are available 24/7, and approximately 100 physicians on staff. STARS is set up to support rural healthcare and works around "no fly" polygons established within 30 minutes of surface travel time from the tertiary centres, so that those areas can rely on ground emergency services.

Physicians are mainly trained as emergency medicine doctors and hired as "transport physicians." Being a transport physician means "quarterbacking the call" to organize services and transport while nurse paramedics travel to the scene. Each of the six STARS bases has a transport physician on 24 hours a day to make care and resource decisions that include what plane to deploy. The transport physician can accept a patient on behalf of a rural physician colleague and then call the rural physician to brief them on the incoming case.

Other services provided by the STARS include the STARS Emergency Link Centre (ELC). One function of the STARS ELC is to connect Emergency Medical Service (EMS) practitioners to Alberta Health Services physicians who are staffed by the Online Medical Control (OLMC). The physician can provide medical opinions and recommendations for patient management. In addition, Saskatchewan operates six Collaborative Emergency Centres at night when there is nurse/paramedic, but no physician, coverage. If the nurse/paramedic team from one of the Collaborative Emergency Centre needs to speak with a physician, they contact the STARS ELC, who connects them to the on-duty transport physician out of the Regina STARS base.

There are two ways that STARS supports rural health: interfacility transfer and scene calls. "Soft" criteria are used during an interfacility transfer. Logistical decisions are based on the transport physician's assessment of the situation. Typically, the transport physician is on the phone with the rural physician to coordinate the logistics of the transfer (time and resources), and to give stabilization advice when necessary. When a patient is unstable, the goal is to move them within an hour from time of initial contact. The transport physician may work with an Alberta Health Services group called RAAPID (Referral, Access, Advice, Placement, Information, and Destination) to facilitate the return of patients to the health care facility closest to their home that best fits their care needs. Depending on the patient's case, the transport physician may also bring on specialists as per the clinical characteristics for additional support.

Scene calls account for approximately 50% of STARS work. Alberta Emergency Medical Services (EMS) dispatch criteria are used to decide when to launch to a scene. These criteria are similar to those used in British Columbia and most of North America.

Comments

The STARS representative interviewed for this review mentioned tensions can arise in the not-for-profit model because the organization is not integrated into the health care system. Yet, they noted, there is a positive side to this: the program can act as a "disrupter" and prompt positive change. More specifically, the program has more leeway to immediately adapt to patients' needs and then allocate the funding afterwards, rather than asking, "What can we afford to do?" before taking action.

With regards to the transport physician and nurse paramedic model, the STARS representative noted that there were initially growing pains of integrating physicians into paramedic work. Currently, the transport physician is doing the work of a dispatcher, but they will also go on flights with the paramedics, not as a requirement, but as a way to stay in touch and learn about being on the team on-scene. This has helped dissipate tensions around integration and contributed to a positive operating culture.

ORNGE

ORNGE (not an acronym) functions as a part of the provincial health system to provide medical air-transport across Ontario as well as ground transport and interfacility transport in the southern metropolitan areas of the province. ORNGE operates as a single system for the entire province, with operations and dispatch in one centre as well as centralized education and medical oversight. The organization operates its own helicopters, fixed wing aircrafts, and land transfer units with no out-sourcing. A critical care medic is present on all crafts with the exception of the pediatric specialist transport team, which is staffed by nurses. ORNGE's critical care medics are one of only two critical medical care teams in Canada that are accredited by the Canadian Medical Association.

Ontario has a population of 13 million people dispersed over 1.1 million square kilometres, with 90% of the population concentrated in the southern area covering just one tenth of the province's total land mass. This means that roughly one million people are spread out over one million square kilometres in the north of Ontario. Two thirds of those are in two large communities, and the rest are scattered in small communities of 100 to 2,000 people. In the winter, frozen rivers and lakes are ploughed to create a road system, and as such ground ambulances are not a feasible form of transport.

To manage this diversely populated geography, ORNGE divides the northern part of Ontario by East and West. The West has three bases with five acute life support (ALS) aircrafts and four basic life support (BLS) aircrafts. The East has three bases as well, with three ALS aircrafts. The most northern community served is Fort Severn with the closest referral hospital at Sioux Lookout, a 2 to 2.5 hour flight away in ORNGE's fastest airplane. The southern part of the province is serviced by helicopters and land-based critical care units.

Ontario's critical care medics function under the delegated acts model, similar to British Columbia. This means that a physician is staffed in dispatch and recommends responses through sending critical care medics, triaging calls when there are not enough resources to meet demands in communication with the sending physician about what they might need to prepare the patient. The dispatching physician is not involved in the logistics of "bed shopping," as this is determined before ORNGE gets the call.
The majority of the approximately 19,500 calls a year answered by ORNGEs result in transport. The remaining 5% of their work is on-scene calls. When a call comes into the dispatch centre, the responder passes on the information on level of care needed, and assigns call priority to a flight resource planner who allocates an aircraft to transport the patient. ORNGE handles all air and ground transfer for the Greater Toronto Area (GTA) and National Capital Region.

Many communities in Northern Ontario have only basic local care, typically through nursing stations with part-time itinerant physicians. Those with local hospitals are generally not equipped to handle trauma, making emergency transport essential for high acuity patients. Critical care medics are also available to assist with stabilizing patients for transport (i.e., intubations). Their scope of practice includes use of mechanical repressors, the capacity to administer norepinephrine intravenously, and inserting gastric tubes and central lines. All critical care medics can effectively take care of a chest tube if it has already been put in. A smaller group of medics are trained to manage patients who have an intra-aortic balloon pump, which is typically in the realm of ICU care. This group supports the regionalization of cardiac services with one helicopter, one fixed wing airplane, and one ground ambulance available to them at all times.

A mandate of ORNGE is to stabilize the local health services by providing transport escorts that would otherwise fall to physicians or nurses. When members of the local team do have to accompany transports (such as when a BLS-supporting aircraft is proximal to the community), ORNGE prioritizes facilitating transport back to the community for the local care provider. ORNGE responds to between 40-50 calls a day. Just under half of these calls are non-acute transfers to secondary or tertiary levels of care.

ORNGE is currently working to set up a multi-national process for emergency transport programs to share their outcome measures on key indicators. Participating services – including programs in the US and Europe, the Rural Flying Doctors of Australia, STARS, ORNGE, and Emergency Health Services in British Columbia and Nova Scotia — will be able to compare performance indicators to other jurisdictions in order to better understand facilitators of good outcomes. The data sharing project has adopted performance measures from hospital acute care guidelines (e.g. ischemic chest pain, high-risk obstetrics), which will be tracked in the patient population and made available through a web portal to participating groups. The project is close to launch and is awaiting legal and proprietary data sharing agreements. This innovation

in data sharing across jurisdictions is one of the first international projects of its kind and may lead to strengthening accountability for individual services.

Comments

The representative from ORNGE interviewed for this review emphasized that their model was successful because ORNGE is an integrated single system that has a central command: it has dedicated medical oversight; it operates its own aircrafts and so it does not have to worry about contractors and business relationships; and it is associated with academic institutions so that they can create measures of system performance for iterative quality improvement.