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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This evidence review was produced using a realist methodology in response to a specific question from the commissioning agencies. It is not necessarily a comprehensive review of all literature relating to the topic area(s) contained within. It was current at the time of production. It is reproduced for general information and third parties rely on it at their own risk.

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

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.

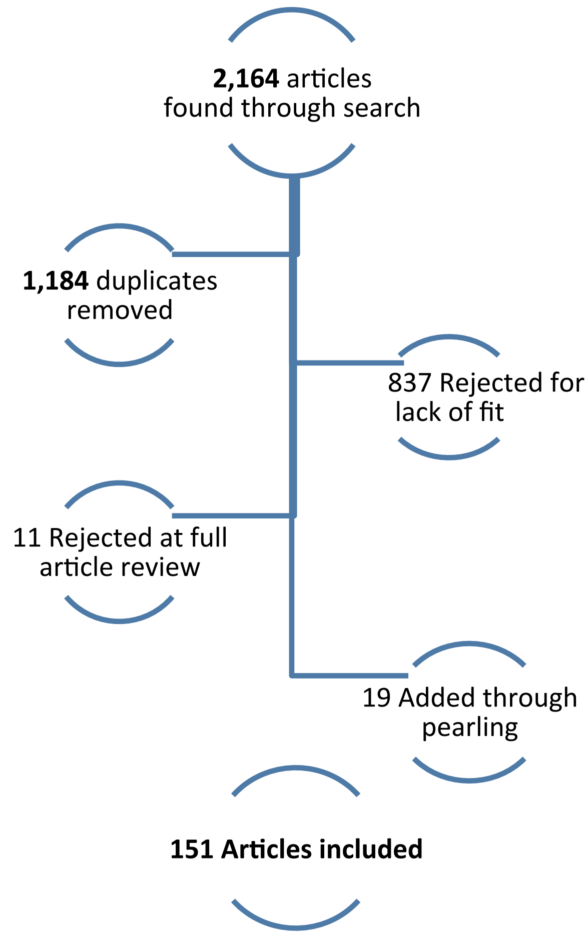
Table 1: Search Terms

Concept	Terms	Reasoning and Commentary
Rural	<u>Keywords:</u> rural remote <u>MeSH:</u> 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	<u>Keywords:</u> emergencies critically ill critically injured <u>MeSH:</u> 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	<u>Keywords:</u> transportation of patients patient transport patient transfer transfer of patients interfacility transport interfacility transfer <u>MeSH:</u> 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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