

**External Review of the Development of
the 2013 British Columbia Emergency
Health Services Resource Allocation Plan**

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Executive Summary

Key Conclusions

The BCEHS Resource Allocation Plan (RAP) process is a careful and prudent approach for determining the medically most-appropriate Emergency Medical Services (EMS) system response to 9-1-1 medical incidents and warrants the support of all stakeholders.

In both whole and in detail, the EMS system policy decisions which the BCEHS RAP process embodies are consistent with contemporary best practices nationally and internationally. The process has a strong foundation in robust clinical evidence of the actual medical needs of British Columbia's EMS patients, and is superior to the processes used in many major EMS systems.

After implementation, ongoing validation of this model should be undertaken prospectively to assess agreement between the 2014 plan and future actual patient data. Such periodic reviews would form the foundation for enhancements and for adjustments to reflect evolving circumstances and new medical science.

Background

In late 2013, the British Columbia Ambulance Service (BCEHS) completed a major redefinition of its policies for the assignment of emergency resources to incoming 9-1-1 medical incidents.

Incidents received through 9-1-1 by BCEHS communications call-takers are classified into one of nearly 1,200 possible unique dispatch categories (known as “determinants”) using an internationally recognized scripted interview algorithm known as “Medical Priority Dispatch System” (MPDS). The determinant defines each new EMS call’s priority relative to other EMS incidents, and has a predefined response plan which instructs dispatchers as to what kind of emergency vehicles should respond (ALS ambulance, BLS ambulance, fire and/or police first responders, etc), and a response mode (“Hot” – using emergency lights and siren, or “Cold” – response at normal traffic speeds).

A master BCEHS document known as the Resource Allocation Plan (RAP) defines the response plan for each MPDS determinant and has been revised five times since its inception in 1997, largely using a consultation process involving various stakeholders but limited clinical data. In 2012-13, BCEHS undertook its first “evidence-based” RAP review, providing its decision-makers not only with a range of dispatch information for each determinant but also with selected 2012 clinical information about patients actually seen by BCEHS crews at calls falling into each MPDS determinant. This pairing of dispatch and clinical data is a powerful decision-support enhancement and reflected analysis of more

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

than 630,000 actual BCEHS responses falling into 319 MPDS determinants. Response plan recommendations were made for each determinant by a working group of stakeholders including physicians, paramedics, dispatchers, and first responders. Each group member cast votes on the most appropriate response options in a three-round “modified Delphi” process, aimed at anonymously reaching consensus on each decision. A second BCEHS executive group reviewed each decision, resolving issues upon which consensus could not be reached, and in selected circumstances, altering the working group’s decision for risk management and other policy reasons.

The External Review Report

This report was commissioned in early 2014 to provide the BCEHS Vice President - Medical Programs with external advice on the wisdom of the RAP’s development processes and conclusions, and to evaluate whether it represented a “best practices” approach which should be adopted by the Province as medical and administrative policy.

In this report, we considered:

- Where this process fits in contemporary EMS clinical and operational “best practices”
- The data upon which the decisions were based
- The resulting Resource Allocation Plan itself
- Key strengths
- Opportunities for strengthening the process
- Recommendations including an overall professional opinion as to whether this plan should be recommended by BCEHS as policy in British Columbia

Key Strengths

The BCEHS RAP process has a number of key strengths:

- The process was informed by actual patient data from the BC experience, instead of relying solely expert opinion or stakeholder advocacy.
 - This is a sophisticated and laudable approach which places BCEHS as a leader among major EMS systems. It is also a remarkably uncommon effort in both the Canadian and international EMS experience, with many EMS systems relying simply upon a subjective opinion of the possible acuity represented in the wording of dispatch category descriptions without any supporting clinical data, or even relying solely upon stakeholder advocacy.

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

- It is supported by a very robust data sample of more than 630,000 contemporary BCEHS incidents which includes clinical information from paramedic patient care reports used to create a profile of the range of patient acuities actually arising within each determinant. Case acuity assessments include, among other data, acuity scoring against the Australasian Triage Scale, widely used to categorize hospital emergency department patients.
- The final response recommendations reflect the contemporary medical consensus that:
 - Patient outcomes are not associated with EMS response time except in cardiac arrest, respiratory arrest, and total airway obstruction
 - “Lights-and siren” emergency vehicle response carries with it significant risk to providers and to the public, and is therefore warranted in only the most serious EMS incidents
 - Dispatch of first responders is most useful when focused on EMS incidents where truly time-sensitive interventions available from first responders (CPR, defibrillation and bag-mask ventilation) are actually likely to be needed.

Key Opportunities to Strengthen the Process

Some opportunities exist to strengthen the RAP development process:

- Although supported by extensive clinical data, BCEHS RAP development was in essence an “expert opinion” process. In medical science, expert opinion is considered less powerful than decisions derived objectively from actual data.
 - Transitioning future decision processes towards increased reliance on clinical data, and less upon expert opinion, would enhance the process.
- While collegiality and consensus have organizational value, the substantial number of cases where consensus was not reached suggests that alternatives – including recommendations derived principally from the clinical data alone – could be considered without loss of organizational benefit.
- Analysis of the actual clinical interventions performed by BCEHS paramedics and first responders for each patient, and tallying each of these by MPDS determinant, would significantly leverage the Australasian Triage Scale data in future amendment cycles for the RAP.
 - Reliable data on the use of time-sensitive first responder interventions (CPR, defibrillation, bag-valve-mask ventilation) would add granularity and increased transparency to future decisions about dispatching first responders.

Protecting Public Safety through emerging medical science

The science of emergency medicine, and of pre-hospital care in particular, is evolving extremely rapidly. Over the past ten years, assumptions central to the original design of EMS systems have been overturned by compelling scientific evidence. For instance, twenty years ago, aggressive ALS

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

intervention in critically injured trauma patients – particularly those with brain injuries -- was considered essential; it is now known to be harmful. Similarly, short EMS response times, including the extensive use of first responders to shorten that time, were previously considered universally beneficial to patients. There is now a formal consensus among EMS physicians that short response times alter patient outcome in only cardiac arrest, respiratory arrest and total airway obstruction, conditions found in less than 1% of all EMS responses.

Not surprisingly, the magnitude of contemporary changes in emergency medicine may conflict with the expectations and the culture of some paramedics, some first responders and some members of the public. BCEHS is in a position to optimally protect public safety by both continuous updating its response procedures and by communicating the clear medical rationale for doing so as it introduces these changes. However, the BCEHS process's reliance on medical data describing the actual patients is more likely to match the needs of those patients than advocacy not bound by the evidence.

Balancing Competing Risk

In this report, we discuss the continuously competing risks which drive EMS resource allocation policy. It is important to recall that every EMS response policy decision is a balancing of competing risks, and that reactive efforts to limit future risk demonstrated by a sentinel exception or by strongly held opinions may inadvertently increase other equally compelling countervailing risk.

Managing Exceptions

BCEHS is a very large EMS system and responds to a daunting number of incidents each year. Like every EMS system, and like every incident triage process, there will always be small numbers of perhaps compelling examples of unexpected occurrences, such as a high acuity patient assigned a low priority response. These exceptions are inevitable in large EMS systems, and do not constitute structural failure of the response plan. The task is to minimize their occurrence and to put patient safety monitoring systems in place to detect, review and understand these exceptions.

Summary Recommendations

After a careful review of the BCEHS Resource Allocation Plan process and the data used to support its decision process, we recommend the following:

- That BCEHS implement the 2013 Resource Allocation Plan (RAP) as developed.
- That public safety be protected following implementation by a schedule of RAP performance reviews as follows:

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

- **After six months** – Review of data completeness including acquisition of EMS and first responder clinical intervention data proposed in this report
- **After 12 months** – Review of agreement between contemporary patient acuity data and that used to produce the 2013 RAP, supported by supplementary acuity scoring derived from the EMS and first responder clinical intervention data
- **After 18 months** – Complete revision of the BCEHS Resource Allocation Plan with increased reliance on pre-agreed decision criteria applied to actual clinical data, permitting a reduction in reliance upon voted expert opinion

Summary

British Columbia Emergency Health Services and its partner agencies have undertaken a complex and important process to optimize EMS response to the residents of and visitors to British Columbia. Although challenging as a change management process, the new Resource Allocation Plan is likely to improve public safety by the careful balancing of risk and benefit.

Contents

Executive Summary

Summary of Recommendations

Part 1 - Background

Part 2 - Call Triage in the EMS Dispatch Process

- Part 2A - The Medical Priority Dispatch System (MPDS)
- Part 2B - BCEHS compliance with the MPDS algorithm
- Part 2C - Issues in EMS call triage processes

Part 3 - The BCEHS 2013 Resource Allocation Plan process in context

- Part 3A - The influence of contemporary EMS science
- Part 3B - Management of competing risks in EMS resource allocation
- Part 3C - Decision-making strategies in Resource Allocation Planning

Part 4 – The BCEHS Resource Allocation Plan as a clinical prediction rule

- Part 4A - Data supporting the process
- Part 4B - The RAP decision-making process
- Part 4C - The final product – The BCEHS response plans

Part 5 - Options for the future of the RAP process

Appendices

A – Data points reported to the RAP Working Group

B – Selected references in EMS resource allocation

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

Summary of Recommendations

The following recommendations are made to the BCEMS Vice-President – Medical Programs:

Summary Recommendations:

- *It is recommended that BCEHS implement the 2013 Resource Allocation Plan (RAP) as developed.*
- *It is recommended that BCEHS conduct consecutive RAP performance reviews on the following schedule:*
 - **After six months** – *Review of data completeness including acquisition of EMS and first responder clinical intervention data proposed in this report*
 - **After 12 months** – *Review of agreement between contemporary patient acuity data and that used to produce the 2013 RAP, supported by supplementary acuity scoring derived from the EMS and first responder clinical intervention data*
 - **After 18 months** – *Complete revision of the BCEHS Resource Allocation Plan with increased reliance on pre-agreed decision criteria applied to actual clinical data, permitting a reduction in reliance upon voted expert opinion*

Supplementary Recommendations:

- *It is recommended that BCEHS consider acceptable levels of risk for both under-triage and over-triage in deciding the most appropriate response to groups of MPDS determinants.*
- *It is recommended that, when risk thresholds are set, competing risks be explicitly considered in the decision process.*
- *It is recommended that the Australasian Triage Scale be used as an adjunctive data point in future RAP revision processes if issues of data completeness and a more substantial alignment between ATS's criteria and the BCEHS pre-hospital setting can be achieved.*
- *It is recommended that the BCEHS analytic metrics be amended as described to improve the precision and usefulness of the analysis.*
- *It is recommended that a detailed retrospective and prospective review of BCEHS incidents in the MPDS determinant 09-B-01 be conducted to assess whether patients warranting resuscitation are unexpectedly encountered.*
- *It is recommended that the firefighter first response plan contained in the 2013 BCEHS RAP be implemented as written.*
- *It is recommended that comprehensive patient care reports documenting each instance of firefighter patient care of all types to BCEHS patients be integrated into the BCEHS clinical data to power future evidence-based reviews of this plan*

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

- *It is recommended that all BCEHS cases where critically-time-sensitive EMR-level interventions (CPR, defibrillation, BVM ventilation and tourniquet application) are provided be identified prospectively, regardless of whether these were provided by EMS paramedics or first responders, and collated by MPDS determinant*
- *It is recommended that once statistically useful prospective data is available, periodic re-assessments of this plan be undertaken to assess the performance of the first responder components of the 2013 BCEHS resource allocation plan*

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

Part 1 - Background

The 2013 BCEHS Resource Allocation Plan

During late 2012 and early 2013, British Columbia Emergency Health Services conducted a major revision to its Resource Allocation Plan (RAP), a master document which defines the most appropriate Emergency Medical Services (EMS) system response to incoming 9-1-1 emergency medical calls. BCEHS serves as a “Secondary Public Safety Answering Point” (S-PSAP) in the 9-1-1 system, and all 9-1-1 callers requesting an ambulance are immediately transferred to one of BCEHS’s three wide-area dispatch centres.

The BCEHS call-takers conduct a brief scripted medically-oriented interview with the 9-1-1 caller to rapidly classify and prioritize the incident, and the centre then assigns an appropriate response which may involve a combination of EMS ambulance resources with or without Fire Service first responders. The response is defined by the RAP which predetermines the response for each of several hundred possible dispatch categories known as “determinants”.

The 2012-13 review was a consensus process involving a “Working Group” comprised of a range of stakeholders including physicians, paramedics, dispatchers, EMS managers, and first responders. The group reviewed data related to each possible dispatch determinant, and then each group member cast votes on the most appropriate response options in a three-round “modified Delphi” process, aimed at anonymously reaching consensus on each decision. Many votes produced a unanimous decision, but consensus was not achieved in others. A second BCEHS senior executive group, including a physician, reviewed each decision, resolving issues upon which consensus could not be reached, and in selected circumstances, altering the working group’s decision for risk management and other medical policy reasons.

In November, 2013, a final revised RAP document was completed including a summary report outlining the process and the changes it entails.

The External Review Report

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External Review of the British Columbia Emergency Health Services Resource Allocation Plan

Since the 2013 BCEHS RAP has not been fully implemented at this writing, it is not possible to assess or predict the actual performance of the plan, but rather to assess the likelihood of its success based on the infrastructure and processes used to develop it.

In this report, we considered:

- Where this process fits in contemporary EMS clinical and operational practices, including the rapidly evolving emergency medical science environment, issues in risk tolerance and optimal medical decision-making practices.
- The data upon which the decisions were based, including dispatch centre data, data extracted from paramedic patient care records, and interpretative and analytic data related to patient acuity and sentinel events such as out-of-hospital cardiac arrest (OHCA)
- The resulting Resource Allocation Plan itself, including an assessment of its role as a clinical prediction rule.
- Key strengths and weaknesses
- Opportunities for strengthening the process, including protection of public safety through a scheduled process of data quality assessment, validation of the RAP's predictive strength, options in additional data and analytic approaches to improve its scientific strength and developmental efficiency.
- Recommendations including an overall professional opinion as to whether this plan should be recommended by BCEHS as policy in British Columbia

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

Part 2 - Call Triage in the EMS dispatch process

BCEHS's three wide-area dispatch centres receive a total daily average of 1,900 requests for emergency response. For the most part, these incidents are considered authentic "emergencies" by those who call 9-1-1, but like patients presenting at hospital emergency departments, many EMS patients – in fact, most – do not face immediately life-threatening conditions, but rather conditions of a wide range of relative clinical priorities. However, for those incidents involving immediate threats to life – such as cardiac arrest, drowning, or extreme shortness of breath – rapid reliable identification and response to their need is of paramount importance.

A central task of EMS systems is the classification of each incoming 9-1-1 incident, ascertaining its priority relative to other concurrent calls, and defining what resource or combination of resources should respond. Known collectively as response plans (or in British Columbia, as the Resource Allocation Plan), this process relies upon two distinct elements:

- A reliable and consistently accurate process for call classification and prioritization
- Medically-supervised predefined response plans which direct dispatch staff as to what resources should respond and how rapidly

In a theoretical perfect system, the priority designations in a resource allocation plan would perfectly match patient acuity, neither over-triaging, nor under-triaging, any call. The inherent vagaries of prioritizing patients the EMS dispatcher cannot see and the need to rely upon information from lay callers makes such perfect allocation highly unlikely if not impossible. However, high levels of accuracy (the combination of sensitivity and specificity) and patient safety are possible.

Optimally, a multi-layer EMS system would assign its resources to achieve the following:

- Allocate most high priority incidents to high priority dispatch categories
- Allocate most low priority incidents to low priority dispatch categories
 - These two appear to be mirrors of each other, but they are not, as it is possible to achieve one without achieving the other.
- Dispatch ALS to incidents likely to produce a patient requiring ALS
- Dispatch only BLS units to incidents unlikely to produce a patient requiring ALS
- Dispatch first responders (Fire or Police) to only those incidents where their most time-sensitive interventions such as CPR and defibrillation are likely to be required

It would be unreasonable and unpredictable to ask EMS dispatch centre staff to make the decisions required to execute this process in real-time based solely on each dispatcher's individual knowledge, experience, preferences and approach. Accordingly, decision support mechanisms, mandatory

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

processes, and medically-supervised response policies are in place in every BCEHS site and in most contemporary EMS systems worldwide.

Medical Priority Dispatch System (MPDS)

BCEHS uses a commercial emergency medical call triage product known as the Medical Priority Dispatch System (MPDS) [Priority Dispatch Corporation, Salt Lake City, UT] which employs a brief scripted interview with the 9-1-1 caller to establish key information about the patient's condition. The interview is algorithmic, using different questions for different chief complaints and incident types. By the end of the interview, the algorithm routes the EMS call-taker to one of nearly 1,300 possible decision end-points known as "determinants" in one of 33 general incident categories.

Where necessary, dispatchers are provided with scripted instructions to provide assistance to callers in managing a range of critical emergencies prior to the arrival of emergency responders. For instance, in cardiac arrest, dispatchers now routinely instruct lay bystanders over the phone in cardiopulmonary resuscitation (CPR), critically shortening the time to starting life-sustaining chest compressions.

The MPDS system is the most widely used call triage algorithm in the world, and more than 65 million emergency calls are processed through it annually in 3,100 MPDS-equipped dispatch centres worldwide. MPDS has been adopted for all EMS dispatch centres in BC, Alberta, Ontario, Nova Scotia, New Brunswick, Prince Edward Island and many local dispatch points such as Winnipeg EMS-Fire Service and Urgences Sante in Montreal. Although several competitor products exist, they represent a small part of 9-1-1 practice, and MPDS remains the only algorithm with a significant presence in the independent peer-reviewed emergency medicine scientific literature, including studies assessing MPDS's performance and predictive accuracy in various EMS systems.

BCEHS Compliance with the MPDS algorithm

All decision systems such as MPDS operate safely only to the extent that they are carefully and consistently followed. Even flaws in the process cannot be identified without rigorous compliance to the interview scripts and the algorithm's flow. BCEHS conducts routine structured reviews of its adherence to the MPDS process and reports that in 2012, its dispatch centres were typically 88-89% compliant.

In 2013, this compliance rate rose to 95%, placing BCEHS's communications centres among the best in North America. BCEHS has applied for Center of Excellence accreditation for all of its sites through the National Academies of Emergency Dispatch, a rating only achieved by a small percentage of MPDS sites. Accreditation would be an important asset to BCEHS as it imbeds strong ongoing quality assessment, compliance and patient safety processes into Center of Excellence sites.

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

Issues in EMS Call Triage Processes

Over the past 15 years, EMS researchers have recognized that even when well-designed dispatch triage algorithms such as MPDS are assiduously applied to classify incoming calls, the group of patients arising from calls assigned to each of the dispatch categories (“determinants”) will not all be of a single acuity (such as “critical”) but have a spectrum of acuities from critical to very low acuity.

In recognition of this, MPDS is designed to err on the side of caution in calls with the potential for high acuity. The MPDS process has been shown in research papers that high priority determinants such as those at the “Delta” level produce a spectrum of patients with substantially more critical and seriously ill patients, and fewer low acuity patients. Conversely, low priority determinants such as those at the “Alpha” level produce a range of patients whose acuities are heavily biased towards low and very low acuity.

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

Part 3 - The BCEHS Resource Allocation Plan Process in Context

In assessing the BCEHS Resource Allocation Plan and the process which produced it, it is very useful to place the plan in the context of key factors which affect best practices in response planning for high quality EMS systems.

These include:

- The contemporary medical science affecting both emergency medicine and pre-hospital care systems such as BCEHS
- Strategies in EMS risk management, and in particular, recognition of the interaction between competing risks
- Issues arising from undertaking evidence-informed “expert opinion” decision-making in medicine

Part 3A - Contemporary EMS Science

During the past ten years, a growing body of scientific research has dramatically altered the science of emergency medicine, cardiac arrest resuscitation and Emergency Medical Services. The pace of change is accelerating, and EMS systems will require frequent re-design to optimize care. The most significant changes include:

- Conclusive evidence now exists that rapid commencement of high-quality minimally-interrupted chest compressions is the single most important contributor to survival from out-of-hospital cardiac arrest when coupled with defibrillation when a shockable rhythm is detected.
- There is extremely limited evidence that intravenous drugs and advanced airway management such as endotracheal intubation improve survival to hospital discharge in the initial pre-hospital resuscitation of primary cardiac arrest. Certain drugs are believed to remain important in the pre-hospital management of patients after restoration of spontaneous circulation after cardiac arrest (eg vasopressors and inotropes).
- In optimized EMS systems, patients who do not achieve durable restoration of spontaneous circulation prior to arriving at hospital are extremely unlikely to survive to hospital discharge.
- With limited exceptions, urgent transportation of a cardiac arrest patient to hospital before restoration of spontaneous circulation is unlikely to improve survival (and may in fact harm the patient), dramatically impairs CPR quality, and increases risk to providers and the public alike.
- Oxygen should be administered in pre-hospital care primarily to correct specific occurrences of oxygen desaturation, based on clinical assessment and on biometric readings. The practice of

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

routine administration of oxygen (by EMS staff or by first responders) without specific clinical indication is unwarranted and growing evidence shows substantial harm to certain patients.

- Rapid EMS response times – by either ambulance crews and first responders – do not affect patient outcomes except in cardiac arrest, respiratory arrest and total airway obstruction.
- Excessively strict EMS response times and unwarranted “lights-and-siren” responses by either EMS ambulances or first responders endanger the safety of the public and responders alike, and inflate emergency services costs without altering patient outcomes.

Implications of new science for EMS Resource Allocation planning

These scientific developments fundamentally alter strategies in EMS resource allocations planning, including the following:

- EMS calls likely to involve a patient whose heart has stopped beating or who is not breathing should receive the fastest possible response including dispatcher-coached bystander CPR, public access defibrillation, fire and/or police first response, and an EMS ambulance. Initial EMS resuscitation (high quality CPR and automated defibrillation) can be provided at the BLS and first responder level.
 - Therefore, knowing which EMS dispatch categories (such as MPDS determinants) are actually most likely to produce these patients is essential and can only be derived from matching dispatch data with paramedic patient records.
- In cardiac arrest, Advanced Life Support care is now known to be most useful after initial resuscitation where restoration of spontaneous circulation is achieved.
 - Accordingly, even delayed arrival of an ALS ambulance in cardiac arrest may still be beneficial.
- Dispatching first responders (fire apparatus, police or others) is most beneficial where the specific time-sensitive interventions available from these responders (CPR, automated defibrillation, and bag-mask ventilation) are most likely to be needed. At present, there is limited scientific evidence of outcome benefit from first response beyond these most urgent incidents.
- Response time requirements should be reconsidered to provide patients with the interventions they actually require in the time frame they need them and to:
 - Ensure the promptest possible response to incidents likely to produce patients in unexpected cardiac arrest, respiratory arrest or with total airway obstruction. This includes drowning, hanging and other asphyxial events. No clinically optimal standard exists other than “absolutely as fast as possible” and the use of dispatcher-initiated engagement of bystanders to commence interventions such as CPR and rescue breathing is beneficial.

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

- Provide other care in a reasonable and consistent time frame, having regard to those at aggravated risk, such as, but not limited to, persons exposed to inclement weather, the isolated elderly, and unprotected minors.
 - Previously common response time standards for lower priority calls (12 min 59 sec at the 90th percentile, 20:59, 30:59, etc) are not based in medical specific evidence.
- Prevent accumulation of undispached incidents in EMS communications centres which may prove difficult to serve later should a surge in demand occur.
- Balance the costs of shorter response times against competing health care system needs, community expectations and ethical practice.
- It is not necessary to dispatch everyone capable of an intervention, but rather a response which most efficiently meets that need.
- The use of “light-and-siren” response should be restricted to only the most urgent incidents.
 - Response plans mandating non-emergency response should be routine for both ambulance crews and first responders for other incidents.

Part 3B - Management of Competing Risks in EMS Resource Allocation

All EMS triage processes – including a decision not to triage at all – share common risks which interact and compete with one another. These interactions of risk preclude adoption of “all-or-nothing” solutions and are best resolved using the highest possible level of clinical evidence.

Acceptance of Background Risk

All EMS resource planning decisions involve acceptance of low level background risk of serious adverse events (SEAs) caused by process variation or imprecisions in the triage process itself. Even those reporting an emergency precipitate a serious adverse event because they imprecisely or erroneously describe the nature of an incident, causing it to be assigned a low priority when in fact it is later found to be immediately life-threatening. This can occur because the caller is not actually with the patient, because the caller lacks medical training, because of the caller’s personal, cultural and experiential bias, and many other reasons.

In all EMS call triage interactions, there is the risk of under- or over-triage. In under-triage, the process fails to identify an emergent – even life-threatening – condition. In over-triage, risk arises from assigning a needlessly high priority and therefore providing a response which is both too urgent and involves over-commitment of emergency resources.

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

Either form of error can occur when triage procedures are not followed, when those procedures have insufficient sensitivity and/or specificity, and when the caller cannot, or fails to, accurately answer the EMS call-taker's structured questions. In each case, risk can range from low to unacceptably high, depending up the combination of probability and consequence.

Over-triage deserves special notice. Some EMS systems believe that they can minimize overall system risk by very aggressive response plans for every call, sending an ALS ambulance, a BLS ambulance and first responders, all using "lights-and-siren". Despite the superficial appeal of this approach, its benefits (reduced risk of under-triage) may well be met or overshadowed by the competing risks of response accidents, local resource depletion, and cost. For instance, wrongly assigning a call to a needlessly high priority – either in real time or in the RAP – may deny a rapid response to another call which arises shortly thereafter in the immediate area.

Defining Local Tolerability of Risk

EMS resource planning processes are strengthened when the tolerance for specific high consequence risks is quantified in advance of evaluation of data. For instance, an EMS system might hypothetically decide that "we will accept the risk of sending BLS ambulance alone to calls in a particular determinant as long as there is no more than one chance in 500 that a call in this determinant will be found to be a cardiac arrest warranting resuscitation." This would establish one "cut-off" criterion for "BLS-only" responses. It should be noted that specific risk-adjusted statistical techniques are available (such as Receiver Operating Characteristic [ROC] curves) which assist in optimizing these choices.

Perception of Risk

Individuals, their communities and stakeholders within communities are routinely tempted to minimize or entirely discount even lethal risk when acceptance of that risk would force individual or public policy choices which are seen as negative. For instance, the risk of disastrous flooding, volcanic eruption or contamination from nuclear accidents is often dismissed by those who would otherwise be forced to give up their traditional place of residence, work or recreation. In EMS resource planning, stakeholders may discount the risk of collisions involving emergency vehicles during "lights-and-siren" response as being events which "don't happen here." Considerable caution is required in considering dismissal of risk, particularly when probability of occurrence is low but possesses high consequence.

Imposition of Risk in Absence of Consent

EMS triage policy decisions possess risk which accrues to people whose individual consent is inherently impossible to obtain either in advance or at the time of a 9-1-1 call. That risk may accrue to either individual patients (eg where ALS response is forgone), to persons not directly involved in a particular

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

EMS event (eg where emergency vehicle response results in a motor vehicle accident), or both. The assignment of risk to persons who, by definition, cannot offer their informed consent imposes a high burden upon decision-makers, a burden amplified when competing risks exist. Excellent literature exists which defines strategies for establishing tolerability of risk imposed upon those who cannot consent.

Efficiency of Response

Careful stewardship of EMS resources protects public safety, minimizes risk to providers and community alike, and limits cost escalation as demand for service increases with population and consumption of emergency care.

A central characteristic of EMS data disaggregated by MPDS determinant is the dramatic clustering of EMS incidents in a small percentage of the available EMS determinants. For instance, in the 2012 BC EMS dataset, all 630,542 events appear in only 319 of MPDS's more than 1,300 possible determinants. Moreover, more than 90% of all incidents appear in only the 100 most frequently-used determinants, and 50% of incidents appear in only 24 MPDS determinants. Similarly, 90% of the 5,401 cardiac arrests documented in the dataset occurred in 27 determinants and involving 154,460 responses. The remaining 10% of cardiac arrests recorded in the 2012 dataset are spread sparsely over 392,812 responses in 178 additional dispatch determinants.

The impressive clustering of EMS incidents in relatively small numbers of MPDS determinants strongly support the establishment of risk/benefit cut-offs to improve system efficiency within known risk boundaries.

Recommendation:

- *It is recommended that BCEHS consider acceptable levels of risk for both under-triage and over-triage in deciding the most appropriate response to groups of MPDS determinants.*
- *It is recommended that, when risk thresholds are set, competing risks be explicitly considered in the decision process.*

Part 3C - Decision-making Strategies in Resource Allocation Planning

In contemporary academic emergency medicine, there is wide agreement that evidence-based decision-making including diagnostic approaches, treatment protocols and advice to patients produces the most reliable and reproducible results. Evidence-based decisions are typically informed by robust data, carefully-designed high-quality research trials of sufficient power to resolve the issues at hand, and vetting through the scientific peer review process.

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

However, the development of EMS policy – both medical and operational – does not always lend itself well to a fully-evidence-based approach, in part because consent issues in the randomized controlled trials which would be required to resolve some of the leading issues. On the other hand, these problems do not license arbitrary or ill-informed decision-making, and strongly argue for informing any decisions with the best-available evidence while remaining aware of that evidence’s strengths and limitations.

Strong evidence contributes to risk management and to the evolution of practice even when the evidence contradicts past practice and long-held assumptions.

Existing Peer-reviewed Scientific Literature on EMS resource allocation

A small but intelligent and informative literature exists reporting various studies and strategies related to EMS resource allocation, in particular in relation to the Medical Priority Dispatch System. A comprehensive review of that literature is beyond the scope of this review, but to assist, we have included a bibliography of key papers as Appendix B.

Role of Expert Opinion, Stakeholders and Consensus

Where strong levels of evidence such as randomized trials do not exist, policies and protocols are often established using expert opinion. The employment of expert opinion is greatly strengthened when:

- The decision process used by the experts is transparent, documented and followed consistently.
- Whatever clinical data is available is brought to bear directly and traceably upon the decisions.

Expert processes are designed to arrive at intelligent decisions informed by the best available evidence. In processes involving multiple true experts, it may be seen as important that the resulting decision broadly represent the opinions of all participants as a formal consensus. In some cases, consensus cannot be achieved due to authentic honest difference of expert opinion, often owing to a lack of overwhelmingly convincing evidence.

By contrast, constituency processes – those designed to ensure representation of defined groups or interests – operate, by definition, to promote the interests of those constituencies. This obligation to represent is legitimate but different than the expectation of impartiality essential to expert processes.

Part 4 - The BCEHS 2013 Resource Allocation Plan as a Clinical Prediction Rule

“Clinical prediction rules are mathematical tools that are intended to guide clinicians in their everyday decision making” – Simon Adams, BMJ, 2012

EMS resource allocation plans function daily as derived clinical prediction rules, closely matching Simon Adams’ definition, and like other clinical prediction rules, are most reliable when derived more from data than opinion and when validated with prospective data samples after implementation.

In this section, we consider three elements of the BCEHS RAP development process:

- The data supporting the process
- The decision process used
- The resulting Resource Allocation Plan

Part 4A – Data supporting the RAP Process

Sourcing Predictive Data

The data used in any resource allocation plan is of value only to the degree that it is predictive.

Five factors largely determine the predictiveness of EMS resource planning data:

- Use of a high quality computer-aided dispatch system which produces reliable and rich categorical, temporal and spatial data.
- Use of a call classification process which consistently places incidents similarly described by 9-1-1 callers into the same dispatch category
- Sample sizes at the finest level of data analysis (determinant level) which are large enough to be likely to produce similar results in future samples.
- The quality, accuracy and completeness of the available clinical data.
- Use of scores, ratings and other interpretive schemes which have been evaluated in advance to confirm that they will produce consistently meaningful results driven by the best available data. For instance, great care should be exercised when a particular score on an interpretive scale is sometimes derived from one group of data elements or patient presentations, and sometime from another.

The RAP process was supported by data derived from two sources, the BCEHS computer aided-dispatch (CAD) system and the BCEHS electronic patient data warehouse system in which manually keyed

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

extracts from paper paramedic patient charts are stored. By matching the CAD and clinical records for EMS incidents (using the unique incident run number which appears in each), it is possible to establish relationships between information upon which dispatch decisions are based and the actual clinical condition of the associated patient. The clinical data also has the potential to describe the pre-hospital medical interventions provided, and to provide attributes about the incident, such as whether the case is an out-of-hospital cardiac arrest (OHCA) warranting resuscitative intervention.

BCEHS provided the RAP Working Group with a selection of analytic metrics – mostly proportions and tallies – to help describe the patient population encompassed by each MPDS determinant in the 2012 BCEHS data sample. These metrics included computerized interpretation of each patient chart against an external clinical acuity scale in an effort to provide a standardized measure of the distribution of patient acuities encountered in calls assigned to each of the 319 MPDS determinants evaluated.

A typical example of the data summary supplied to the RAP Working Group for each MPDS determinant appears in Appendix A.

The BCEHS dataset appears well suited to the RAP task:

- High-quality CAD data
 - BCEHS uses industry-standard CAD systems with rich, reliable data
- Consistent classification of incoming incidents
 - MPDS meets this test and BCEHS has demonstrated high levels of compliance with the MPDS algorithm.
- Sample size
 - This is a robust data set with more than 630,500 records.
 - 243 of the 319 MPDS determinants reviewed had data for 30 or more cases
- Completeness and accuracy
 - Accuracy of paramedic charting and data entry from paper forms, and completeness of patient care documentation were beyond the scope of this report.
 - As a rule, EMS data “missingness” is unlikely to be random and this suggests that statistical techniques such as imputation are unlikely to be appropriate.
- Interpretative Scales and Ratings
 - An extensive discussion of the use of the Australasian Triage Scale follows in this report
 - We provide comments in this report about ways to buttress completeness of the data presented to decision-makers.

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

Use of the Australasian Triage Scale

BCEHS used interpretive software in an effort to assign each of their 2012 EMS patient records to one of five levels of clinical acuity using the Australasian Triage Scale. These decisions were based on based on a combination of physiological and descriptive attributes recorded in electronic data extracted from the paramedics' paper patient chart. The scale has five discrete acuity categories number from one (highest) to five (lowest).

Developed in 2000, this scale is designed to standardize the triage of patients presenting at hospital Emergency Departments and to ensure that ED staff route those with the highest acuity to immediate treatment. ATS has an intelligent architecture whose triage classifications would, by and large, resonate with any ED physician. Similar efforts to classify EMS patients have been made by other Canadian EMS systems using the Canadian Triage Acuity Scale (CTAS), a scale also developed originally for in-hospital -- not pre-hospital -- use.

However, attempting to retrospectively apply any of these hospital-based scales (ATS, CTAS or other) to pre-hospital patients faces four distinct challenges:

- The criteria used by ATS to classify a patient are, in many cases, diagnostic (“Severe behavioural disorder”), while EMS chart data is, by its nature, dominantly physiological (vital signs, coma and trauma scores), observational (“abdominal pain”), and treatment-oriented (“Atropine 1 mg given IV at 10:15 hrs”).
- The BCEHS paramedic patient record data set was not designed around ATS. Attempting to retrospectively apply external criteria to a dataset whose design did not explicitly and comprehensively solicit the criteria’s data points limits the precision of the match between the ATS categories and the patients seen by BCEHS paramedics. This issue is amplified by EMS charts which are less than fully complete, a problem commons to many EMS data sets.
- Assigning a case to a specific ATS acuity such as “ATS-1” required the application of multiple data tests. Each of these tests possesses its own level of precision and the error in identifying ATS-1 patients is the sum of the error in each set of tests applied.
 - In the BCEHS data analysis, six different data tests – some based on objective finding such as systolic blood pressure and others on “provider impression” -- were employed to determine if an incident warranted an Australasian Triage Score of “1”.
- ATS’s acuity determination assists in priority determination, but acuity alone does not define the most appropriate EMS response resource mix. For instance, in the two highest ATS categories, there is no strict relationship between the acuity scores and the likely need for ALS or first responders.

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

Missingness in ATS score fields

In the dataset supporting the RAP process, the precision of the ATS classifications data is limited by the fairly high rate of data “missingness”, cases where an ATS score could not be assigned to an incident. On average, an ATS score was available in about 45% of EMS responses.

We explored whether the availability of an ATS score was statistically more likely in incidents more likely to produce a serious patient, using the MPDS determinant level (Alpha [low] to Delta+Echo [high]) as a predictive surrogate for acuity. While there was a trend towards more complete ATS scores in high priority MPDS determinants, this was not conclusively statistically significant:

| MPDS Level | Patients Charts with an ATS score | Incidents | % of incidents with an ATS score | Deviation from mean (in Standard Deviations) |
|------------|-----------------------------------|-------------------|----------------------------------|--|
| Alpha | 79,409 | 175,760 | 45.18% | +0.02 |
| Bravo | 55,236 | 131,211 | 42.10% | -1.18 |
| Charlie | 69,564 | 155,052 | 44.86% | -0.09 |
| Delta+Echo | 81,421 | 168,519 | 48.32% | +1.25 |
| Totals | 285,630 | 630,542 | 45.11% | |
| | | Mean availability | 45.11% | |
| | | Std Deviation | 2.54% | |

The high proportion of responses without an ATS classification suggests that caution should be exercised in generalizing any of these results to either the total incident volume or to the total number of patients transported. Further, the evidence that data missingness is non-random argues against use of imputation techniques to attempt compensate for missing data.

This poses problems in direct interpretation of the descriptive statistics used by the Working Group:

- The absolute number of patients in a particular ATS category cannot be presumed to be any fixed proportion of the total number which would have been reported had the ATS data been 100% complete.
- The calculated percentage of incidents producing patients within any particular ATS category (reported by BCEHS as the number assigned to the category divided by the total number of incidents) should be treated at best as a cautiously-applied “relative incidence” value (eg some MPDS categories having more ATS1-reported patients than another) whose predictive value cannot be determined.

To explore the ATS data further, we calculated another percentage value for each MPDS determinant where the denominator was the total number of incidents for which an ATS value was available. This

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

provides information about the distribution of patients across the ATS spectrum where ATS data was available. Again, this cannot be extrapolated to the broader patient population but it provides another insight into the observed proportion of fully documented patients in each ATS category and may possess limited value as a relative measure among MPDS determinants.

| Total incidents with an ATS score | ATS-1 | ATS-2 | ATS-3 | ATS-4 | ATS-5 |
|-----------------------------------|--------|--------|---------|--------|-------|
| 285,630 | 19,831 | 35,654 | 178,503 | 47,644 | 3,998 |
| | 6.9% | 12.5% | 62.5% | 16.7% | 1.4% |

These results are reasonably consistent with the ratio of acuities seen in other EMS data set analyses using different acuity scales such as CTAS.

Concordance between ATS score and most appropriate EMS response

Two problems exist in using acuity scores to establish an appropriate EMS response:

- In the majority of determinants, a strong plurality, and often a majority, of patients, have an ATS score of 3, regardless of the varying proportion of patients in the higher and lower score levels. In these cases, one could, at best, infer that determinants later shown to have a high proportion of ATS-1 patients should receive a higher level of response than those with high proportions of ATS-4 and ATS-5 scores.
- The ATS scores align with common EMS resource assignment practices only at the extremes (ATS-1, and ATS-4+5) and even then incompletely. This misalignment limits the direct prescriptive value of ATS in the RAP process to the inference that patients with an ATS score of 1 should, by and large, receive a maximal response.

The table below illustrates the relationship between ATS-1 clinical condition and the likely EMS responses required.

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

| ATS | ATS Criteria | Directly discernable from typical EMS chart data set | Common EMS response | Applicable First Responder medical interventions beyond standard first aid |
|-----|---|--|---------------------|--|
| 1 | Cardiac Arrest | Yes | ALS | CPR Defibrillation BVM |
| 1 | Respiratory Arrest | Yes | ALS | BVM |
| 1 | Pre-arrest airway compromise | Probably | ALS | Chest thrusts, BVM |
| 1 | Respiratory rate <10/min | Yes | ALS | BVM |
| 1 | Extreme respiratory distress | Probably | ALS | Oxygen, BVM |
| 1 | Adult BP <80 or shock in child | Adult – Yes Child – probably | ALS | Unclear |
| 1 | GCS<9 | Yes | ALS | Airway positioning |
| 1 | IV-OD – unresponsive and hypoventilating | Probably | ALS | BVM |
| 1 | Severe behavioural disorder with risk of violence | Not likely | BLS | None |

Does “Critical” mean “Send Everybody”?

There is not necessarily a consistent relationship between patient acuity and the most appropriate EMS response. Consider the following three circumstances, each involving an authentically critical patient:

- A patient with multiple thoracic gunshot wounds
 - The patient requires immediate transport to a trauma center by the closest available ambulance and would benefit little from either ALS or first responder interventions.
- A patient in cardiac arrest in a gym
 - The patient should receive a maximal response – first responders, BLS and ALS
- A patient in septic shock in a nursing home
 - The patient needs ALS but would benefit little from additional BLS or first responder care.

In general, response plans should strive to provide the patient with the interventions actually needed in the time frame actually medically required.

Recommendation:

- *It is recommended that the Australasian Triage Scale be used as an adjunctive data point in future RAP revision processes if issues of data completeness and a more substantial alignment between ATS’s criteria and the BCEHS pre-hospital setting can be achieved.*

Other Metrics Provided to the Working Group

Several other analytic metrics were included in the data summary provided to the Working Group for each MPDS determinant. We provide the following comments on certain important data elements from that list (See Appendix A):

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

- Frequency
- Transport percent
- ALS transport percent
- Cardiac arrests
- Cardiac arrest percent

Frequency

A data point named “Frequency” was provided which reports the number of incident records in the patient care database in each MPDS determinant. In consultation with the BCEHS staff, it was clarified that incidents assigned to ambulances but without an associated clinical record were not included in “Frequency”.

While it is always useful to know the number of patient care charts upon which other clinical metrics are based, the Working Group data summary would be more informative if the total number of incidents assigned to each MPDS determinant and to which a response was dispatched (whether a patient care report is available or not) was also reported as “Total Incidents in Determinant”. This number is an essential denominator for defining “efficiency of response” and total relative risk, such as the incidence of cardiac arrest warranting resuscitative effort as a proportion of all responses to a determinant.

Transport Percent

This data point was defined by BCEHS as the percent of all records reported (“Frequency”) for which a transport from the scene was documented.

In most EMS datasets, “Transport Percent” describes the total number of transports divided by the total number of responses in a determinant (“Total Incidents in Determinant” as defined above). This is an important efficiency metric but also an important patient safety metric as high non-transport rates can be a sentinel warning of unwarranted call cancellations on scene such as where intoxicated patients are encountered.

The data supplied to the Working Group would be stronger if the broader definition of “Transport Percent” were used or supplied as an additional metric.

ALS Transport Percent

This data point is problematic as the final definition used appears to be the percent of patients transported by ALS divided by the total patient care records available for this determinant

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

(“Frequency”). This calculation is of limited utility in resource allocation planning, and could be mistakenly assumed to be the percent of patients in a determinant warranting ALS care, which it is not.

In most EMS datasets, the “ALS Transport Percent” is calculated as the number of patients transported by an ALS crew divided by the number of cases in the determinant to which an ALS unit actually responded. In many EMS systems, this calculation is a useful indication of overall percent of patients who, in the opinion of the ALS crew on scene, warranted ALS care or where an ALS unit responded alone. In “All-ALS” systems, this metric and “Transport Percent” are the same, but in two-tiered systems like BCEHS, this is a distinct and clinically useful measure.

Cardiac Arrests

This metric warrants clarification, and probably should be split into two distinct mutually exclusive metrics. The BCEHS staff indicated that this measure does not necessarily distinguish between cardiac arrests warranting resuscitation (“worked arrests”) and those patients who are obviously dead (“unworked arrests”).

In most EMS systems, each year, about one person per 1,000 residents in the coverage area will sustain an out-of-hospital cardiac arrest (all causes) and somewhat over half will be worked arrests. With 5,401 “cardiac arrests” reported in the 2012 data in a province with a population of about 4.54 million, it appears possible that the BCEHS data is reporting all sudden death patients seen by EMS, whether resuscitation was attempted or not.

Distinguishing between worked and unworked arrests is essential to resource allocation planning for a variety patient safety reasons. For example, the MPDS cardiac arrest interview script provides a very effective method for identifying many obviously dead patients at the time of call classification by directing the EMS call-taker to ask the open-ended question “Why does it look like s/he’s dead?”. Where the caller volunteers signs of obvious death (rigor mortis, decomposition, decapitation, and other descriptors approved by the local EMS Medical Director), a low-risk non-emergency response by a BLS unit is appropriate. Calls meeting this test are classified to MPDS determinant “09-B-01” and in fact, the 2013 RAP process decided that this determinant should receive a “BLS-COLD” non-emergency response.

Ideally, none of the patients in this determinant should be later determined on EMS arrival to warrant resuscitation; where worked arrests are found in this class, a rigorous clinical review is required to resolve the issue.

In the RAP dataset, there were 1,790 documented cases with an MPDS determinant of “09-B-01”, of which 569 were tallied as “cardiac arrests”. The BCEHS staff advised that there may be an inconsistency in the way the resuscitation fields are completed within the paramedic patient care report. At this point,

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

no firm conclusions can be drawn as to whether all, some, or any of the 569 cardiac arrest cases actually warranted aggressive resuscitative efforts. This blunts the data's assistance in defining an appropriate response to this determinant.

This example illustrates how clean data intersects with patient safety in the development of EMS resource allocation plans. Moreover, the inability to distinguish conclusively between worked and unworked arrests clouds interpretation any of the "Cardiac Arrest" totals in all 319 determinants used in the RAP process, as well as the derivative metric "Cardiac Arrest Percent".

Cardiac Arrest Percent

In the BCEHS dataset, this metric reports the number of cardiac arrests (as defined above) divided by the total number of cases in the determinant for which patient care records were available ("Frequency").

In most EMS datasets, this metric is the number of worked cardiac arrests divided by the total number of incidents assigned to the MPDS determinant ("Total Incidents in Determinant" as defined above). This provides a sensitive comparative metric about the risk of cardiac arrest warranting resuscitation in the determinant, often an unexpected and important under-triage risk.

The BCEHS dataset would be stronger if this latter calculation were used or provided as an additional metric. Clearly, resolution of the discrimination between worked and unworked arrests in this dataset is a predicate to this enhancement.

Recommendation:

- *It is recommended that the BCEHS analytic metrics be amended as described to improve the precision and usefulness of the analysis.*
- *It is recommended that a detailed retrospective and prospective review of BCEHS incidents in the MPDS determinant 09-B-01 be conducted to assess whether patients warranting resuscitation are unexpectedly encountered.*

Part 4B - The RAP Decision-making Process

The BCEHS RAP process in the MPDS context

Priority Dispatch Corporation, corporate author of the MPDS algorithm, expects each dispatch centre using its MPDS product to establish locally-appropriate response plans for each of the algorithm end-points (the "determinants"). Each determinant has a letter component known as a determinant level, ranging from A to E.

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

BCEHS has taken a very rigorous approach to the development of determinant-level response plans since 1997 and the 2013 version enhanced previous processes through the addition of clinically related data to the debate about each. This approach is remarkably rare across the EMS profession in general and is highly commendable.

Less rigorous processes are common and, in general, are more speculative in nature and in result. In many cases, communities short-circuit the more complex process of establishing response plans based on consideration of each individual determinant, and instead decide that all determinants bearing a particular MPDS determinant level (A to E) will uniformly receive the same response. Some communities even elect to provide the same response to all EMS calls, regardless of MPDS's strong ability to discriminate between calls likely to be serious and those likely to be minor.

Other communities decide on a local response by simply by speculating about the needs of future patients based solely on the wording of the determinant name such as "Abdominal Pain – Fainting or Near-Fainting – Age >50". This approach presumes that all patients arising from calls in each determinant will precisely match the wording of the determinant, a presumption not warranted without supporting evidence from local clinical data.

Decision mechanisms in the 2013 BCEHS RAP process

The 2013 RAP was the fifth revision to the BCEHS Resource Allocation Plan since its inception in 1997, and the first since 2010. In the 2013 process, decisions about the most appropriate response to each MPDS determinant were made, for the most part, in the deliberations and successive votes of the 15-member RAP Working Group. BCEHS reports that the group was structured to provide representation from a broad cross-section of EMS system participants including physicians, paramedics, dispatchers, EMS managers and Fire Service first responders, and that efforts were made to include representation from both urban and rural parts of the BCEHS system.

A three-round modified Delphi process was employed in an effort to achieve consensus through anonymous voting on the most appropriate response to each of the 319 MPDS determinants considered. In a Delphi process, participants seek consensus on an issue through a series of (usually) anonymous votes, interposed with additional discussion of the issue. In theory, learning the views of one's peers (as revealed in the results of successive votes) nudges participants towards consensus. Importantly, in many Delphi processes, the option receiving the least votes in each round of voting is dropped from further consideration, narrowing the choices and driving the dialogue towards consensus. Elimination of "least-favoured" options did not occur in the RAP process, in part because some of the issues were inherently dichotomous and not suitable to the option deletion process.

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

Finally, the BCEHS RAP process sought unanimous agreement, not always a part of Delphi processes. The ability of a stakeholder to “balk” – withhold unanimous consent – transfers resolution of the issue outside the Delphi process, in this case, to a BCEHS senior executive group for a final decision. This group also reviewed the entire RAP document, and in 56 cases, changed the recommendation of the Working Group.

Factors Affecting the RAP Decision Process

The BCEHS RAP process as it exists today is, at its heart, a consensus process, driven by individuals who play varying roles in the EMS system. Although informed by data, the process was not decided by the data, for a wide range of reasons.

An issue in the use of a Delphi process is that it gives all decisive weight to votes based on unknowable individual decision heuristics, mental decision processes which may differ sharply from one constituent to another. As such, it is theoretically possible that a different selection of providers might apply different individual decision logic and produce significantly different results. This lack of reproducibility is problematic in risk management and patient safety processes. Finally, the desire to seek unanimous consensus carries with it the risk of deadlock on issues seen by some as carrying great weight in their professional constituencies.

Part 4C - The final product – The BCEHS Response Plans

Distribution of response plans

The 2013 BCEHS RAP provides for ambulance response as follows, based on data used in the 2013 RAP plan development process:

- **ALS-HOT – ALS paramedic “lights-and-siren” response**
 - 107 MPDS determinants
 - 23.3% of incidents
 - 146,751 responses
- **BLS-HOT – BLS “lights-and-siren” response**
 - 82 MPDS determinants
 - 21.1% of incidents
 - 132,828 responses
- **BLS-COLD – BLS non-emergency response**
 - 129 MPDS determinants
 - 55.6% of incidents
 - 350,617 responses

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

A “quick-look” test of the general plausibility of the RAP response plan choices is shown below. The variance from strict alignment between MPDS determinant levels and the associated response plan is intentional in the RAP process and entirely appropriate.

| MPDS Determinant Level | MPDS determinants receiving an ALS-HOT response | MPDS determinants receiving an BLS-HOT response | MPDS determinants receiving an BLS-COLD response |
|------------------------|---|---|--|
| A | | 1 | 59 |
| B | 2 | 10 | 44 |
| C | 15 | 41 | 23 |
| D | 79 | 30 | 3 |
| E | 11 | | |

The proposed response plan distribution is reasonable and consistent with choices made in communities such as Toronto, although the BC and Toronto systems are not entirely analogous. Since the RAP’s response plan choices were made based on the data-informed opinions of a large stakeholder group and without specific risk or clinical performance thresholds defined to demarcate these choices, it is not possible to predict the precise clinical performance of each response plan decision. At this point, the Australasian Triage Scale score data is insufficiently complete to directly test against the response plan choices, and even if complete, may not predictively discriminate between patients requiring urgent ALS care and urgent BLS care. However, the overall distribution of response plans and their general alignment with the MPDS determinant levels strongly suggests that the decisions are plausible and a good operational foundation for later fine-tuning, particularly if the data enhancements proposed in this report are implemented.

Use of Fire First Responders

There is substantial literature supporting the use of non-paramedic firefighter responders to speed the delivery of specific highly time-sensitive resuscitation interventions such as CPR, automated defibrillation, bag-valve-mask ventilation, and now, some evidence for application of professional-grade tourniquets in exsanguinating peripheral hemorrhage, interventions required by about 1% of EMS responses and 1-2% of actually treated EMS patients.

In the new BCEHS plan, firefighter first responders will be dispatched to calls in 133 (42%) of the 319 MPDS determinants represented in the plan, representing at least 31% of all BCEHS incidents. They will

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

respond on all Echo-level determinants, and most Delta-level determinants (103 of 123), as well as 30 lower priority Charlie and Bravo level determinants.

By comparison, the 2013 BCEHS plan will dispatch firefighters to a substantially higher percent of EMS incidents than designated in the 2012 revisions to the City of Toronto EMS response plans. The Toronto plan differs from the BCEHS 2013 RAP in that the Toronto plan (based on 230,000 incidents) was derived from call-specific information about the proportion of incidents in a determinant warranting time-critical interventions available from fire service first responders.

In the Toronto plan, determinants producing more than one opportunity per 100 fire responses for firefighters to deliver one of the defined critical interventions before EMS arrival were designated for fire response, a cut-off established by the Toronto medical control group which included two Toronto Fire Service medical directors.

To compare the Toronto and BC plans, 177 MPDS determinants were selected for which data on more than 30 cases was available in the Toronto data. This provides the following useful comparison of the two EMS systems:

| | 2013 BCEHS plan | 2012 Toronto plan | Same choice of determinants in BC and Toronto plans |
|--------------------------------|-------------------------|-------------------------|---|
| Firefighters to respond | 60 determinants | 40 determinants | 29 determinants |
| No fire response | 117 determinants | 137 determinants | 106 determinants |

Even in the MPDS determinants directly addressing cardiac arrest, respiratory arrest, and airway obstruction, many responses do not ultimately actually produce patients requiring urgent interventions, and in other cases, an ambulance will arrive before the fire vehicle. Accordingly, many fire first responses do not afford the fire crew the opportunity to deliver such care.

Important practical issues surround the decision of whether to send firefighters to a particular determinant including:

- What proportion of responses in the determinant ultimately present the fire crew with an opportunity to deliver one of the key critically-time-sensitive interventions before EMS arrives?
- What proportion of responses in the determinant involves a worked cardiac arrest where firefighter CPR will be required after EMS arrival and through to completion of resuscitative efforts?
- What data is available to document these interventions when they occur?

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

- Is other assistance required at the scene such as assistance in moving certain patients to the ambulance after on-scene treatment and should response to provide such assistance be emergency or non-emergency?
- What ratio of “dry runs” – those not offering opportunities to intervene – to responses offering such an opportunity is acceptable for practical, operational and emergency response risk reasons?

All response plans are “organic”, requiring continuous validation and revision. As prospective data accumulates after implementation of this version of the RAP, there is considerable value in engaging in periodic reviews of the plan’s performance in placing firefighters at the calls where their key interventions might be needed.

To place such as review on an evidence-based footing, it is essential that case-by-case documentation of fire first responder medical care be integrated into the BCEHS patient care dataset. This will also ensure that every possible instance of actual firefighter delivery of these key interventions is tracked and incorporated into the complete clinical picture for each incident. This data should include share CAD data so that the time between fire arrival and EMS arrival is known in each case.

Obtaining this important data will likely require implementation of a standardized province-wide first responder patient care record form to be completed for each first responder run, with a complete copy provided to BCEHS in a timely fashion for integration into the overall patient record. This documentation expectation is consistent with that expected of all other health care providers in every interaction with every patient.

Additional inference of opportunities for firefighter critical intervention can be derived by tracking the delivery of the same acts by BCEHS paramedics when firefighters did not attend a call.

From this data, a clear picture of the reality on the ground compared to the plan’s predictions will be established and can form the basis for an ongoing dialogue on improvements.

The BCEHS plan correctly only addresses the medical intervention component of multi-agency response to EMS incidents, considering possible medical value arising in the urgent cases where a fire vehicle arrives before an ambulance. Like the attendance of police on EMS calls, other reasons for fire service attendance at certain EMS calls do exist. These include technical rescue, hazardous materials management, fire suppression, and others. Notification for response in these circumstances is often best governed by multi-agency protocols at the primary PSAP level rather than as part of the EMS response plan process.

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

Recommendations

- *It is recommended that the firefighter first response plan contained in the 2013 BCEHS RAP be implemented as written.*
- *It is recommended that comprehensive patient care reports documenting each instance of firefighter patient care of all types to BCEHS patients be integrated into the BCEHS clinical data to power future evidence-based reviews of this plan*
- *It is recommended that all BCEHS cases where critically-time-sensitive EMR-level interventions (CPR, defibrillation, BVM ventilation and tourniquet application) are provided be identified prospectively, regardless of whether these were provided by EMS paramedics or first responders, and collated by MPDS determinant*
- *It is recommended that once statistically useful prospective data is available, periodic re-assessments of this plan be undertaken to assess the performance of the first responder components of the 2013 BCEHS resource allocation plan*

Protecting Patient Safety after Implementation

Although not explicitly proposed by BCEHS as a scientific clinical decision rule, the RAP performs that function on a daily basis for about 1,900 emergency incidents. Like formal clinical rules, validating the predicted performance and wisdom of the RAP is important for patient safety and public confidence. Further, in this report we recommend specific data quality enhancements which improve the data available for such validations and for the next revisions. Fortunately, the very large size of BCEHS's ambulance operations permits rapid accumulation of statistically robust data, allowing for reassessments on a short cycle.

For these reasons, we make three specific performance review recommendations to be taken in concert with the recommendation for a more complex review of the first responder components of the plan.

Recommendation

- *It is recommended that BCEHS implement the 2013 Resource Allocation Plan (RAP) as developed.*
- *It is recommended that BCEHS conduct consecutive RAP performance reviews on the following schedule:*
 - ***After six months** – Review of data completeness including acquisition of EMS and first responder clinical intervention data proposed in this report*
 - ***After 12 months** – Review of agreement between contemporary patient acuity data and that used to produce the 2013 RAP, supported by supplementary acuity scoring derived from the EMS and first responder clinical intervention data*

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

- **After 18 months** – Complete revision of the BCEHS Resource Allocation Plan with increased reliance on pre-agreed decision criteria applied to actual clinical data, permitting a reduction in reliance upon voted expert opinion

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

Part 5 - Options for the Future of the RAP Process

While the 2013 BCEHS RAP plan is a strong document warranting implementation and the support of all stakeholders, opportunities exist to enhance the process both during the validation phase and in future revisions. These opportunities include:

- The addition of data about the actual pre-hospital medical interventions required by each patient, both those delivered by EMS paramedics and those delivered by first responders. This data provides granularity to any acuity score employed, and provides an appreciation of not only acuity but opportunities from the EMS system as a whole to intervene to change the patient's trajectory.
 - By tallying this data by MPDS determinant, a more complete picture emerges about the most useful future EMS response to the determinant, based on what level of provider is able to deliver the interventions required and in what time frame.
 - Including first responder intervention data allows for further fine-tuning of decisions about where the interventions available from first responders are actually medically useful and how frequently they are actually delivered to patients. This improves the transparency and authenticity of these important decisions.
- Enhancing the quality and completeness of the data available to future processes. We recommend adding or amending the metrics as discussed in this report to standardize the data against other EMS systems and to increase its decision support power.
- Consider increasing the influence of the data on the decision process as a gradual replacement for individual opinion. This will shift the important contribution of stakeholders to a debate about risk and decision thresholds. For instance, it may be possible to decide many response plans through broad risk-minimizing thresholds such as the maximum allowable incidence of unexpected cardiac arrest, need for analgesia, etc, in BLS-only response.
- Consider employing some of the powerful statistical techniques which are available to balance risk against benefit such as Receiver Operating Characteristic curves.
- Finally, expand the broader community understanding of the medical practice foundations underlying EMS response plans:
 - That response time is associated with patient outcome in only a very restricted subset of EMS incidents, incidents which can normally be well identified at the time of dispatch through a data-supported RAP process.
 - That the RAP balances patient safety and community safety including minimizing "lights-and-siren" emergency vehicle response

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

- That very few patients from 9-1-1 calls need to be “rushed to hospital”, and that in fact, most EMS patients and most hospital emergency department patients do not face life-threatening illness or injury.
- That fixed response times for other than the most critical incidents are a major driver of EMS system costs particularly as demand for service continues to rise.

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

Appendix A – Data supplied to RAP Working Group for each MPDS Determinant

Source: BCEHS

| 01A01 | | |
|---|-----------------------|--------|
| Description: Abdominal Pain - Abdominal pain | | |
| | Frequency | 13,669 |
| | Proportion (%) | 2 |
| | Vitals completed (#) | 10,166 |
| | Vitals completed (%) | 74 |
| | Overall transport (#) | 12,988 |
| | Overall transport (%) | 95 |
| | ALS transport (#) | 111 |
| | ALS transport (%) | 1 |
| | ATS1 (#) | 83 |
| | ATS1 (%) | 1 |
| | ATS2 (#) | 247 |
| | ATS2 (%) | 2 |
| | ATS3 (#) | 3,970 |
| | ATS3 (%) | 29 |
| | ATS4 (#) | 337 |
| | ATS4 (%) | 3 |
| | ATS5 (#) | 145 |
| | ATS5 (%) | 1 |
| | ATS NC (#) | 8,887 |
| | ATS NC (%) | 65 |
| | ATS accuracy (#) | 145 |
| | ATS accuracy (%) | 1 |
| | Cardiac arrest (#) | 2 |
| | Cardiac arrest (%) | 0 |

External Review of the British Columbia Emergency Health Services Resource Allocation Plan

Appendix B – Selected papers in EMS resource allocation

Use of warning lights and siren in emergency medical vehicle response and patient transport, Position Paper, National Association of Emergency Medical Services Physicians / National Association of State EMS Directors, 1993 (Accessed July 24, 2007 at: <http://www.naemsp.org/documents/UseWarnLightsSirens.pdf>)

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External Review of the British Columbia Emergency Health Services Resource Allocation Plan

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External Review of the British Columbia Emergency Health Services Resource Allocation Plan

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External Review of the British Columbia Emergency Health Services Resource Allocation Plan

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