



# EXPLORING BEST PRACTICES IN INFECTION PREVENTION AND CONTROL TO ADVANCE CANADIAN PARAMEDIC VEHICLE AND EQUIPMENT DESIGN

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## CSA GROUP RESEARCH

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# EXECUTIVE SUMMARY

Healthcare-associated infections (HAIs) are the most frequent adverse event in healthcare delivery worldwide. Each year, approximately 8,000 Canadians die from these infections, while 220,000 others get infected (Canadian Patient Safety Institute, 2016). While there is limited data specific to HAIs acquired in the prehospital care setting, it is a logical assumption that poor adherence to basic infection prevention and control (IPC) practices is a contributory factor.

A number of controls can be employed to reduce the risk of infection, including engineering controls (to "design out" or minimize hazards and risks through design), administrative controls (institution of safe work practices and policies), and lastly through the use of personal protective equipment (PPE).

After conducting an in-depth pan-global literature review on IPC considerations in the design of paramedic ground ambulances and related paramedic equipment, it was realized that there is a paucity of literature to inform good ambulance design decisions. The most comprehensive work to date comes from the UK's Helen Hamlyn Centre (HHC) for Design and the Royal College of Art, Vehicle Design Department, which was collected in 2011.

The primary sources used to inform the recommendations in this research report for setting standards across the country on this topic came from work conducted through the HHC and the insights and expert recommendations collected from a diverse group of stakeholders at a one-day workshop. By answering reflective, discussion-generating questions and identifying challenges with current ambulance design and IPC practices at the workshop, participants provided insight on areas to target for design and innovation in future generations of ambulances. Participants were asked to consider impacts such as antibiotic resistant organisms, emerging and novel pathogens including severe acute respiratory syndrome (SARS), pandemic influenza, and large scale health emergencies such as Ebola virus disease (EVD), as well as the changing landscape of paramedicine when looking at various architectural and structural challenges and design improvement opportunities for ambulances.

Feedback demonstrated a strong desire for standardization in vehicular design, equipment carried, and the education and training provided to paramedics. While some documented recommendations do not specifically address design and equipment per se, they are adjunct recommendations that together with design, can contribute to a high degree of adherence and understanding of IPC.

Even though significant contributions have been made through published research to address surfaces; furniture, fixtures and equipment; layout, access and storage; communication and data; and education, training and competency evaluation, there are others areas that warranted inclusion and mention in this research report. Manufacturers shared concerns about their ability to incorporate factors such as material costs and durability along with all the priorities necessary to support the delivery of safe, high-quality prehospital care. It was also acknowledged that a patient safety culture is foundational to achieving sustainability and commitment for implementing best IPC practices. Although no specific recommendations were made to improve the patient experience from an IPC perspective, it behooves manufacturers and designers, as well as frontline providers, to consider the patient experience and to take simple steps to mitigate any concern or anxiety on the patient's part.

Lastly, there was a lack of adequate scientific study in the area of ventilation requirements specific to the prehospital care setting and more specifically, within the confines of an ambulance. As a result, no specific recommendations for standardization could be made regarding air flow, pressure gradients, air exchanges or air temperature for the design of paramedic ground emergency response vehicles.



## INTRODUCTION

The uncontrolled, dynamic, and response time-driven prehospital care setting offers unique environmental challenges that make adverse events all the more likely to occur and adherence to best practices in IPC difficult at times. Paramedics often work in small, poorly lit spaces in environments that are chaotic and challenging for emergent or urgent healthcare interventions.

The field of paramedicine continues to evolve, and paramedics are working at advanced scopes of practice to meet the growing needs of the communities they serve. Paramedics have the skills, training, and technology to better manage the complex needs of patients and treat them, where possible, in-place in the community and other non-acute care settings, rather than in the Emergency Department.

A modernized paramedicine service provides definitive treatment for conditions of varying acuity on scene (with possible release back to the community) and also the emergency treatment and transport of seriously ill and injured patients to the centre best suited to their needs. Given Canada's vastly diverse geography, this can involve rapid intercity transport or transport that entails traversing trans-provincial and rural

highways and roadways over long distances. The infrastructure and technologies to support this changing paradigm must advance in lockstep with these new delivery modalities of prehospital care. At the core, it distills down to having the capacity to provide the right treatment at the right time in the right setting.

Addressing the environmental challenges in the prehospital care setting with sound design considerations that incorporate robust engineering controls into the future design of emergency vehicles such as ambulances is a key strategy in preventing the transmission of infectious diseases to paramedics and the patients in their care.

Although most research relating to environmental contamination has been conducted in acute care facilities, the results and basic principles can also translate, to a certain degree, to the prehospital care environment. It can be argued that the level of contamination in the prehospital care environment may even be greater due to the unpredictability of responding to calls and the physical environment where care is delivered. Prehospital care delivery and its environs are also not immune to the challenges in providing care to patients colonized or infected with antimicrobial resistant organisms that sometimes plague the bricks-and-mortar healthcare facilities.

Ironically, even with all the heightened awareness of the need for robust IPC and concern about new and emerging infectious diseases on our Canadian borders, ambulance design has been slow to evolve. In a similar vein, the instillation of thorough and comprehensive IPC education and training in course curriculum for healthcare providers, including paramedics, has also been lacking, and some healthcare disciplines may be ill-equipped to manage communicable disease scenarios with full confidence.

Following a pan-global review of the literature and a full one-day workshop with a diverse range of subject matter experts (SME), a number of realities were confirmed:

- There is a dearth of literature regarding ambulance design to support adherence to IPC best practices.
- There is not a strong body of knowledge in the manufacturing domain to ensure design supports IPC.
- There is a felt need to have current, comprehensive, and ongoing education embedded in paramedic professional practice standards and in curriculum.

In an effort to provide tangible recommendations to drive change in the standardization of future ambulance design, and to advocate for stronger curriculum and structure to support training and education, this report will incorporate and collate:

- Findings from the pan-global literature review;
- Findings of the one-day SME workshop; and
- Recommendations for optimal IPC practices relevant to:
  - Ambulance design, spatial layout, and use of related medical equipment; and
  - Healthcare provider education, training, and evaluation of competencies.

## RESEARCH CONTENT

### Methodology

In assessing relevant, evidence-based literature to support the standardization of Canadian recommendations for the standardization of ambulance design that allows for the implementation of IPC best practices, a number of exercises were conducted. This included an initial pan-global literature

review that looked at IPC considerations in the design of paramedic ground ambulances and related equipment with an emphasis on evidence-based technologies for cleaning and disinfection. A systematic review of the literature, including grey literature, was conducted using the PubMed search engine, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), and a rapid response request through the Canadian Agency for Drugs and Technologies in Health (CADTH). This review articulated, at a high level, the gaps in current vehicle design and explored potential design considerations that could be incorporated into a set of design standards. It should be noted that a paucity of evidence exists in this area of study. A summary of some of the studies included in the literature review is provided in Appendix A. Other articles for reference are included in Appendix B.

The second exercise brought Canadian SMEs together for a one-day workshop to share insights and expertise. Participants included IPC professionals, paramedics (frontline, leadership, and management), ambulance manufacturing engineering representatives, academia/research professionals, as well as experts in prehospital medicine. A summary of the participant representation is included in Appendix C. Participants of the workshop were asked to consider the following focus group questions:

1. In light of changing paramedic scopes of practice and changes to care delivery models (e.g., community paramedicine), what are some of the challenges that face current ambulance and equipment design that impact the provision of care?
2. What are the concerns with current ambulance and equipment design when dealing with emerging pathogens and pandemics including SARS, pandemic influenza, and EVD? What was learned with respect to IPC (e.g., air circulation, use of alcohol-based hand rubs, PPE, etc.)?
3. How can intentional design support good IPC practices?
4. How can current education and training tools, municipal mandates, and provincial initiatives support increased capacity to implement and adhere to IPC best practices?
5. When designing ambulances for IPC, what should manufacturers be concerned about or have increased awareness of?



“ Ironically, even with all the heightened awareness of the need for robust IPC and concern about new and emerging infectious diseases on our Canadian borders, ambulance design has been slow to evolve. ”

In responding to each focus group question, SMEs were asked to consider a number of elements in their responses:

- interior design and circulation;
- access and egress;
- storage of PPE;
- environmental cleaning and disinfection;
- sharps, linen and waste disposal;
- surfaces and finishes;
- reprocessing of reusable medical devices;
- worker training, education, and competencies;
- communication; and
- the patient's experience.

## Literature Review Findings

### Ambulance design challenges

The most comprehensive literature available that addressed design challenges in current ambulance design was provided in an ambulance redesign project through the Helen Hamlyn Centre for Design and the Royal College of Art, Vehicle Design Department in the UK (2011). Its project report noted that improved design, and more specifically, a seamless finish to avoid dirt traps and simplifying the cleaning/ disinfection process, contributes to a decreased risk of HAIs (Helen Hamlyn Centre for Design, 2011). While hygiene and cleanliness were listed as one of ten targeted design challenges, several other challenges identified by the Helen Hamlyn Centre for Design would invariably contribute to improved IPC practices and support compliance with routine practices, including patient experience, stock control, technology integration, standardization of equipment, diagnostics, spatial considerations for treatment processes, and functionality (e.g., 360° patient access, lay down space for equipment, wall-mounted modular treatment packs, etc.).

Coleman et al., (2007) found that there was a lack of consistency in the equipment, consumables, and interior layout of emergency vehicles in the UK. They identified nine design challenges through their research, which were expanded into a set of performance requirements for the present day and the

future. These nine variables were of vital importance as they could impact safe systems of work and the efficiency of clinical care. An outcome of the Coleman report was a desire for strong standardization for different types of emergency service vehicles and equipment, and recommendations that included innovation and modularization as options for the future.

### Cleaning and disinfecting ambulances

Ambulance design should also address the proper cleaning and disinfection of ambulances and related paramedic equipment (e.g., stretchers, mattresses, backboards, monitors, etc.) to prevent the transmission of infectious pathogens.

To highlight the prevalence of infectious pathogens, a study by Rago et al., (2012) showed that 70 percent of advanced life support ambulances sampled throughout the metropolitan Chicago area yielded at least one isolate of *Staphylococcus aureus* (*S. aureus*). Given the hardiness of this species under a variety of environmental conditions and the persistence of pathogens despite conventional cleaning methods on equipment that were thought to be clean, a growing trend of increasing antibiotic resistance in *S. aureus* is expected to continue. If transmitted to patients, this could lead to prolonged hospitalization and other severe complications in health.

An exploratory study by Alves et al., (2008) demonstrated that after ambulance and equipment cleaning, bacterial pathogens still persisted, contrary to expectations that the level of cleaning was sufficient. They found that four of the seven species isolated from their sampling from five different areas in ambulances were substantial nosocomial pathogens, and three of these four possess formidable antibiotic resistance patterns.

Literature on the topic of effective cleaning that covers newer technologies such as ultraviolet (UV) irradiance in hospital rooms is limited. Lindsley et al., (2017) reported that there was considerable variation in the effectiveness of UV irradiance on different surfaces and it was not feasible to perform UV irradiance measurements at every possible location in an ambulance. There is also limited data to advise on appropriate disinfection time and few benchmarking studies have been performed. The authors proposed that rigorous testing is needed to validate this method of cleaning before deployment.



Boyce et al., (2008) conducted a prospective before and after intervention study to determine whether hydrogen peroxide vapor (HPV) decontamination can reduce environmental contamination with and nosocomial transmission of *Clostridium difficile* (*C. difficile*). The study showed that HPV was effective in eradicating *C. difficile* from contaminated surfaces; however, the authors concluded that further studies of the impact of HPV decontamination on nosocomial transmission of *C. difficile* are still warranted. There currently is no evidence to prove that this method of cleaning is effective for ambulances and related paramedic equipment.

A number of organizationally-driven reference documents have been developed and are available publically for local, provincial, and national application. Infection Prevention and Control (IPAC) Canada has released widely utilized, consensus-developed reference documents on IPC core competencies for healthcare workers (including paramedics). IPAC Canada has also released position statements on the cleaning and disinfection of non-critical multi-use equipment/devices in community settings.

The Provincial Infectious Diseases Advisory Committee (PIDAC, 2012) has produced best practice guidelines on environmental cleaning for prevention and control of infections in all healthcare

settings. A position statement by Rhodenizer Rose et al., (2013) provides guidance for the disinfection of environmental surfaces in prehospital care vehicles following off-loading; however, limited data was available at the time of the release of this position statement regarding newer technologies. A revised position statement for cleaning and disinfection of prehospital care vehicles is forthcoming.

Lastly, the National Health Service's National Patient Safety Agency (2007) recommended that efforts be undertaken to improve ambulance design. From its perspective, areas that need further research include provider communication, hand hygiene compliance, and the overall patient experience.

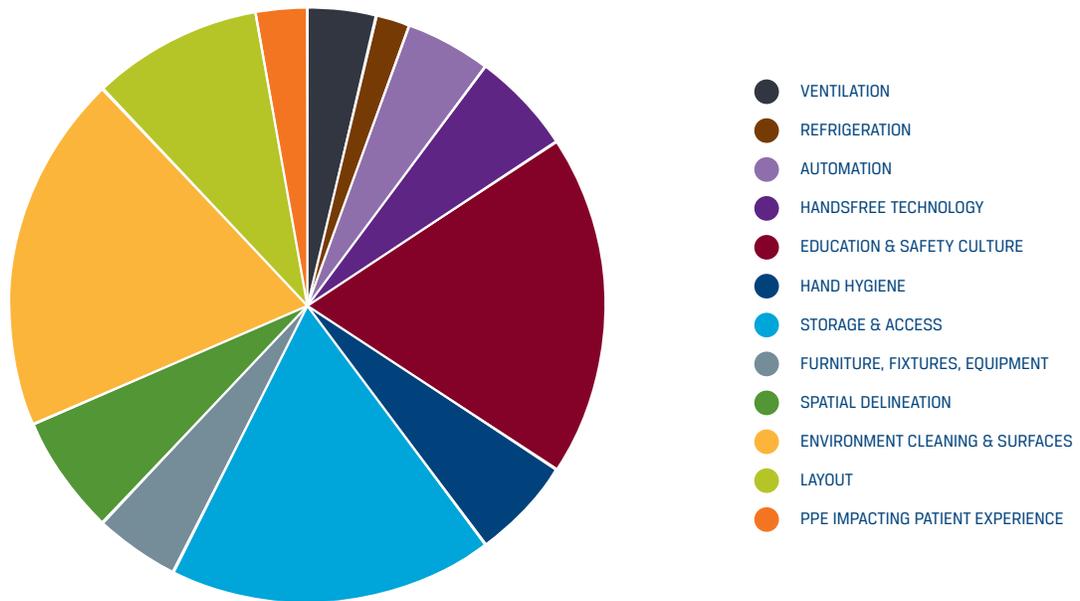
A list of articles used for the literature review is included in Appendix A.

### **Workshop Experts' Advisory Elements**

The workshop brought together SMEs representing broad interest categories. A number of common themes arose and the frequency of their discussion in the workshop is represented in Figure 1.

**FIGURE 1: COMMON THEMES THAT EMERGED FROM THE SUBJECT MATTER EXPERT WORKSHOP**

**INFECTION PREVENTION & CONTROL THEMES**



Based on the workshop discussions, the top three themes brought forward for standardization were:

- 1) Environmental cleaning and surfaces;
- 2) Paramedic education and safety culture; and
- 3) Storage and access.

These areas of concern were targeted foci during the discussions, however the challenges associated with all three were also intertwined with most other thematic areas.

**Ambulance IPC Themes Identified from the Workshop**

**Environmental cleaning and surfaces**

Overwhelmingly, the ability to be able to perform adequate cleaning and disinfection was a primary consideration. Knowledge gaps were considered key barriers to ensuring this core foundational element of IPC best practices could be completed effectively and efficiently. The pressure for timely off-loads and the prompt return of vehicles to service were

identified as being key contributors to inadequate cleaning and disinfection.

Surfaces that were incompatible with a variety of disinfectant chemistries (i.e. surfaces that were textured, grooved, designed with recessed spaces and dirt traps, and otherwise difficult to clean) were also cited as problematic in both the literature and by workshop participants. The presence of porous surfaces, fabric in particular, presented significant cleaning challenges. Fabric is often used for restraints, chair coverings in the cab and patient compartments, supply bags, blood pressure cuffs, and other fasteners. It was stressed in the workshop that materials, equipment, and cleaning/disinfection systems that facilitate rapid and effective cleaning and disinfection in this fast paced environment are essential.

Given the number of chemistries and disinfection technologies on the market, there was an expressed need for IPC subject matter experts to compile and maintain a current list of appropriate materials and chemistries for ambulance surfaces and equipment. Given the time pressures placed on loading

and off-loading, services should build cleaning and disinfection capacity into the turnaround time. Concurrently, services should also evaluate and implement appropriate disinfection technologies that have short wet contact times or exposure times to surfaces. IPAC Canada was suggested as a potential developer or contributor for the creation of this list.

### **Paramedic Education and safety culture**

Safety culture, or lack thereof, was evidenced in much of the discussion at the workshop. Although relatively subjective or perceptual in nature, it appeared that IPC best practices were not viewed as a high priority in comparison to time pressures associated with treating and transporting/off-loading; ergonomics and occupational health and safety; and delivery of emergency and urgent care. In essence, it was a secondary consideration.

As a result, comments regarding lack of compliance to IPC best practices were noted on numerous occasions and a number of recommendations were offered to address this. Such concerns and potential solutions were not directly within the scope of the report; however not seizing the opportunity to advocate for and recommend improvements that support enhanced safety culture, particularly with respect to IPC, would negate the ultimate goals of improved infection prevention and control in prehospital care settings through ambulance design and education. Indeed, education is but one component used to build a stronger patient safety culture in addition to leadership, performance indicators and tools, a just culture, and team engagement.

Significant opportunities were discussed for colleges, academia, and paramedicine associations to take a key role in setting a standardized course curriculum focusing on IPC best practices and in establishing a standardized approach to develop up-to-date core competencies and competency evaluation. IPAC Canada, Accreditation for College Paramedic Programs, and the Ontario Association of Designated Officers were cited as potential developers and drivers of such a standardized approach. In the absence of a collective national approach to standardized education, local and municipal services' leadership is relied upon to provide access to, and competency assessment of IPC best practices.

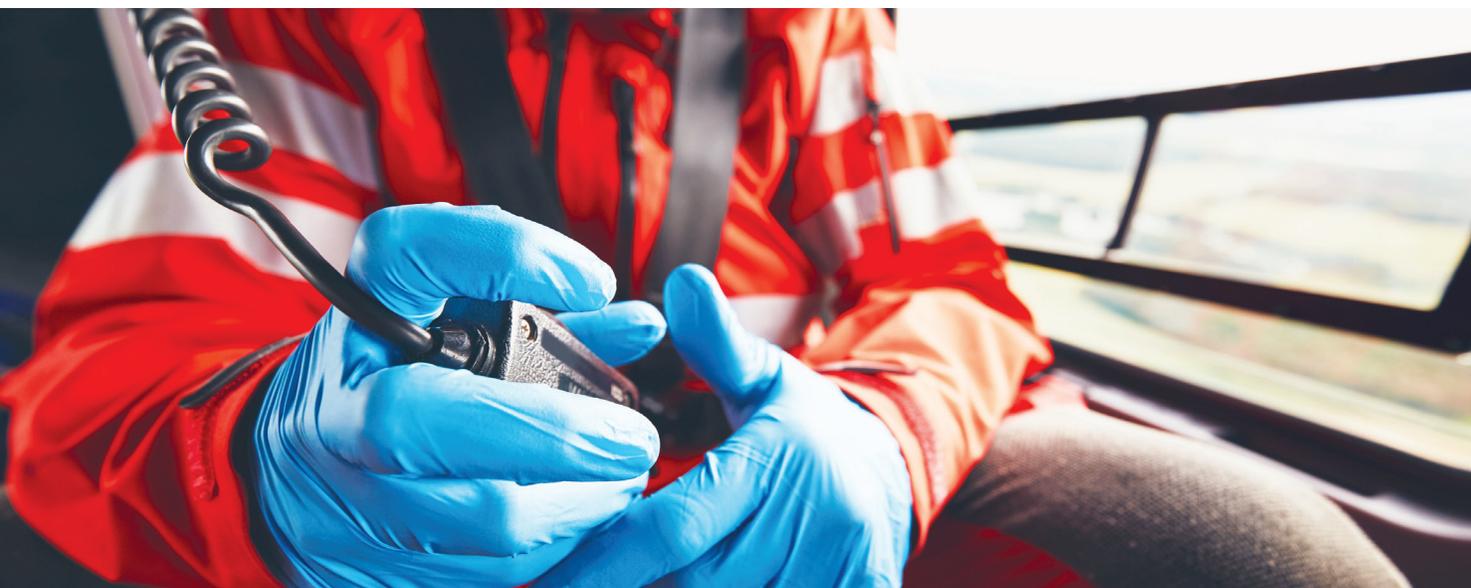
### **Storage and access**

Storage and access was a strong recurring theme that was applied to PPE (routine and advanced), waste (biohazardous, biomedical, and regular waste streams), clean and soiled reusable devices, and clean and soiled linens. Most ambulances are challenged with limited storage space for equipment, let alone for soiled equipment however, opportunities exist to take a more minimalist or lean approach to streamline or reduce what is transported routinely and where supplies and items are kept.

The ability to segregate clean and soiled items was particularly pressing. Options for consideration included area colour coding to facilitate clear visual surveillance of clean and dirty areas, distinct spatial separation, and storage of equipment away from the patient care area (e.g., accessible from the outside of the vehicle). Exploration of pneumatic transport to storage spaces or simple chute mechanisms as design solution options were ideas that came forward, although the feasibility from an engineering perspective was not considered.

Access is directly related to storage and most notably, having access to PPE, sharps containers, and alcohol-based hand rub (ABHR) which are frequently located in less than ideal places. Not infrequently, PPE is stored in cabinets inside the vehicle that require paramedics to reach over a patient who may be coughing or vomiting, to secure their PPE thus putting them at risk for exposure. With this layout, there is also increased risk of PPE becoming contaminated by a patient's actions even prior to the donning by paramedics.

Additionally, cabinetry was cited as source of contamination from continued access during care with contaminated hands, and it is often overlooked as a cleaning priority. Secure access to PPE and ABHR should also be incorporated into cabinet design. Storage of ABHR is not often within the point-of-care and, as a result, hand contamination becomes a common vector for transmission through direct and indirect contact. It was also recognized that PPE storage and access must be available on the outside of the vehicle. It was felt that better understanding of equipment priorities and use would inform improved storage configuration and options for manufacturers to incorporate in future design.



### Additional considerations for design

There is an ever-increasing need for manufacturers to look toward innovation and technology to improve design to support IPC. There is also a need for engaging paramedics, IPC professionals, occupational health leaders, industrial engineers, human factors engineers, lean six sigma experts, and academia in the design and evaluation process.

Additional considerations for design include:

- a) **Hands-free technology** – In terms of technology, the time has come to incorporate hands-free technology and Bluetooth capabilities to reduce touch points and potential sources of contamination associated with digital manipulation of a device. This will also improve ergonomics and facilitate communication during transport with both the driver and the receiving facility. Hands-free communication would also allow the paramedic to continue providing care to the patient without additional delays. It was noted that radio communication typically involves hand-to-radio contact in close proximity to mucous membranes of the nose, mouth, and eyes that can easily result in self-inoculation.
- b) **Electronic medical records** – Ensuring information technology capability to integrate prehospital and electronic medical records will also improve patient care, including the ability

to improve communication of infectious disease status. The challenge will be in designing electronic screens and monitors that can be cleaned and disinfected. Simple coverings have been developed for keyboards and panels; however it is necessary to have these coverings in the initial design, as opposed to purchasing after-market solutions and workarounds.

- c) **Hand hygiene** – While ABHR has proven to be an efficient means to perform hand hygiene, it does not completely preclude the need for hand washing. In instances where paramedics have visible soiling or organic material on their hands, ABHR is not effective in removing bioburden. It is also less effective against spore-forming microorganisms such as *Clostridium difficile*. One option is the provision of wet wipes to remove as much visible soil or organic matter as possible before using ABHR. It was noted that incorporating a hand hygiene sink that meets sink design specifications set out in other standards and guidelines is desirable; however with vehicles that already have inherent space challenges, it was felt that the additional risks of infection from splash back, and the anticipated difficulties with maintenance of the plumbing system in colder climates, warrants further study before inclusion in vehicles is considered. Although paramedics do have access to ABHR

and antiseptic cleaning wipes for hand hygiene, the use of these is less than ideal. Greater innovation in future design to explore superior options for conducting hand hygiene outside of brick and mortar facilities is desired.

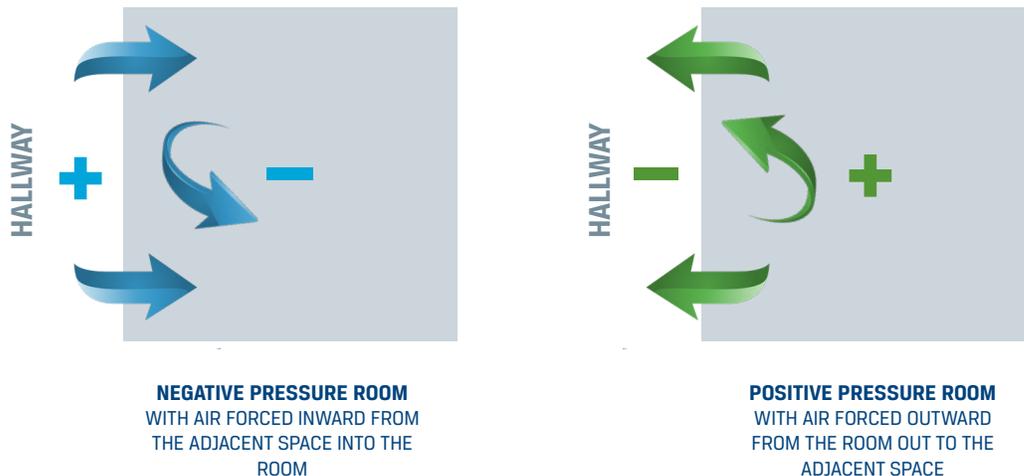
d) **Ventilation** - Typical ambulance design involves air circulation and ventilation that is relatively passive and one-way (front to back). Windows may or may not open to allow circulation of fresh air and there is no ability to alter pressure gradients. In hospitals, room pressurization, or the differential pressure between air movement and the adjacent area (negative, positive, or neutral), and the number of air changes per hour (ACH) vary depending on the type of procedure being executed, the chemicals or gases being used, and the types of infectious diseases that are suspected or confirmed. For example, in hospital spaces where immunocompromised patients are located (e.g., burn units, bone marrow transplant units), positive pressure airborne isolation rooms are required, whereby the air flow is out of the room. In instances where airborne infectious diseases are suspected, such as *Mycobacterium tuberculosis* or measles, negative pressure airborne isolation rooms are required. Figure 2 shows airflow for both negative and positive pressure room scenarios.

The premise for having negative or positive pressure in relation to adjacent spaces is to protect patients at greatest risk. In the confines of an ambulance, the rationale for a pressure differential is not clear, as in most instances, there are usually no adjacencies to consider. Ventilation is typically managed through simple intake fans at the front of the vehicle and exhaust fans near the rear.

Opportunities exist to manage this aspect of the environment with better fan controls, directional air flow optimization, and HEPA air filtering; however, in the absence of scientific literature to inform specific ventilation recommendations, more research specific to the prehospital care environment is required for standardization. As well, having the ability to air-isolate the patient compartment from the cab will assist in minimizing exposure risk, provided there is a nimble, hands-free mechanism to communicate directly.

e) **Furniture, fixtures, and equipment (FFE)** - From an IPC perspective, FFE's primary feature is that it is able to withstand cleaners/disinfectants and other disinfection technologies that are recommended in healthcare settings by certified IPC professionals. Materials must be sealed, non-porous, and non-textured. Rounded or molded corners

**FIGURE 2: RELATIVE PRESSURIZATION OF AIRBORNE ISOLATION ROOMS IN HOSPITALS.**





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There is an ever-increasing need for manufacturers to look toward innovation and technology to improve design to support IPC.

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and joints (including covered flooring) will eliminate dirt traps and inaccessible spaces, facilitating effective cleaning and containment. Storage cabinets can prove particularly problematic, with tracks to slide doors, handles, hinges, or other mechanisms that are difficult to clean. Use of modular storage, configurable furniture, and working walls can diminish the need for traditional cabinetry, provided it is accessible without creating a contamination risk to other supplies or to the paramedic. Eliminating fixtures that control lighting (e.g., toggle switches) and ventilation, and moving toward a touchless control option with adjustable task lighting, will decrease surface/hand contamination and facilitate cleaning. With changing scopes of practice, paramedics are now providing vaccinations, and the ability to ensure maintenance of the cold chain for vaccines is imperative. As well, other drugs and therapeutics now administered by paramedics require appropriate refrigeration that is secure and features alarms when the temperature swings out of acceptable range.

- f) **Layout and spatial considerations** – The ability to access a patient from all angles improves care and reduces close contact between the patient and paramedic that can contribute to transmission of infection. Various configurations with layout, configurable furniture, point-of-care access to supplies, PPE, and ABHR all must factor into the design equation. The skills and expertise of industrial and human factor engineers, as well as Lean Six Sigma experts, can fulfil a valuable role in design that improves patient and provider safety. Designers need to consider point-of-care as occurring both outside and inside the vehicle, as patient care needs and exposure potential can change rapidly during response and transport.

### **Commentary on manufacturer concerns**

Bringing science, practice, and design/manufacturing together to discuss challenges and opportunities proved extremely beneficial to the process. Participants in the SME workshop were reminded to ensure discussion consistently supported routine practices application and other foundational IPC elements. The daunting task for manufacturers is to design an ambulance with a host of competing priorities, with IPC being but one. The opportunity to utilize lean methodologies and standardization of the design of vehicles and equipment will assist manufacturers to incorporate adequate storage

while mitigating a larger ambulance footprint. Ensuring regular dialogue exists between providers and manufacturers will contribute to the manufacturing of ambulances that will support the changing scope of practice and care delivery models in paramedicine.

## **RECOMMENDATIONS**

Based on the findings from the literature review and recommendations stemming from SME workshop participants, key recommendations for IPC considerations for the design of ambulances and related equipment were identified.

Many recommendations focused on storage, access, and spatial layout of the patient care compartment. Recommendations were also made regarding the availability of ABHR, PPE, and appropriate soiled waste and sharps receptacles close to the point of care of the patient to help mitigate delays associated with reaching, bending, and searching for these items.

Another topic brought to the forefront from the literature review and the SME workshop was the need for IPC to be included in the physical design of the patient care compartment and the need to continue ongoing dialogue with IPC experts, manufacturers, and paramedics in the design of their work environment. Problems were identified for materials, surfaces, and finishes for items that are typically challenging to clean and/or disinfect, including fabric fasteners, tracks, and shelving compartments. This led to the proposal of using different materials such as seamless and covered surfaces, slip-resistant flooring, and in terms of equipment – using modular pre-assembled equipment packs.

With respect to paramedic education and training in IPC, there were a number of valuable opportunities to explore and drive positive change at provincial and national levels, including suggestions for self-regulating provincial and national bodies to advocate and advance the practice of paramedics so that all paramedics are expected to adhere to the same scope of practice standard.

Finally, further exploration for evidence-based design recommendations and impact on clinical outcomes is needed where data can help inform reasonable decision-making. Organizations such as CSA Group, IPAC Canada, Accreditation for College Paramedic Programs, the Ontario Association of



Designated Officers, and the Paramedic Association of Canada are all in a unique position to advance IPC in the delivery of paramedicine, and could benefit from strengthening partnerships with each other.

While no specific IPC recommendations were made to improve the patient experience, it was acknowledged that patients interacting with providers wearing PPE may contribute to increased anxiety or even fear. Paramedics and other providers interacting with patients should always be mindful of how PPE may impact a patient's mental and emotional health. Use of facial PPE may also impede communication between the paramedic and patient, so ensuring accurate interpretation of spoken words is important as well.

## CONCLUSION

With limited research and literature available to inform an ambulance design standard that supports adherence to best practices in IPC, the exercise to bring SMEs together and focus on several direct questions proved most beneficial in understanding what the vehicle and equipment design challenges are in Canada and where the opportunities for improvement and innovation lie.

As the scope of practice in the field of paramedicine changes and prehospital healthcare delivery models continue to evolve, the types of ambulances and the equipment they carry must evolve in turn to meet the changing needs of patients.



## ACKNOWLEDGEMENTS

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Special thanks to Greg Bruce and Jennifer Amyotte, paramedics by profession and founding members of the IPAC Canada Prehospital Care Interest Group, who provided expert counsel on approach and professional engagement during workshop planning and their contribution to the final draft of this report.

# APPENDIX A

## REFERENCES USED IN THE LITERATURE REVIEW

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# APPENDIX B

## ADDITIONAL REFERENCES FOR INFORMATION

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# APPENDIX C

## SUMMARY OF WORKSHOP SME REPRESENTATION

**NOTE:** The following individuals have granted permission for their name and affiliation to be listed in this report but the full participant list is not included.

INTEREST GROUPS	TOTAL NUMBER OF PARTICIPANTS
<p><b>Paramedic Services</b> <i>(front-line paramedics, paramedic managers and superintendents)</i></p> <ul style="list-style-type: none"> <li>• <b>Michael Feldman</b>, Paramedic Services Medical Director, County of Simcoe, District of Muskoka, Rama and Beausoleil First Nations, Sunnybrook Centre for Prehospital Medicine, Ontario</li> <li>• <b>Pierre Poirier</b>, Manager, Security and Emergency Management, City of Ottawa, Ontario (representing the Paramedic Association of Canada)</li> <li>• <b>Jeff Walsh</b>, Superintendent, Peel Regional Paramedic Services, Ontario</li> </ul>	<b>5</b>
<p><b>Infection Prevention and Control Experts</b> <i>(IPC professionals, organizations/associations advocating for IPC in pre-hospital care)</i></p> <ul style="list-style-type: none"> <li>• <b>Jennifer Amyotte</b>, Commander of Community Paramedicine &amp; Professional Standards, Greater Sudbury Paramedic Services, Ontario</li> <li>• <b>Greg Bruce</b>, Platoon Supervisor/Infection Control Officer, County of Simcoe Paramedic Service, Ontario</li> <li>• <b>Kathy Ellis</b>, BScN, RN, CIC, Nova Scotia Health Authority, Nova Scotia</li> <li>• <b>James Gauthier</b>, Senior Clinical Advisor, Infection Prevention, Diversey, Ontario</li> <li>• <b>Alexis Silverman</b>, Occupational Health Nurse, Peel Regional Police, Ontario and Chair of the Ontario Association of Designated Officers (representing IPC perspective)</li> </ul>	<b>6</b>
<p><b>Ambulance Manufacturers</b></p> <ul style="list-style-type: none"> <li>• <b>Stan Ellis</b>, Tri-Star Industries Ambulances, Nova Scotia</li> </ul>	<b>2</b>
<p><b>Research/Academia and Consultants</b></p> <ul style="list-style-type: none"> <li>• <b>David LeBlanc</b>, Consultant, Meditecture Consulting, Ontario</li> <li>• <b>Suzanne Rhodenizer Rose</b>, Consultant, Meditecture Consulting, Ontario</li> </ul>	<b>3</b>
<b>TOTAL</b>	<b>16</b>

## About CSA Group

CSA Group is an independent, not-for-profit membership association dedicated to safety, social good and sustainability. CSA's strategic focus and core service offering includes: standards development; training solutions; consumer product evaluation; and global testing & certification. CSA products and services target a range of key businesses, including: hazardous location & industrial; plumbing & construction; medical safety & technology; appliances & gas; alternative energy; lighting; and sustainability. The CSA certification mark appears on billions of products worldwide. For more information about CSA Group visit [www.csagroup.org](http://www.csagroup.org).

