NIST Technical Note 1766

Workshop Report for Ambulance Patient Compartment Design

Allison Barnard Feeney
Deogratias Kibira
Yung-Tsun T. Lee
Jennifer Marshall

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Allison Barnard Feeney
Deogratias Kibira
Yung-Tsun T. Lee
Systems Integration Division
Engineering Laboratory

Jennifer Marshall
Office of Law Enforcement Standards
Special Programs Office

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Abstract

Recently, the U.S Department of Homeland Security Science and Technology Directorate's Human Factors/Behavioral Sciences Division and First Responder Resources Group sponsored formation of the Ambulance Patient Compartment Design Project. Project participants are NIST, the National Institute of Occupational Safety and Health (NIOSH), and BMT Designers and Planners (BMT). The purpose of this Project is to develop standards to address performance and safety issues associated with the design of ambulance patient. NIST hosted the Ambulance Patient Compartment Design Workshop to allow leaders in the EMS community to review and validate the preliminary set of user design requirements, The workshop, facilitated by Energetics Incorporated, was held on February 29, 2012, during the EMS Today Conference and Expo 2012 at the Baltimore Convention Center in Baltimore, Maryland. This document presents the raw output collected by Energetics and NIST at that workshop. It includes participants combined ratings and comments. It is being published without analysis to keep stakeholders informed as our work progresses. The input we received is currently feeding the analysis and selection of the requirements for evaluation and validation prior to modeling.

Key words

Ambulance; standard; EMS; EMT; seating; patient compartment; ergonomics; safety; Box I and III; restraint systems

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1. Introduction

The National Institute of Standards and Technology (NIST) provides research-based input to standards initiatives in many areas, including criminal justice, public safety, emergency responder, and homeland security. Recently, the U.S Department of Homeland Security Science and Technology Directorate's Human Factors/Behavioral Sciences Division and First Responder Resources Group sponsored formation of the Ambulance Patient Compartment Design Project. Project participants are NIST, the National Institute of Occupational Safety and Health (NIOSH), and BMT Designers and Planners (BMT). The purpose of this Project is to develop standards to address performance and safety issues associated with the design of patient compartments in emergency medical services (EMS) vehicles (i.e., ambulances).

The Ambulance Patient Compartment Design Project undertook a human factors approach to the design of patient compartments in ambulances. Using multiple data gathering methods, including practitioner interviews and ride-alongs, a web-based survey, and focus group meetings, the project identified potential performance and safety concerns to drive development of a comprehensive set of patient compartment user design requirements. These requirements will be assessed using rigorous analytic tools, including emergency medical provider task analysis and modeling and simulation in the next phase of the project. The validated requirements and design guidance will be the basis for input into current and emerging ambulance design standards.

NIST hosted the Ambulance Patient Compartment Design Workshop to allow leaders in the EMS community to review and validate the preliminary set of user design requirements, The workshop, facilitated by Energetics Incorporated, was held on February 29, 2012, during the EMS Today Conference and Expo 2012 at the Baltimore Convention Center in Baltimore, Maryland. The input to this workshop was the initial set of user design requirements compiled from the numerous interviews, ride alongs, focus group meetings, and survey results. This document presents the raw output collected by Energetics and NIST at that workshop. It includes participants combined ratings and comments. It is being published without analysis to keep stakeholders informed as our work progresses. The input we received is currently feeding the analysis and selection of the requirements for evaluation and validation prior to modeling.

2. Workshop approach

This section discusses how the workshop was organized, how participants were asked to prioritize potential requirements, and the rating system used.

2.1 Workshop structure

The workshop was structured to promote dialogue and knowledge sharing among a diverse set of practitioners and assess the collective priorities for the design of patient compartments in ambulances. Information collected during the workshop will be used to inform ambulance design and help NIST identify key requirements to recommend for inclusion in the next release of the National Fire Protection Association (NFPA) 1917 standard.

The workshop used breakout sessions to initiate focused discussions on safety and functionality, help establish consensus on technical issues, identify gaps in current practices, and prioritize requirements. The breakouts were focused on design issues in the following domains:

- Breakout 1: Seating and restraints/communications
- Breakout 2: Work environment
- Breakout 3: Patient care and general equipment and storage
- Breakout 4: Patient care and special equipment and storage

Given that the patient compartment is a single space, the domains represent somewhat artificial divisions. They were used to help focus the discussion and present participants with a manageable set of design issues to assess at any one time.

2.2 Assessment from three perspectives

Each breakout session was structured to assess the subset of design issues in terms of their importance for inclusion in the next release of NFPA 1917. Typically, standards and requirements for the design of EMS vehicles are established to ensure safety and functionality. However, these two imperatives do not always correspond. For example, the restraints that keep an EMS provider safe also impair his or her movement and access to the patient. Maximizing safety may thus be incompatible with maximizing functionality in terms of patient care. Given the potential conflict, participants were asked to consider the design issues from the following three distinct perspectives:

2.2.1 Safety point of view

Participants looked at the design issues solely in terms of their importance for protecting both the patient and the caregiver. The safety considerations included risks ranging from unsecured objects hitting the patient or caregiver to the unsecured caregiver and patient encountering sharp objects, hard surfaces, and sharp edges. Considerations also included the risk to the caregiver from the strain of lifting and/or working in an awkward or bent-over position.

2.2.2 Functionality point of view

Participants looked at the design issues solely in terms of their importance in enabling or enhancing the caregiver's ability to deliver the necessary care to the patient. This included issues of access to both the patient and to equipment and supplies.

2.2.3 Combined point of view

After assessing the items separately from the safety and functionality perspectives, participants then considered them from a combined point of view. In particular, participants were asked to identify the top priority items across both points of view.
At the beginning of each breakout session, participants reviewed the design issues for the particular domains and identified any gaps or missing issues. After completing both the safety and functionality ratings, participants were again asked to identify missing issues. They were

also asked to discuss any difficulties they had in rating particular items and to provide suggestions.

2.3 Rating format for assessment of design issues

To conduct a systematic assessment of the design issues for each breakout, participants were given a list of the issues in the form of a written survey. The survey asked participants to rate each issue, first from a safety point of view, and second from a functionality point of view, using a three-point scale of Essential, Conditional, and Low.

For the functionality perspective, the scale points were defined as follows:

> Essential – A critical requirement for safety that would significantly improve patient and EMS provider safety if implemented; strongly recommended for inclusion in the next release of the NFPA 1917 standard
>
> Conditional – An important requirement that would improve safety, but could wait until a later release of the standard if necessary
>
> Low – Not an important requirement for safety at this time
> For the functionality perspective, the scale points were defined as follows:
>
> Essential – A critical requirement for functionality that would significantly improve patient care if implemented; strongly recommended for inclusion in the next release of the NFPA 1917 standard
>
> Conditional – An important requirement that would improve functionality, but could wait until a later release of the standard if necessary
>
> Low – Not an important requirement for functionality at this time

It is important to keep in mind that the design issues were presented to participants as precursors to potential requirements, not as actual requirements. They identified specific conditions, features, or design elements of the patient compartment around which a requirement or standard item would be written, but they did not quantify specific threshold levels to be included in the standard. Thus, participants were asked to rate the importance of each issue, given that it was translated into an actual standard item or requirement.

3. Workshop raw results

The remainder of this document presents the raw results of the workshop. It is broken up into four sections corresponding to the four breakout sessions. Each section presents the following:

- Scope of the breakout session
- Rating results from the safety point of view
- Rating results from the functionality point of view

- Results of the combined prioritization
- Summary of participant comments

The rating results are presented in this report exactly as presented to workshop participants. In several cases participants sought clarification of the statements on the written surveys. In a small number of cases, participants agreed upon alternative wording. Such discussion is captured in the summary of participant comments, not in the rating results. Similarly, the tabulated ratings are presented here exactly as tabulated and presented by the workshop facilitators. We recognize that in some cases the sum of the ratings on a given item differ from the majority of the item totals on a rating sheet. The ratings served as a tool to focus discussion and drive agreement on combined priorities, they are not to be viewed as definitive results. The survey ratings do not directly correlate to the group consensus on combined priorities.

3.1 Seating and restraints and communications

This breakout covered two domains. The Seating and restraints domain concerns the extent to which the patient compartment/workspace enables the EMS provider to provide (a) safe and effective patient care from a seated position in the ambulance patient compartment, and (b) safe and effective patient care while in a restrained position within the ambulance patient compartment. The Communication systems concerns the extent to which the patient compartment/workspace (a) enables efficient and effective communications between the patient compartment, the driver, and others; (b) facilitates driver awareness of activity in the patient compartment; and (c) allows the EMS provider to be more aware of the driver's actions.

3.1.1 Raw data sheets

The tables in this section presents the raw output collected by Energetics and NIST at that workshop. Table 1 and Table 3 present the safety and functional ratings for candidate requirements in the area of Seating and Restraints. Table 2 and Table 4 present the safety and functional ratings for candidate requirements in the area of Communications.

Table 1. Safety rating – Seating and restraints

	Low	Conditional	Essential
1. The EMS provider is able to reach the patient's full body length while in a seated position.	0	7	7
2. The EMS provider is able to reach common and critical equipment/supplies from a seated position.	0	7	7
3. Seating is quickly adjustable if needed to reach the patient or equipment/supplies from a seated position.	0	5	9
4. The EMS provider is able to face and interact with the patient while in a seated position.	0	7	7
5. Seating has the ability to be forward or rear facing.	2	8	4
6. The EMS provider is able to reach common and critical equipment/supplies from a restrained position.	0	2	12

7. The EMS provider is able to operate equipment controls from a seated and restrained position.	0	3	11
8. The EMS provider is able to quickly move in and out of being in a restraint system.	0	6	8
9. Restraints are comfortable.	0	6	8
10. The restraint system incorporates ergonomic/anthropometric design to minimize risk of injury and support safe and comfortable use by the diverse EMS provider populations.	0	2	12
11. Each seat is equipped with its own restraint system.	1	2	11
12. The EMS provider is able to reach the patient's full body length from a restrained position.	0	4	10
13. The EMS provider is able to face and interact with the patient from a restrained position.	0	6	9

Table 2. Safety rating – Communication systems

	Low	Conditional	Essential
1. Means for communicating between the EMS provider, the driver, and third parties, such as the hospital, are provided and accessible from all EMS provider workstations.	2	4	8
2. Communication systems support the EMS provider's ability to continue providing safe and effective patient care.	0	2	12
3. EMS providers in the patient compartment are able to establish communications quickly with the driver or other third party.	0	2	12
4. The EMS provider or patient's status can be communicated to the driver non-verbally	2	8	4
5. The driver can visually communicate driving actions to the EMS Providers in the patient compartment.	5	5	4

Table 3. Functionality rating – Seating and restraints

	Low	Conditional	Essential
1. The EMS provider is able to reach the patient's full body length while in a seated position.	2	6	6
2. The EMS provider is able to reach common and critical equipment/supplies from a seated position.	4	2	8
3. Seating is quickly adjustable if needed to reach the patient or equipment/supplies from a seated position.	1	5	8
4. The EMS provider is able to face and interact with the patient while in a seated position.	1	6	7
5. Seating has the ability to be forward or rear facing.	5	4	5
6. The EMS provider is able to reach common and critical equipment/supplies from a restrained position.	0	4	10
7. The EMS provider is able to operate equipment controls from a seated and	0	4	10

restrained position.			
8. The EMS provider is able to quickly move in and out of being in a restraint system.	2	3	9
9. Restraints are comfortable.	2	5	7
10. The restraint system incorporates ergonomic/anthropometric design to minimize risk of injury and support safe and comfortable use by the diverse EMS provider populations.	1	4	9
11. Each seat is equipped with its own restraint system.	2	6	6
12. The EMS provider is able to reach the patient's full body length from a restrained position.	0	4	10
13. The EMS provider is able to face and interact with the patient from a restrained position.	0	4	10

Table 4. Functionality rating – Communication systems

	Low	Conditional	Essential
1. Means for communicating between the EMS provider, the driver, and third parties, such as the hospital, are provided and accessible from all EMS provider workstations.	2	2	10
2. Communication systems support the EMS provider's ability to continue providing safe and effective patient care.	0	1	13
3. EMS providers in the patient compartment are able to establish communications quickly with the driver or other third party.	0	4	10
4. The EMS provider or patient's status can be communicated to the driver non-verbally	1	9	4
5. The driver can visually communicate driving actions to the EMS Providers in the patient compartment.	5	6	3

3.1.2 Combined prioritization

In the Seating and Restraint Systems/Communication systems breakout session, the group identified the following design issues as most important across both safety and functionality:

- The EMS provider is able to reach common and critical equipment/supplies from a seated position. (Item 2)
- The EMS provider is able to reach common and critical equipment/supplies from a restrained position. (Item 6)
- The EMS provider is able to operate equipment controls from a seated and restrained position. (Item 7)
- The EMS provider is able to reach the patient’s full body length from a restrained position. (Item 12)

3.1.3 Participant comments

The following comments were offered during the discussions following the separate ratings and the combined prioritization. The comments were collected in a non-attribution manner and are paraphrased.

Although the ability to reach the patient from a restrained position is a combined priority, the participants felt that they do not particularly need to have access to the full body length of the patient.

Regarding seating requirements, participants expressed concerns about the possibility that new seat designs could infringe on space for equipment and storage. Participants did not perceive that forward-facing or rear-facing seating arrangements were functional enough to address the patient's needs. The group suggested investigating best practices and designs used in other countries.

Concerning restraint systems, the group felt that the ability to reach the patient is just as important as the ability to reach equipment. Comfort was identified as an important requirement for restraint systems because lack of comfort hinders widespread use of systems by practitioners. The group identified that existing retractable restraints do not work efficiently, and that there is a need to clarify the difference between restraint systems and seat belts. It was noted that restraint systems could differ according to specific needs; for example, an advanced restraint system would not be needed for "walking wounded," but such patients would still need to be subjected to some form of restraint.

With regard to communication requirements, items 2 and 3 scored high for both safety and functionality however the group felt that it did not surpass items 2, 6, 7 and 12 (from Seating and restraints). They indicated that communication is important. Participants expressed concern about item 4 regarding the use of non-verbal Communication systems, which they felt could cause distractions. Hands-free verbal devices were perceived as safer options. The group noted that new technologies could be readily available before the next release of NFPA 1917. Participants also perceived that means of communicating between the EMS provider, the driver, and third parties (e.g., hospitals) do not need to be provided in, and accessible from, all EMS-provider workstations.

3.2 Work environment

This domain concerns the extent to which the patient compartment/workspace (a) enables the EMS provider to safely and effectively treat patients and perform patient care through environmental controls (i.e., air flow, temperature, humidity, lighting, and noise control are accessible); (b) allows for easy cleaning and restocking after each trip; (c) provides an effective means of sanitizing/cleaning; (d) enables quick and safe ingress/egress; (e) includes safety mechanisms to reduce hazard risks such as securing portable equipment; and (f) provides for securing and accessibility to trash disposal.

3.2.1 Raw data sheets

The tables in this section present the raw output collected by Energetics and NIST at that workshop. Table 5 and Table 6 present the safety and functional ratings for candidate requirements in the area Work Environment.

Table 5. Safety rating – Work environment

	Low	Conditional	Essential
1. HVAC system maintains a comfortable and appropriate environment.	0	2	5
2. Lighting system provides appropriate illumination to support task performance.	0	2	5
3. The patient compartment has enough power supply to power/charge all necessary equipment.	1	4	2
4. Power outlets in the patient compartment meet the needs of the EMS provider with respect to powering equipment or recharging batteries during patient care and transport.	2	2	3
5. IV bags that are administered to the patient are placed and secured in a manner that allows them to remain accessible to the EMS provider while not introducing risks to the safety of the patient or EMS provider.	1	5	1
6. O_2 port placement allows for the EMS provider to readily access and use O_2 for patient care while not introducing risks to the safety of the patient or EMS provider.	0	4	3
7. Workspace provides appropriate space to allow the EMS provider to securely and safely place and use equipment, papers, and supplies.	1	0	6
8. There are no head strike obstacles when the EMS provider is in a restrained position.	0	0	7
9. Pathways are clear of obstacles.	0	3	4
10. Equipment and compartment design minimizes the risk of injury during evasive maneuvers and accidents.	0	0	7
11. EMS providers can quickly identify and replace consumable supplies like light bulbs and filters.	4	3	0
12. The interior of the patient compartment can be quickly sanitized and cleaned.	0	3	4
13. All potentially exposed surfaces can be reached for sanitization and cleaning.	0	2	5
14. Individuals are able to quickly ingress and egress the ambulance patient compartment in all weather conditions.	2	3	1
15. Individuals are able to safely ingress and egress the ambulance patient compartment in all weather conditions.	0	1	6
16. The design of the entrances/exits of the patient compartment considers best practices in ergonomic/anthropometric design.	0	2	5
17. Doors do not intrude on an EMS provider's workspace or be a potential striking hazard.	0	2	5
18. EMS providers are able to egress the patient compartment with a patient loaded	0	2	5

on a patient transport device from the main loading/unloading doors and one other door(s).			
19. Interior height of patient compartment ergonomically supports task performance.	0	4	3
20. Flooring supports patient care while reducing injury risk to EMS provider and patient.	0	1	6
21. Patient compartments include devices, such as handholds and grab bars, to aid the EMS provider in moving around the space safely.	0	1	6
22. Safety measures, such as padding, nets, and airbags, are included in the patient compartment to reduce the likelihood of injury to EMS providers & patients during crashes or evasive maneuvers.	0	0	7
23. Disposal containers are secure.	0	2	5
24. Disposal containers are accessible from a restrained position.	0	4	3

Table 6. Functionality rating – Work environment

	Low	Conditional	Essential
1. HVAC system maintains a comfortable and appropriate environment.	0	2	6
2. Lighting system provides appropriate illumination to support task performance.	0	1	6
3. The patient compartment has enough power supply to power/charge all necessary equipment.	1	2	4
4. Power outlets in the patient compartment meet the needs of the EMS provider with respect to powering equipment or recharging batteries during patient care and transport.	1	3	3
5. IV bags that are administered to the patient are placed and secured in a manner that allows them to remain accessible to the EMS provider while not introducing risks to the safety of the patient or EMS provider.	1	3	3
6. O_2 port placement allows for the EMS provider to readily access and use O_2 for patient care while not introducing risks to the safety of the patient or EMS provider.	0	5	2
7. Workspace provides appropriate space to allow the EMS provider to securely and safely place and use equipment, papers, and supplies.	0	2	5
8. There are no head strike obstacles when the EMS provider is in a restrained position.	1	2	4
9. Pathways are clear of obstacles.	0	2	5
10. Equipment and compartment design minimizes the risk of injury during evasive maneuvers and accidents.	0	1	6
11. EMS providers can quickly identify and replace consumable supplies like light bulbs and filters.	3	3	1
12. The interior of the patient compartment can be quickly sanitized and cleaned.	0	3	4
13. All potentially exposed surfaces can be reached for sanitization and cleaning.	0	3	4
14. Individuals are able to quickly ingress and egress the ambulance patient compartment in all weather conditions.	2	2	3

15. Individuals are able to safely ingress and egress the ambulance patient compartment in all weather conditions.	1	1	5
16. The design of the entrances/exits of the patient compartment considers best practices in ergonomic/anthropometric design.	0	2	5
17. Doors do not intrude on an EMS provider's workspace or be a potential striking hazard.	0	4	3
18. EMS providers are able to egress the patient compartment with a patient loaded on a patient transport device from the main loading/unloading doors and one other door(s).	0	0	7
19. Interior height of patient compartment ergonomically supports task performance.	0	4	3
20. Flooring supports patient care while reducing injury risk to EMS provider and patient.	0	2	5
21. Patient compartments include devices, such as handholds and grab bars, to aid the EMS provider in moving around the space safely.	0	1	6
22. Safety measures, such as padding, nets, and airbags, are included in the patient compartment to reduce the likelihood of injury to EMS providers & patients during crashes or evasive maneuvers.	0	3	4
23. Disposal containers are secure.	0	4	3
24. Disposal containers are accessible from a restrained position.	0	4	3

3.2.2 Combined prioritization

In the Work environment breakout session, the group identified the following three design issues as most important across both safety and functionality:

- Workspace provides appropriate space to allow EMS provider to securely and safely place and use equipment, papers, and supplies. (Item 7)
- EMS providers are able to exit patient compartment with a patient loaded on a patient transport device from the main loading/unloading doors and one other door. (Item 18)
- Safety measures, such as padding, nets, and airbags, are included in the patient compartment to reduce the likelihood of injury to EMS providers &patients during crashes or evasive maneuvers. (Item 22) This priority was seen as also subsuming three additional items:
    - There are no head strike obstacles when the EMS provider is in a restrained position. (Item 8)
    - Pathways are clear of obstacles (e.g., pathway should not be used to store equipment or loose items). (Item 9)
    - Doors do not intrude on an EMS provider’s workspace or be a potential striking hazard. (Item 17)

3.2.3 Participant comments

The following comments were offered during the discussions following the separate ratings and the combined prioritization. The comments were collected in a non-attribution manner and are paraphrased.

Participants felt that “Pathways are clear of obstacles” should mean “Pathways are clear of portable patient care equipment” (e.g., pathway should not be used to store equipment or loose items).

Participants commented that air ambulance design would be a useful model for ambulance design. They noted that ambulance design is often viewed from the perspective of designing the inside of a large automobile. They suggested that the patient compartment be viewed more as a cockpit.

Participants commented that the National Institute for Occupational Safety and Health accident trend data and no-strike zones will help prioritize implementation (spending).
Participants suggested that Item 1 should include airflow and filtration as well as temperature.

With regard to Item 23, participants indicated that a key issue is minimizing exposure or injury when emptying the disposal containers.

For Items 5 and 6, participants suggested including the term “restrained.”
For Item 6, the participants suggested including onboard suction.

With regard to Item 9, participants reported that it is difficult to require pathways to be totally clear. They suggested that the requirement should apply to loose, portable equipment (i.e., pathways should not be used to store equipment, and all portable equipment should have a place where it can be secured).

With regard to Item 10, it was noted that maintaining a balanced payload is a critical component of reducing this risk.

With regard to Item 22, participants noted the reference to “nets” as a safety measure and commented that nets are not currently strong enough to qualify as safety equipment.

Participants noted that the requirements to access and operate equipment should carry the additional requirement that the equipment is accessed and used while the EMS provider is restrained.

Participants suggested including hand sanitizers for infection control in the interior of the compartment, and minimizing the handling of infectious materials.

Participants noted that reducing back injury to EMS providers should be emphasized.

3.3 Patient care and general equipment and storage

This domain concerns the extent to which the patient compartment/workspace provides accessibility to general equipment and storage such that (a) equipment allows the EMS provider to safely and effectively treat the patient, (b) storage supports the ability of the EMS provider to safely and effectively perform patient care, (c) facilitates the ability of EMS providers to perform inventory management, and (d) the compartment allows for ability to stow additional equipment.

3.3.1 Raw data sheets

The tables in this section presents the raw output collected by Energetics and NIST at that workshop. Table 7 and Table 8 present the safety and functional ratings for candidate requirements in the area Patient care and general equipment and storage.

Table 7. Safety rating – Patient care and general equipment and storage

	Low	Conditional	Essential
1. The location of equipment while in use in the patient compartment minimizes the likelihood of introducing additional risks to EMS provider and patient safety.	0	0	9
2. Placement of equipment, including the monitor, that requires EMS provider interaction allows EMS providers to complete this interaction from a restrained position.	0	2	7
3. Placement of equipment, including the monitor, that requires EMS provider interaction allows EMS providers to complete this interaction from a seated position.	0	2	7
4. Equipment stored outside of a cabinet is secured such that it does not become a hazard to the EMS provider or patient.	0	1	8
5. Mechanisms for securing equipment stored outside of a cabinet that is required for patient care allows the EMS providers to access the equipment.	2	1	6
6. Equipment, supplies, and controls are easily identifiable.	1	4	4
7. Storage compartments provide adequate storage space for all required equipment and supplies.	2	4	3
8. Interior storage compartments whose contents are used frequently or are critical to patient care are accessible from a restrained position.	0	1	8
9. Interior storage compartments whose contents are used frequently or are critical to patient care are accessible from a seated position.	0	4	5
10. Equipment/supplies stored within a storage compartment will remain secured while in transit, but are accessible to EMS provider when needed.	0	1	8
11. Lockable storage compartment for equipment/supplies (e.g., narcotics) is	1	4	4

provided.			
12. Storage compartment doors do not intrude on an EMS provider's workspace or pose a potential striking hazard.	0	2	7
13. EMS providers are able to quickly determine the inventory of equipment and supplies on-board the ambulance.	4	5	0
14. EMS providers are able to quickly resupply the ambulance.	5	4	0
15. The patient compartment design allows for secure and safe storage of specialty equipment not normally carried on the ambulance and used infrequently for special calls.	1	6	2
16. Temperature controlled storage is accessible from a seated position.	1	4	4
17. Temperature controlled storage is accessible from a restrained position.	0	6	3

Table 8. Functionality rating – Patient care and general equipment and storage

	Low	Conditional	Essential
1. The location of equipment while in use in the patient compartment minimizes the likelihood of introducing additional risks to EMS provider and patient safety.	0	1	8
2. Placement of equipment, including the monitor, that requires EMS provider interaction and allows EMS providers to complete this interaction from a restrained position.	0	1	8
3. Placement of equipment, including the monitor, that requires EMS provider interaction and allows EMS providers to complete this interaction from a seated position.	1	2	6
4. Equipment stored outside of a cabinet is secured such that it does not become a hazard to the EMS provider or patient.	0	4	5
5. Mechanisms for securing equipment stored outside of a cabinet that is required for patient care allows the EMS providers to access the equipment.	0	1	8
6. Equipment, supplies, and controls are easily identifiable.	0	3	6
7. Storage compartments provide adequate storage space for all required equipment and supplies.	0	3	6
8. Interior storage compartments whose contents are used frequently or are critical to patient care are accessible from a restrained position.	0	1	8
9. Interior storage compartments whose contents are used frequently or are critical to patient care are accessible from a seated position.	1	3	5
10. Equipment/supplies stored within a storage compartment will remain secured while in transit, but are accessible to EMS provider when needed.	0	3	6

11. Lockable storage compartment for equipment/supplies (e.g., narcotics) is provided.	0	7	2
12. Storage compartment doors do not intrude on an EMS provider's workspace or pose a potential striking hazard.	1	2	6
13. EMS providers are able to quickly determine the inventory of equipment and supplies on-board the ambulance.	1	7	1
14. EMS providers are able to quickly resupply the ambulance.	2	5	2
15. The patient compartment design allows for secure and safe storage of specialty equipment not normally carried on the ambulance and used infrequently for special calls.	1	6	2
16. Temperature controlled storage is accessible from a seated position.	3	3	4
17. Temperature controlled storage is accessible from a restrained position.	0	6	3

3.3.2 Combined prioritization

In the Patient care and general equipment and storage breakout session, the group identified the following design issues as most important across both safety and functionality:

- The location of the equipment while in use in the patient compartment minimizes the likelihood of introducing additional risks to EMS provider and patient safety. (Item 1)
- Placement of equipment, including the monitor, that requires EMS provider interaction and allows EMS providers to complete this interaction from a restrained position. (Item 2)
- Placement of equipment, including the monitor, that requires EMS provider interaction and allows EMS providers to complete this interaction from a seated position. (Item 3)
- Equipment stored outside of cabinet is secured such that it does not become a hazard to the EMS provider or patient. (Item 4)

3.3.3 Participant comments

The following comments were offered during the discussions following the separate ratings and the combined prioritization. The comments were collected in a non-attribution manner and are paraphrased.

Participants expressed that the first three design issues depend on each other and should be coupled together.

The group identified the need to reword some requirements for clarity and pointed out that some requirements are related to internal policy requirements rather than safety and functionality; for example, the ability to quickly determine inventory and resupply the ambulance. Participants

also expressed that the speed at which inventory can be assessed and resupplied is not as important as the ability to complete those tasks with ease.

The group felt that the availability of a lockable storage compartment for equipment and supplies, such as for narcotics, was not an important need.

Participants mentioned the ability to transport more than one patient as a possible requirement to add to the list.

Participants noted that equipment storage locations should take into account ergonomic issues such as weight and lifting height.

3.4 Patient care and special equipment and storage

This domain concerns the extent to which the patient compartment/workspace accommodates locations such that (a) cots and cot locking mechanisms allow the EMS provider to safely and effectively treat the patient, (b) special equipment allows the EMS provider to safely and effectively treat the patient, (c) EMS providers can safely and readily access secured jump bags while providing patient care, and (d) storage of the patient's equipment/belongings can be safe and secure.

3.4.1 Raw Data Sheets

The tables in this section presents the raw output collected by Energetics and NIST at that workshop. Table 9 and Table 10 present the safety and functional ratings for candidate requirements in the area Patient care and special equipment and storage

Table 9. Safety rating – Patient care and special equipment and storage

	Low	Conditional	Essential
1. The EMS provider has access around the entire cot.	5	5	0
2. Cot allows for the patient to be comfortably restrained without hindering the ability of the EMS provider to provide safe and effective patient care.	0	6	9
3. Cot allows for the patient to be securely restrained without hindering the ability of the EMS provider to provide safe and effective patient care.	0	0	9
4. The cot guidance and securing mechanism allows for the cot to be quickly secured and released.	0	8	1
5. The cot guidance and securing mechanism allows for the cot to be safely secured and released.	0	0	9
6. The cot has sufficient storage locations for all required equipment that is carried with the cot and patient.	1	5	3
7. Where the ambulance is designed to use a powered cot, the powered cot can be	3	3	3

charged in the ambulance.			
8. Cot loading mechanisms are quick to set up, load/unload the cot, and stow.	0	4	5
9. The cot loading system allows for the patient to be loaded or unloaded safely with minimal risk of injury to the patient or EMS provider.	0	0	9
10. Cots are capable of securing children of any age for transport.	0	1	7
11. Backboard has a quick method of fully securing the patient to the backboard.	0	6	3
12. The EMS provider is able to perform CPR with minimal risk of injury to the patient and him/herself.	0	0	9
13. When being used for patient care, the placement of secured jump bags allows EMS providers to quickly and safely access them.	0	2	7
14. When being used for patient care, jump bags are designed to allow the EMS provider to organize stored supplies and equipment to allow quick access.	0	4	5
15. Jump bags are designed to allow EMS providers to quickly transport them to and from the patient care scene and the patient compartment while minimizing their risk of injury.	0	2	7
16. Space is provided to accommodate patient equipment and belongings without compromising EMS performance and safety.	0	5	4
17. Secure storage is available for patient belongings.	1	3	5

Table 10. Functionality rating – Patient care and special equipment and storage

	Low	Conditional	Essential
1. The EMS provider has access around the entire cot.	4	3	3
2. Cot allows for the patient to be comfortably restrained without hindering the ability of the EMS provider to provide safe and effective patient care.	0	6	4
3. Cot allows for the patient to be securely restrained without hindering the ability of the EMS provider to provide safe and effective patient care.	0	4	6
4. The cot guidance and securing mechanism allows for the cot to be quickly secured and released.	0	9	1
5. The cot guidance and securing mechanism allows for the cot to be safely secured and released.	0	2	8
6. The cot has sufficient storage locations for all required equipment that is carried with the cot and patient.	1	3	6
7. Where the ambulance is designed to use a powered cot, the powered cot can be charged in the ambulance.	1	2	7

8. Cot loading mechanisms are quick to set up, load/unload the cot, and stow.	0	3	7
9. The cot loading system allows for the patient to be loaded or unloaded safely with minimal risk of injury to the patient or EMS provider.	0	0	10
10. Cots are capable of securing children of any age for transport.	0	3	6
11. Backboard has a quick method of fully securing the patient to the backboard.	0	3	7
12. The EMS provider is able to perform CPR with minimal risk of injury to the patient and him/herself.	0	1	9
13. When being used for patient care, the placement of secured jump bags allows EMS providers to quickly and safely access them.	0	1	9
14. When being used for patient care, jump bags are designed to allow the EMS provider to organize stored supplies and equipment to allow quick access.	0	2	8
15. Jump bags are designed to allow EMS providers to quickly transport them to and from the patient care scene and the patient compartment while minimizing their risk of injury.	0	1	9
16. Space is provided to accommodate patient equipment and belongings without compromising EMS performance and safety.	1	5	4
17. Secure storage is available for patient belongings.	1	4	5

3.4.2 Combined prioritization

In the Patient care and special equipment and storage breakout session, the group identified the following design issues as most important across both safety and functionality:

- The cot guidance and securing mechanism allows for the cot to be safely secured and released. (Item 5)
- The cot loading system allows for the patient to be loaded or unloaded safely with minimal risk of injury to patient or EMS provider. (Item 9)
- When being used for patient care, the placement of secured jump bags allows EMS providers to quickly and safely access them. (Item 13)
- Secure storage is available for patient belongings. (Item 17)
- Cot allows for the patient to be securely restrained without hindering the ability of the EMS provider to provide safe and effective patient care. (Item 3)

3.4.3 Participant comments

The following comments were offered during the discussions following the separate ratings and the combined prioritization. The comments were collected in a non-attribution manner and are paraphrased.

Item 10 was revised before voting to read "Patient restraint devices are capable of securing children of any age for transport."

Participants indicated that protecting the EMS provider is of paramount importance. This would help to control insurance costs, which are out of control. More importantly, however, is the human cost. Participants indicated that they care about their employees, and that protecting them from injury is their primary concern.

Participants indicated that designers need to think broadly about safety. Although crashes are the leading cause of EMS fatalities, lifting/loading patients is the leading cause of EMS injury. Lifting heavy equipment is also a major cause of back and muscle strain.
Participants mentioned that patients who are aggressive or move unpredictably represent a safety consideration that should be added to Item 3.

Participants commented that there should also be a space provided to accommodate EMS providers' belongings.

Participants recommended not using the adult cot equipped with child restraints, noting that a child safety seat is a better option.

Item 11 states "Backboard has a quick method of fully securing the patient to the backboard." Participants expressed that they are not especially concerned with doing things quickly (however, for medical care reasons there might be a need for speed).
Participants stated that they do not usually duplicate items in the jump bag and ambulance storage; however, there is variation across companies.

Participants recommended revising Item 1 because the intent was not clear. They interpreted the statement to mean that the provider has access to the patient around the entire cot.

With regard to the loading of patients, participants noted that hospitals are increasingly prohibiting EMS providers from lifting patients, due to the rate of back injury claims and patient injuries.

Participants expressed concern that there is no available data on EMS provider injuries, or the causes, severity, etc., of those injuries.

Participants commented on the possibility of introducing specially designed helmets that are easy to use.

3.5 Workshop summary session – Crosscutting comments

The following are a number of items that were mentioned during the breakout summary session:

- There is a need to start from scratch on patient compartment design, with no legacy.

- To avoid head strike, EMS providers could wear a helmet when entering or leaving the compartment.
- There is a need to address the items carried by EMS providers.
- There is a need to address requirements for individual equipment items.
- There is a need to address training in the standard.

The results collected from the workshop participants are driving adjustments to the requirements that include rephrasing as well as addition/deletion of requirements. The workshop provided invaluable insight into priorities and confirmed that no significant gaps exist in the requirements presented. The next step is to evaluate the data from this workshop and finalize the requirements. These requirements will be assessed using rigorous analytic tools, including emergency medical provider task analysis and modeling and simulation in the next phase of the project. The validated requirements and design guidance will be the basis for input into current and emerging ambulance design standards.

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