NIST Technical Note 1772

Survey Report for Ambulance Patient Compartment Design

Jennifer Marshall
Y. Tina Lee
Allison Barnard Feeney
Deogratias Kibira

http://dx.doi.org/10.6028/NIST.TN.1772

National Institute of Standards and Technology
U.S. Department of Commerce

NIST Technical Note 1772

Survey Report for Ambulance Patient Compartment Design

Jennifer Marshall
Law Enforcement Standards Office
Special Programs Office

Y. Tina Lee
Allison Barnard Feeney
Deogratias Kibira
Systems Integration Division
Engineering Laboratory

http://dx.doi.org/10.6028/NIST.TN.1772

January 2013

U.S. Department of Commerce
Rebecca M. Blank, Acting Secretary

National Institute of Standards and Technology
Patrick D. Gallagher, Under Secretary of Commerce for Standards and Technology and Director

ABSTRACT

NIST conducted a nationwide survey (Office of Management and Budget, Control No. 1090-0007) of emergency medical services (EMS) professionals in December 2011. The objective of the survey was to aid in the development of design standards for the patient compartment in ambulances and to measure customer satisfaction with current design standards. A total of 2537 responses were collected and provided insight into the EMS work environment such as seating, occupancy, ergonomics, restraint systems, and communications. The survey provides information regarding the EMS professional's ability to provide care to an injured patient in the patient compartment of ambulances with the current reach and usage of equipment and supplies. This report summarizes the data collected from the survey responses.

The survey supports a larger effort to develop standards to address performance and safety issues associated with the design of patient compartments in EMS vehicles (i.e., ambulances).

ACKNOWLEDGEMENTS

The U.S. Department of Homeland Security Science and Technology Directorate Human Factors/Behavioral Sciences Division and First Responder Resources Group sponsored the material presented in this document under interagency agreement #HSHQDC-11-X-00049. We would also like to thank BMT Designers and Planners for their assistance in technical support and editing, the Department of Interior for guidance and securing Office of Management and Budget clearance of the survey in compliance of the Paperwork Reduction Act, and the CFI Group for the hosting and collection of results and summation, which formed the basis of this report.

Most importantly, we want to thank those who participated in the survey. Your input has been truly valuable to this entire effort.

KEY WORDS

ambulance; standard; EMS; EMT; seating; patient compartment; ergonomics; safety; Box I and III; restraint systems; ASCI; CPR seat

TABLE OF CONTENTS

TERMINOLOGY

ACSI	American Customer Satisfaction Index
ALS	Advanced Life Support
BLS	Basic Life Support
EMS	Emergency Medical Services
EMT	Emergency Medical Technician
CPR	Cardiopulmonary Resuscitation
PPE	Personal Protective Equipment

INTRODUCTION AND METHODOLOGY

Background

The National Institute of Standards and Technology (NIST) provides research-based input to standards initiatives in criminal justice, public safety, emergency response, homeland security and many other areas. Recently, the U.S. Department of Homeland Security (DHS) Science and Technology Directorate's Human Factors/Behavioral Sciences Division and First Responder Resources Group sponsored NIST, the National Institute of Occupational Safety and Health (NIOSH), and BMT Designers and Planners (BMT) to form the Ambulance Patient Compartment Design Project. 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).

A survey of EMS professionals was conducted in December 2011. These professionals included emergency medical technicians (who ride in the back of the ambulance performing emergency medical care), dispatchers (those who coordinate EMS activities), and national emergency medical services association officials. The survey complements the prior Project efforts, which include conducting focus group meetings, practitioner interviews and ambulance ride-alongs with emergency medical technicians (EMTs) and representatives within the ambulance industry during rescue missions. The objective of the survey was to aid in the development of design standards for the patient compartment in ambulances and to measure customer satisfaction with current design standards.

NIST worked closely with the CFI Group who administers surveys using the American Customer Satisfaction Index (ACSI). The ASCI is the national indicator of customer evaluations of the quality of goods and services available to U.S. residents. It is a uniform, cross-industry/government measure of customer satisfaction. This allows benchmarking between the public and private sectors and provides information unique to each agency on how its activities that interface with the public affect the satisfaction of customers. The effects of satisfaction are estimated, in turn, on specific objectives (such as public trust).

Data Collection

The data collection was a collaborative effort between NIST and the Department of the Interior (DOI). A contractor for DOI (i.e., CFI Group) conducted and hosted the online survey. The U.S. Office of Management and Budget, Control No. 1090-0007, per the Paperwork Reduction Act of 1995, authorized the survey. NIST made the survey link available to respondents via the NIST website, the DHS Responder Knowledge Base, EMT organizations (e.g., National Association of Emergency Medical Technicians) and through communications directly to individual EMTs. Data were collected November 29, 2011, through December 28, 2011. A total of 2537 responses were collected and used in analysis. The analysis of the survey is presented in the text and tables that follow. The data in the tables include percentages, which may sum 99 % or 101 % because of rounding. In addition, the data include frequency of response, for which the totals may be less

or more than the number of survey respondents (2537) because some respondents did not answer a particular question or because multiple responses were allowed since the options are not mutually exclusive, respectively.

Reporting

The questionnaire used is shown in Appendix A. The questionnaire was developed through a collaborative effort between DOI, CFI Group, NIST, and BMT Designers and Planners.

BACKGROUND – WORK-RELATED INFORMATION

The survey showed that 72 % of respondents are career EMS providers affiliated with ambulance service. Twenty percent (20 %) are volunteers, i.e., skilled persons but not paid for their emergency medical services, while 3 % are trainers. Most respondents (89 %) work in a Box type ambulance (Type I and Type III). Only 9 % of the EMS providers work in a Van type ambulance (Type II). The services typically performed by EMS providers are initiated by a 911 call as shown by 84 % of respondents. Regarding level of service, advanced life support (ALS) is the service typically performed by 76 % while basic life support (BLS), as the typical service, is mentioned by 61 % of respondents. Just under half (47 %) of the respondents report that they typically simply transport the patient without emergency medical care performed in transit to a medical facility.

With respect to the average transit time of patient to a hospital, approximately three-fourths of respondents say their transit time is between 6 minutes and 20 minutes. A further breakdown shows that the 11 minute to 15 minute transit range occurred 29 % of the time, while 24 % fall into the 6 minute to 10 minute range and 21 % are in the 16 minute to 20 minute range.

	Response Count	
	Percent	**Frequency**
Affiliation with ambulance service		
EMS Provider – Career	72 %	1825
EMS Provider – Volunteer	20 %	507
Other	5 %	138
Trainer	3 %	67
Number of Respondents	**2537**	

Average transit time with a patient to a hospital		
5 minutes or less	3 %	88
Between (6 and 10) minutes	24 %	604
Between (11 and 15) minutes	29 %	742
Between (16 and 20) minutes	21 %	538
Between (21 and 30) minutes	14 %	362
More than 30 minutes	8 %	203
Number of Respondents	**2537**	

Type of ambulance do you usually work in		
Box (Type I and III)	89 %	2269
Van (Type II)	9 %	216
Other	2 %	52
Number of Respondents	**2537**	

Type of service typically performed *		
911	84 %	2122
ALS	76 %	1924
BLS	61 %	1546
Transport	47 %	1202
Number of Respondents	**2537**	

Seating

The most commonly used seat by EMS providers is bench seating with 72 % of the mentions, while bucket seats are used by one-quarter (25 %) of respondents. Side-facing seating in the patient compartment is preferred by over half (54 %) of respondents and just under one-quarter (23 %) prefer rearward-facing seating. Forward facing is only preferred by 9 % of the respondents, while 14 % had no preference. Eighty percent of the respondents recommend a CPR seat in the patient compartment.

	Response Count	
	Percent	Frequency
Type of seat do you currently use		
Bench	72 %	1816
Bucket	25 %	626
Other	4 %	95
Number of Respondents	**2537**	

Seating orientation you prefer in the patient compartment		
Side-facing	54 %	1373
Rearward-facing	23 %	591
Forward-facing	9 %	221
No preference	14 %	352
Number of Respondents	**2537**	

Recommend a CPR seat in the patient compartment		
Yes	80 %	1721
No	20 %	443
Number of Respondents	**2164**	

Occupancy/Transport

It is rare to transport more than one patient at a time because just 2 % of respondents report that transporting more than one patient occurs more than one-quarter of their trips. On the other hand, eighty-six percent (86 %) of the EMS providers either never transport more than one patient or have done so less than 10 % of the time. With respect to the capacity of their ambulance, 78 % of the EMS providers can safely transport two patients and another 14 % can safely transport three patients. Safely, in this context, refers to transporting a person that is using some form of restraint systems to reduce risk of injury in case of a vehicle crash or sudden turn. The capability to transport more than three patients is reported by only 9 %.

	Response Count	
	Percent	Frequency
Percent of time you transport more than one patient		
Never	7 %	176
Less than 10 %	79 %	2011
Between 10 % and 25 %	12 %	304
Between 26 % and 50 %	1 %	30
More than 50 %	1 %	16
Number of Respondents	**2537**	

Number of patients you have the capability to safely transport		
2	78 %	1986
3	14 %	343
4	6 %	146
5	2 %	45
More than 5	1 %	17
Number of Respondents	**2537**	

Ergonomics

The capability to reach controls by EMS personnel, especially from a seated or restrained position, is a major concern for ambulance services. Approximately half of respondents cannot reach at least one of the major controls, i.e., lighting, ventilation, or radio. Just 37 % can reach all needed controls, but nearly 39 % indicate that they cannot reach all of the three major controls mentioned. Two-thirds (65 %) of the respondents had no concerns about the gurney/stretcher. Security of the gurney/stretcher is an issue for one-quarter (25 %) of respondents, while its location is a concern for 14 %. Orientation is much less of a concern since only 8 % think it is an issue.

	Response Count	
	Percent	Frequency
Cannot reach from seat *		
Lighting	50 %	1260
Radio	49 %	1242
Ventilation	50 %	1275
I can reach all needed controls	37 %	951
Other	11 %	282
Number of Respondents	**2537**	

Gurney-stretcher concerns *		
Location of the gurney/stretcher	14 %	344
Orientation of the gurney/stretcher	8 %	197
Security of the gurney/stretcher	25 %	624
I have no concern about the gurney/stretcher	65 %	1650
Number of Respondents	**2537**	

Restraint Systems

Lap belts are in 79 % of ambulances, while nearly one-third (32 %) have lap and shoulder belts. Four-point, five-point and seven-point restraints are relatively uncommon with only 16 % having one of these types in their ambulance. Respondents are split on wearing restraints when not treating the patient with just over one-third (36 %) claiming they nearly always wear them (more than 90 % of the time) and the same percentage (36 %) saying they rarely wear restraints (less than 15 % of the time). However, when treating the patient, respondents were more consistent since just over three-quarters (76 %) rarely wear them (less than 15 % of the time). Only 3 % of respondents indicate that they nearly always (more than 90 % of the time) wear their restraints even when treating the patient.

Regulations on seatbelt usage are somewhat common with nearly half (48 %) having either State or Organization regulations requiring the usage of seatbelts. District (9 %) and County (13 %) regulations were less common. Awareness of regulations is not very extensive, since one-quarter (25 %) of respondents did not know if there were regulations on seat belt usage.

	Response Count	
	Percent	**Frequency**
Restraints in patient comp *		
Lap belt	79 %	2012
Lap and shoulder belt	32 %	821
4-point	7 %	184
5-point	9 %	229
7-point	0 %	11
Other	2 %	56
Number of Respondents	**2537**	

Time wearing restraint system in patient compartment when NOT treating patient		
Less than 15 %	36 %	917
Between 15 % and 40 %	10 %	249
Between 41 % and 65 %	7 %	189
Between 66 % and 90 %	11 %	277
More than 90 %	36 %	905
Number of Respondents	**2537**	

Time wearing restraint system in patient compartment when treating patient		
Less than 15 %	76 %	1933
Between 15 % and 40 %	11 %	276
Between 41 % and 65 %	7 %	175
Between 66 % and 90 %	3 %	82
More than 90 %	3 %	71
Number of Respondents	**2537**	

	Response Count	
	Percent	Frequency
Regulations seat belt usage *		
District	9 %	221
County	13 %	318
State	48 %	1206
Organization	48 %	1219
Don´t know	25 %	632
Other	7 %	168
Number of Respondents	**2537**	

Communications

The majority of ambulances (62 %) are equipped with a computer system. As to how respondents would like to receive information from the driver, verbal is most preferred with 54 % of mentions. Visual displays are the second most preferred with 37 % and notification lights are close behind with 31 % of mentions. Very few (9 %) would want to receive information from the driver by radio. In fact, the same percentage would not want to receive information at all.

	Response Count	
	Percent	Frequency
Ambulance equipped with a computer system		
Yes	62 %	1552
No	38 %	942
Number of Respondents	**2494**	

Receive info from driver *		
Verbally/yelling	54 %	1381
Radio	9 %	225
Visual Displays	37 %	941
Notification lights	31 %	785
Would not want to receive information	9 %	229
Other	7 %	186
Number of Respondents	**2537**	

PERFORMANCE – USAGE AND REACH OF EQUIPMENT/SUPPLIES

Respondents were asked how frequently they use the following equipment/supplies and how easy the equipment/supplies are to reach.

Ventilation/Respiration Equipment

Stationary oxygen is used a majority of the time (50 % or more) by 81 % of respondents, while portable oxygen is used a majority of the time by 65 % of respondents. Most of the other ventilation/respiration equipment is used infrequently. Only 21 % use resuscitator with oxygen inlet and masks a majority of the time. Non-manual suction devices, portable suction devices and mouth-to-mask ventilators are used a majority of the time by 10 % or fewer of the respondents. In the case of the mouth-to-mask ventilator 41 % never use it.

Frequency of use	Portable oxygen	Stationary oxygen	Resuscitator with oxygen inlet masks	Mouth-to-mask ventilator with oxygen inlet	Non-manual suction device	Portable suction device	Other
100 %	5 %	7 %	2 %	1 %	1 %	1 %	4 %
75 % to 99 %	31 %	45 %	8 %	3 %	3 %	2 %	7 %
50 % to 74 %	29 %	29 %	11 %	5 %	6 %	5 %	7 %
25 % to 49 %	16 %	13 %	18 %	10 %	16 %	12 %	4 %
1 % to 24 %	16 %	5 %	50 %	40 %	67 %	71 %	7 %
0 %	3 %	1 %	10 %	41 %	7 %	9 %	71 %

With respect to difficulty of reach for ventilation/respiration equipment, those equipment most frequently used, stationary and portable oxygen, are difficult to reach for most. Half (51 %) need to leave their seat to reach the portable oxygen and 18 % can reach it with strain. Slightly fewer need to leave their seat (40 %) to reach the stationary oxygen, but another 20 % can only reach it with strain. The rarely used portable suction device is the most difficult to reach ventilation/respiration item since 71 % need to leave their seat to reach it.

Difficulty of reach	Portable oxygen	Stationary oxygen	Resuscitator with oxygen inlet masks	Mouth-to-mask ventilator with oxygen inlet	Non-manual suction device	Portable suction device	Other
Reach without strain	32 %	40 %	26 %	26 %	36 %	14 %	15 %
Reach with strain	18 %	20 %	20 %	20 %	20 %	14 %	17 %
Unable to reach without leaving seat	51 %	40 %	54 %	55 %	44 %	71 %	68 %

Diagnostic Equipment

Stethoscopes and blood pressure monitors are the diagnostic equipment most used. Nearly all respondents (96 %) use a stethoscope a majority of the time and nearly as many use the blood pressure monitor (95 %). The oximeter (88 %), blood glucose meter (68 %) and diagnostic light (59 %) were all frequently mentioned as being used a majority of the time as well. Thermometers were somewhat less frequently used since only 30 % use them a majority of the time and 28 % never use them.

Frequency of use	Oximeter	Stethoscope	Thermometer	Blood glucose meter	Diagnostic light	Blood pressure monitor	Other
100 %	36 %	59 %	8 %	12 %	19 %	62 %	5 %
75 % to 99 %	41 %	30 %	10 %	30 %	22 %	28 %	6 %
50 % to 74 %	11 %	7 %	12 %	26 %	18 %	5 %	4 %
25 % to 49 %	5 %	2 %	14 %	16 %	16 %	2 %	2 %
1 % to 24 %	2 %	1 %	27 %	8 %	12 %	1 %	2 %
0 %	4 %	1 %	28 %	8 %	13 %	3 %	82 %

Stethoscopes are relatively within reach since 77 % can reach them without strain. The majority of respondents (57 %) can reach the blood pressure monitor without strain and one-fifth (21 %) of EMS workers have to get out of their seat to reach it. The oximeter can be reached without strain by 51 %, while one-quarter (26 %) need to get out of their seat to reach it. The thermometer, a rather infrequently used diagnostic equipment, requires 41 % to leave their seat to reach it. The blood glucose meter, however, was frequently used by 68 % but was difficult to reach with one-third (32 %) having to leave their seat to reach it.

Difficulty of reach	Oximeter	Stethoscope	Thermometer	Blood glucose meter	Diagnostic light	Blood pressure monitor	Other
Reach without strain	51 %	77 %	36 %	46 %	59 %	57 %	33 %
Reach with strain	23 %	12 %	23 %	22 %	18 %	22 %	19 %
Unable to reach without leaving seat	26 %	11 %	41 %	32 %	22 %	21 %	48 %

Infusion Material or Equipment

Infusion solutions and equipment for injections and infusions are somewhat frequently used since 57 % use infusion solution a majority of the time, while 53 % use equipment for injections and infusions a majority of the time. Infusion mounting is used frequently by 43 % of respondents, while one-quarter (26 %) never use them. Pressure infusion devices and infusion system for administration of warm fluid are infrequently used since only 13 % and 19 %, respectively, mention using them a majority of the time. Additionally, the infusion system for administration of warm fluid is not used at all by half (51 %) of EMS workers.

Frequency of use	Infusion solutions	Equip for injections infusions	Infusion sys for admin warm fluid	Infusion mounting	Pressure infusion device	Other
100 %	4 %	4 %	2 %	4 %	2 %	2 %
75 % to 99 %	23 %	20 %	6 %	16 %	4 %	2 %
50 % to 74 %	30 %	29 %	11 %	23 %	7 %	3 %
25 % to 49 %	19 %	19 %	10 %	18 %	8 %	2 %
1 % to 24 %	8 %	11 %	20 %	12 %	42 %	3 %
0 %	16 %	16 %	51 %	26 %	37 %	89 %

The infusion materials and equipment that are more frequently used are difficult to reach since only one-fifth (20 %) can reach infusion solutions without strain and nearly three-fifths (58 %) need to leave their seat. Similarly, the equipment for injections and infusions is nearly as difficult to reach with only one-quarter (24 %) able to reach them without strain while 55 % need to leave their seat. Those rarely used infusion materials and equipment are the most difficult to reach since 71 % are unable to reach pressure infusion devices or infusion systems for administering warm fluid without leaving their seats.

Difficulty of reach	Infusion solutions	Equip for injections infusions	Infusion sys for admin warm fluid	Infusion mounting	Pressure infusion device	Other
Reach without strain	20 %	24 %	14 %	16 %	13 %	21 %
Reach with strain	22 %	22 %	15 %	25 %	15 %	14 %
Unable to reach without leaving seat	58 %	55 %	71 %	59 %	71 %	66 %

Equipment for Managing Life-Threatening Situations

In general, much of the equipment for managing life-threatening situations is used less frequently. While cardiac monitors are used a majority of the time by 69 % of respondents, the next most used is the defibrillator with rhythm and patient data recording since 41 % of respondents use this equipment a majority of the time. The nebulization apparatus (23 %), capnometer (20 %) and external cardiac pacing (20 %) are the only other equipment with at least 20 % using them a majority of the time.

Central vein catheters, volumetric infusing devises and thorax drainage kits are the least used equipment since a sizable majority report never using these.

Frequency of use	Defibrillator with rhythm and patient data recording	Cardiac monitor	External cardiac pacing	Portable Resuscitation System	Nebulization apparatus	Thorax drainage kit	Volumetric infusing device	Central vein catheters	PEEP-valve	Capnometer	Other
100 %	7 %	13 %	4 %	3 %	2 %	1 %	1 %	1 %	2 %	3 %	1 %
75 % to 99 %	18 %	33 %	8 %	3 %	5 %	1 %	2 %	2 %	1 %	6 %	1 %
50 % to 74 %	16 %	23 %	8 %	6 %	16 %	2 %	3 %	3 %	4 %	11 %	1 %
25 % to 49 %	13 %	11 %	10 %	9 %	27 %	2 %	5 %	3 %	7 %	15 %	1 %
1 % to 24 %	38 %	7 %	50 %	34 %	37 %	27 %	25 %	11 %	30 %	36 %	4 %
0 %	8 %	12 %	19 %	45 %	13 %	66 %	64 %	79 %	56 %	30 %	91 %

The more frequently used cardiac monitor and defibrillator are easier to reach than other equipment in this category, but many struggle to reach them. Forty-one percent of respondents had to leave their seat to reach the defibrillator and 37 % had to get up to reach the cardiac monitor. Rarely used equipment for managing life-threatening situations were the most unreachable. Seventy-one percent (71 %) cannot reach the thorax drainage kit and 70 % cannot reach the volumetric infusing devises without leaving their seat.

Difficulty of reach	Defibrillator with rhythm and patient data recording	Cardiac monitor	External cardiac pacing	Portable Resuscitation System	Nebulization apparatus	Thorax drainage kit	Volumetric infusing device	Central vein catheters	PEEP-valve	Capnometer	Other
Reach without strain	36 %	38 %	37 %	22 %	22 %	13 %	12 %	20 %	18 %	33 %	23 %
Reach with strain	23 %	24 %	24 %	19 %	24 %	16 %	18 %	17 %	20 %	22 %	15 %
Unable to reach without leaving seat	41 %	37 %	39 %	59 %	54 %	71 %	70 %	63 %	62 %	45 %	62 %

Supplies/Bandaging/Nursing/Personal Protective Equipment

The most commonly used supplies include non-sterile gloves for single use, sharps containers and blankets. Eighty-three percent (83 %) use non-sterile gloves a majority of the time, while 69 % use sharps containers and 67 % use blankets a majority of the time. Less frequently used supplies include materials for treatment of wounds, vomiting bag and sterile surgical glove pairs. Materials for treatment of wounds are used a majority of the time for 34 % of respondents, while 22 % mention using vomiting bag and sterile surgical gloves a majority of the time. The kidney bowl, bedpan, non-glass urine bottle and hazardous material suits are the least frequently used supplies.

Frequency of use	Blankets	Material for treatment of wounds	Material for burns and corrosives	Kidney bowl	Vomiting bag	Bedpan	Non-glass urine bottle	Sharps container	Sterile surgical gloves pairs	Non-sterile gloves for single use	Hazardous material suits	Other
100 %	16 %	3 %	3 %	2 %	3 %	2 %	2 %	11 %	13 %	62 %	1 %	1 %
75 % to 99 %	28 %	8 %	4 %	2 %	5 %	2 %	2 %	30 %	5 %	16 %	1 %	1 %
50 % to 74 %	23 %	23 %	8 %	6 %	14 %	4 %	3 %	28 %	4 %	5 %	2 %	1 %
25 % to 49 %	18 %	37 %	15 %	11 %	26 %	6 %	6 %	16 %	5 %	4 %	2 %	1 %
1 % to 24 %	14 %	29 %	67 %	46 %	48 %	59 %	56 %	12 %	41 %	6 %	42 %	3 %
0 %	1 %	1 %	4 %	33 %	5 %	28 %	31 %	3 %	32 %	7 %	52 %	92 %

The frequently used sharps container is the only item that can be reached without strain by a majority of respondents (56 %). Two-thirds of EMS workers use blankets a majority of the time and 59 % have to leave their seat to reach them. One-third (35 %) of the respondents had to leave their seat to reach the frequently used non-sterile gloves. Rarely used items are out of reach for

most EMS workers. Fewer than 10 % can reach the bedpans or non-glass urine bottles without strain and only 6 % can reach their hazardous material suit.

Difficulty of reach	Blankets	Material for treatment of wounds	Material for burns and corrosives	Kidney bowl	Vomiting bag	Bed-pan	Non-glass urine bottle	Sharps container	Sterile surgical gloves pairs	Non-sterile gloves for single use	Hazardous material suits	Other
Reach without strain	23 %	16 %	11 %	13 %	28 %	9 %	9 %	56 %	23 %	45 %	6 %	21 %
Reach with strain	18 %	25 %	21 %	18 %	24 %	12 %	12 %	25 %	18 %	20 %	8 %	12 %
Unable to reach without leaving seat	59 %	59 %	68 %	69 %	48 %	78 %	79 %	19 %	58 %	35 %	87 %	67 %

Medicine Storage

The jump bag is used a majority of the time by 78 % of respondents, while locked narcotics are only used a majority of the time by one-quarter (25 %) of respondents.

Frequency of use	Jump bag	Locked narcotics	Other
100 %	39 %	5 %	2 %
75 % to 99 %	25 %	6 %	1 %
50 % to 74 %	14 %	14 %	2 %
25 % to 49 %	9 %	22 %	2 %
1 % to 24 %	9 %	36 %	3 %
0 %	4 %	18 %	91 %

Despite its frequent use, nearly half of respondents cannot reach the jump bag without leaving their seat. Locked narcotics are only accessible without strain to 17 % of EMS workers.

Difficulty of reach	Jump bag	Locked narcotics	Other
Reach without strain	27 %	17 %	24 %
Reach with strain	23 %	12 %	12 %
Unable to reach without leaving seat	49 %	71 %	64 %

Communications

Mobile radio transceivers are always used by 44 % of respondents and three-quarters (75 %) use them a majority of the time. Portable radio transceivers have slightly lower usage with one-third (34 %) using them all the time and two-thirds (65 %) using them a majority of the time. Intercoms are used with much less frequency; only 12 % report using them a majority of the time and three-quarters (74 %) never use them. Cell phones are used somewhat frequently in ambulances, but less so than mobile or portable radios since only 54 % use cell phones a majority of the time

Difficulty of reach	Mobile radio transceiver	Portable radio transceiver	Intercom	Cell phone	Other
Reach without strain	47 %	73 %	49 %	72 %	45 %
Reach with strain	15 %	9 %	15 %	9 %	13 %
Unable to reach without leaving seat	38 %	18 %	36 %	19 %	42 %

Although they are not quite as frequently used as mobile radios, portable radio transceivers are much more accessible. Nearly three-quarters (73 %) can reach portable radio transceivers without strain, while just under half (47 %) can reach mobile radio transceivers. Surprisingly 19 % cannot reach a cell phone without leaving their seat.

Frequency of use	Mobile radio transceiver	Portable radio transceiver	Intercom	Cell phone	Other
100 %	44 %	34 %	6 %	24 %	3 %
75 % to 99 %	22 %	20 %	3 %	18 %	1 %
50 % to 74 %	9 %	11 %	3 %	12 %	1 %
25 % to 49 %	6 %	8 %	3 %	10 %	1 %
1 % to 24 %	10 %	15 %	10 %	19 %	1 %
0 %	9 %	12 %	74 %	18 %	94 %

ASCI RESULTS

Respondents were asked about their satisfaction with the current design standards in ambulances using the ACSI methodology. The ACSI asks three questions which include overall satisfaction, satisfaction compared to expectations and satisfaction compared to the ideal. Scores indicate that EMS workers are quite unsatisfied with the current design standards with a CSI (Customer Satisfaction Index) of just 49. This value is 18 points below the federal government average of 67 and indicates a strong need to revamp the design standards.

In addition to asking respondents to rate their satisfaction with design standards, they were asked to rate their work environment, ergonomics, restraint systems and communications. The scores in the table are ratings on a 0 to 100 scale and not percentages.

Three questions were asked to gauge how well the work environment allowed EMS workers to do their jobs. Questions were asked on a scale of 1 to 10, where "1" is "strongly disagree" and "10" is "strongly agree." Scores are reported on a 0 to 100 scale. The location and height of seats providing reach was somewhat of an issue with a rating of 61. However, seating allowing EMS workers to do their jobs rates even lower (55) and seat location/height providing sufficient reach to equipment/supplies (46) is even a greater issue.

With respect to ergonomics, respondents somewhat agree with the statement that there is enough room and general mobility around the ambulance patient compartment when taking care of the patient (64). The ergonomic features scored 50 on a "poor" to "excellent" scale with "0" being "poor" and "100" being excellent. Clearly, the feeling is that there is room to improve the ergonomic features.

In conjunction with the feelings about ergonomics, with a score of just 28, the overwhelming feeling was that the restraint system features do not allow EMS workers to do their jobs. EMS workers did feel rather strongly that moving within the ambulance unrestrained is just an inherent risk that comes with caring for patients (77).

While scores for communications systems were not strong, respondents felt somewhat more positive about communication systems allowing them to do their job with a score of 63.

SUMMARY

The survey of over 2,500 EMS workers provides insights into their attitudes and behaviors with regard to ambulance design. Most of the respondents are career EMS providers who work primarily in Box Type I or III ambulances. While just under half perform transport, they generally perform 911, ALS, BLS or a combination of these services.

Bench seating is the most commonly used seat type and side facing is the most preferred orientation. Eighty percent would recommend a CPR seat in the patient compartment. It is somewhat rare for an EMS to transport more than one patient since 86 % report doing so less than 10 % of the time. Although over three-quarters can safely transport two patients and nearly one-quarter can transport three or more.

In the work environment reaching controls is an issue since half of EMS workers reported not being able to reach at least one of the following controls: lighting, ventilation or radio. While gurney or stretcher security is an issue for one-quarter of respondents, nearly two-thirds have no concerns about the gurney or stretcher.

Lap belts were in nearly four-fifths of ambulances, while lap and shoulder restraints were in one-third. Four, five and seven-point restraints are somewhat uncommon since only 16 % have these systems in their ambulances. When not treating a patient, just over one-third of respondents said they always wear their restraint system and the same amount said they almost never wear it. However, when treating a patient only 3 % said they almost always wear it, while three-quarters never or almost never wear it. Seatbelt regulations are in effect at the state and organization level for nearly half the respondents. However, one-quarter did not know if there are any such regulations.

With respect to communications, almost 60 % of ambulances have a computer system. As far as receiving information from the driver, over half of EMS workers prefer verbal. The mobile radio transceiver is most frequently used, however, well over one-third cannot reach it without standing. The portable radio, while used slightly less than the mobile, is much more accessible with nearly three-fourths reaching it without strain.

The ventilation and respiration equipment most often used is stationary or portable oxygen. However, these are difficult to reach with half having to leave their seats to reach portable oxygen. Diagnostic equipment that is most frequently used includes stethoscopes, blood pressure monitors and oximeter. While stethoscopes are within reach for over three-quarters of EMS workers, oximeters and blood pressure monitors are slightly more difficult to reach in a seated position.

Infusion solutions and equipment for infusions and injections are used a majority of the time by over half of EMS workers. However, these are mostly difficult to reach since over half need to leave their seat to reach them. Cardiac monitors and defibrillators are the equipment for managing life-threatening situations that are most commonly used. Reach is somewhat problematic since just over one-third can reach these devices without strain. Other supplies that

are frequently used include blankets, non-sterile gloves and sharps containers. Nearly three-fifths of the time EMS workers need to leave their seats to reach a blanket. Sharps containers are somewhat reachable since four-fifths can reach them, including those who can do so with strain.

The satisfaction index of EMS workers with ambulance design standards is quite low (49) and indicates a need to revise the current standards. Rating questions show that EMS workers feel that the work environment in terms of seating is not very conducive to treating patients, nor does it provide sufficient reach to equipment or supplies. Ergonomics are poor and somewhat limit mobility around a patient when treating them. Most of all, EMS workers strongly believe that restraints do not allow them to do their job and that moving within the ambulance while unrestrained is an inherent risk in treating the patient.

APPENDIX A: SURVEY QUESTIONNAIRE

NIST - Ambulance Design Standards
2011 Customer Satisfaction Questionnaire
Final

Introduction

The U.S. Department of Homeland Security Science and Technology Directorate Human Factors and Behavioral Sciences Division is teaming with the National Institute of Standards and Technology (NIST), the National Institute for Occupational Safety and Health (NIOSH) and BMT Designers and Planners to aid in the development of standards for the design of patient compartments in ambulances. In conjunction with that goal, this survey is also measuring satisfaction with current design standards.

This survey is being administered by CFI Group. All information you provide will be combined with information from other respondents for research and reporting purposes. Your individual responses will not be released. This survey will take about 15 minutes of your time.

If you have any questions about this survey, please contact (CONTACT EMAIL).

This survey is authorized by the U.S. Office of Management under Budget Control No. 1090-0007.

Work-related Information

Please tell us a bit about your work background. The following questions will be used for categorizing your responses only:

1. What is your affiliation with ambulance service?
    1. EMS Provider – Volunteer
    2. EMS Provider – Career
    3. Trainer
    4. Other (Please specify)

2. What is your average transit time with a patient to a hospital?
    1. 5 minutes or less
    2. Between 6 minutes to 10 minutes
    3. Between 11 minutes to 15 minutes
    4. Between 16 minutes to 20 minutes
    5. Between 21minutes and 30 minutes
    6. More than 30 minutes

3. What type of ambulance do you usually work in?
    1. Box (Type I and III)
    2. Van (Type II)
    3. Other (Please specify)

4. What type of service does your ambulance typically perform? (Select all that apply.)
    1. Transport
    2. 911
    3. BLS
    4. ALS

Work Environment

Please tell us about your preferences for ambulance seating.

5. What type of seat do you currently use?
    1. Bench
    2. Bucket
    3. Other (Please specify)

6. What seating orientation do you prefer in the patient compartment?
    1. Side-facing
    2. Rearward-facing
    3. Forward-facing
    4. No preference

7. Do you recommend a CPR seat in the patient compartment?
    1. Yes
    2. No
    3. No preference

Please indicate the extent to which you agree or disagree with the following statements. Use a scale from "1" to "10", where "1" is "strongly disagree" and "10" is "strongly agree."

8. The location and height of the seats provide me with sufficient reach to the patient.

9. The location and height of the seats provide me with sufficient reach to equipment and supplies.

10. Thinking about the type of ambulance you typically work in, please rate the seating in the patient compartment in terms of allowing you to do your job. Use a 10-point scale, where "1" means "poor" and "10" means "excellent."

10a. Please provide any comments you have on ambulance seating.

Occupancy

The following questions ask about your experiences with ambulance occupancy and patient transport.

11. What percent of the time do you transport more than one patient?
    1. Never
    2. Less than 10 %
    3. Between 10 % and 25 %
    4. Between 26 % and 50 %
    5. More than 50 %

12. How many patients do you have the capability to safely transport?
    1. 2
    2. 3
    3. 4
    4. 5
    5. More than 5

13. Thinking about the type of ambulance you typically work in, please rate the how the level of ambulance occupancy and patient transport features allow you to do your job. Use a 10-point scale, where "1" means "poor" and "10" means "excellent."

13a. Please provide any comments you have on ambulance occupancy and/or patient transport.

Ergonomics

Please indicate the extent to which you agree or disagree with the following statement. Use a scale from "1" to "10", where "1" is "strongly disagree" and "10" is "strongly agree."

14. There is enough room and general mobility around the ambulance patient compartment when taking care of the patient.

15. Please indicate if there are any controls, such as lighting, radio and ventilation, that you cannot reach from your seat as you provide patient care? (Select all that apply.)
    1. Lighting
    2. Radio
    3. Ventilation
    4. Other(s) (Please specify)
    5. Not a problem. I can reach all needed controls

16. Please indicate if you have concerns about any of the following as they relate to the gurney/stretcher. (Select all that apply.)
    1. Location of the gurney/stretcher
    2. Orientation of the gurney/stretcher
    3. Security of the gurney/stretcher
    4. I have no concern about the gurney/stretcher

(IF 16=1, 2 or 3 ASK Q17)

17. What are your concerns? Please describe.
18. Thinking about the type of ambulance you typically work in, please rate the ergonomic features of its patient compartment on a 10-point scale, where "1" is "poor" and "10" is "excellent."

18a. Please provide any comments you have on the ergonomic features of ambulances.

Restraint Systems

19. What kinds of safety restraints are currently in your patient compartment? (Select all that apply.)
    1. Lap belt
    2. Lap and shoulder belt
    3. 4-point
    4. 5-point
    5. 7-point
    6. Other (Please specify)

20. Think about the times when you are in the patient compartment and NOT treating the patient. What percentage of the time do you wear the restraint system in the patient compartment when NOT treating the patient?
    1. Less than 15 %
    2. Between 15 % and 40 %
    3. Between 41 % and 65 %
    4. Between 66 % and 90 %
    5. More than 90 %

21. Think about the times when you are in the patient compartment treating the patient. What percentage of the time do you wear the restraint system in the patient compartment when treating the patient?
    1. Less than 15 %
    2. Between 15 % and 40 %
    3. Between 41 % and 65 %
    4. Between 66 % and 90 %
    5. More than 90 %

(IF Q20 or Q21 =1, 2, 3 or 4 ASK Q22)

22. What is the main reason for not wearing restraints? (Please describe.)

Please indicate the extent to which you agree or disagree with the following statement. Use a scale from "1" to "10", where "1" is "strongly disagree" and "10" is "strongly agree."

23. Moving within the ambulance while unrestrained and caring for the patient is an inherent risk of EMS work.

24. Please indicate if you have any of the following regulations for seat belt usage. (Select all that apply.)
    1. District
    2. County
    3. State
    4. Organization
    5. Other (Please specify)
    6. Don't know

25. Thinking about the type of ambulance you typically work in, please rate how well its safety restraint features allow you to do your job. Use a 10-point scale, where "1" means "poor" and "10" means "excellent."

25a. Please provide any comments you have on the restraint systems in ambulances.

Communications

26. Is your ambulance equipped with a computer system?
    1. Yes
    2. No
    3. Don't know

(IF Q26=1 ASK Q27)

27. What is your computer system's primary use?

28. If you could be given information regarding what the driver is going to do next (e.g., stop, turn, change in speed), how would you want to receive it? (Select all that apply.)
    1. Verbally/yelling
    2. Radio
    3. Visual display
    4. Notification lights
    5. Other (Please specify)
    6. Would not want to receive that information

29. What is the most effective form of communication between the driver and patient compartment? (Please describe.)

30. Thinking about the type of ambulance you typically work in, please rate its communication system in terms of allowing you to do your job. Use a 10-point scale, where "1" means "poor" and "10" means "excellent."

30a. Please provide any comments you have on communication systems in ambulances.

Performance

The following tables list some of equipment/supplies provided in the ambulance patient compartment. Please indicate how easy it is to reach the item (equipment or supply), and the frequency of using the item.

31. Ventilation/respiration equipment	**Difficulty of reach from the seated position**: (Reach without strain; Reach with strain; Unable to reach without leaving seat; N/A)	**Frequency of use**: (100 %; <100 % to >75 %; <75 % to >50 %; <50 % to >25 %; <25 % to >0 %; (0 %)
a) Portable oxygen		
b) Stationary oxygen		
c) Resuscitator with oxygen inlet and masks		
d) Mouth-to-mask ventilator with oxygen inlet		
e) Non-manual suction device		
f) Portable suction device		
g) Other (Please specify)		

32. Diagnostics Equipment	**Difficulty of reach from the seated position**: (Reach without strain; Reach with strain; Unable to reach without leaving seat; N/A)	**Frequency of use**: (100 %; <100 % to >75 %; <75 % to >50 %; <50 % to >25 %; <25 % to >0 %; (0 %)
a) Oximeter		
b) Stethoscope		
c) Thermometer		
d) Blood glucose meter		
e) Diagnostic light		
f) Blood pressure monitor		
g) Other		

33. Infusion material or equipment (e.g., intravenous therapy)	**Difficulty of reach from the seated position**: (Reach without strain; Reach with strain; Unable to reach without leaving seat; N/A)	**Frequency of use**: (100 %; <100 % to >75 %; <75 % to >50 %; <50 % to >25 %; <25 % to >0 %; (0 %)
a) Infusion solutions		
b) Equipment for injections and infusions		
c) Infusion system for administration of warm fluid		
d) Infusion mounting		
e) Pressure infusion device		
f) Other		

34. Equipment for managing of life-threatening situations	**Difficulty of reach from the seated position**: (Reach without strain; Reach with strain; Unable to reach without leaving seat; N/A)	**Frequency of use**: (100 %; <100 % to >75 %; <75 % to >50 %; <50 % to >25 %; <25 % to >0 %; (0 %)
a) Defibrillator with rhythm and patient data recording		
b) Cardiac monitor		
c) External cardiac pacing		
d) Portable Resuscitation System		
e) Nebulization apparatus		
f) Thorax drainage kit		
g) Volumetric infusing device		
h) Central vein catheters		
i) PEEP-valve		
j) Capnometer		
k) Other		

35.Supplies/Bandaging/Nursing/PPE	**Difficulty of reach from the seated position**: (Reach without strain; Reach with strain; Unable to reach without leaving seat; N/A)	**Frequency of use:** (100 %; <100 % to >75 %; <75 % to >50 %; <50 % to >25 %; <25 % to >0 %; (0 %)
a) Blankets		
b) Material for treatment of wounds		
c) Material for treatment of burns and corrosives		
d) Kidney bowl		
e) Vomiting bag		
f) Bed-pan		
g) Non-glass urine bottle		
h) Sharps container		
i) Sterile surgical gloves, pairs		

j) Non-sterile gloves for single use		
k) Hazmat suits		
l) Other		

36. Medicine Storage	**Difficulty of reach from the seated position**: (Reach without strain; Reach with strain; Unable to reach without leaving seat; N/A)	**Frequency of use:** (100 %; <100 % to >75 %; <75 % to >50 %; <50 % to >25 %; <25 % to >0 %; (0 %)
Jump bag		
Locked narcotics		
Other		

37. Communications	**Difficulty of reach from the seated position**: (Easy; Reach with strain; Can't reach without leaving seat; N/A)	**Frequency of use:** ((100 %; <100 % to >75 %; <75 % to >50 %; <50 % to >25 %; <25 % to >0 %; (0 %)
Mobile radio transceiver		
Portable radio transceiver		
Intercom		
Cell phone		
Other		

ACSI

Think about how satisfied you are with the current design standards in ambulances in terms of safety and allowing you to do your job.

38. On a scale from 1 to 10 where "1" means *Very Dissatisfied* and "10" means *Very Satisfied*, how satisfied are you with the current standards of design in ambulances.
39. Using a 10-point scale on which "1" now means *Does Not Meet Expectations* and "10" means *Exceeds Expectations*, to what extent do the design standards meet your expectations.
40. Forget for a moment your experiences with ambulances and current design standards. Now imagine the ideal design standards for ambulances. How well do you think the current design standards compare with that ideal? Please use a scale from "1" to "10", where "1" means "very far from ideal" and "10" means "very close to ideal."