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Optimal Physical Space for En Route Care: Medic Posture and Injury Survey Results

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Introduction

This project involved designing a survey to investigate awkward postures associated with delivering patient care in the confined space of common medical evacuation (MEDEVAC) platforms. The survey also related care provider health and efficiency with these postures and resulting injuries. The goal of this work was to provide recommendations for countermeasures to reduce the impact of awkward postures. The survey was presented via email and social media to Active Duty U.S. Army, Reserve, and National Guard en route care medical providers. Valid data were collected from 60 respondents. Statistical analyses were used to define trends in the data. Results will contribute to the long-term health of care providers and to en route care task administration efficiency.

Study Background

Civilian Emergency Management System (EMS) personnel experience muscle fatigue and injury because of their work environment. The back is the body part most often injured during civilian EMS patient movement tasks (Maguire et al., 2005). Many back injuries reported by EMS personnel were related to the stretcher. Toivonen and Fagerstrom (2011) defined the impacts of lifting the stretcher off the ground, carrying the patient, installing auxiliary equipment, and loading everything into the ambulance. Furthermore, bending towards the patient, especially when standing or sitting on the edge of a seat, was one of the leading activities inside a moving ambulance that was shown to cause repetitive muscle strain and lead to developing musculoskeletal disorders (MSDs) (Deros et al., 2016). Analysis of injury and illness data from 2008 through 2013 found that the greatest portion of injuries involved overexertion of the upper and lower trunk (The National Institute for Occupational Safety and Health [NIOSH], 2013). More than half (62 percent [%]) of all prehospital provider back injuries resulted from lifting patients. Their injuries were a consequence of three major factors: significant lifting forces (patient weight), repetitive movements, and awkward positions (Hogya et al., 1990). Johnos (2011) found that force, repetition, and awkward postures experienced while performing EMS job tasks led to a variety of MSDs, including epicondylitis, sciatica, low back pain, carpal tunnel syndrome, and rotator cuff injuries.

An MSD is defined as a condition or disorder that involves the muscles, nerves, tendons, ligaments, joints, cartilage, or spinal discs (Torma-Krajewski et al., 2009a). MSDs develop gradually and increase in frequency when a person handling materials manually engages in repetitive lifting or performs tasks improperly. In ergonomic studies at four sites where people work in confined environments, MSDs were identified as a significant and costly problem (Torma-Krajewski et al., 2009b; Steiner, 2004). Stobbe and Bobick (1986) reported that strain and sprain injuries accounted for almost 25% of all reported injuries for workers in confined environments. The study also indicated that the three most common overload conditions were: (1) bending forward, bending to the side, or twisting the neck or back; (2) unsupported abducted elbows, forearms resting on sharp edges, tossing motions at extremes of range of motion, working with elbows above shoulders; and (3) lifting more than 50 pounds (lbs.) unaided. The

same study showed that at least 35% of workers in confined environments were potentially exposed to each of these three overload conditions.

MSDs can result from suddenly or improperly lifting or handling heavy loads, which can cause excessive stress and strain in certain parts of the musculoskeletal systems. Such disorders can also occur because of musculoskeletal fatigue resulting from prolonged or repeated loading. One example is the process of cable-lifting in underground coal mining. Miners may be required to hold this heavy load for some time while they are stooping or kneeling in confined zones (Gallagher & Unger, 1990). Such a situation will induce musculoskeletal fatigue, a state where workers cannot keep using the same set of muscles and thus unintentionally adopt new postures with different sets of muscles (Alvarez & Semmlow, 2002). The new posture may induce improper loading to the musculoskeletal system and lead to extreme loading on the lower back or joints, which may cause musculoskeletal injuries (Gallagher, Marras, Davis, & Kovacs 2002).

When designing ambulance interiors, safety constraints are sometimes overlooked. Inadequate design of the ambulance interior would expose all occupants of emergency vehicles, providers and patients, to risk of injury (Brice et al., 2012). While EMS personnel are focused on providing patient care and the driver is proceeding in an emergency fashion with lights and sirens, the medical service providers in the rear of the vehicle are often unrestrained. A sudden stop, change in direction or swerve, or crash may result in serious injury to the medical service provider, and quite possibly the patient (Patterson et al., 2010).

There is a current focus on utilizing proper ergonomics to prevent injury in this career field. Labeling and standardizing the medical equipment arrangement inside the ambulance plays an important role during emergency medical service. This activity reduces confusion and places the equipment in the best ergonomic position possible, which may reduce injury (Biesbroek & Teteris, 2012). While significant data exists identifying back injuries as a major problem in the EMS field, the data reported are not separated to show whether the injuries were caused by poor lifting technique, repetitive movement, or posture; however, the data concludes that back injury is a major problem for these medical providers.

Military Relevance

In the military environment, en route care providers are also often exposed to combinations of high forces, awkward postures, continuous or prolonged gripping, and repetitive motions that may lead to symptoms related to long-term MSDs. The nature of the confined spaces of MEDEVAC interiors where care providers normally conduct their tasks during air and ground transport add considerable constraints on their movement and range of motion, and can force them to take extremely awkward postures while subjected to heavy loads. These tasks often impose a localized load on relatively small muscles in different locations on the body and may rapidly lead to muscle fatigue, which will make their tasks even more challenging. It has been shown that posture plays a role in medical provider injuries (Lester, Hsu, & Ahmed, 2012).

En route care providers are often subjected to the similar awkward postures and lifting requirements as industrial workers. Focused research that takes place in the en route care environment is needed to define these stresses and to recommend countermeasures.

Previous Studies

The U.S. Army Aeromedical Research Laboratory (USAARL) conducted a study examining fixed position litter loading (Kinsler & Barazanji, 2011) in a MEDEVAC helicopter. It was observed that the receiving medic inside the aircraft was often challenged to perform lifting of litter-patient packages at awkward angles. USAARL conducted another study to evaluate the adequacy of space available for a Critical Care Flight Paramedic (CCFP) to perform advanced medical treatment scenarios on simulated critical care patients (manikins) in existing MEDEVAC aircraft, e.g., HH-60 and UH-60 (Kinsler et al., 2015). The motion of three flight medics, a second percentile female, seventy-fifth percentile male, and ninety-ninth percentile male (based on height), was recorded while each medic wore a motion capture suit. Neck and back bend angles were calculated and averaged for all scenarios and medical tasks for each medic.

Literature indicates that a 30-degree flexion in upper limbs for an extended time of 5 hours will result in severe pain (Golob & Sykes, 2002; Buckle & Devereaux, 2002; Chaffin, 1973). USAARL's study showed that the medics' neck angles increased with shorter stature, up to 66 degrees for a stature of 4 feet (ft) 11 inches (in.) versus 37 degrees for a 6 ft 5 in. stature. This trend was the same regardless of the platform type. The second percentile medic's neck angle had more than a 30-degree flexion 94% of the time while completing medical tasks and scenarios. Surprisingly, the ninety-ninth percentile medic's neck angle was 28 degrees lower with a back angle slightly higher than the second percentile medic, suggesting complex postures were assumed while accomplishing tasks. The medics' back angles were less sensitive to their stature. It was observed during this study that shorter medics tended to stand and lean over, while the taller medics knelt and then leaned over to perform tasks. This led to the surprising observation that taller medics had smaller neck angles. These findings support the need to further investigate the ergonomic role of postures assumed by medics in causing MSDs.

Specific Aims

This project investigated the postures and injuries associated with working in the confined space of common MEDEVAC platforms.

- (1) Specific aim 1: The team's survey collection goal was 41 complete survey responses. This aim was exceeded because the team received 60 valid responses, 46 of which were fully completed by en route care medical providers.
- (2) Specific aim 2: The team aimed to identify relationships and trends between body mass index (BMI), gender, equipment, injuries, medical environment constraints, medical tasks, and awkward postures by analyzing the survey responses. These relationships were examined using analysis of variance (ANOVA) and Fisher's exact analyses.

A range of care providers were asked about the effects of the environment on their health and efficiency. Anonymous survey responses were received from en route care providers regarding postures assumed during administration of en route critical care tasks, routine medical transport scenarios, and patient loading. The survey inquired about the care provider's experience, tasks, performance, awkward postures experienced, and occupational injuries that occurred as a result of performing their duties, such as back, neck, and joint pain, injuries, and discomfort. The survey questions intended to gather care provider opinions on the awkward postures and lifting demands associated with confined space medical interiors, and any potential association with increased risk for occupational injuries among care providers. Topics addressed in the survey are listed in Table 1.

Table 1. Survey Question Topics

Section Number	Data Element/Variable
Section 1	Gender
	Height
	Weight
	Position title
	Platform or position location
	Length of time in position
Section 2	Aircraft/vehicle/gear design characteristics that impacted mission performance
Section 3	Items in the current aeromedical or ground evacuation Medical Equipment Set (MES) which caused awkward or painful postures
Section 4	If number of patients affects postures
	Number of patients typically cared for
Section 5	Frequency of awkward postures during tasks
Section 6	Occupational injuries or discomfort associated with any postures during patient loading and patient care
Section 7	Reasons for not reporting injuries
	Specific postures or tasks that cause primary source of pain
	Other injuries that were not previously mentioned

Methods

First, the number of respondents needed for statistical significance was calculated using the following parameters:

Threshold probability for rejecting the null hypothesis (Type I error rate),
 α (two-tailed) = 0.050.

Probability of failing to reject the null hypothesis under the alternative hypothesis (Type II error rate), β = 0.800.

The expected correlation coefficient based on past relevant findings, $r = 0.180$.

The standard normal deviate for α , $Z_\alpha = 1.960$.

The standard normal deviate for β , $Z_\beta = -0.842$.

$$C = 0.5 * \ln \left[\frac{1+r}{1-r} \right] = 0.182$$

$$\text{Total sample size} = N = \left[\frac{Z_\alpha + Z_\beta}{C} \right]^2 + 3 = 41$$

Thus, a minimum of 41 respondents were needed for statistical relevance.

The survey was created and distributed online using ClassApps LLC SelectSurvey.NET v4 .154.010. Once the data were gathered, they were organized into a Microsoft Office Professional Plus Excel 2013 (henceforth referenced as Excel) database, where general frequency charts, graphs, and filter tables were created.

Data Analysis

Analysis of variance (ANOVA) was performed by using an Excel filter table to compare the numbers of a single continuous variable between two groups. The two-number lists were examined using the ANOVA single factor feature of Excel's Analysis ToolPak Add-In. Power analyses were performed on the ANOVA results in R 3.6.1 using the `pwr.t2n.test` function from the PWR package.

Fisher's exact analyses were performed in RStudio 0.99.903 using the `fisher.test` function on two-by-two tables created in Excel with the alternative hypothesis set to "two.sided."

Open-ended data were read and categorized according to the content of each comment. The categories were created as the comments were sorted, and the comments were broken down into their components since most comments cited multiple issues. Each part of a comment was either listed under a pre-existing category or a new category was created. The data were then tallied and reported as bar graphs.

Results

The study group expected to collect a minimum of 41 anonymous surveys and exceeded the goal by 47 surveys, with 88 surveys collected in total. Out of those 88 surveys, 24 were invalid because the first question, which would have verified status as an Army en route care provider, was skipped. Out of the 64 remaining surveys, 3 respondents were not en route care medical providers and were notified that they were ineligible to complete the survey. One

response was from a medic that did not answer any questions beyond Question (Q) 1. Once these four surveys were removed, the number of valid surveys received was reduced to 60 total (46 complete responses completed by en route care medical providers and 14 incomplete responses, which contained partial responses from en route care providers).

The 46 valid surveys completed by en route care providers were used for analysis. If the 14 incomplete surveys from en route care providers contained responses for certain sections, a second analysis was performed for that section in isolation to include the responses. Missing data were also analyzed to determine if there were any identifiable trends in the skipped questions.

Throughout this report, tables and graphs containing data from these valid surveys are color coded:

- Grey = Complete Valid Surveys (46 complete responses out of 60 total)
- Green = All Valid Surveys (60 total – includes complete and incomplete responses)

Surveys were considered complete and valid if the respondent reached the end of the survey and had filled out the majority of the information (not necessarily that all answers were filled), and a survey was incomplete yet valid if the respondent had filled out at least the first section and skipped one or more sections. The website used to distribute the surveys identified which respondents had completed their surveys and which ones had not. It is worth noting that some answers were blank in the complete and valid surveys, but because the surveys were completed, these missing data points were interpreted as deliberate negative answers. Blank answers in incomplete surveys were interpreted as skipped questions. Response percentages in graphs were calculated based on how many respondents answered individual questions and not the total number of surveys.

All survey questions (Q1 through Q44) are numbered in the order that they were listed in the survey and summaries of the responses are provided. The first seven questions asked respondents for their basic information and demographics. Results are summarized in Tables 2 through 17.

Section 1: Basic Information and Demographics

Q1. Are you or have you ever been a U.S. Army en route care medical provider (medic, nurse, doctor, etc.)?

Table 2. Responses to Q1 – All Surveys

Response	Number of Responses	Response Percentage
Yes	61	95.3%
No	3	4.7%
Skipped	24	Not Applicable (N/A)

Q2. Are you male or female?

Table 3. Responses to Q2 – Complete Valid Surveys

Complete Valid Survey Responses to Q2		
Response	Number of Responses	Response Percentage
Male	43	93.5%
Female	3	6.5%
Skipped	0	0%

Table 4. Response to Q2 – All Valid Surveys (Complete and Incomplete)

All Valid Survey Responses to Q2		
Response	Number of Responses	Response Percentage
Male	56	93.3%
Female	4	6.7%
Skipped	0	0%

The ratio of male to female differs very little between the group of complete valid surveys and the group of all valid surveys, which includes complete valid responses combined with the incomplete valid responses. However, the ratio is very different from the overall population of U.S. Army medical specialists (68Ws), including Active Duty U.S. Army, National Guard, and Reserve U.S. Army Soldiers, as shown in Table 5. Since the majority of respondents were CCFPs (shown in Table 12), the male-to-female ratio for Active Duty U.S. Army CCFPs is also displayed in Table 5.

Table 5. Male-to-female Ratio among the Total 68W Population versus Survey Respondents

	Total 68W Population		CCFP Population		Survey Respondents			
	Number of Personnel	Percentage of Population	Number of Personnel	Percentage of Population	Complete Valid Surveys		All Valid Surveys	
					Number of Responses	Response Percentage	Number of Responses	Response Percentage
Male	26,136	76.07%	374	89.3%	43	93.5%	56	93.3%
Female	8220	23.93%	45	10.7%	3	6.5%	4	6.7%

The percentage of females represented in the survey respondents is approximately one-fourth of the total percentage of females among the population, and over half the percentage of females in the Active Duty U.S. Army CCFP population.

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Q3. What is your height in inches?

Table 6. Responses to Q3 – Complete Valid Surveys

Complete Valid Survey Responses to Q3					
Average Height	Standard Deviation of Height	Maximum Height	Minimum Height	Response Total	Skipped
70.63 in.	3.06 in.	78.0 in.	63.0 in.	46	0

Table 7. Responses to Q3 – All Valid Surveys

All Valid Survey Responses to Q3					
Average Height	Standard Deviation of Height	Maximum Height	Minimum Height	Response Total	Skipped
70.68 in.	2.97 in.	78.0 in.	63.0 in.	60	0

According to the 2014 Anthropometric Survey of U.S. Army Personnel: Methods and Summary Statistics, the average height for U.S. Army males is 69.09 in. and females is 64.02 in. (Gordon et al., 2014). The averages for both analyses, with and without the incomplete surveys, are close to the national average for males in the U.S. Army, which is reasonable considering the low percentage of females among respondents.

Q4. What is your weight in pounds?

Table 8. Responses to Q4 – Complete Valid Surveys

Complete Valid Survey Responses to Q4					
Average Weight	Standard Deviation of Weight	Maximum Weight	Minimum Weight	Response Total	Skipped
190.0 lbs.	25.44 lbs.	240.0 lbs.	136.0 lbs.	46	0

Table 9. Responses to Q4 – All Valid Surveys

All Valid Survey Responses to Q4					
Average Weight	Standard Deviation of Weight	Maximum Weight	Minimum Weight	Response Total	Skipped
189.7 lbs.	25.02 lbs.	240.0 lbs.	136.0 lbs.	60	0

According to the 2014 Anthropometric Survey of U.S. Army Personnel: Methods and Summary Statistics, the average weight for U.S. Army males is 186.51 lbs. and for females is

147.27 lbs. (Gordon et al., 2014). As was the case with height, the survey respondents' average was slightly above the national average for males, which is reasonable considering the low percentage of females among the respondents.

From the responses of weight and height, the BMI of each respondent was calculated (Tables 10 and 11) using:

$$BMI = 703 * \frac{[weight (lbs)]}{[height (in)]^2}$$

Table 10. BMI Statistics of Respondents – Complete Valid Surveys

BMI Statistics for Complete Valid Survey Responses to Q4			
Average BMI	Standard Deviation of BMI	Maximum BMI	Minimum BMI
26.74	2.83	33.47	19.64

Table 11. BMI Statistics of Respondents – All Valid Surveys

BMI Statistics for All Valid Survey Responses to Q4			
Average BMI	Standard Deviation BMI	Maximum BMI	Minimum BMI
26.66	2.84	33.47	19.64

Q5. What was your job/position as a medical care provider?

Table 12. Responses to Q5 – Complete Valid Surveys

Complete Valid Survey Responses to Q5		
Position Title	Number of Responses	Response Percentage
CCFP	43	93.5%
Ground Medic (GM)	5	10.9%
Standardization Instructor	2	4.3%
Flight Instructor	2	4.3%
Flight Surgeon	2	4.3%
Flight Medic	1	2.2%
None (Skipped Q5)	0	0%

Note. The sum of percentages is over 100% because many medics served in more than one position.

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Table 13. Responses to Q5 – All Valid Surveys

All Valid Survey Responses to Q5		
Type of Respondent	Number of Responses	Response Percentage
CCFP	52	86.7%
GM	6	10.0%
Flight Medic	5	8.3%
Standardization Instructor	2	3.3%
Flight Instructor	2	3.3%
Flight Surgeon	2	3.3%
Crew Chief for MEDEVAC	1	1.7%
None (Skipped)	0	0%

Note 1. The sum of percentages is over 100% because many medics served in more than one position.

Note 2. With the exception of one respondent with experience solely as a Crew Chief for MEDEVAC, all respondents had experience as a 68W at some point in their service.

Q6. What was the general platform/location where you performed the majority of your duties as a medical care provider?

Table 14. Responses to Q6 – Complete Valid Surveys

Complete Valid Survey Responses to Q6		
Platform Type	Number of Responses	Response Percentage
HH-60	31	67.4%
UH-60	26	56.5%
Field Light Ambulance (FLA)/ Ground Vehicle	4	8.7%
Field Hospital/Hospital/Clinic	3	6.5%
Skipped	0	0%

Note. The sum of percentages is over 100% because many medics served in more than one position.

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Table 15. Responses to Q6 – All Valid Surveys

All Valid Survey Responses to Q6		
Platform Type	Number of Responses	Response Percentage
HH-60	39	65.0%
UH-60	34	56.7%
FLA/Ground Vehicle	7	11.7%
Field Hospital/Hospital/Clinic	3	5.0%
Skipped	0	0%

Note. The sum of percentages is over 100% because many medics served in more than one position.

Though the respondents' platform and position were collected as variables, it was determined that these should not be used as comparison filters for analysis because of the excessive overlap in data. There was only one GM who had not held another position, and almost all respondents had been CCFPs at some point in their military career. The platform issue is related to position: the medics had served on multiple different aircraft as well as ground vehicles in some cases, so there was quite a bit of overlap of data. Consequently, any analysis comparing platforms or positions would be unreliable.

Q7. What is the length of time you have been in this position as a medical care provider?

Table 16. Responses to Q7 – Complete Valid Surveys

Complete Valid Survey Responses to Q7				
Average Number of Years	Maximum Number of Years	Minimum Number of Years	Response Total	Skipped
7.15	21.0	.083	46	0

Table 17. Responses to Q7 – All Valid Surveys

All Valid Survey Responses to Q7				
Average Number of Years	Maximum Number of Years	Minimum Number of Years	Response Total	Skipped
7.34	21.25	.083	60	0

Note. All respondents, including those that submitted incomplete surveys, answered the "Respondent Information" section fully.

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Section 2: Platform Design Features that Negatively Affected Performance

Q8. Please select aircraft/vehicle/gear design characteristics from this list that negatively affected your mission performance or caused you to perform your mission as a care provider in awkward or painful postures.

For Q8, the respondents were given a list of 16 specific and 2 “Other” (non-specific, respondent-defined) design characteristics to rate as “Significant” or “Insignificant” with respect to negatively affecting missions. The results of their ratings are summarized in Tables 18 and 19, which are both represented visually in Figures 1 and 2.

Table 18. Responses to Q8 – Complete Valid Surveys

Complete Valid Survey Responses to Q8						
Design Feature	Significant		Insignificant		Response Total	Skipped
Compartment Configurability	37	80.4%	9	19.6%	46	0
Litter System	31	67.4%	15	32.6%	46	0
Compartment Size	31	67.4%	15	32.6%	46	0
Cabin Ergonomics	30	65.2%	16	34.8%	46	0
Patient Loading Capability	29	63.0%	17	37.0%	46	0
Personal Protective Gear (PPG)	28	60.9%	18	39.1%	46	0
Crew Seats	22	47.8%	24	52.2%	46	0
Seat Belts	20	43.5%	26	56.5%	46	0
Windows	20	43.5%	26	56.5%	46	0
Communication System	15	32.6%	31	67.4%	46	0
Environmental Control System	13	28.3%	33	71.7%	46	0
Lighting System	13	28.3%	33	71.7%	46	0
Suction System	12	26.1%	34	73.9%	46	0
Lack of Litter System	12	26.1%	34	73.9%	46	0
Hoist	10	21.7%	36	78.3%	46	0
Oxygen (O ₂) System	8	17.4%	38	82.6%	46	0
Other	6	13.0%	40	87.0%	46	0
Other	2	4.3%	44	95.7%	46	0

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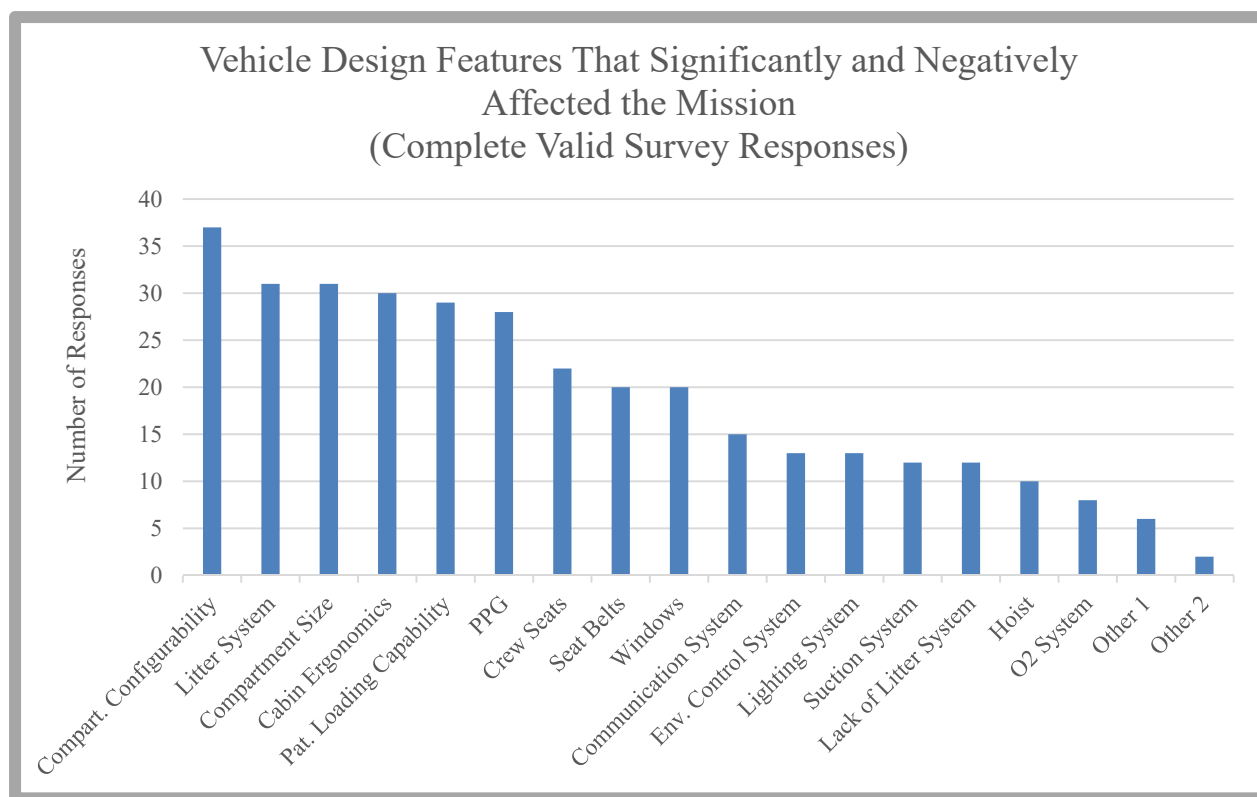


Figure 1. Summary of Table 18.

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Table 19. Responses to Q8 – All Valid Surveys

All Valid Survey Responses to Q8						
Design Feature	Significant		Insignificant		Response Total	Skipped
Compartment Configurability	48	82.8%	10	17.2%	58	2
Litter System	42	72.4%	16	27.6%	58	2
Cabin Ergonomics	41	70.7%	17	29.3%	58	2
Compartment Size	41	70.7%	17	29.3%	58	2
Patient Loading Capability	40	69.0%	18	31.0%	58	2
PPG	36	62.1%	22	37.9%	58	2
Crew Seats	28	48.3%	30	51.7%	58	2
Seat Belts	27	46.6%	31	53.4%	58	2
Windows	26	44.8%	32	55.2%	58	2
Communication System	20	34.5%	38	65.5%	58	2
Lighting System	19	32.8%	39	67.2%	58	2
Hoist	18	31.0%	40	69.0%	58	2
Environmental Control System	17	29.3%	41	70.7%	58	2
Lack of Litter System	17	29.3%	41	70.7%	58	2
Suction System	15	25.9%	43	74.1%	58	2
O ₂ System	12	20.7%	46	79.3%	58	2
Other	9	15.5%	49	84.5%	58	2
Other	2	3.4%	56	96.6%	58	2

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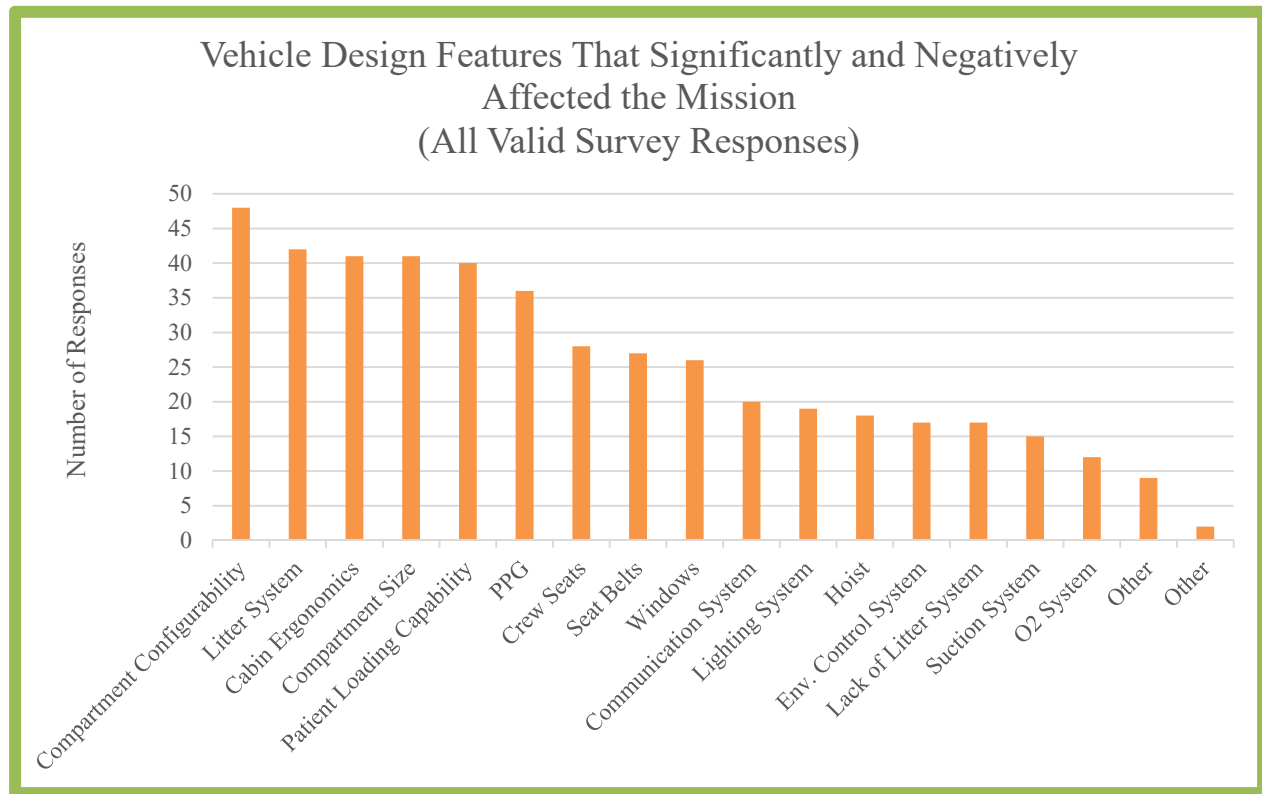


Figure 2. Summary of Table 19.

Every respondent who answered this section answered every question, and so a second analysis that included incomplete valid surveys was performed. Since this question necessitated a dichotomous response (significant or insignificant) it was obvious which respondents with incomplete surveys had answered this section and which ones had not. Out of the 60 valid surveys, 58 respondents answered Q8 and 2 left it blank.

The distribution between complete valid surveys and all valid surveys is nearly identical, except for slight changes in the ranking of “Cabin Ergonomics” and “Compartment Size” on the high end of the graph along with the “Lighting System,” “Hoist,” “Environmental Control System,” and “Suction System” on the lower end. In both graphs, “Compartment Configurability” ranks as the greatest impediment to mission performance, while “Litter System,” “Cabin Ergonomics,” “Compartment Size,” and “Patient Loading Capability” all rank closely behind.

For every platform design feature marked “significant,” the respondent was asked to provide an open-ended response for how the feature negatively impacted the mission. These responses are represented in Figures 3 through 19 for all valid surveys. The number of respondents who found each feature significant is noted in the title of Figures 3 through 19.

Q9. How has patient loading capability negatively impacted you or the mission?

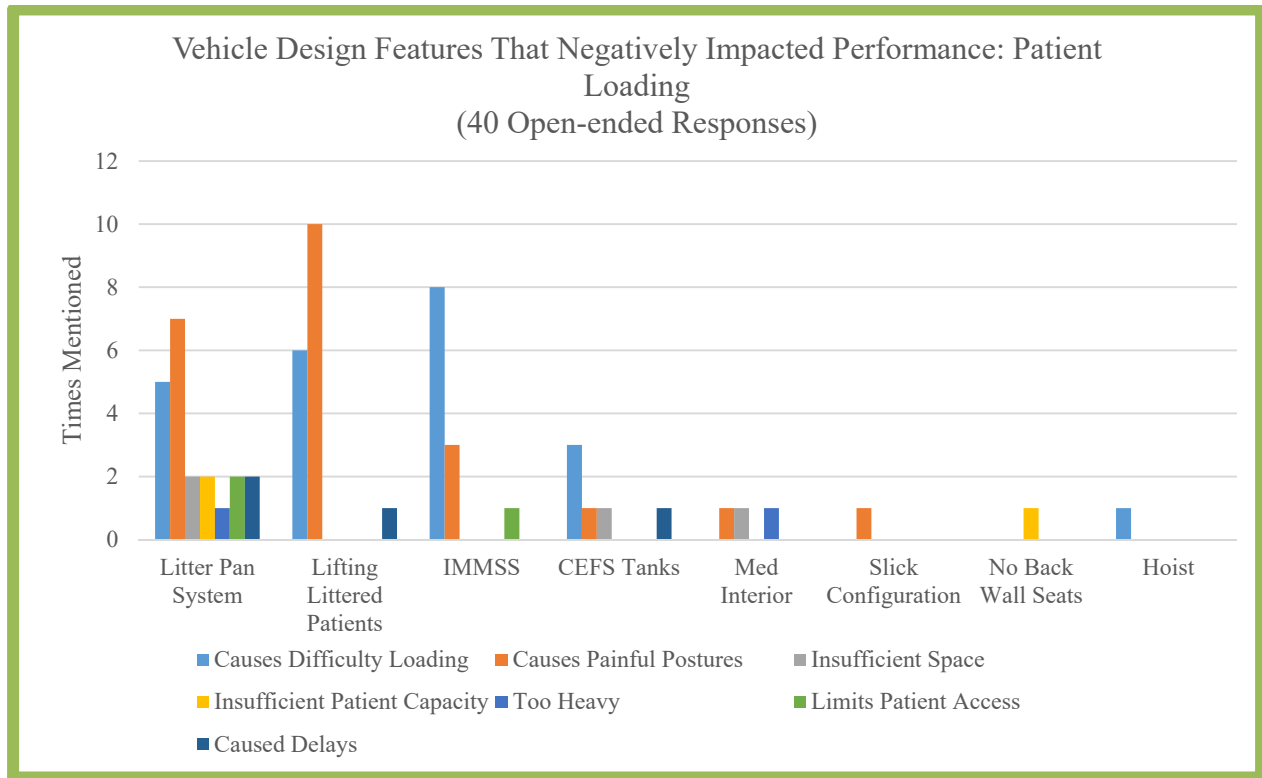


Figure 3. Categorized open-ended responses to Q9.

The most commonly cited issue related to patient loading was the “Litter Pan System,” which was mentioned 21 times by the respondents. Here is a breakdown of the responses to Q9 ranked in order of number of times mentioned from most to least:

- o Litter Pan System – 21 mentions
- o Lifting Littered Patients – 17 mentions
- o Interim Medical Mission Support System (IMMSS) – 12 mentions
- o Crashworthy External Fuel System (CEFS) Tanks – 6 mentions
- o Med Interior – 3 mentions
- o Slick Configuration – 1 mention
- o No Back Wall Seats – 1 mention
- o Hoist – 1 mention

The categories “Causes Difficulty Loading” and “Causes Painful Postures” were the most frequent issues among all Patient Loading features that negatively affected the mission. Respondents indicated the “Litter Pan System” and “Lifting Littered Patients” negatively impacted performance mainly because they caused the respondents to assume painful postures.

The “IMMSS,” “Lifting Littered Patients,” and “Litter Pan System” were all features that significantly contributed to the “Caused Difficulty Loading” category. “Lifting Littered Patients” was the most cited activity that caused painful postures, with the “Litter Pan System” coming in second and the “IMMSS” coming in third.

Q10. How have cabin ergonomics (i.e., crew comfort) negatively affected your mission performance or caused you to perform your mission as a care provider in awkward or painful postures?

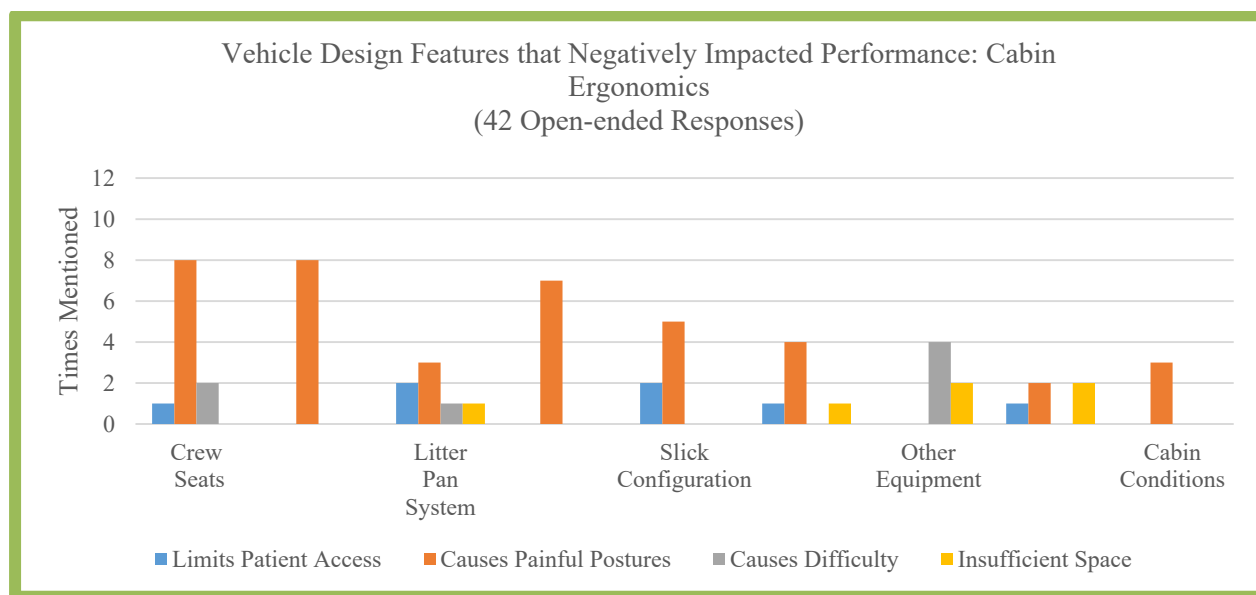


Figure 4. Categorized open-ended responses to Q10.

Overall, the most commonly cited negative feature related to Cabin Ergonomics was the “Crew Seats,” mentioned by 11 respondents. Here is a breakdown of the responses to Q10 ranked in order of number of times mentioned from most to least:

- o Crew Seats – 11 mentions
- o Cabin Height – 8 mentions
- o Litter Pan System – 7 mentions
- o Personal Protective Gear (PPG) – 7 mentions
- o Slick Configuration – 7 mentions
- o Cabin Area – 6 mentions
- o Other Equipment – 6 mentions
- o IMMSS – 5 mentions
- o Cabin Conditions – 3 mentions

The most common issue related to Cabin Ergonomics was “Causes Painful Postures” with “Crew Seats” and “Cabin Height” being the most cited features to cause the painful

postures, both mentioned eight times each. The second most-cited feature to cause painful postures was “PPG,” which was mentioned seven times. The “Slick Configuration,” “Cabin Area,” “Cabin Conditions,” and “Litter Pan System” also were cited, but were lesser issues contributing to painful postures.

Q11. How has cabin/patient compartment configurability negatively affected your mission performance or caused you to perform your mission as a care provider in an awkward or painful posture?

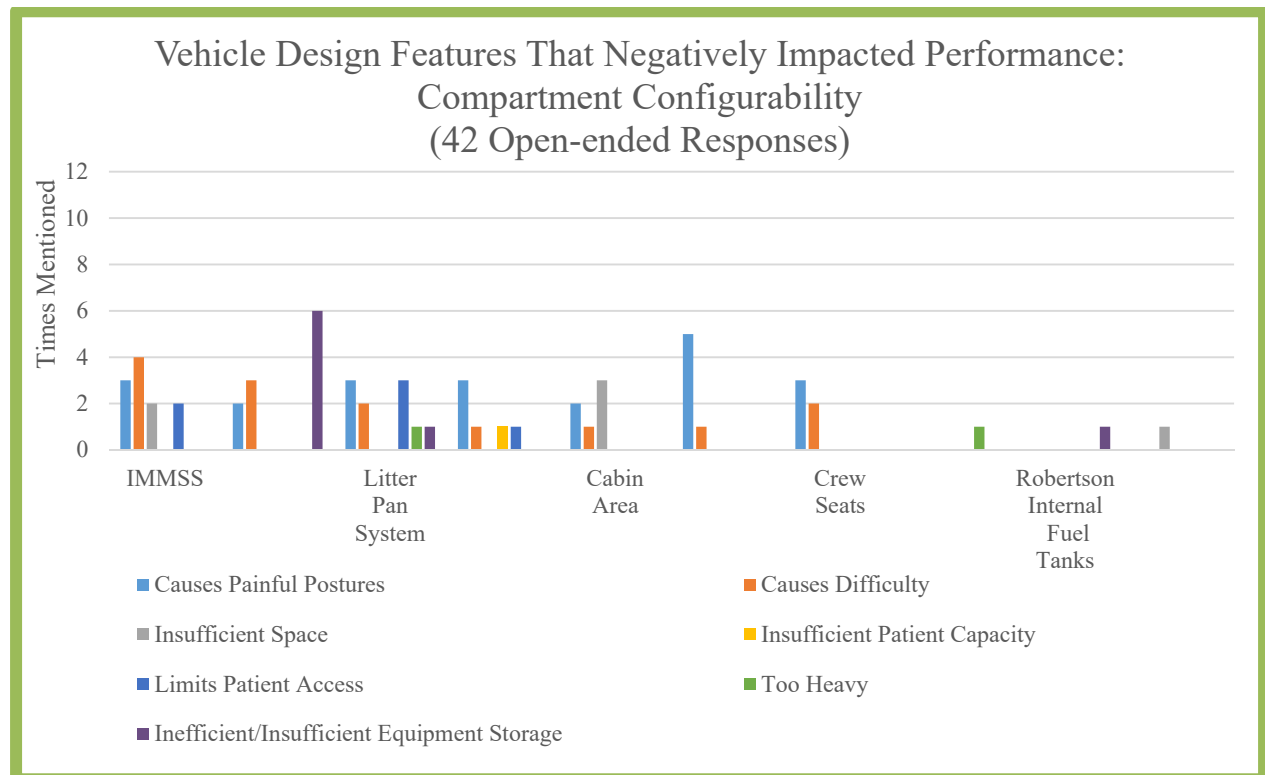


Figure 5. Categorized open-ended responses to Q11.

The features related to Compartment Configurability that were most frequently cited as negatively affecting the mission were the “IMMSS” and “Equipment,” both mentioned 11 times each. Here is a breakdown of the responses to Q11 ranked in order of number of times mentioned from most to least:

- o IMMSS – 11 mentions
- o Equipment – 11 mentions
- o Litter Pan System – 10 mentions
- o Slick Configuration – 6 mentions
- o Cabin Area – 6 mentions
- o Cabin Height – 6 mentions

- o Crew Seats – 5 mentions
- o CEFS Tanks – 1 mention
- o Robertson Internal Fuel Tanks – 1 mention
- o Med Interior – 1 mention

The most common issue related to Compartment Configurability was “Causes Painful Postures,” followed by “Causes Difficulty.” The feature that was mentioned most frequently for causing painful postures was “Cabin Height,” which was mentioned by five respondents. The “IMMSS,” “Litter Pan System,” “Slick Configuration,” “Crew Seats,” “Equipment,” and “Cabin Area” were also mentioned as contributors to painful postures. The feature mentioned most frequently to cause difficulty was the “IMMSS,” which was mentioned by four respondents. However, “Equipment,” “Litter Pan System,” “Crew Seats,” “Slick Configuration,” and “Cabin Area” were also mentioned to cause difficulty.

Q12. How has the hoist negatively affected your mission performance or caused you to perform your mission as a care provider in an awkward or painful posture?

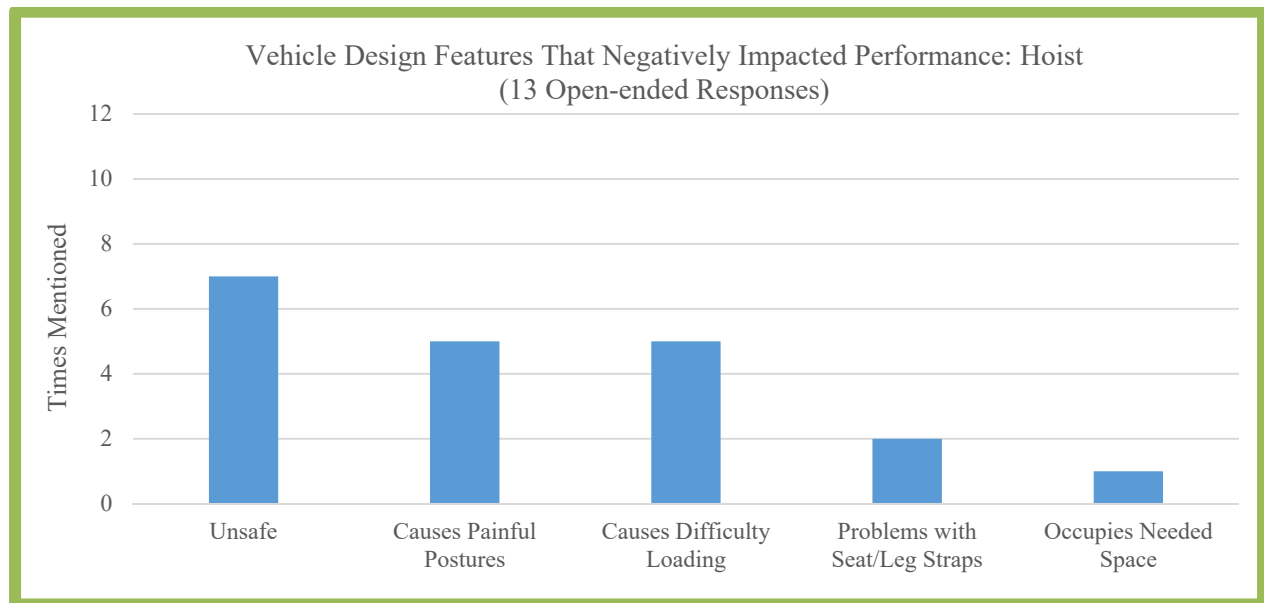


Figure 6. Categorized open-ended responses to Q12.

The most commonly cited issue with the Hoist was that it was “Unsafe” for both the care provider and the patient being lifted (mentioned seven times). Here is a breakdown of the responses to Q12 ranked in order of number of times mentioned from most to least:

- o Unsafe – 7 mentions
- o Causes Painful Postures – 5 mentions
- o Causes Difficulty – 5 mentions

- o Problems with Seat/Leg Straps – 2 mentions
- o Occupies Needed Space – 1 mention

Q13. How has the oxygen system negatively affected your mission performance or caused you to perform your mission as a care provider in an awkward or painful posture?

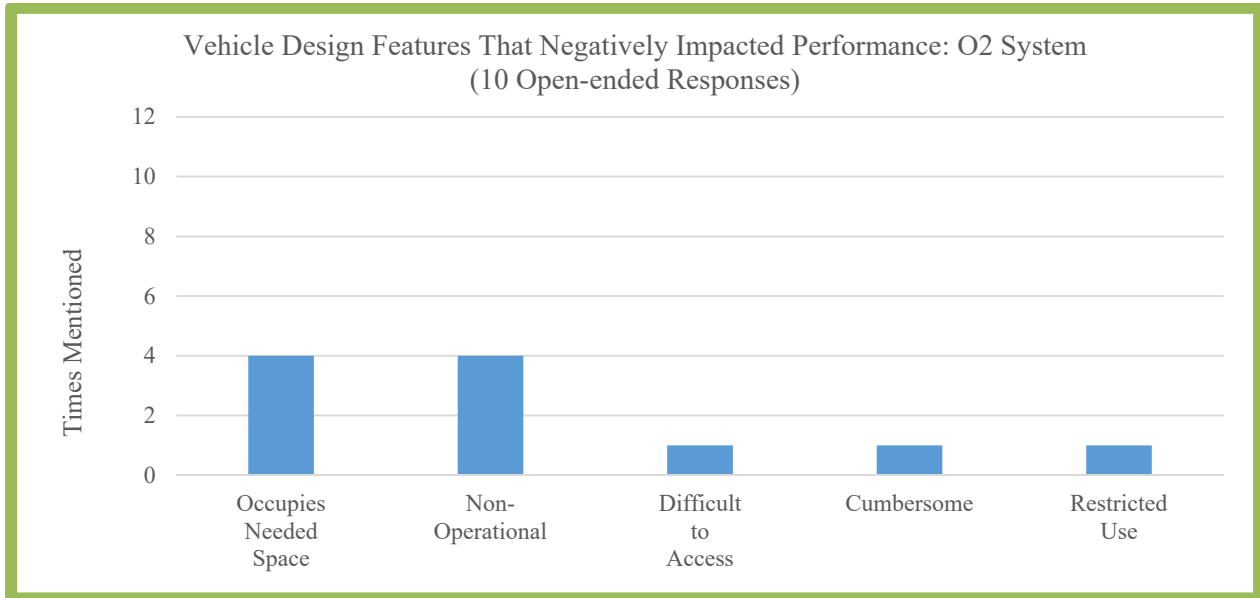


Figure 7. Categorized open-ended responses to Q13.

The O₂ System was the vehicle design feature that had the fewest reported issues (excluding “Other”) among the respondents. The most common issues with the O₂ System were “Occupies Needed Space” and “Non-Operational,” both mentioned four times each. Here is a breakdown of the responses to Q13 ranked in order of number of times mentioned from most to least:

- o Occupies Needed Space – 4 mentions
- o Non-Operational – 4 mentions
- o Difficult to Access – 1 mention
- o Cumbersome – 1 mention
- o Restricted Use – 1 mention

It was specifically stated that the “Restricted Use” system was the On-Board Oxygen Generation System (OBOGS).

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Q14. How has the environmental control system negatively affected your mission performance or caused you to perform your mission as a care provider in an awkward or painful posture?

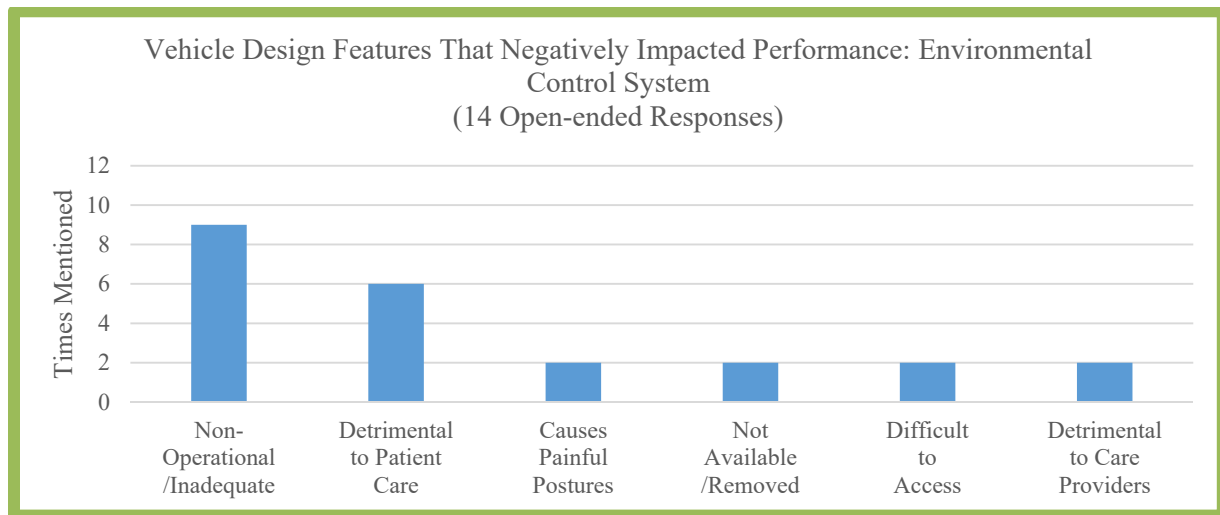


Figure 8. Categorized open-ended responses to Q14.

The most commonly cited issue with the Environmental Control System was that the system was “Non-Operational/Inadequate,” which was mentioned nine times. Here is a breakdown of the responses to Q14 ranked in order of number of times mentioned from most to least:

- o Non-Operational/Inadequate – 9 mentions
- o Detrimental to Patient Care – 6 mentions
- o Causes Painful Postures – 2 mentions
- o Not Available/Removed – 2 mentions
- o Difficult to Access – 2 mentions

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Q15. How has the suction system negatively affected your mission performance or caused you to perform your mission as a care provider in an awkward or painful posture?

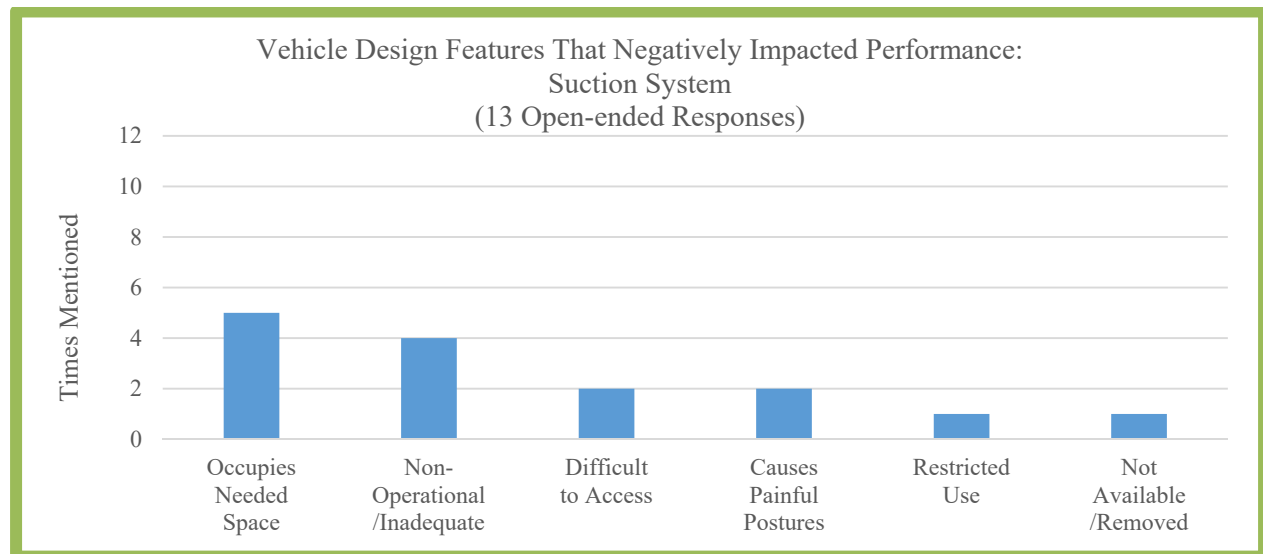


Figure 9. Categorized open-ended responses to Q15.

The most commonly cited issue with the Suction System was that it “Occupies Needed Space” due to its size (mentioned five times). Here is a breakdown of the responses to Q15 ranked in order of number of times mentioned from most to least:

- o Occupies Needed Space – 5 mentions
- o Non-Operational/Inadequate – 4 mentions
- o Difficult to Access – 2 mentions
- o Causes Painful Postures – 2 mentions
- o Restricted Use – 1 mention
- o Not Available/Removed – 1 mention

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Q16. How has the lighting system negatively affected your mission performance or caused you to perform your mission as a care provider in an awkward or painful posture?

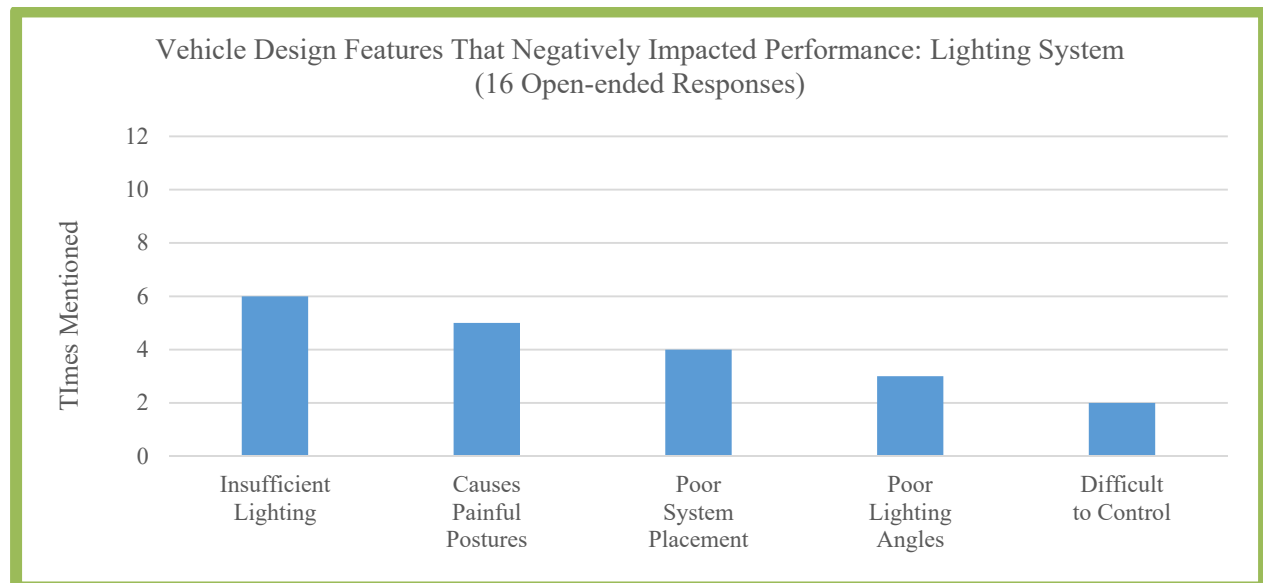


Figure 10. Categorized open-ended responses to Q16.

The most commonly cited issue with the Lighting System was “Insufficient Lighting” (mentioned six times). Here is a breakdown of the responses to Q16 ranked in order of number of times mentioned from most to least:

- Insufficient Lighting – 6 mentions
- Causes Painful Postures – 5 mentions
- Poor System Placement – 4 mentions
- Poor Lighting Angles – 3 mentions
- Difficult to Control – 2 mentions

Note that the “Poor System Placement” issue was specifically cited as resulting in helmet collisions.

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Q17. How have the seatbelts negatively affected your mission performance or caused you to perform your mission as a care provider in an awkward or painful posture?

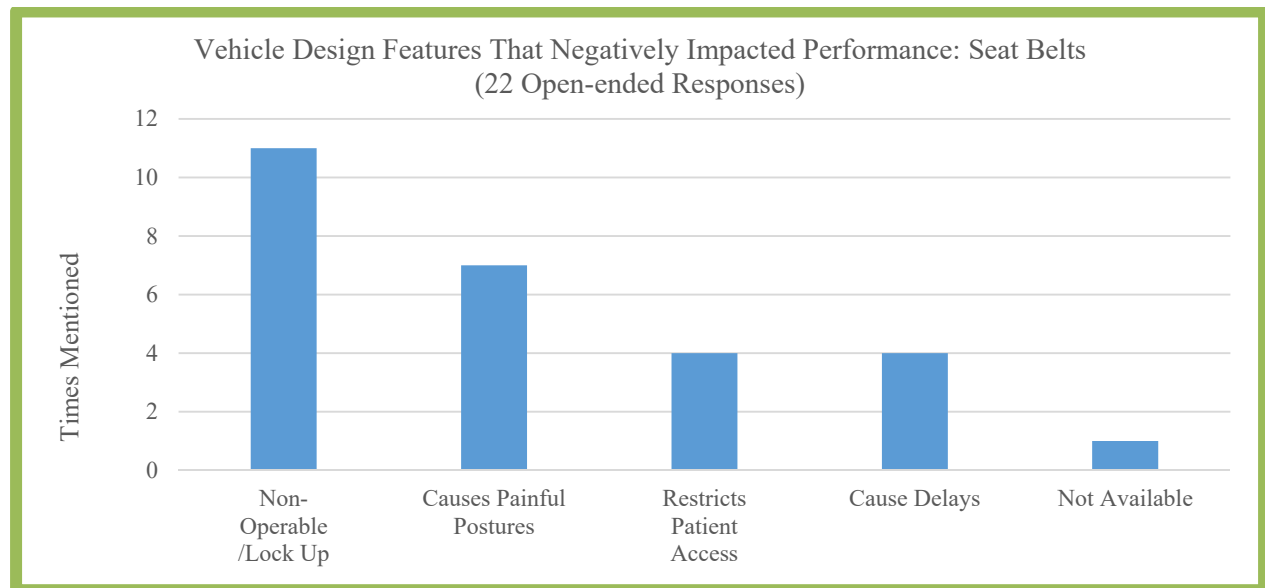


Figure 11. Categorized open-ended responses to Q17.

The most commonly cited issue with the Seat Belts was “Non-Operable/Lock Up” meaning the belts often got stuck, came loose, or were difficult to secure, which were mentioned 11 times. Here is a breakdown of the responses to Q17 ranked in order of number of times mentioned from most to least:

- o Non-Operable/Lock Up – 11 mentions
- o Causes Painful Postures – 7 mentions
- o Restricts Patient Access – 4 mentions
- o Cause Delays – 4 mentions
- o Not Available – 1 mention

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Q18. How has the litter system negatively affected your mission performance or caused you to perform your mission as a care provider in an awkward or painful posture?

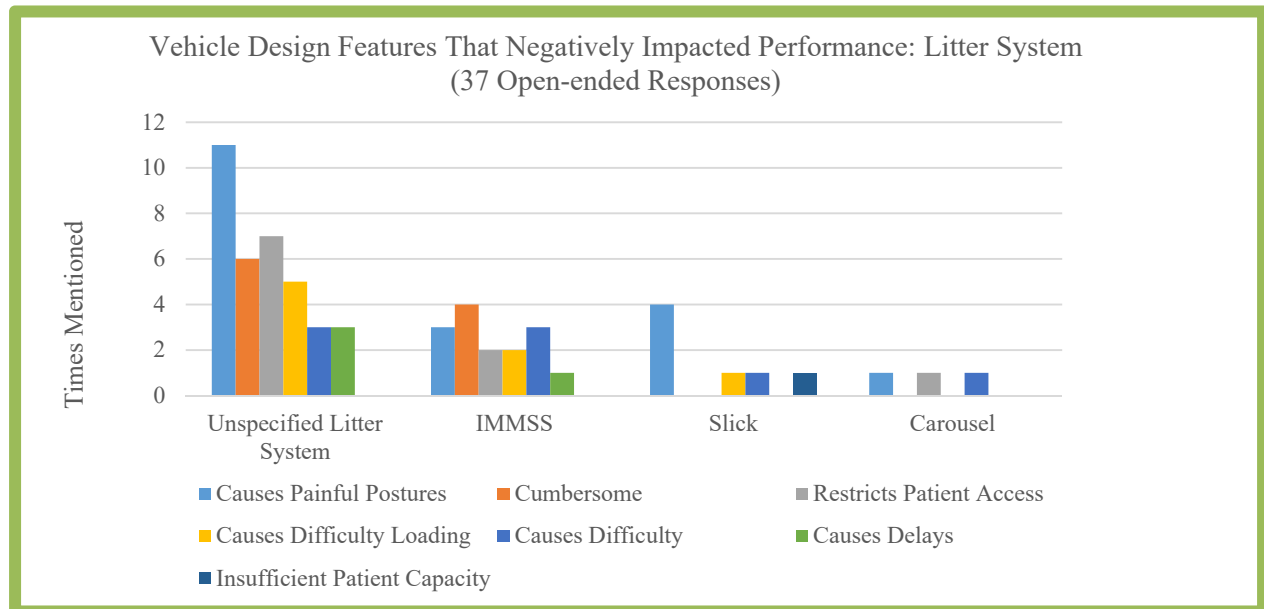


Figure 12. Categorized open-ended responses to Q18.

The type of Litter System that was most commonly cited as being problematic was the “Unspecified Litter System,” which was mentioned 35 times. Here is a breakdown of the responses to Q18 ranked in order of number of times mentioned from most to least:

- o Unspecified Litter System – 35 mentions
- o IMMSS – 15 mentions
- o Slick – 7 mentions
- o Carousel – 3 mentions

The most commonly mentioned issue across all four types of Litter Systems was that the systems caused painful postures. “Unspecified Litter Systems” were mentioned most often in this specific category (11 mentions), along with the “Slick” configuration (4 mentions), “IMMSS” (3 mentions), and “Carousel” (1 mention).

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Q19. How has the lack of a litter system negatively affected your mission performance or caused you to perform your mission as a care provider in an awkward or painful posture?

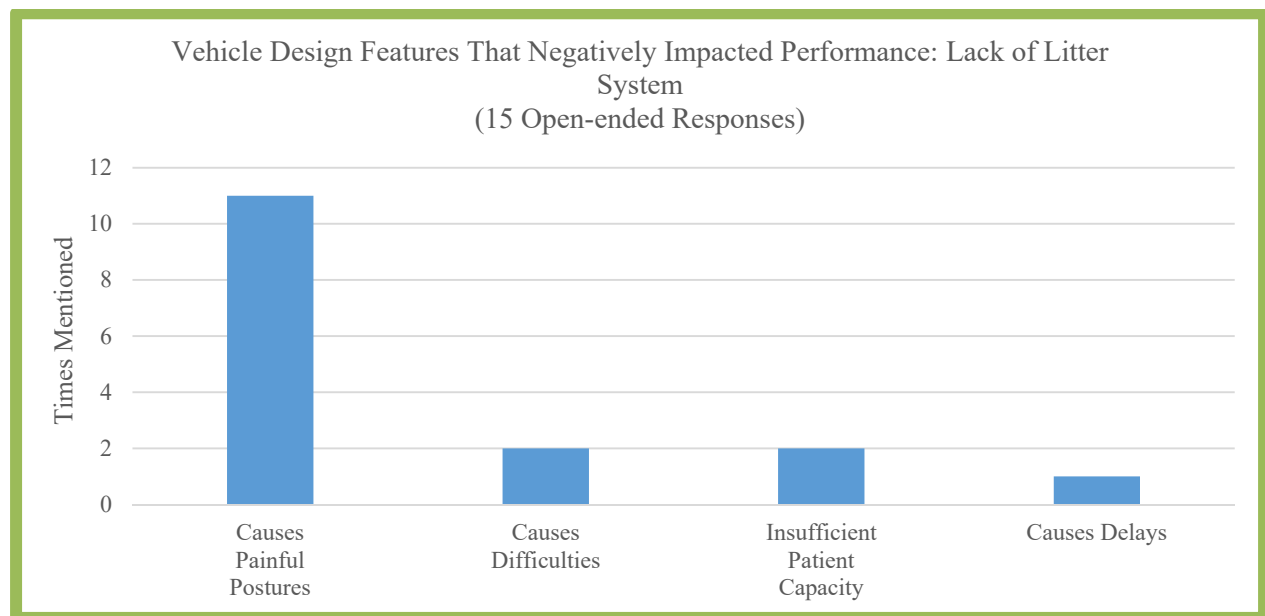


Figure 13. Categorized open-ended responses to Q19.

The most commonly cited issue with the Lack of Litter System was “Causes Painful Postures,” mentioned 11 times. Respondents specifically stated that it caused the care provider to assume painful postures when loading or providing care to the patients. Here is a breakdown of the responses to Q19 ranked in order of number of times mentioned from most to least:

- o Causes Painful Postures – 11 mentions
- o Causes Difficulty – 2 mentions
- o Insufficient Patient Capacity – 2 mentions
- o Causes Delays – 1 mention

Respondents stated that the lack of a litter system caused difficulty for the care providers when strapping down multiple patients and with the equipment being on the floor.

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Q20. How has the cabin/patient compartment size (dimensions-length, width, height) negatively affected your mission performance or caused you to perform your mission as a care provider in an awkward or painful posture?

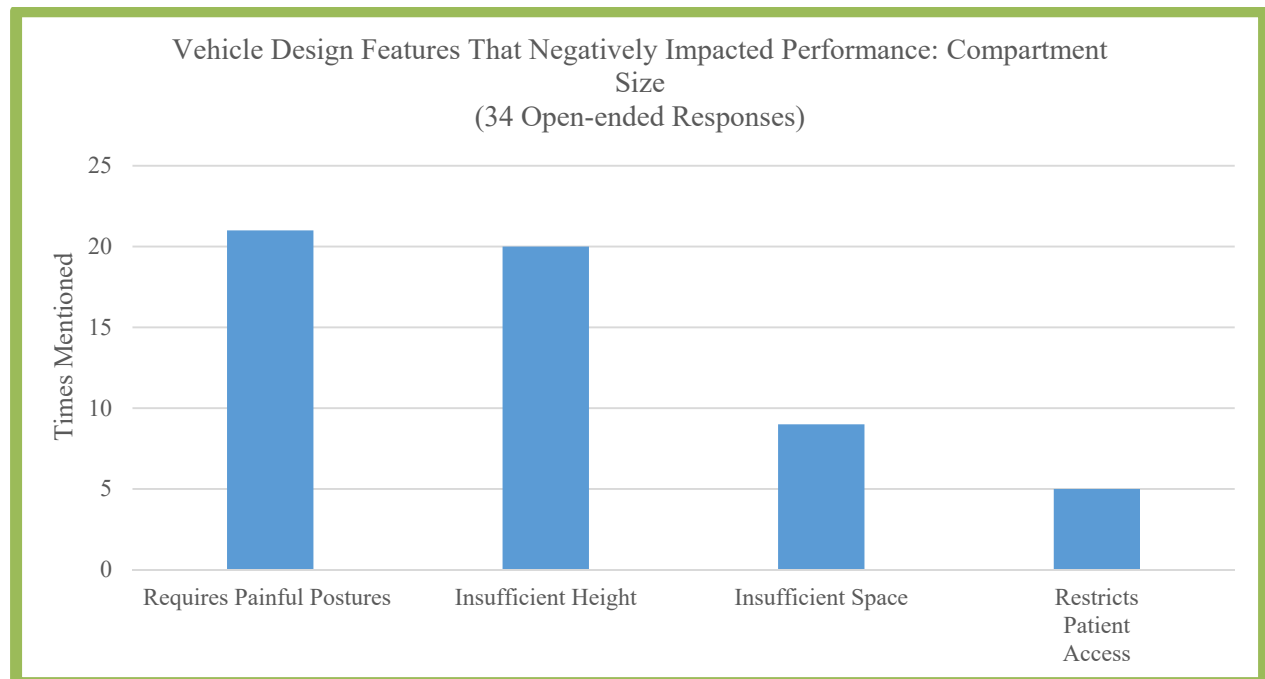


Figure 14. Categorized open-ended responses to Q20.

The most common issue with the Compartment Size was “Requires Painful Postures,” mentioned 21 times. This was often coupled with the “Insufficient Height,” which was mentioned 20 times. Here is a breakdown of the responses to Q20 ranked in order of number of times mentioned from most to least:

- o Requires Painful Postures – 21 mentions
- o Insufficient Height – 20 mentions
- o Insufficient Space – 9 mentions
- o Restricts Patient Access – 5 mentions

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Q21. How have the windows negatively affected your mission performance or caused you to perform your mission as a care provider in an awkward or painful posture?

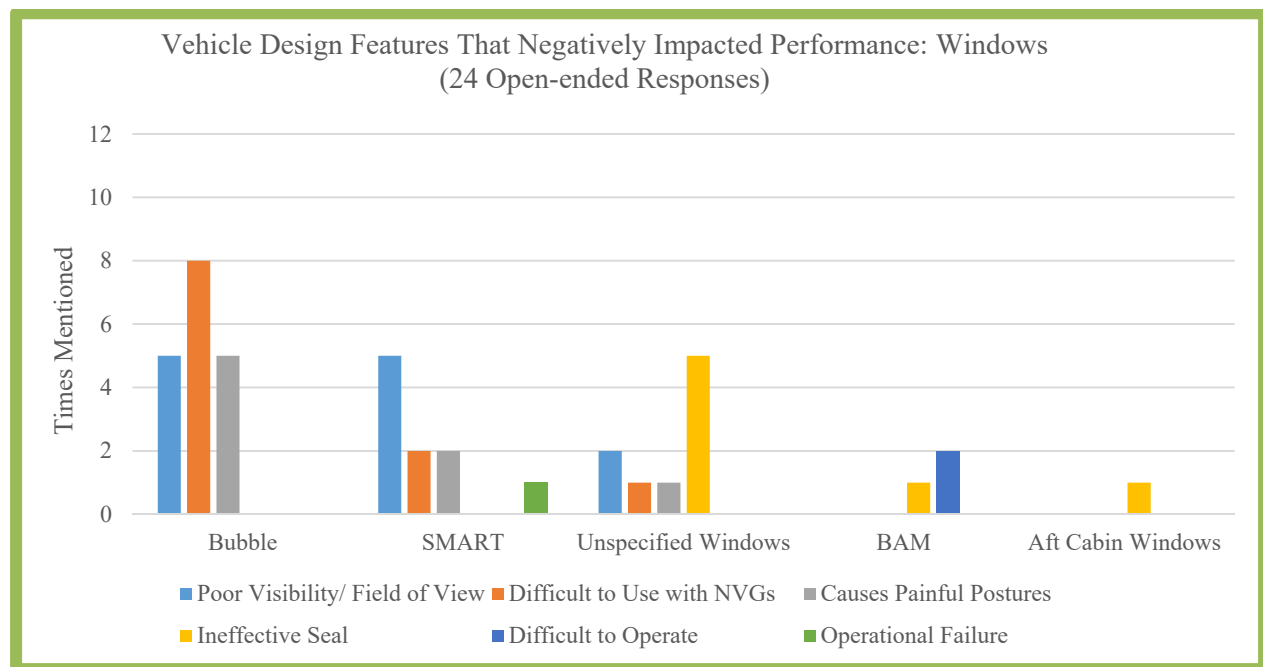


Figure 15. Categorized open-ended responses to Q21.

The type of Windows that most frequently caused issues for care providers were the “Bubble” windows, mentioned 18 times. Here is a breakdown of the responses to Q21 ranked in order of number of times mentioned from most to least:

- o Bubble – 18 mentions
- o SMART – 10 mentions
- o Unspecified Windows – 9 mentions
- o Black Hawk Advanced MEDEVAC (BAM) – 3 mentions
- o Aft Cabin Windows – 1 mention

The most commonly cited issue with all types of windows was “Poor Visibility/Field of View” (mentioned 12 times). The “Bubble” windows and “SMART” windows were the most mentioned when referring to visibility issues (mentioned five times), and the “Unspecified Windows” also contributed to this category (mentioned two times). The “BAM” windows and “Aft Cabin Windows” did not have any reported issues of visibility. The next-most common issue with the windows was that they were difficult to use with night vision goggles (NVGs) (mentioned 11 times). The “Bubble” window was the hardest to use with NVGs (mentioned eight times), while the “SMART” windows also were problematic in this area (mentioned two times), along with “Unspecified Windows” as well (mentioned once). Some common issues

related to using the windows with NVGs were that the field of view became distorted, or the goggles would collide with the windows and prevent the appropriate clearing of the aircraft.

Q22. How have the crew seats negatively affected your mission performance or caused you to perform your mission as a care provider in an awkward or painful posture?

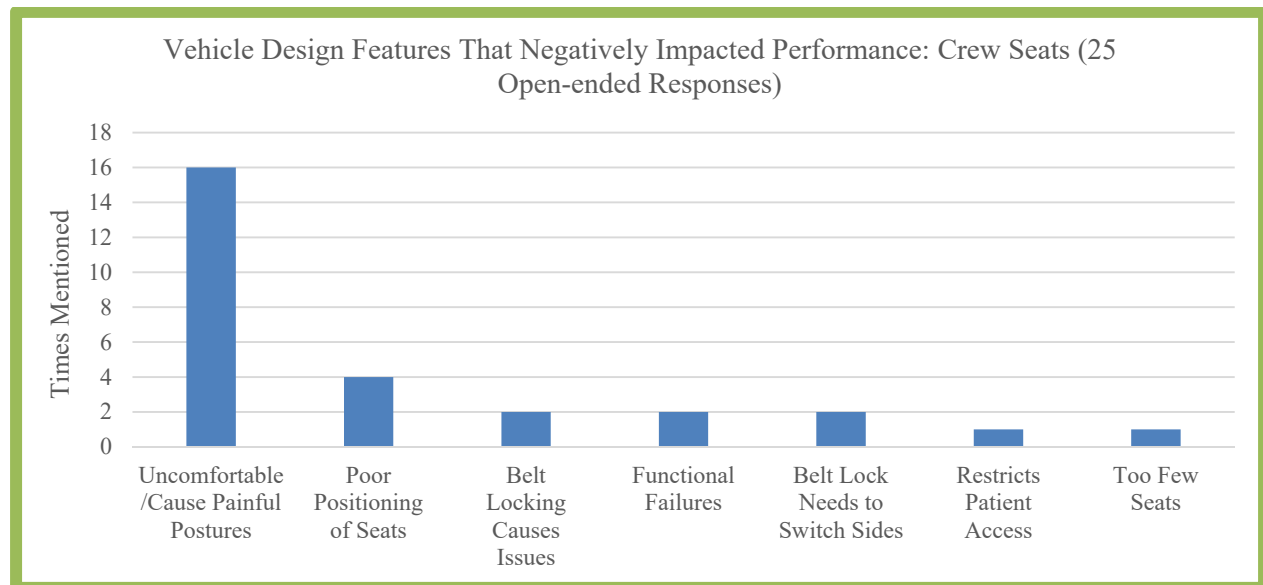


Figure 16. Categorized open-ended responses to Q22.

The most commonly cited issue with the crew seats was “Uncomfortable/Cause Painful Postures (mentioned 16 times). Here is a breakdown of the responses to Q22 ranked in order of number of times mentioned from most to least:

- o Uncomfortable/Cause Painful Postures – 16 mentions
- o Poor Positioning of Seats – 4 mentions
- o Belt Locking Causes Issues – 2 mentions
- o Functional Failures – 2 mentions
- o Belt Lock Needs to Switch Sides – 2 mentions
- o Restricts Patient Access – 1 mention
- o Too Few Seats – 1 mention

The respondents often cited the seats as causing them to sit hunched forward, which resulted in back pain. The seat stiffness was specifically cited as causing discomfort.

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Q23. How has the communication system negatively affected your mission performance or caused you to perform your mission as a care provider in an awkward or painful posture?

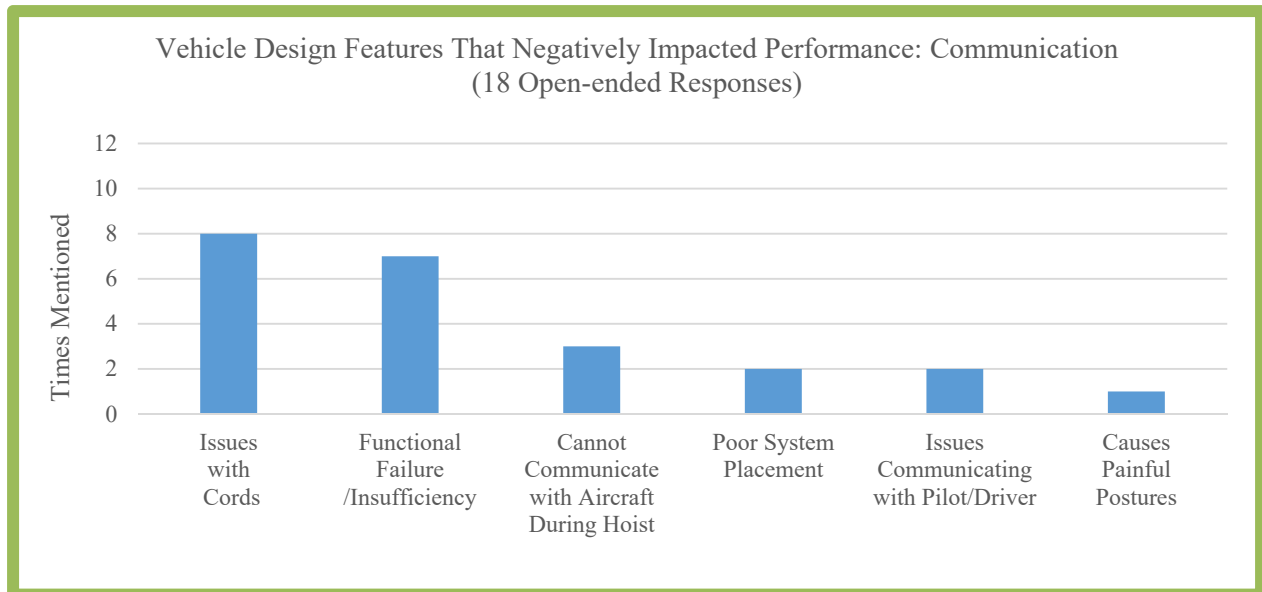


Figure 17. Categorized open-ended responses to Q23.

The most commonly cited issue with the communication system was Issues with Cords (mentioned eight times). The integrated communication system (ICS) cords were reported to often tangle and make maneuvering about the cabin difficult. Note that many respondents expressed a desire to change to a wireless mode of communication. Here is a breakdown of the responses to Q23 ranked in order of number of times mentioned from most to least:

- Issues with Cords – 8 mentions
- Functional Failure/Insufficiency – 7 mentions
- Cannot Communicate with Aircraft During Hoist – 3 mentions
- Poor System Placement – 2 mentions
- Issues Communicating with Pilot/Driver – 2 mentions
- Causes Painful Postures – 1 mention

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Q24. How has the personal protective gear (body armor/helmet) negatively affected your mission performance or caused you to perform your mission as a care provider in an awkward or painful posture?

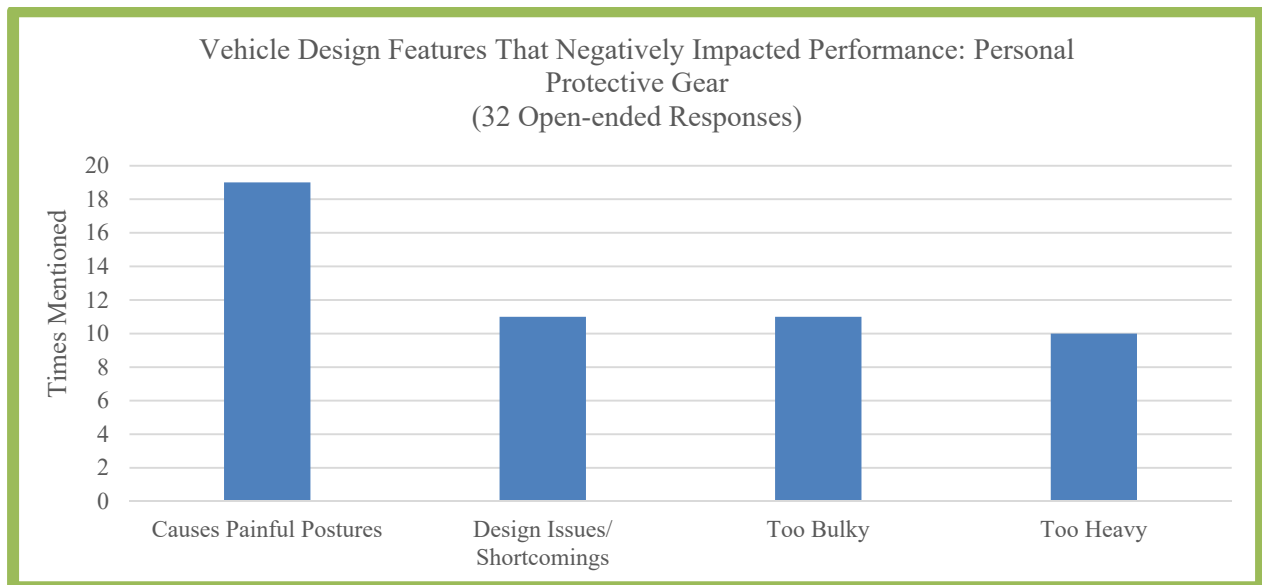


Figure 18. Categorized open-ended responses to Q24.

The most commonly cited issue with PPG was “Causes Painful Postures,” which was mentioned 19 times. Here is a breakdown of the responses to Q24 ranked in order of number of times mentioned from most to least:

- o Causes Painful Postures – 19 mentions
- o Design Issues/Shortcomings – 11 mentions
- o Too Bulky – 11 mentions
- o Too Heavy – 10 mentions

The PPG was most often said to cause neck and back strain due to the distribution of weight in the body armor. The design issues were said to be the lack of ballistic protection offered by the helmets.

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Q25. You selected “Other” as a choice. Please tell what has negatively affected your mission performance or caused you to perform your mission as a care provider in an awkward or painful posture and what those impacts were?

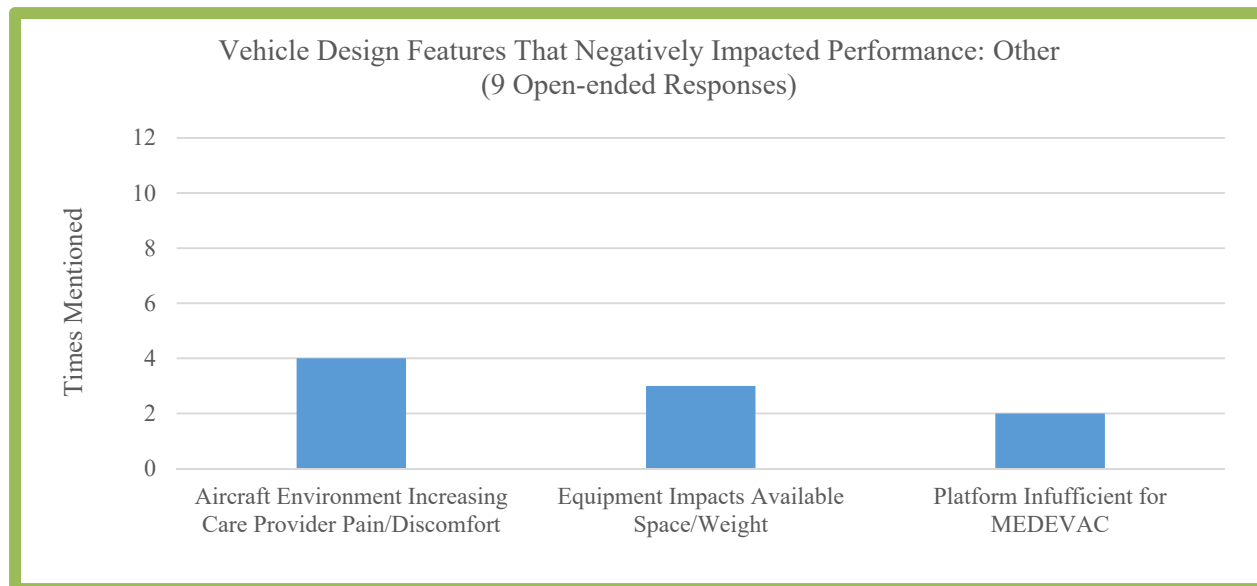


Figure 19. Categorized open-ended responses to Q25.

The most commonly cited issue in the “Other” category was “Aircraft Environment Increasing Care Provider Pain/Discomfort,” mentioned four times. The responses were most often related to remaining in one position for an extended period of time as necessitated by the platform arrangement as well as the vibration of the environment. Here is a breakdown of the responses to Q25 ranked in order of number of times mentioned from most to least:

- Aircraft Environment Increasing Care Provider Pain/Discomfort – 4 mentions
- Equipment Impacts Available Space/Weight – 3 mentions
- Platform Insufficient for MEDEVAC – 2 mentions

The responses in the last category pertained to the UH-60L and the HH-60M. The complaint for the UH-60L was that there was not enough room for proper patient treatment, and the complaint for the HH-60M was that the platform could either be for casualty evacuation and have the medical interior on both sides of the cabin, or be for MEDEVAC and only have the medical interior on one side.

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Section 3: Equipment that Caused Awkward/Painful Postures

Q26. Did any of the following items in the current Aeromedical or Ground Evacuation Medical Equipment Sets cause you to use an awkward or painful posture?

After being asked Q26, respondents were presented with 20 specific and 2 optional “Other” pieces of equipment to indicate whether or not they caused awkward/painful postures by responding “yes” or “no.” Table 20 and Figure 20 show the responses given in the complete valid surveys. Table 21 and Figure 21 show the responses given in all valid surveys (complete and incomplete valid surveys).

Table 20. Responses to Q26 – Complete Valid Surveys

Complete Valid Survey Responses to Q26				
Equipment Description	Number of Yes Responses	Number of No Responses	Response Total	Skipped
Litter	14	32	46	0
Monitor	10	36	46	0
Defibrillator	9	37	46	0
Sked® Basic Rescue System (BRS)	9	37	46	0
Special Medical Emergency Evacuation Device (SMEED)	8	38	46	0
Oxygen Bottle with Regulator	8	38	46	0
Trauma Panel	8	38	46	0
Traction Splint	7	39	46	0
Intravenous (IV) Pump	6	40	46	0
Suction	6	40	46	0
Medical Aid Bag	6	40	46	0
Ventilator	5	41	46	0
Medicine (Med.) Box	5	41	46	0
Fluid Warmer	5	41	46	0
Spine Board	5	41	46	0
Litter Straps	5	41	46	0
EZ Intraosseus (I.O.) Kit	1	45	46	0
Other	1	45	46	0
Spine Splint	0	46	46	0
Thermometer	0	46	46	0
Glucometer	0	46	46	0
Other	0	46	46	0

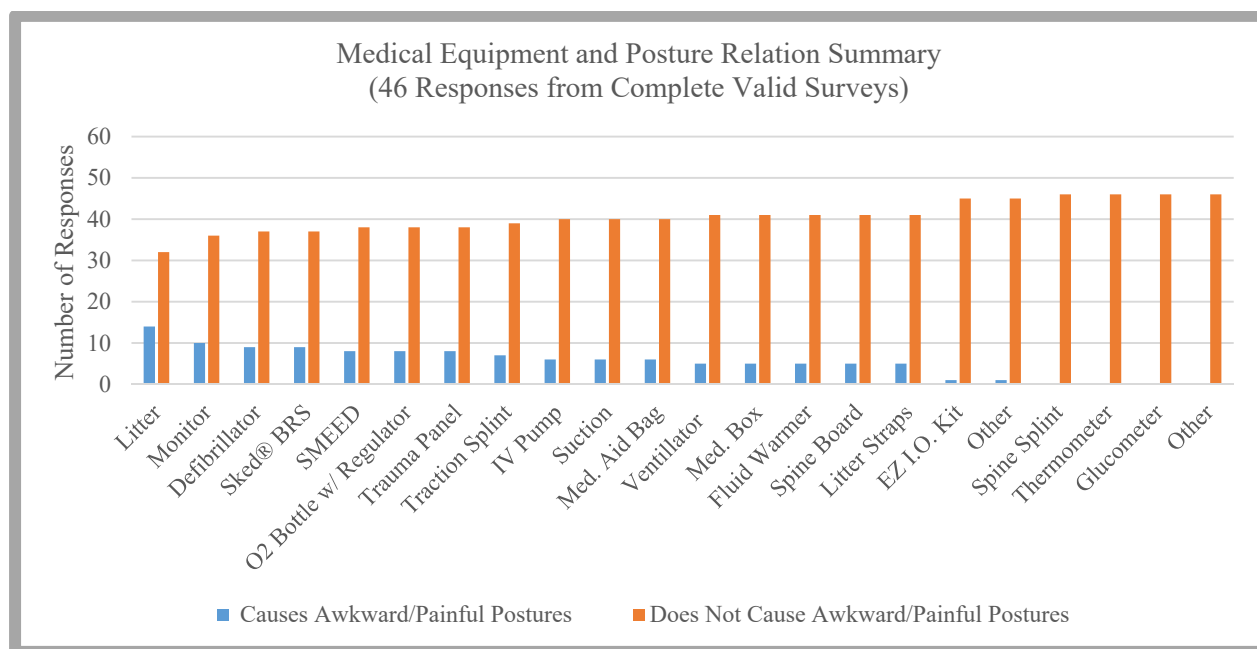


Figure 20. Summary of Table 20.

In general, the medical equipment did not significantly contribute to painful postures expected during MEDEVAC scenarios. The piece of equipment that caused awkward or painful postures most often was the litter, marked by 14 respondents.

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Table 21. Responses to Q26 – All Valid Surveys

All Valid Survey Responses to Q26				
Equipment Description	Number of Yes Responses	Number of No Responses	Response Total	Skipped
Litter	16	36	52	8
Monitor	12	40	52	8
Defibrillator	11	41	52	8
Oxygen Bottle with Regulator	10	42	52	8
Trauma Panel	10	42	52	8
Sked [®] BRS	10	42	52	8
IV Pump	8	44	52	8
Suction	8	44	52	8
SMEED	8	44	52	8
Ventilator	7	45	52	8
Traction Splint	7	45	52	8
Med. Aid Bag	6	46	52	8
Med. Box	6	46	52	8
Spine Board	6	46	52	8
Litter Straps	6	46	52	8
Fluid Warmer	5	47	52	8
EZ I.O. Kit	1	51	52	8
Spine Splint	1	51	52	8
Other	1	51	52	8
Thermometer	0	52	52	8
Glucometer	0	52	52	8
Other	0	52	52	8

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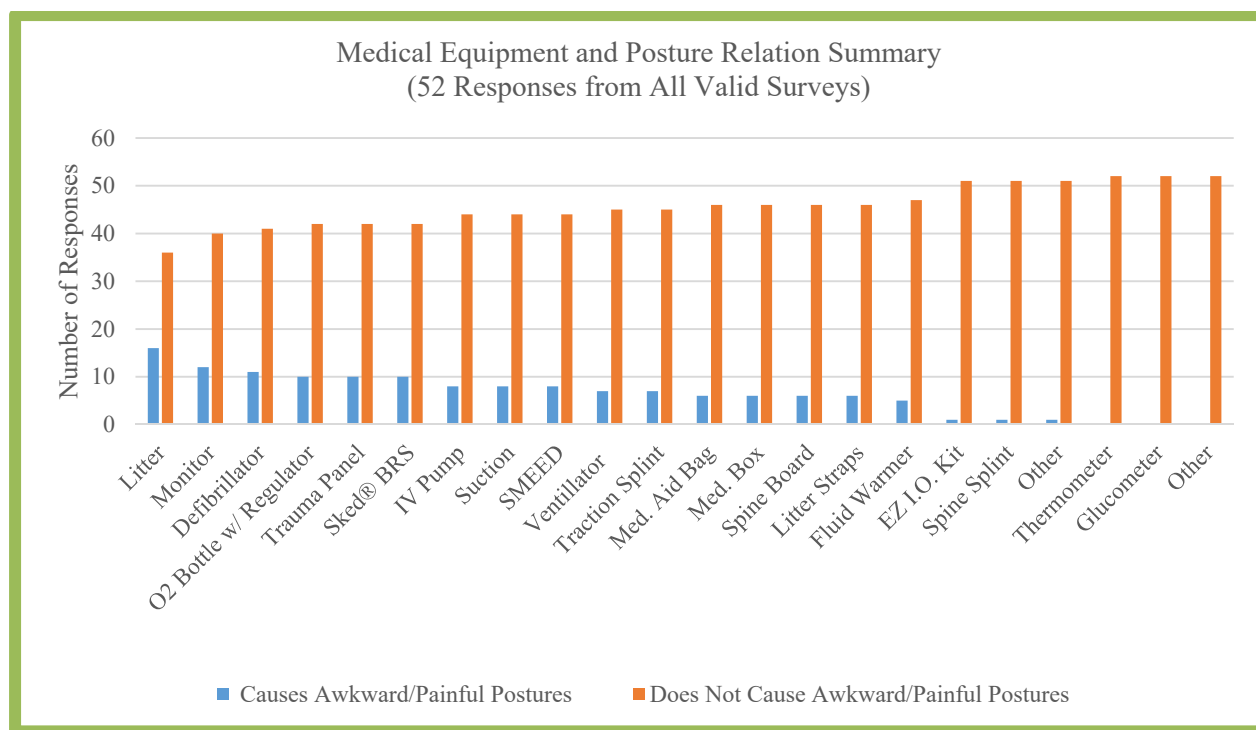


Figure 21. Summary of Table 21.

Just as in the analysis of the complete valid surveys, the litter was again the most marked piece of equipment as causing painful postures in all valid surveys, as marked by 16 respondents.

A second analysis was performed on the responses to Q26 which included all valid surveys because respondents who completed this section answered every question in the section, whether their survey was complete or not.

If a respondent marked a piece of equipment as causing awkward/painful postures, they were then asked to provide an open-ended response describing how the equipment caused the posture. The categorized responses to those questions are shown in Figures 22 through 38. Since the responses more often expressed general issues with the piece of equipment rather than how it caused awkward postures, the graphs categorize how the equipment negatively affected the mission, rather than how it caused awkward/painful postures. The open-ended responses of all valid surveys were analyzed for Figures 22 through 39, and the number of respondents that found each piece of equipment significant and provided an open ended response can be found in the figure titles.

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Q27. How did the use of [piece of equipment] cause you to use an awkward or painful posture?

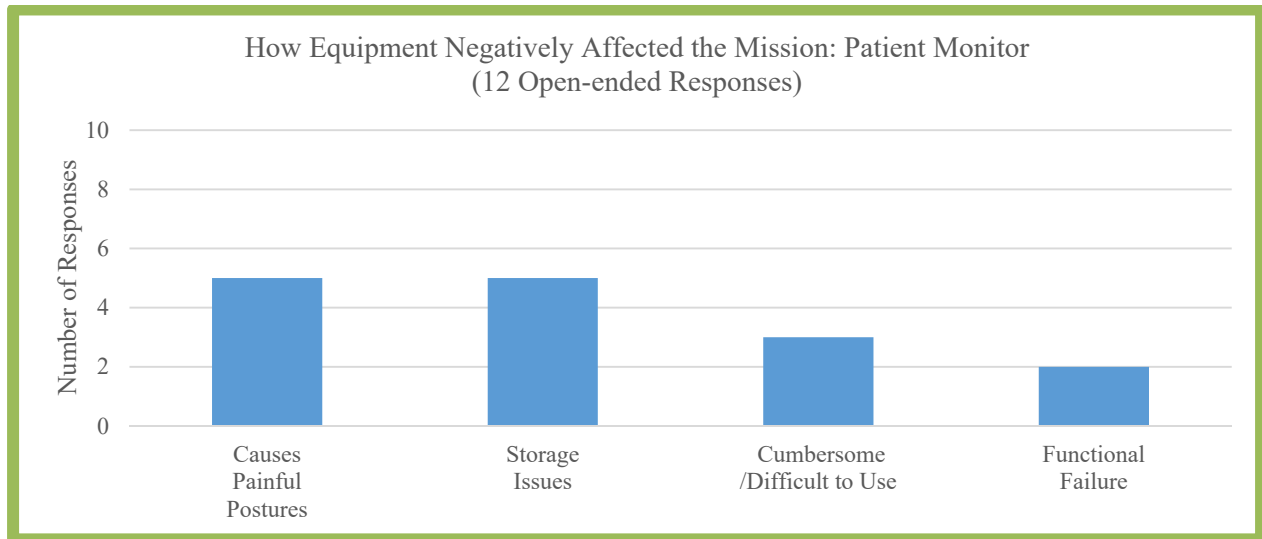


Figure 22. Categorized open-ended responses to Q27 for patient monitors.

The most common issues with the patient monitor were that it caused painful postures and was difficult to store properly. Here is a breakdown of the responses to Q27 for patient monitors ranked in order of number of times mentioned from most to least:

- o Causes Painful Postures – 5 mentions
- o Storage Issues – 5 mentions
- o Cumbersome/Difficult to Use – 3 mentions
- o Functional Failure – 2 mentions

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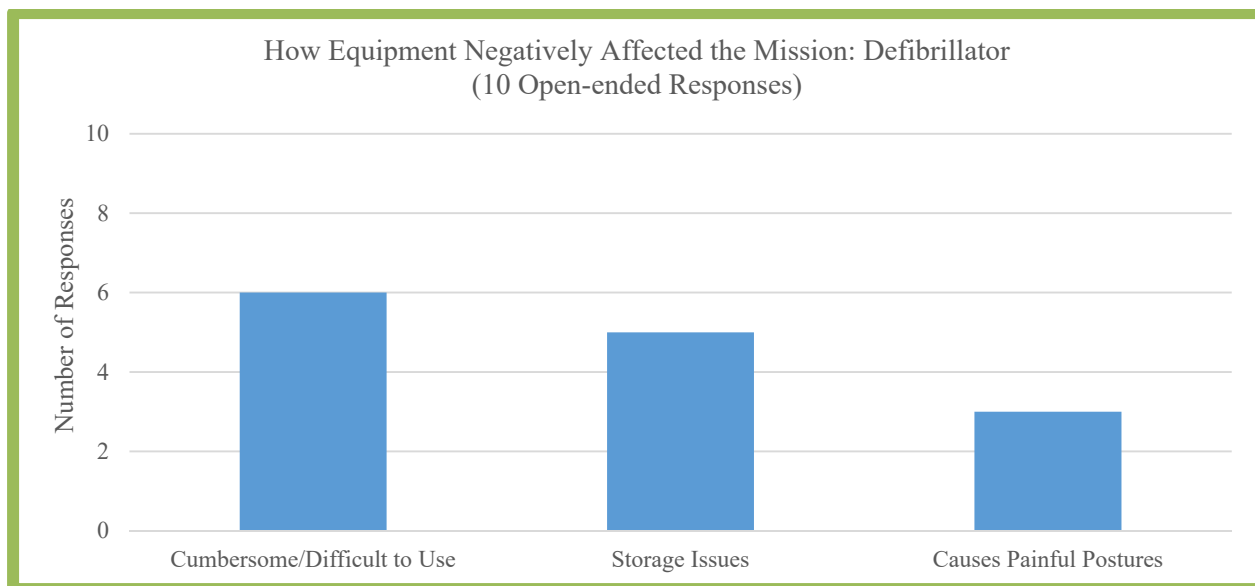


Figure 23. Categorized open-ended responses to Q27 for defibrillators.

The most commonly cited issue with the defibrillator was that it was cumbersome or difficult to use. Here is a breakdown of the responses to Q27 for defibrillators ranked in order of number of times mentioned from most to least:

- o Cumbersome/Difficult to Use – 6 mentions
- o Storage Issues – 5 mentions
- o Causes Painful Postures – 3 mentions

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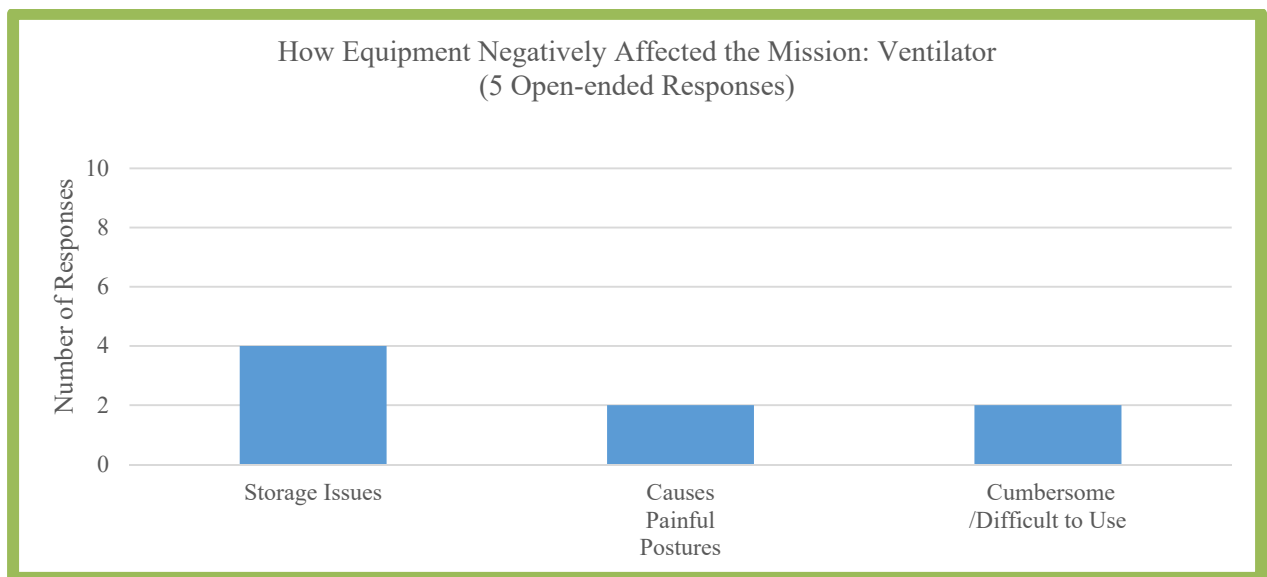


Figure 24. Categorized open-ended responses to Q27 for ventilators.

The most commonly cited issue with the ventilator was “Storage Issues.” Here is a breakdown of the responses to Q27 for ventilators ranked in order of number of times mentioned from most to least:

- o Storage Issues – 4 mentions
- o Causes Painful Postures – 2 mentions
- o Cumbersome/Difficult to Use – 2 mentions

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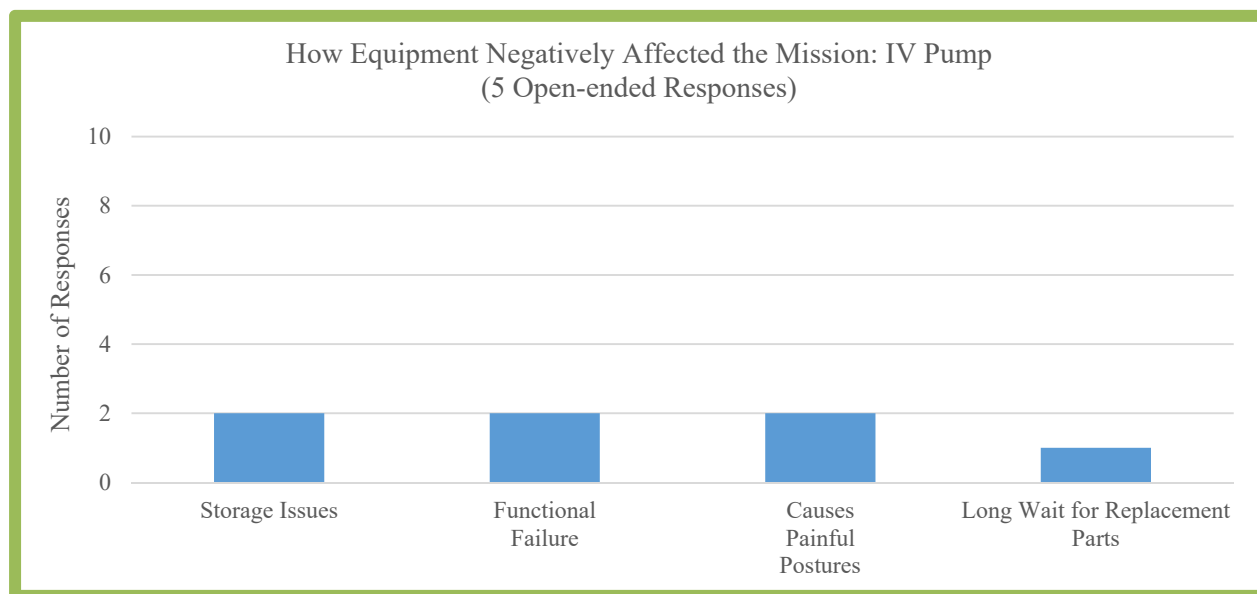


Figure 25. Categorized open-ended responses to Q27 for IV pumps.

The most commonly cited issues with the IV pump were “Storage Issues,” “Functional Failure,” and “Causes Painful Postures.” Here is a breakdown of the responses to Q27 for IV pumps ranked in order of number of times mentioned from most to least:

- o Storage Issues – 2 mentions
- o Functional Failure – 2 mentions
- o Causes Painful Postures – 2 mentions
- o Long Wait for Replacement Parts – 1 mention

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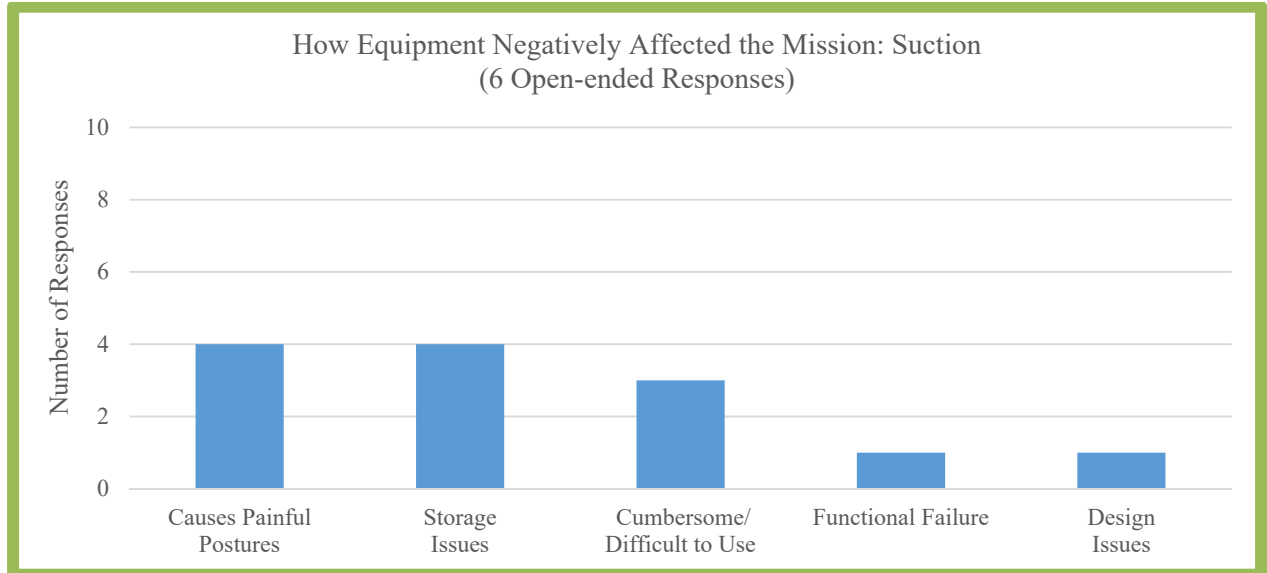


Figure 26. Categorized open-ended responses to Q27 for suction.

The most commonly cited issues with the suction system were “Causes Painful Postures” and “Storage Issues.” Here is a breakdown of the responses to Q27 for suction ranked in order of number of times mentioned from most to least:

- o Causes Painful Postures – 4 mentions
- o Storage Issues – 4 mentions
- o Cumbersome/Difficult to Use – 3 mentions
- o Functional Failure – 1 mention
- o Design Issues – 1 mention

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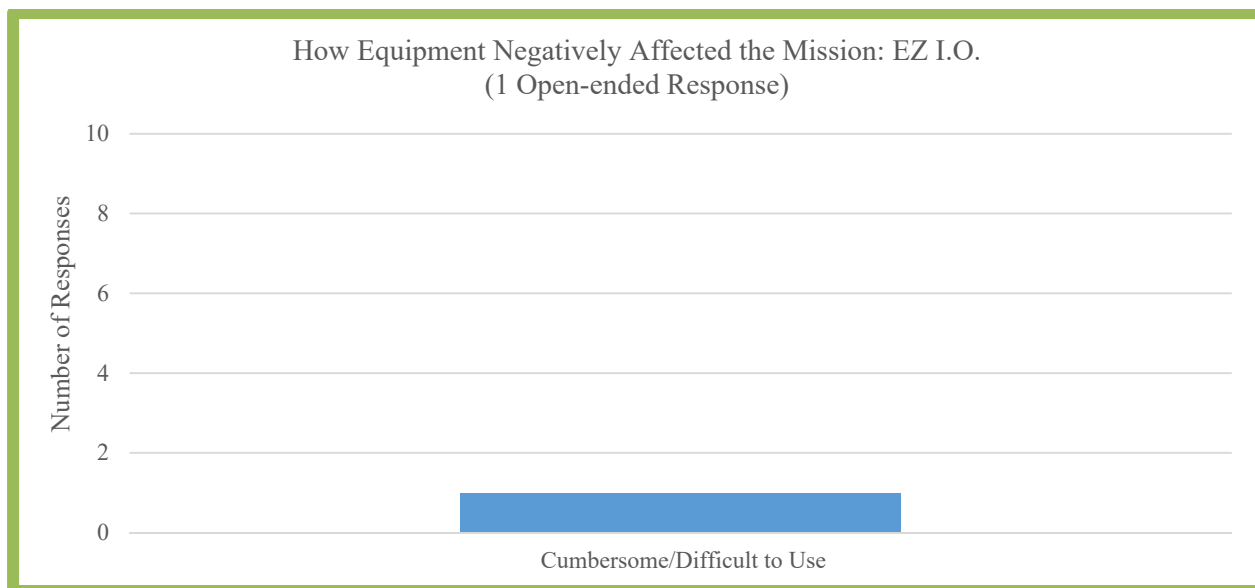


Figure 27. Categorized open-ended responses to Q27 for EZ I.O.

The only issue cited with the EZ I.O. was that it was cumbersome or difficult to use, mentioned one time.

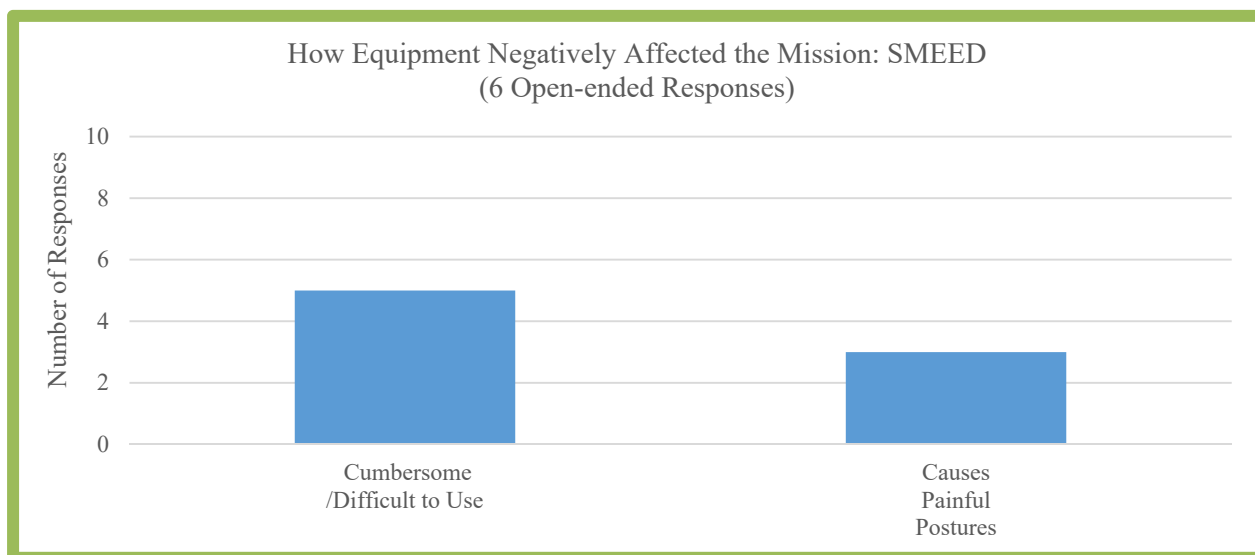


Figure 28. Categorized open-ended responses to Q27 for SMEEDs.

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The most commonly cited issue with the SMEED was “Cumbersome/Difficult to Use.” Here is a breakdown of the responses to Q27 for SMEEDs ranked in order of number of times mentioned from most to least:

- Cumbersome/Difficult to Use – 5 mentions
- Causes Painful Postures – 3 mentions

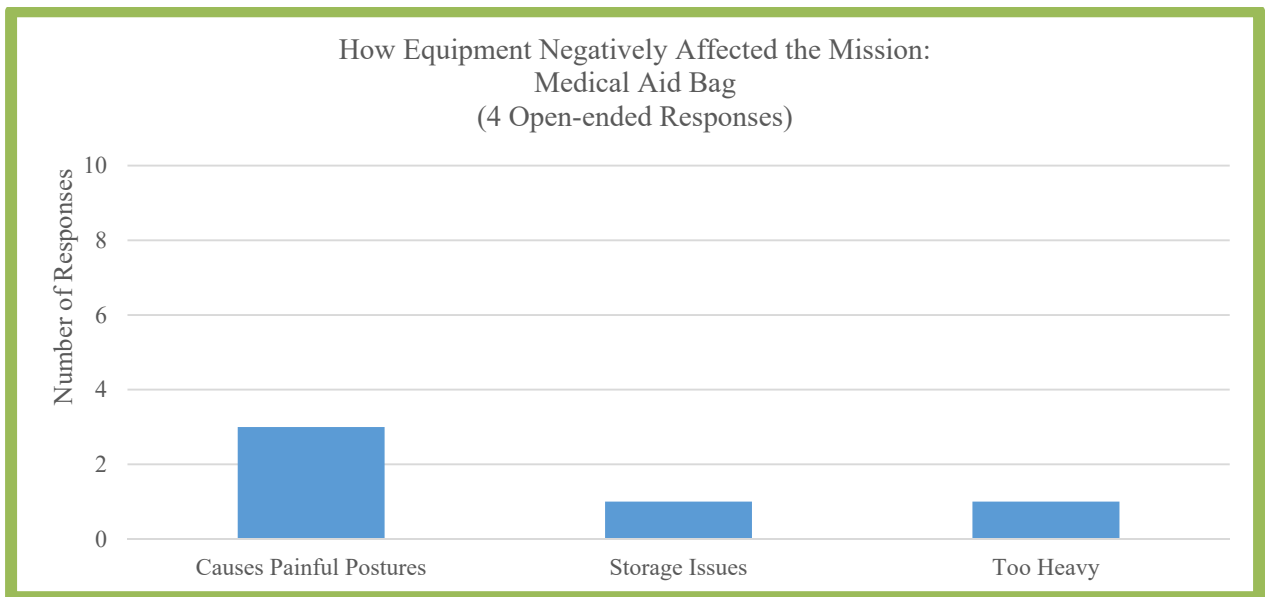


Figure 29. Categorized open-ended responses to Q27 for medical aid bags.

The most commonly cited issue with the medical aid bag was “Causes Painful Postures.” Here is a breakdown of the responses to Q27 for medical aid bags ranked in order of number of times mentioned from most to least:

- Causes Painful Postures – 3 mentions
- Storage Issues – 1 mentions
- Too Heavy – 1 mentions

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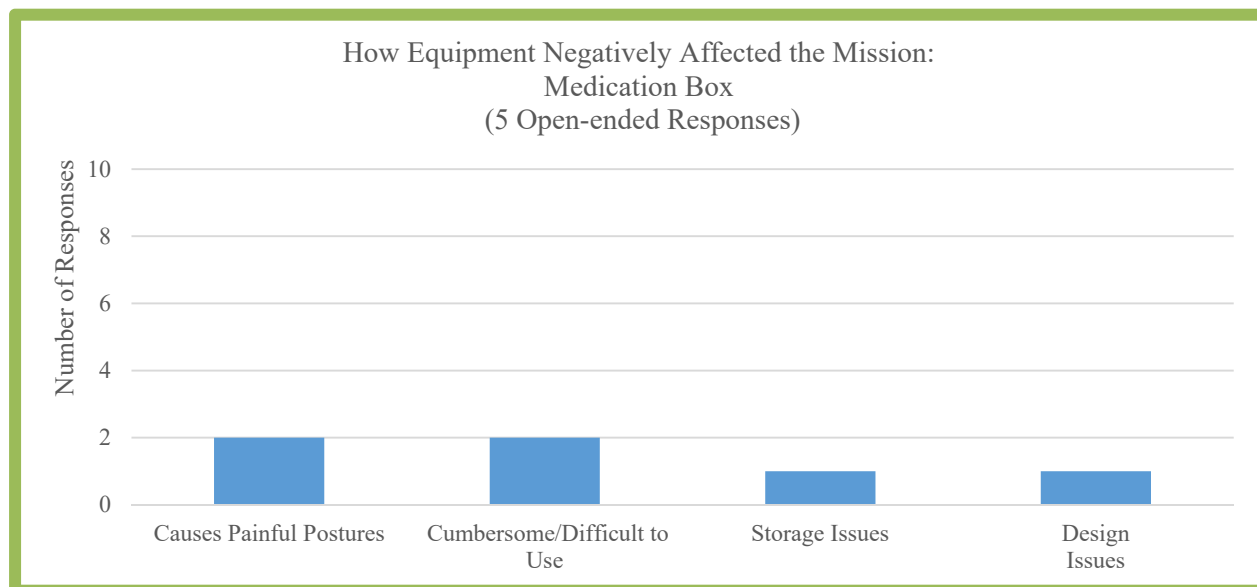


Figure 30. Categorized open-ended responses to Q27 for medication boxes.

The most common issues with the medication box were “Causes Painful Postures” and “Cumbersome/Difficult to Use.” Here is a breakdown of the responses to Q27 for medication boxes ranked in order of number of times mentioned from most to least:

- o Causes Painful Postures – 2 mentions
- o Cumbersome/Difficult to Use – 2 mentions
- o Storage Issues – 1 mention
- o Design Issues – 1 mention

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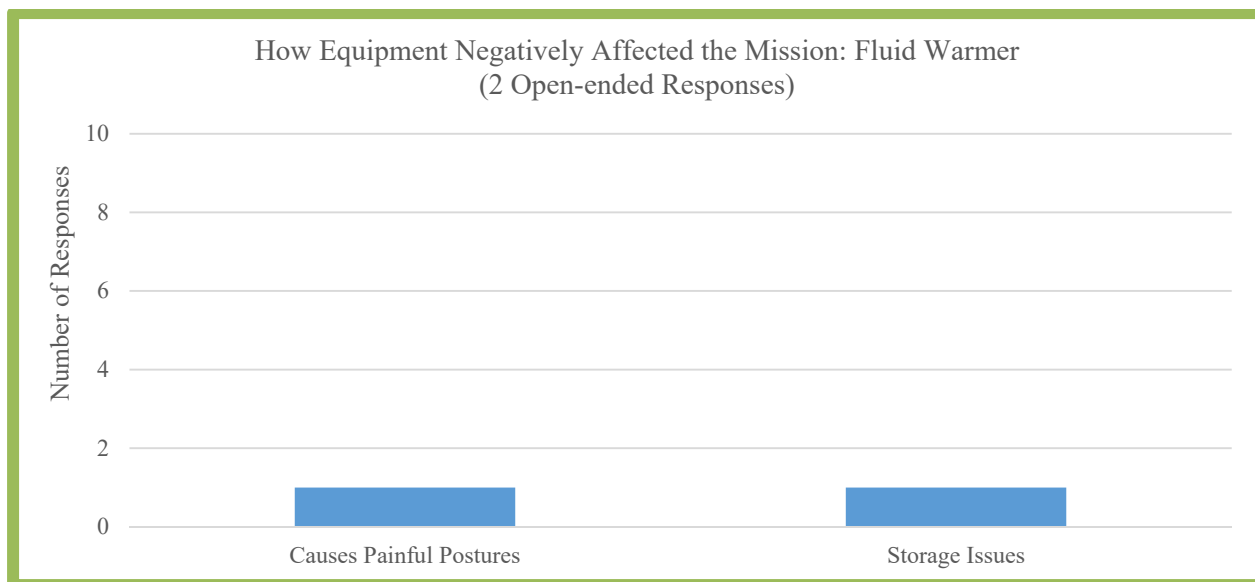


Figure 31. Categorized open-ended responses to Q27 for fluid warmers.

Only two issues were identified with the fluid warmer and each was cited once: the fluid warmer was cited as causing care providers to assume painful postures and being difficult to store.

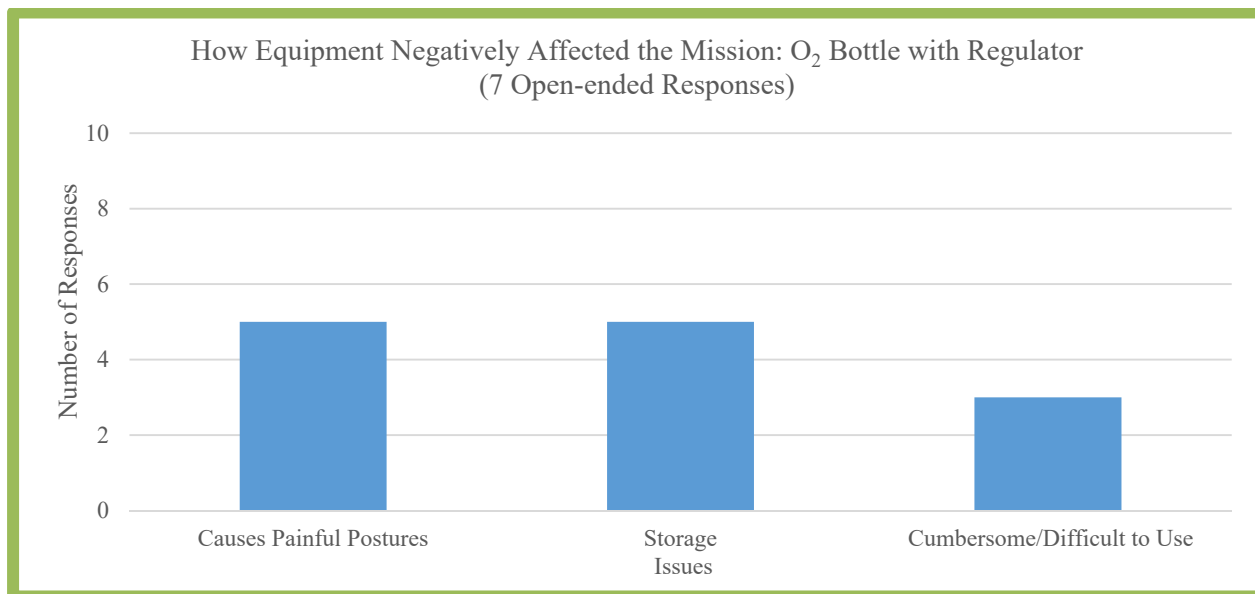


Figure 32. Categorized open-ended responses to Q27 for O₂ bottles with regulators.

The most commonly cited issues with the O₂ bottle with regulator were “Causes Painful Postures” and “Storage Issues.” Here is a breakdown of the responses to Q27 O₂ bottles with regulators ranked in order of number of times mentioned from most to least:

- o Causes Painful Postures – 5 mentions
- o Storage Issues – 5 mentions
- o Cumbersome/Difficult to Use – 3 mentions

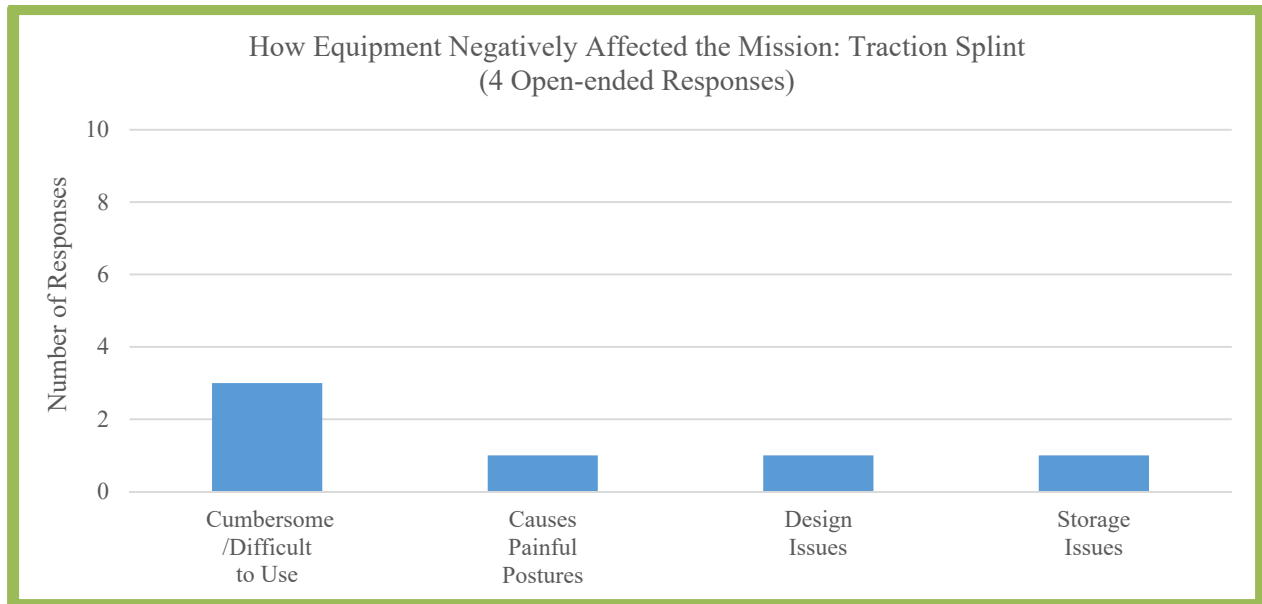


Figure 33. Categorized open-ended responses to Q27 for traction splints.

The most commonly cited issue with the traction splint was “Cumbersome/Difficult to Use.” Here is a breakdown of the responses to Q27 for traction splints ranked in order of number of times mentioned from most to least:

- o Cumbersome/Difficult to Use – 3 mentions
- o Causes Painful Postures – 1 mention
- o Design Issues – 1 mention
- o Storage Issues – 1 mention

The design issue mentioned was that the traction splint could not fit tall patients, and necessitated placing the patient in an angled position or removing the splint if multiple patients were onboard.

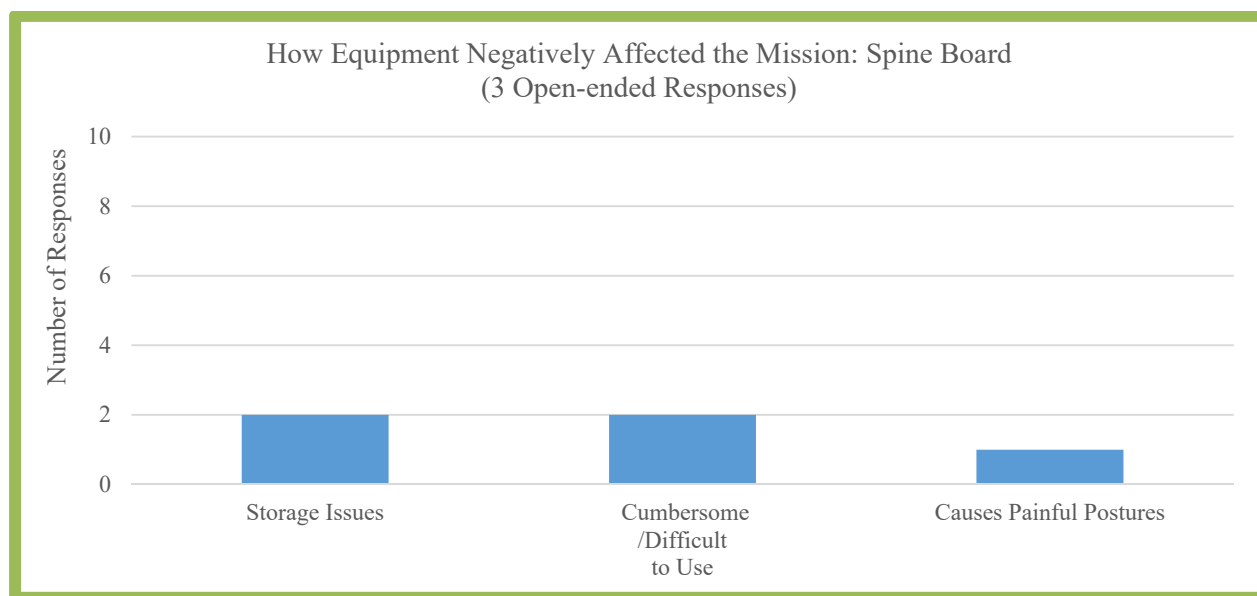


Figure 34. Categorized open-ended responses to Q27 for spine boards.

The most commonly cited issues with the spine board were “Storage Issues” and “Cumbersome/Difficult to Use.” Here is a breakdown of the responses to Q27 for spine boards ranked in order of number of times mentioned from most to least:

- o Storage Issues – 2 mentions
- o Cumbersome/Difficult to Use – 2 mentions
- o Causes Painful Postures – 1 mention

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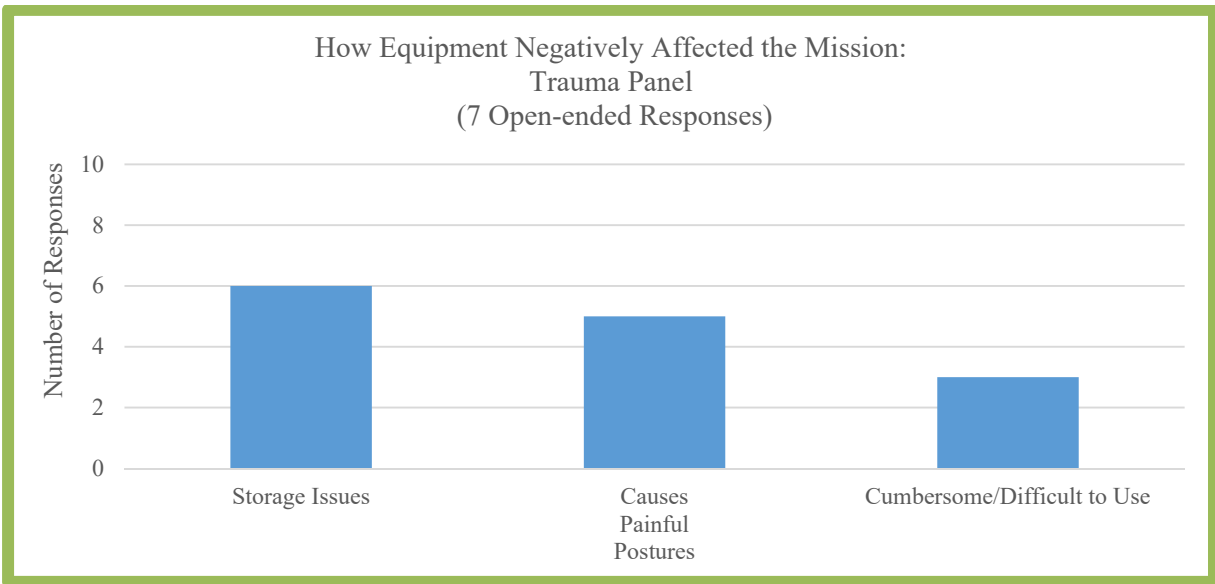


Figure 35. Categorized open-ended responses to Q27 for trauma panels.

The most commonly cited issue with the trauma panel was “Storage Issues.” Here is a breakdown of the responses to Q27 for trauma panels ranked in order of number of times mentioned from most to least:

- o Storage Issues – 6 mentions
- o Causes Painful Postures – 5 mentions
- o Cumbersome/Difficult to Use – 3 mentions

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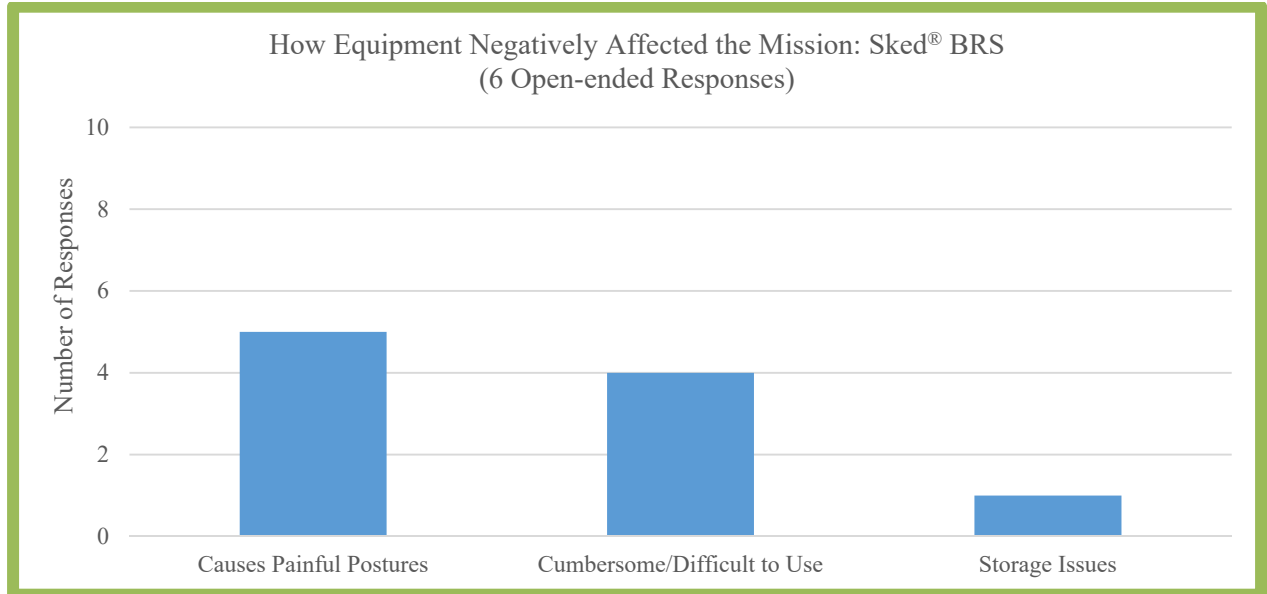


Figure 36. Categorized open-ended responses to Q27 for Sked® BRSs.

The most commonly cited issue with the Sked® BRS was “Causes Painful Postures.” Here is a breakdown of the responses to Q27 for medication boxes ranked in order of number of times mentioned from most to least:

- o Causes Painful Postures – 5 mentions
- o Cumbersome/Difficult to Use – 4 mentions
- o Storage Issues – 1 mention

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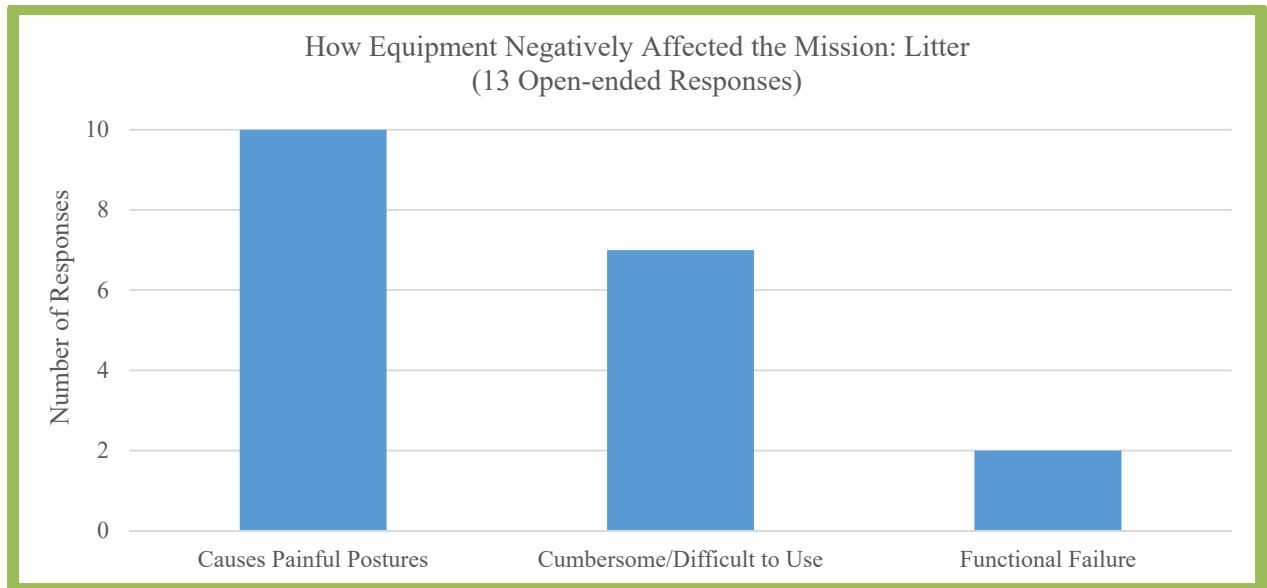


Figure 37. Categorized open-ended responses to Q27 for litters.

The most commonly cited issue with the litter was “Causes Painful Postures” Here is a breakdown of the responses to Q27 for litters ranked in order of number of times mentioned from most to least:

- o Causes Painful Postures – 10 mentions
- o Cumbersome/Difficult to Use – 7 mentions
- o Functional Failure – 2 mentions

The functional failures mentioned included the litter support brackets collapsing under heavy loads and the North American Rescue Talon II® 90C Collapsible Handle Litter coming unlocked during use.

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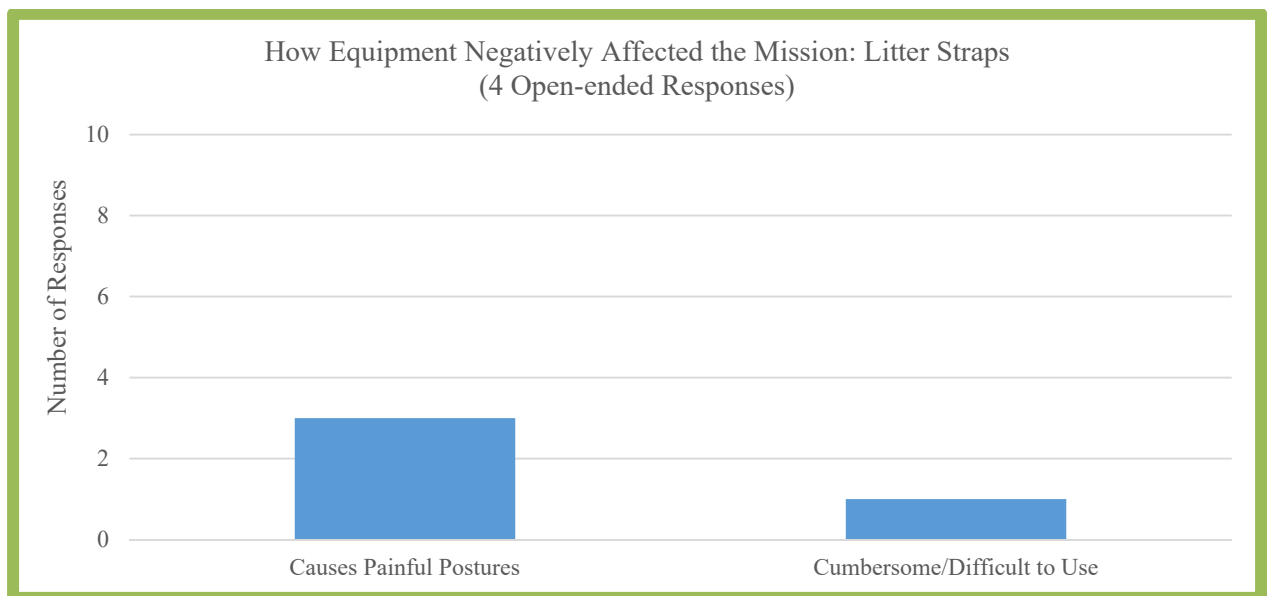


Figure 38. Categorized open-ended responses to Q27 for litter straps.

The most commonly cited issue with the litter straps was “Causes Painful Postures.” Here is a breakdown of the responses to Q27 for litter straps ranked in order of number of times mentioned from most to least:

- o Causes Painful Postures – 3 mentions
- o Cumbersome/Difficult to Use – 1 mention

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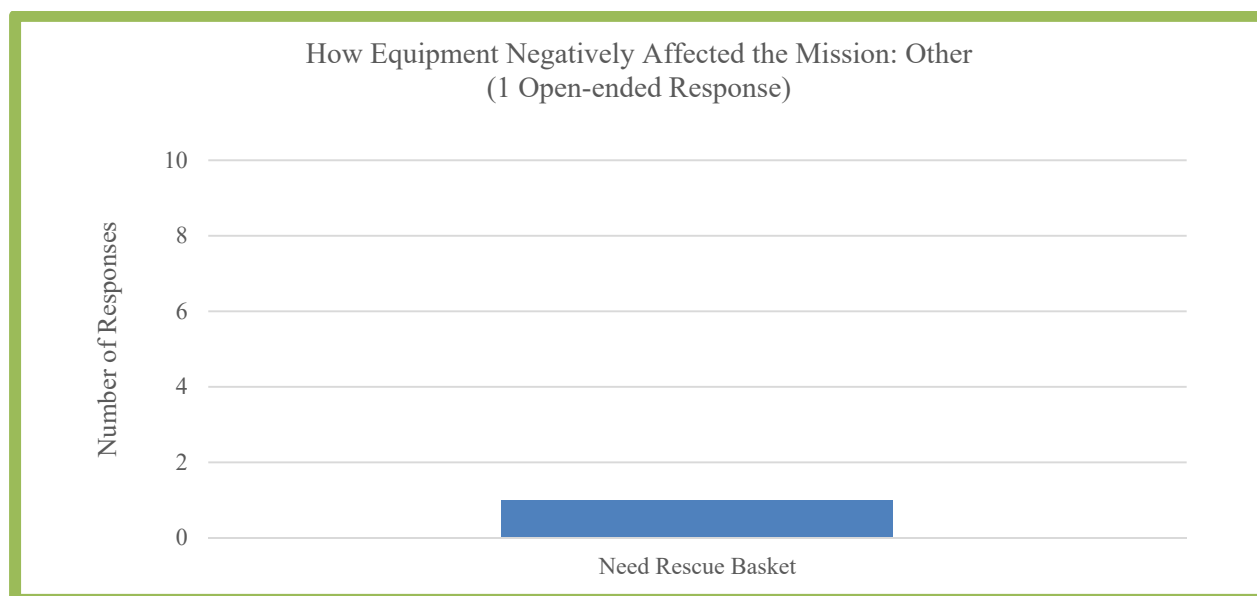


Figure 39. Categorized open-ended responses to Q27 for other equipment.

The only issue related to other equipment was that a medic stated the rescue basket would be a faster option for extracting conscious patients, versus a Sked® BRS or Rescue Seat.

Some respondents marked certain equipment as affecting the mission negatively, but did not provide the reasoning, and sometimes the respondents marked a piece of equipment as not being a significant factor but still commented on how that piece of equipment had negatively affected the mission. Also, some respondents mentioned more than one way a piece of equipment negatively affected the mission. As a result of these imbalances, the numbers on the graph are not necessarily a direct reflection of the number of responses in Table 19.

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Section 4.1: Relation Between Number of Patients and the Use of Painful Postures

Q28. Assuming the average transport time will be approximately 30 minutes (min), would the number of patients cared for increase the likelihood of awkward or painful postures for the care provider?

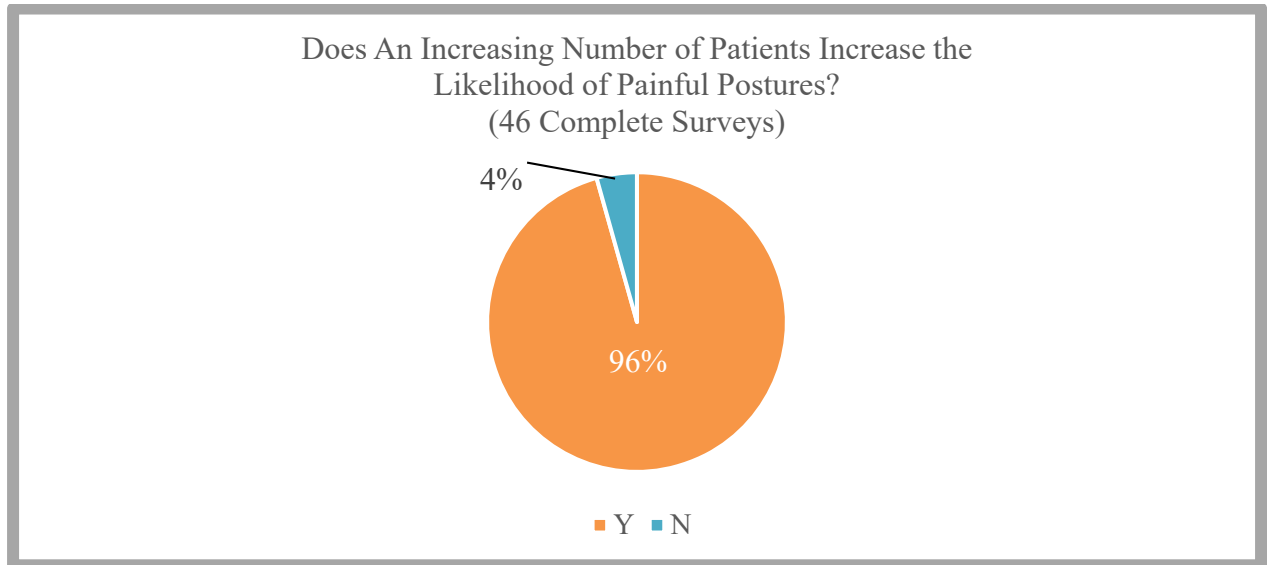


Figure 40. Pie chart of complete valid survey responses to Q28.

Table 22. Responses Indicating if an Increasing Number of Patients Increases the Likelihood of Painful Postures from Complete Valid Surveys

Response	Number of Responses	Response Percentage
Yes	44	95.7%
No	2	4.3%
Skipped	0	0%

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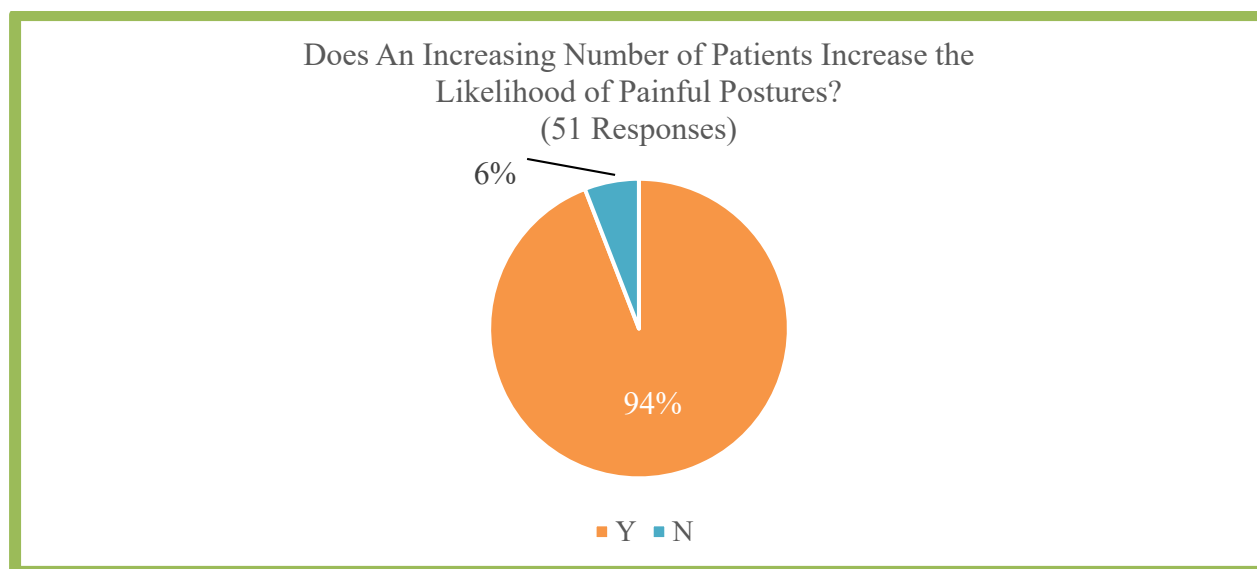


Figure 41. Pie chart of complete and incomplete responses to Q28.

Table 23. Responses Indicating if an Increasing Number of Patients Increases the Likelihood of Painful Postures from All Valid Surveys

Response	Number of Responses	Response Percentage
Yes	48	94.1%
No	3	5.9%
Skipped	9	0%

In both analyses, complete surveys and complete combined with incomplete, the overwhelming majority of respondents agree that increasing the number of patients will increase the likelihood that the care provider will need to assume painful postures to provide treatment.

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Section 4.2: Typical Number of Patients Cared for at One Time

Q29. On average, how many patients do you typically provide care for at one time?

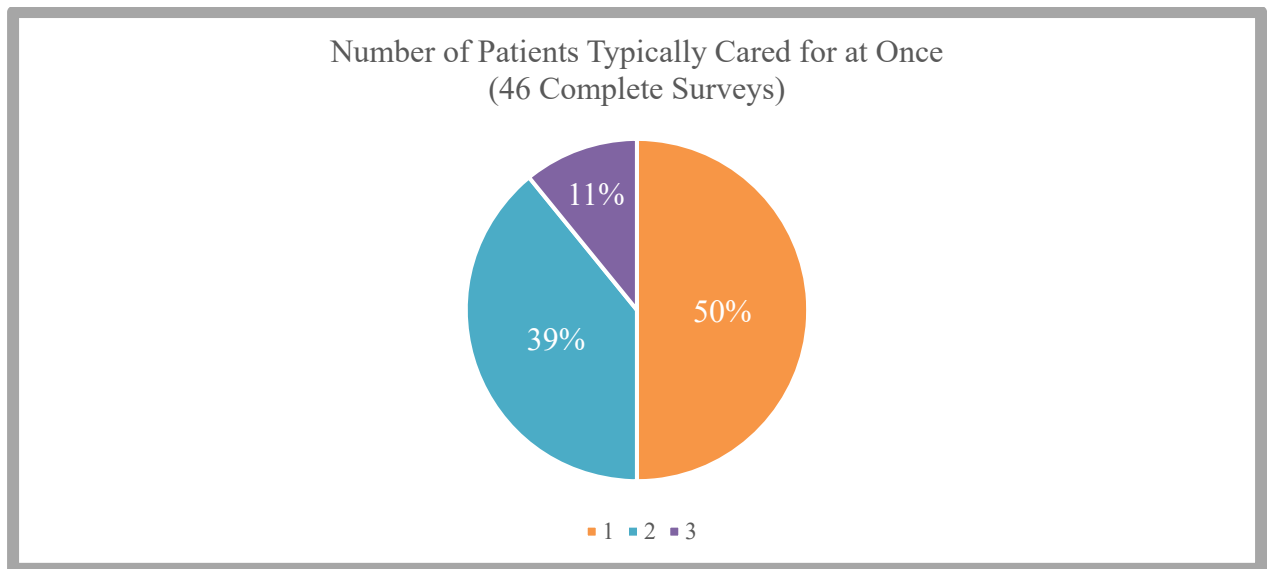


Figure 42. Pie chart of complete valid survey responses to Q29.

Table 24. Number of Patients Usually Cared for at Once According to Complete Valid Surveys

Response	Number of Responses	Response Percentage
1	23	50.0%
2	18	39.1%
3	5	10.9%
Skipped	0	0%

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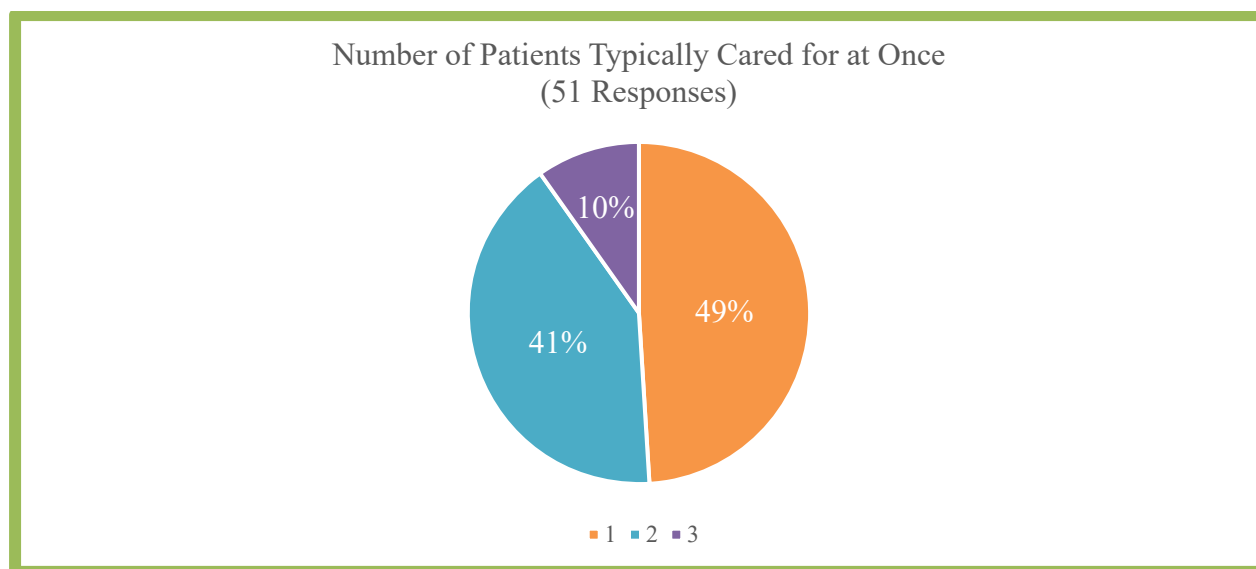


Figure 43. Usual number of patients according to all valid survey responses to Q29.

Table 25. Number of Patients Usually Cared for at Once According to All Valid Surveys

Response	Number of Responses	Response Percentage
1	25	49.0%
2	21	41.2%
3	5	9.8%
Skipped	9	0%

The percentages between complete valid surveys and all valid surveys varies only very slightly. Most often respondents usually care for one patient at a time, second-most often they care for two patients at a time, and a small percentage of respondents care for three patients at a time. The ratio in both analyses is approximately 5:4:1 in order of increasing number of patients.

Section 5: Frequency of Awkward Postures for a Given Task

Q30. Please read each task and check the box under the frequency you have experienced each awkward posture during each task listed. If you have not experienced the posture, leave the box unchecked.

After answering Q30, the respondents were presented with 27 specific tasks, 1 optional “Other” task, and 6 possible postures that might be utilized to perform each task. The possible postures were bending at the waist, kneeling, squatting, overextending, reaching behind you, and

straining to lift heavy weight. Respondents indicated if this posture was required once or more than once per patient for the associated task.

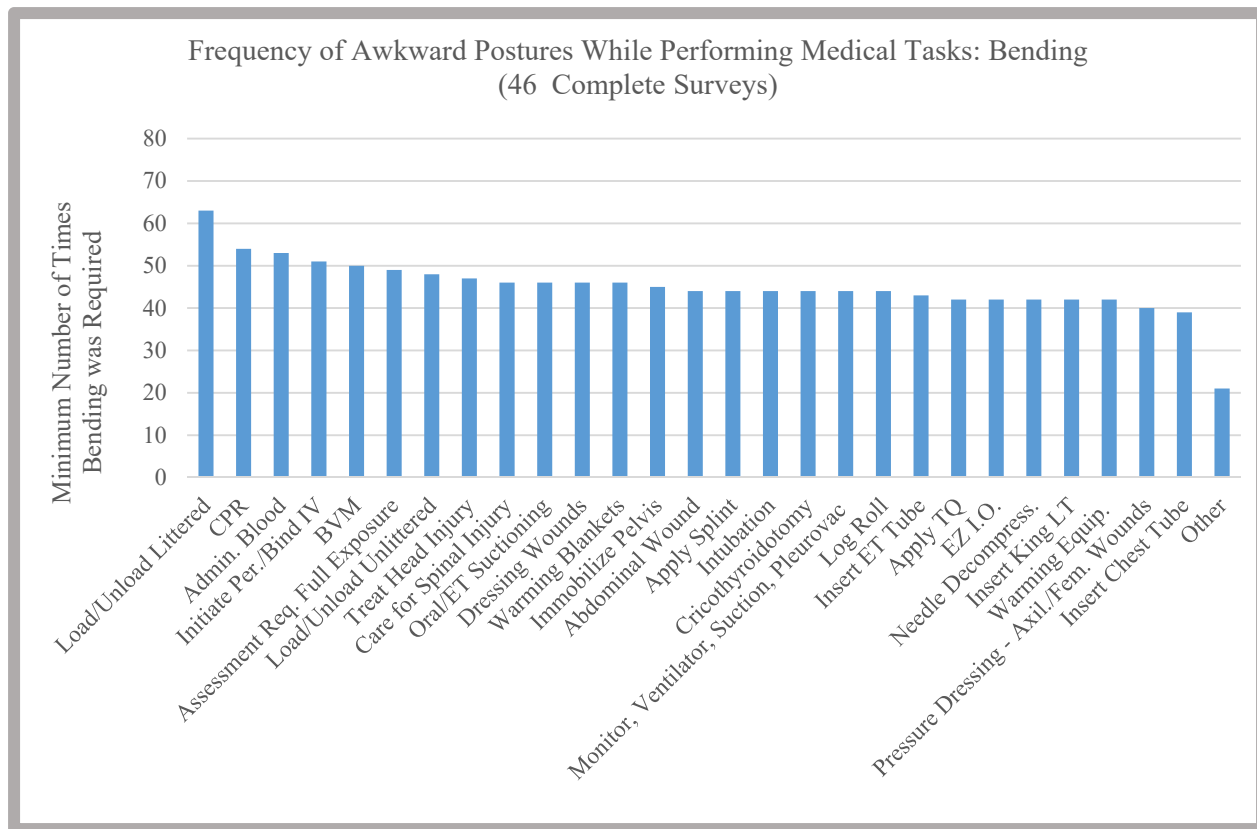


Figure 44. The minimum frequency of bending at the waist for medical tasks.

The task that required “Bending at the Waist” most frequently was “Load/Unload Littered Patients,” cited as being required a minimum of 63 times when combining answers that said the posture was required once or more-than-once per patient among the complete valid surveys.

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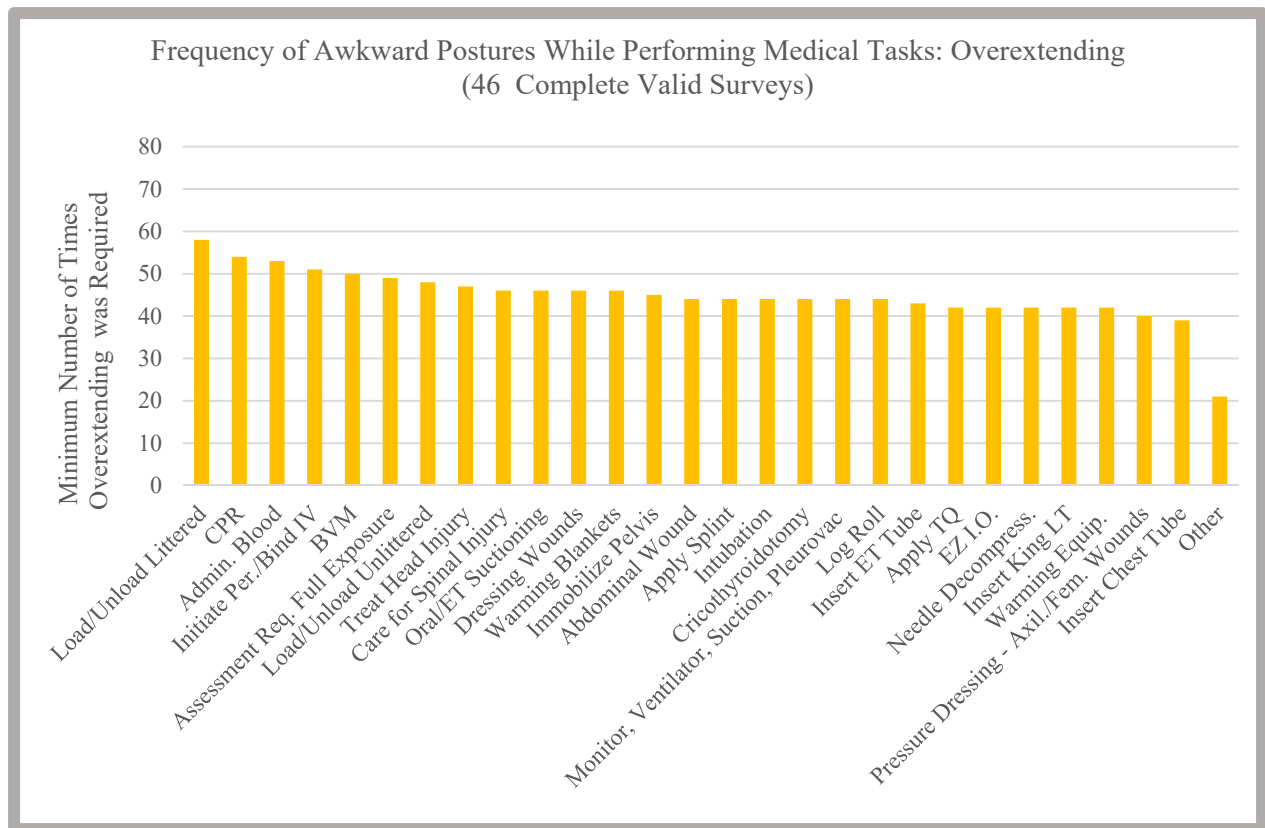


Figure 45. The minimum frequency of overextending for medical tasks.

The task that required “Overextending” most frequently was “Load/Unload Littered Patients,” cited as being required a minimum of 58 times when combining answers that said the posture was required once or more-than-once per patient among the complete valid surveys.

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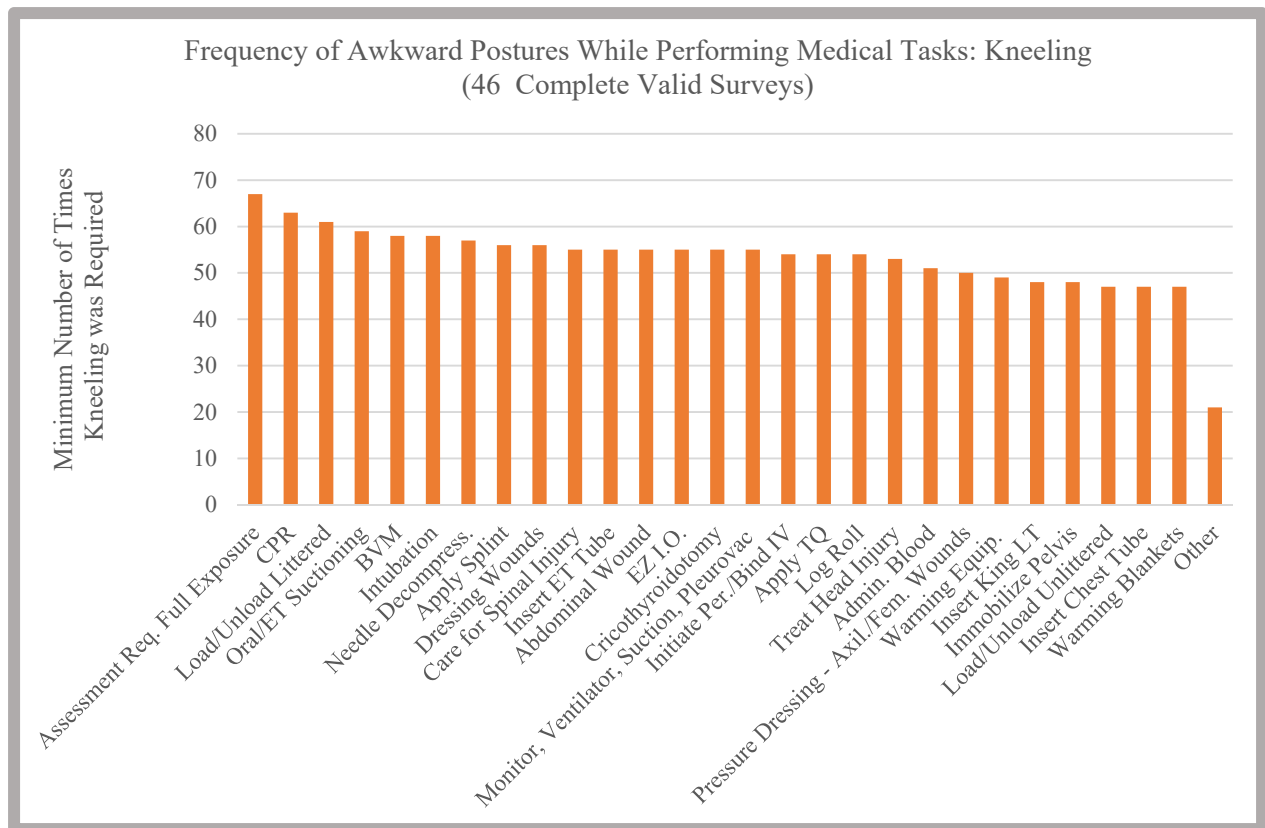


Figure 46. The minimum frequency of kneeling for medical tasks.

The task that required “Kneeling” most frequently was “Assessment Requiring Full Exposure” of the patient, cited as being required a minimum of 67 times when combining answers that said the posture was required once or more-than-once per patient among the complete valid survey.

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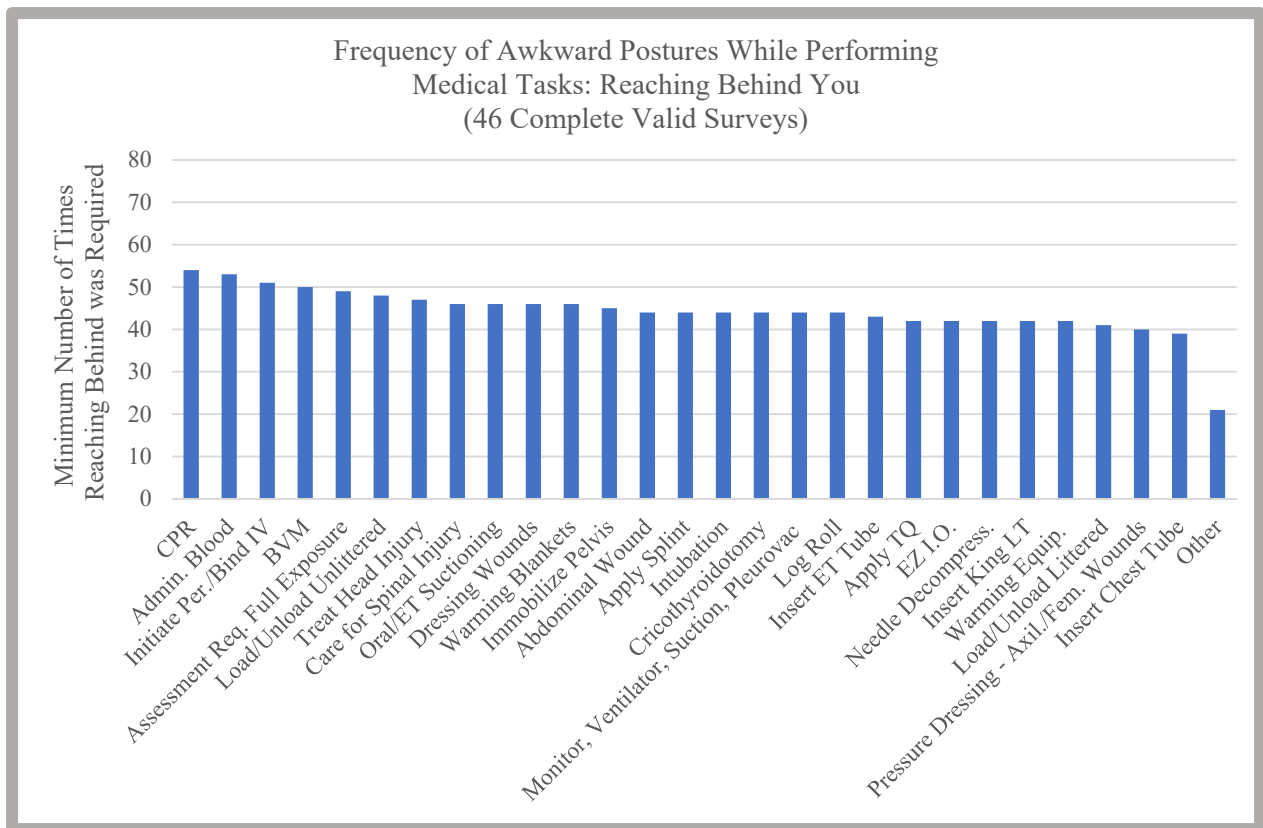


Figure 47. The minimum frequency of reaching behind you for medical tasks.

The task that required “Reaching Behind You” most frequently was “CPR,” cited as being required a minimum of 54 times when combining answers that said the posture was required once or more-than-once per patient among the complete valid survey.

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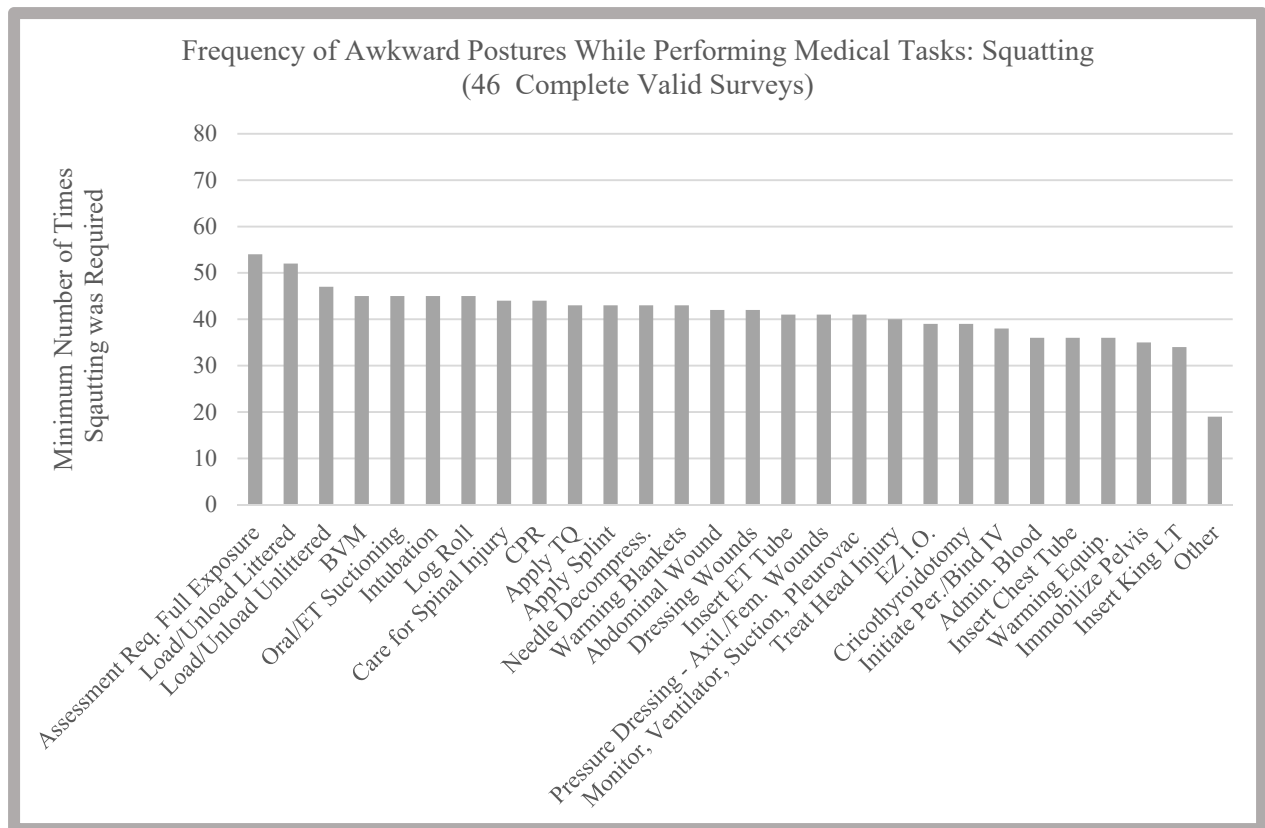


Figure 48. The minimum frequency of squatting for medical tasks.

The task that required “Squatting” most frequently was “Assessment Requiring Full Exposure,” cited as being required a minimum of 54 times when combining answers that said the posture was required once or more-than-once per patient among the complete valid surveys.

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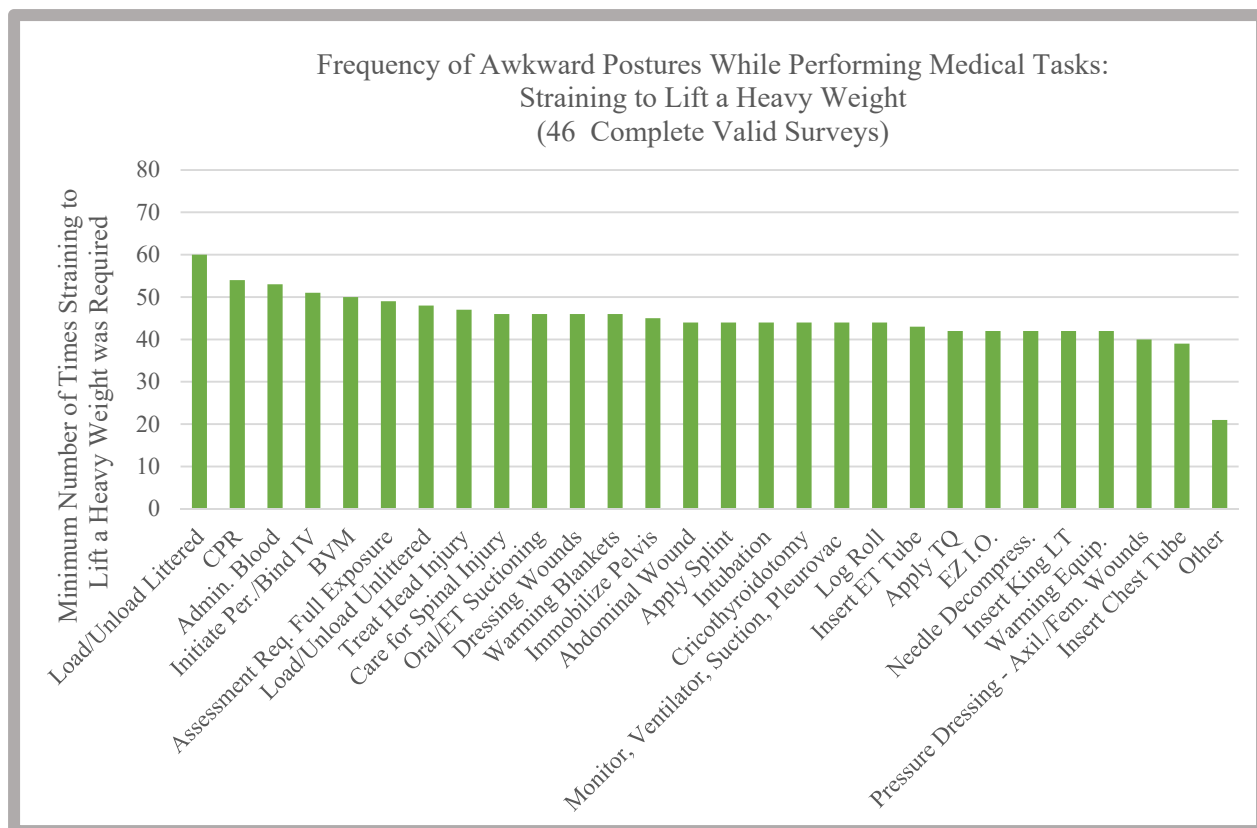


Figure 49. The minimum frequency of straining to lift a heavy weight for medical tasks.

The task that required “Straining to Lift a Heavy Weight” most frequently was “Load/Unload a Littered Patient,” cited as being required a minimum of 60 times when combining answers that said the posture was required once or more-than-once per patient among the complete valid surveys.

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A second analysis for all valid surveys was not performed on the postures section because if a posture was not required for an action, the posture was to be left unmarked. This method left the deliberately unmarked posture responses indistinguishable from the skipped questions in this section. Due to the fact that most respondents with incomplete valid surveys did not mark any postures for any actions, it is reasonable to assume that the section was skipped (instead of left blank, which would have meant that the actions did not require painful postures) and not include the incomplete surveys in the frequency analysis.

Section 6: Occupational Injuries/Discomforts

Q31. Check the boxes below for any occupational injuries or discomfort you have experienced associated with any postures during patient loading and patient care.

Table 26. Tally of Injuries Sustained and Report Status from Complete Surveys

Location of Injury	Reported/Treated	Not Reported	Total Number of Injuries	Area Uninjured
Lower Back	18	23	41	6
Knee injury	12	25	37	9
Neck	10	22	32	14
Shoulder Injury	13	14	27	19
Upper Back	9	13	22	24
Ankle	4	9	13	33
Hip Injury	4	7	11	35
Wrist	4	7	11	35
Other	2	9	11	35
Elbow	4	6	10	36

Note. One respondent reported more than one back injury, which is why the total number of injuries plus uninjured areas for the lower back category is greater than 46.

None of the incomplete valid surveys contained information on injuries sustained, making it impossible to distinguish between uninjured areas and skipped questions. Due to the large amount of unanswered questions surrounding the injury section of the questionnaire in the incomplete surveys, it is likely that these sections were skipped, so only the complete valid surveys were analyzed. Skipped answers in complete valid surveys were interpreted as the area not being injured due to the format of the survey (respondents only marked areas injured, there was not an option to mark an area uninjured, as uninjured areas were intended to be left blank).

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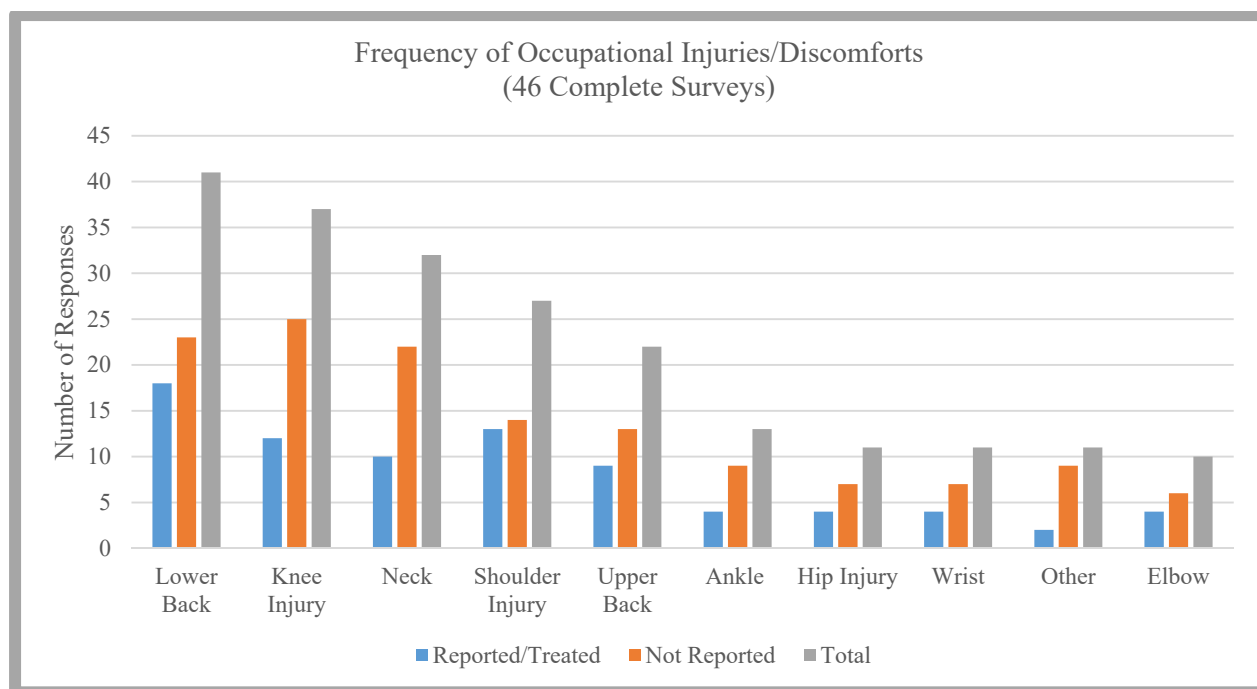


Figure 50. Frequency of occupational injuries.

Lower back, knee, neck, shoulder, and upper back injuries were prevalent among respondents. For all injuries, more cases were unreported than were reported. Lower back injuries were the most common, suffered by 87% of respondents (one respondent reported two lower back injuries).

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Q32. What caused your (un)reported neck injury/discomfort?

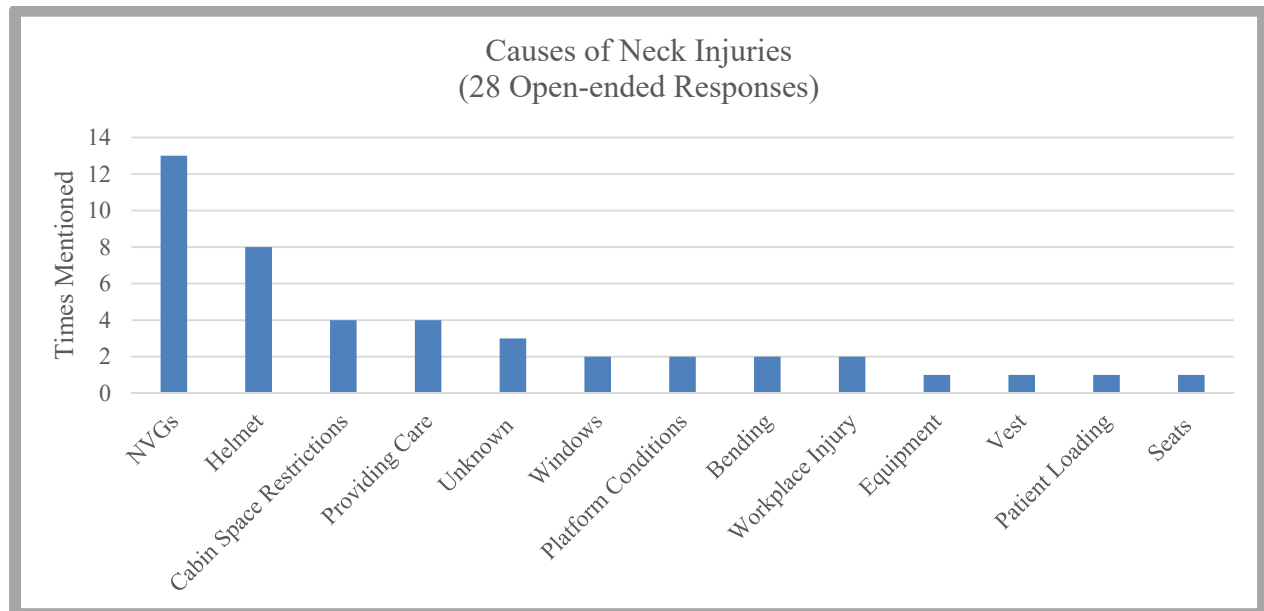


Figure 51. Causes of neck injuries.

The most commonly cited cause of neck injuries among respondents was “NVGs.” Here is a breakdown of the responses to Q32 ranked in order of number of times mentioned from most to least:

- o NVGs – 13 mentions
- o Helmet – 8 mentions
- o Cabin Space Restrictions – 4 mentions
- o Providing Care – 4 mentions
- o Unknown – 3 mentions
- o Windows – 2 mentions
- o Platform Conditions – 2 mentions
- o Bending – 2 mentions
- o Workplace Injury – 2 mentions
- o Equipment – 1 mention
- o Vest – 1 mention
- o Patient Loading – 1 mention
- o Seats – 1 mention

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Q33. What caused your (un)reported knee injury/discomfort?

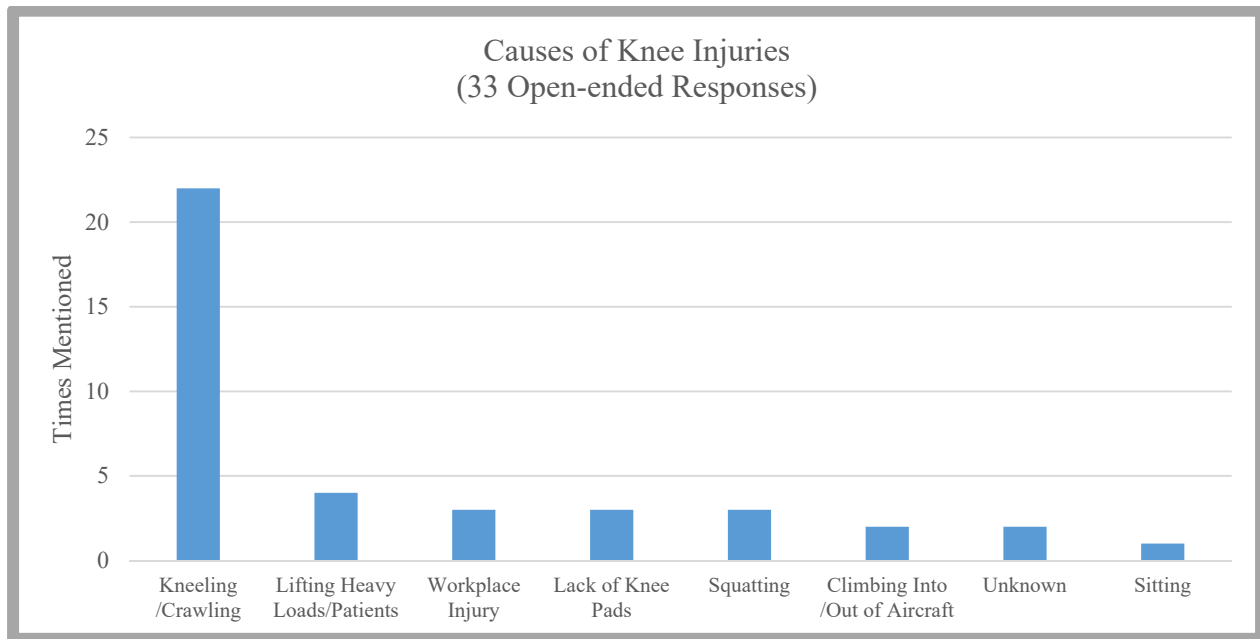


Figure 52. Causes of knee injuries.

The most commonly cited cause of knee injuries among respondents was “Kneeling/Crawling,” which were often required during patient care. Here is a breakdown of the responses to Q33 ranked in order of number of times mentioned from most to least:

- o Kneeling/Crawling – 22 mentions
- o Lifting Heavy Loads/Patients – 4 mentions
- o Workplace Injury – 3 mentions
- o Lack of Knee Pads – 3 mentions
- o Squatting – 3 mentions
- o Climbing Into/Out of Aircraft – 2 mentions
- o Unknown – 2 mentions
- o Sitting – 1 mention

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Q34. What caused your (un)reported hip injury/discomfort?

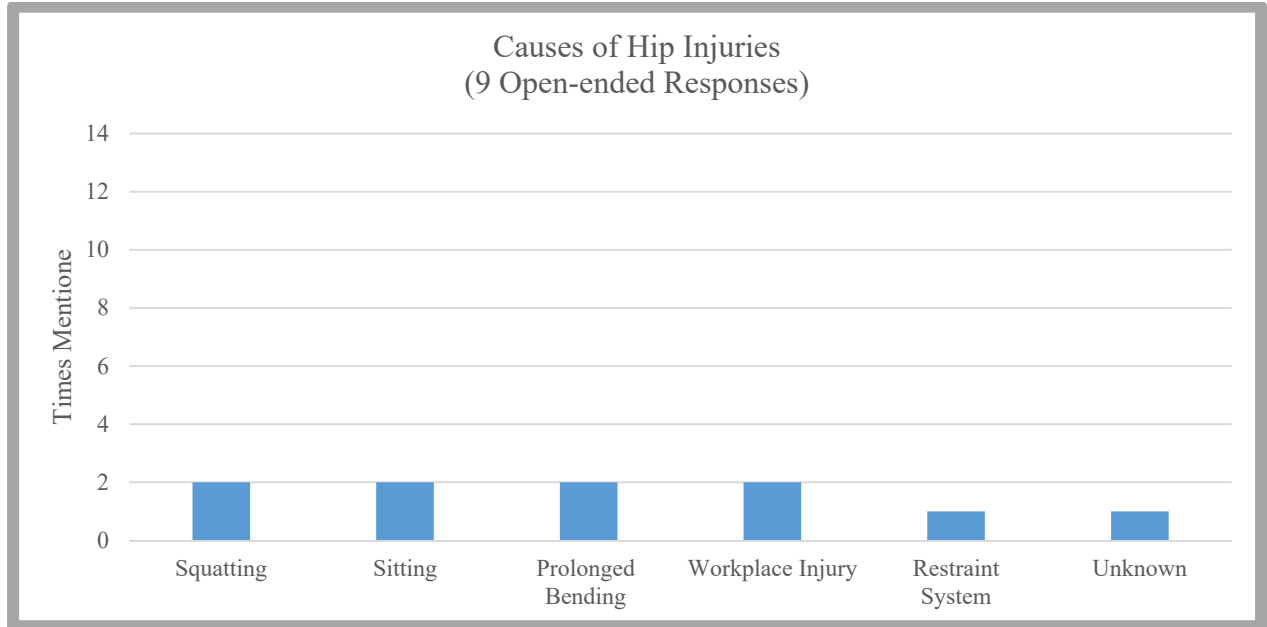


Figure 53. Causes of hip injuries.

The most commonly cited causes of hip injuries among respondents were “Squatting,” “Sitting,” “Prolonged Bending,” and “Workplace Injury.” Here is a breakdown of the responses to Q34 ranked in order of number of times mentioned from most to least:

- o Squatting – 2 mentions
- o Sitting – 2 mentions
- o Prolonged Bending – 2 mentions
- o Workplace Injury – 2 mentions
- o Restraint System – 1 mention
- o Unknown – 1 mention

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Q35. What caused your (un)reported shoulder injury/discomfort?

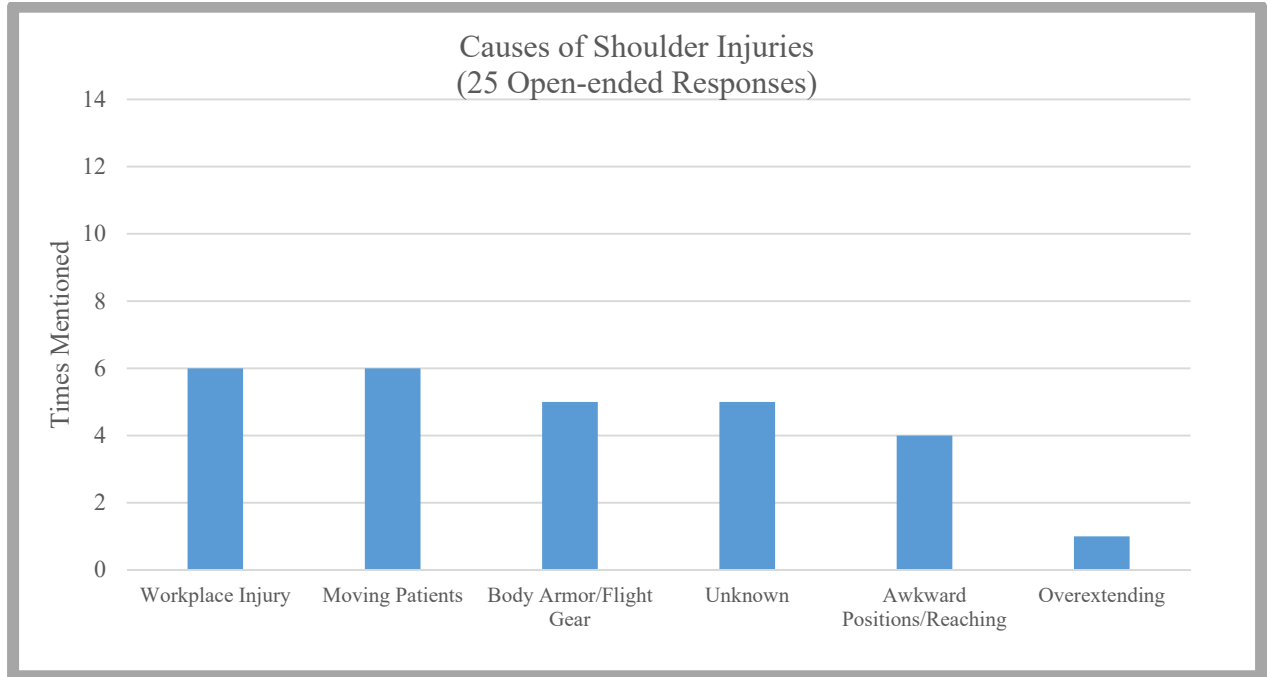


Figure 54. Causes of shoulder injuries.

The most commonly cited causes of shoulder injuries among respondents were “Workplace Injury” and “Moving Patients.” Here is a breakdown of the responses to Q35 ranked in order of number of times mentioned from most to least:

- o Workplace Injury – 6 mentions
- o Moving Patients – 6 mentions
- o Body Armor/Flight Gear – 5 mentions
- o Unknown – 5 mentions
- o Awkward Positions/Reaching – 4 mentions
- o Overextending – 1 mention

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Q36. What caused your (un)reported ankle injury/discomfort?

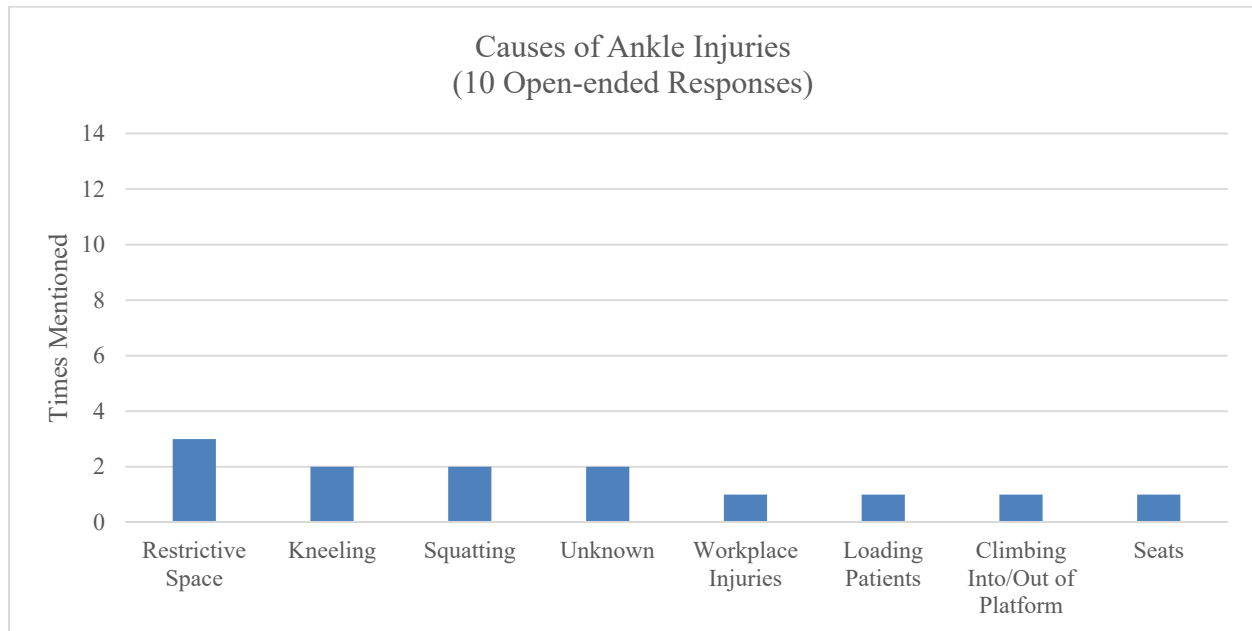


Figure 55. Causes of ankle injuries.

The most commonly cited cause of ankle injuries among respondents was “Restrictive Space.” Here is a breakdown of the responses to Q36 ranked in order of number of times mentioned from most to least:

- o Restrictive Space – 3 mentions
- o Kneeling – 2 mentions
- o Squatting – 2 mentions
- o Unknown – 2 mentions
- o Workplace Injury – 1 mention
- o Loading Patients – 1 mention
- o Climbing Into/Out of Platform – 1 mention
- o Seats – 1 mention

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Q37. What caused your (un)reported elbow injury/discomfort?

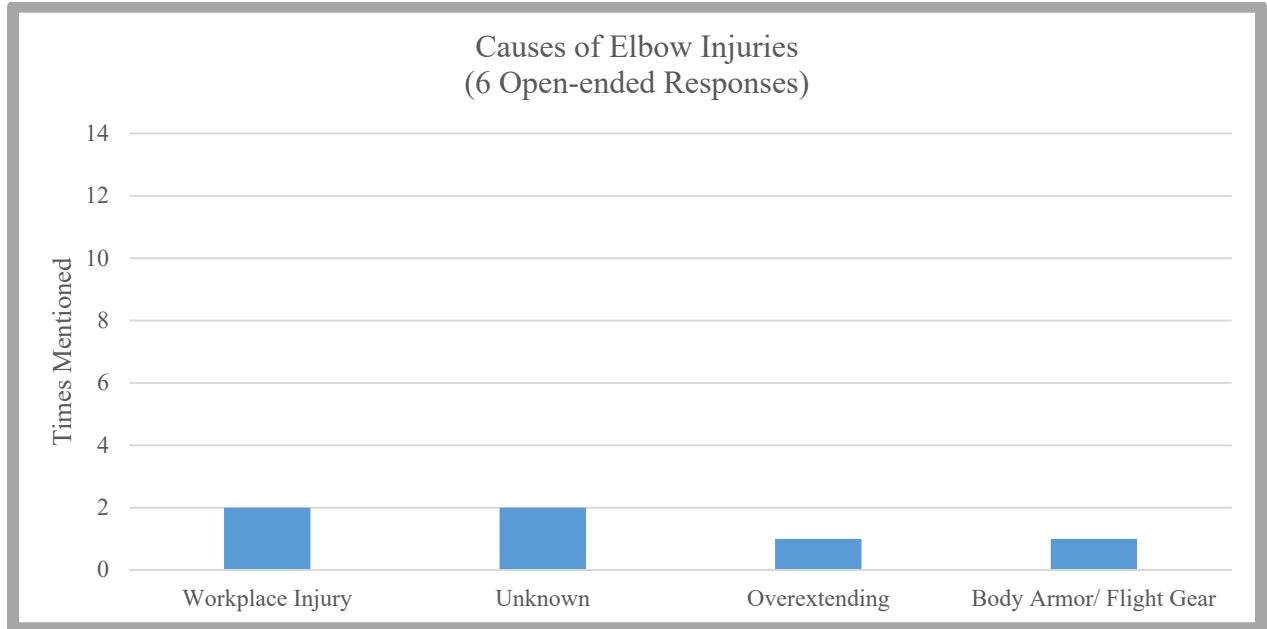


Figure 56. Causes of elbow injuries.

The most commonly cited causes of elbow injuries among respondents were “Workplace Injury” and “Unknown.” Here is a breakdown of the responses to Q37 ranked in order of number of times mentioned from most to least:

- o Workplace Injury – 2 mentions
- o Unknown – 2 mentions
- o Overextending – 1 mention
- o Body Armor/Flight Gear – 1 mention

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Q38. What caused your (un)reported wrist injury/discomfort?

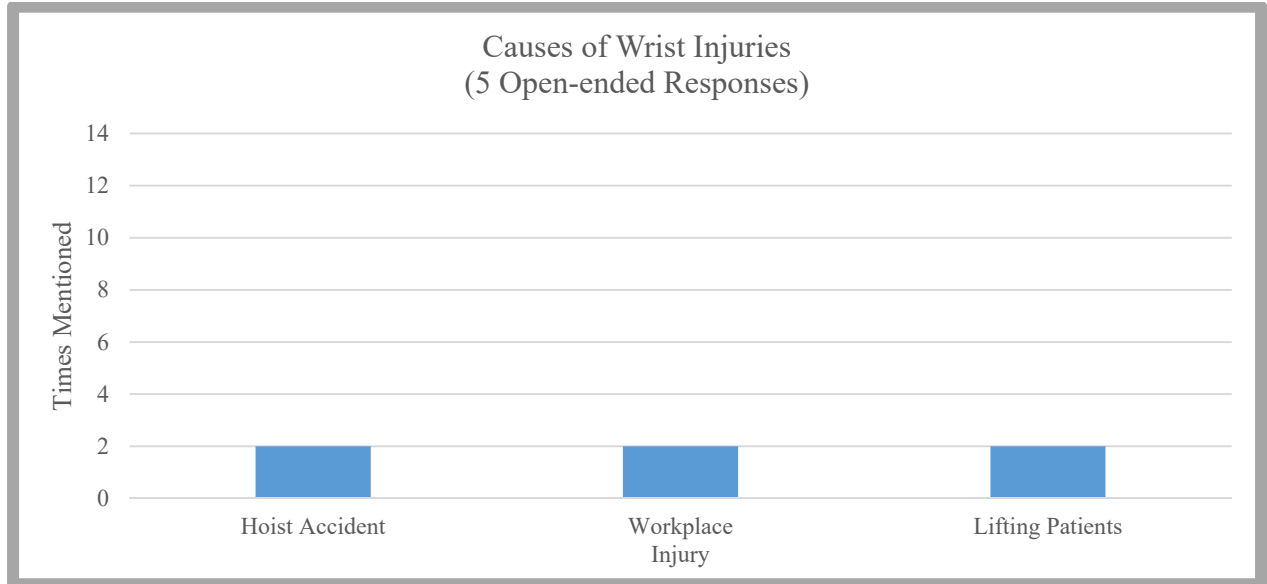


Figure 57. Causes of wrist injuries.

All causes of wrist injuries were equally common, they include “Hoist Accident,” “Workplace Injury,” and “Lifting Patients,” all mentioned two times.

Q39. What caused your (un)reported upper back injury/discomfort?

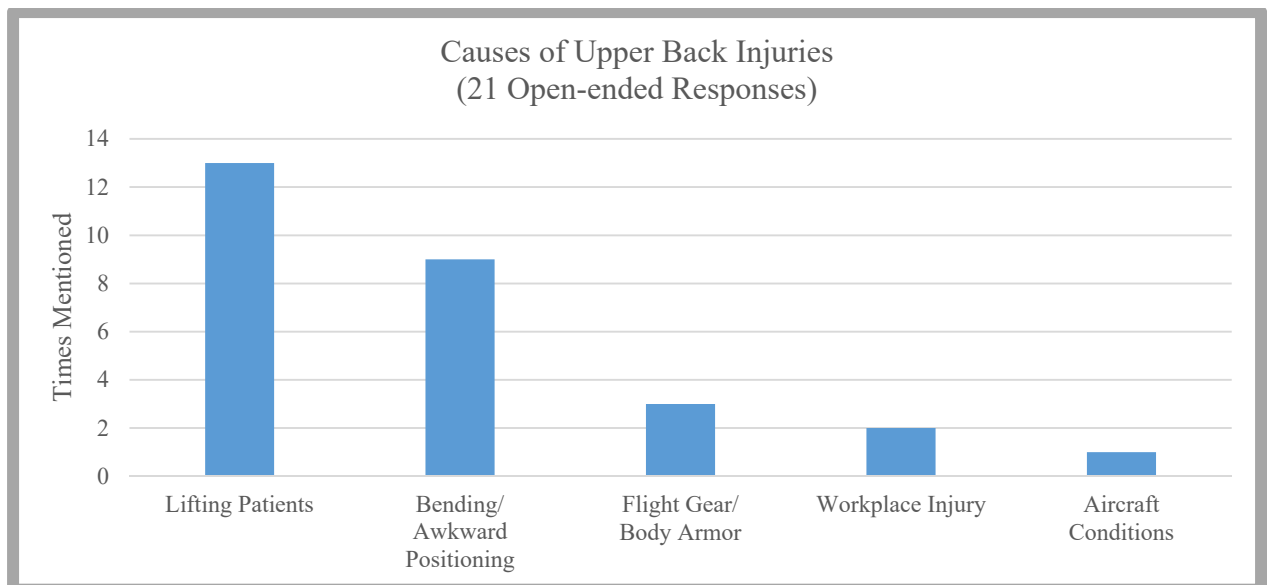


Figure 58. Causes of upper back injuries.

The most commonly cited cause of upper back injuries among respondents was “Lifting Patients.” Here is a breakdown of the responses to Q39 ranked in order of number of times mentioned from most to least:

- o Lifting Patients – 13 mentions
- o Bending/Awkward Positions – 9 mentions
- o Flight Gear/Body Armor – 3 mentions
- o Workplace Injuries – 2 mentions
- o Aircraft Conditions – 1 mention

Q40. What caused your (un)reported lower back injury/discomfort?

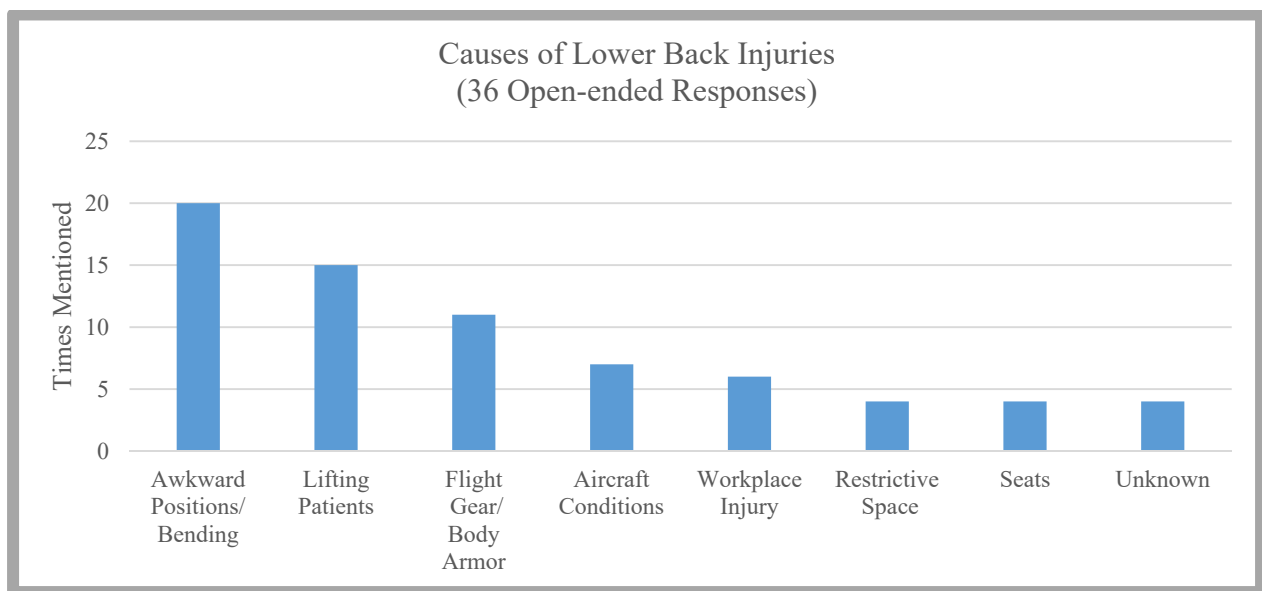


Figure 59. Causes of lower back injuries.

The most commonly cited cause of lower back injuries among respondents was “Awkward Positions/Bending.” Here is a breakdown of the responses to Q40 ranked in order of number of times mentioned from most to least:

- o Awkward Positions/Bending – 20 mentions
- o Lifting Patients – 15 mentions
- o Flight Gear/Body Armor – 11 mentions
- o Aircraft Conditions – 7 mentions
- o Workplace Injury – 6 mentions
- o Restrictive Space – 4 mentions
- o Seats – 4 mentions
- o Unknown – 4 mentions

Q41. You chose “Other” injury. What was this injury/discomfort and what caused it?

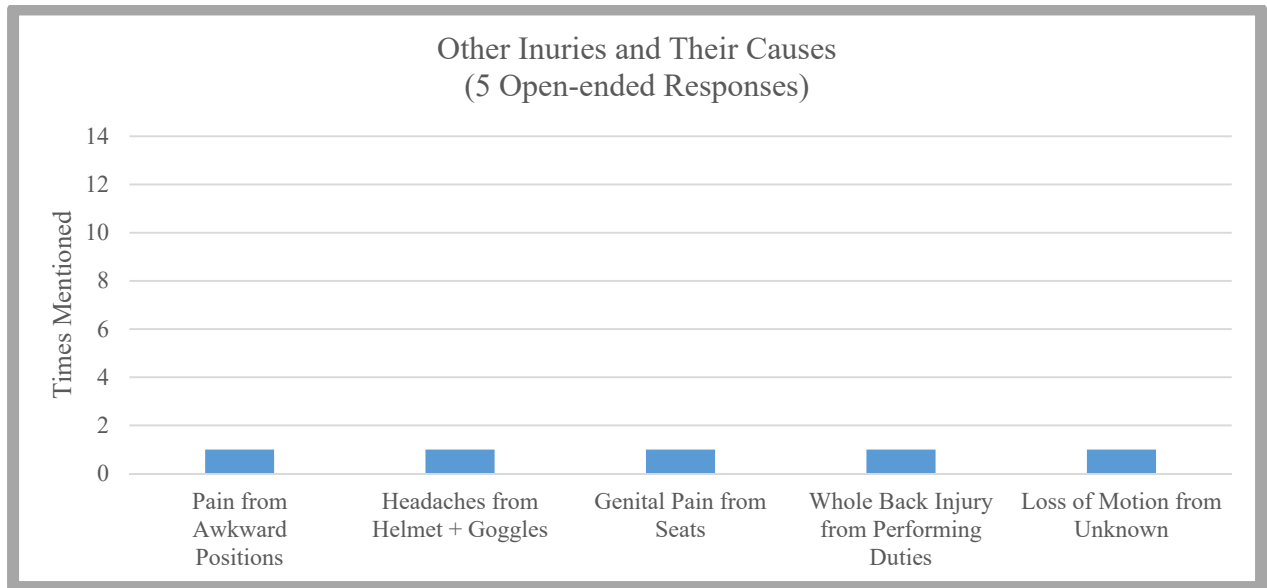


Figure 60. Types and causes of other injuries.

All “Other” injuries were mentioned one time each, and vary in their nature and causes. One commenter had pain from awkward positions, location was not specified. Commenters also had headaches from wearing their helmets and NVGs, genital pain from sitting on the stiff seats for lengths of time, whole back injury from performing crewmember duties, and loss of range of motion from an unspecified cause and in an unspecified location.

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Section 7: Reasons for Not Reporting and Primary Sources of Pain

All graphs in this section are based on all valid responses, complete and incomplete.

Q42. For injuries that you did not report, what were your reasons for not reporting?

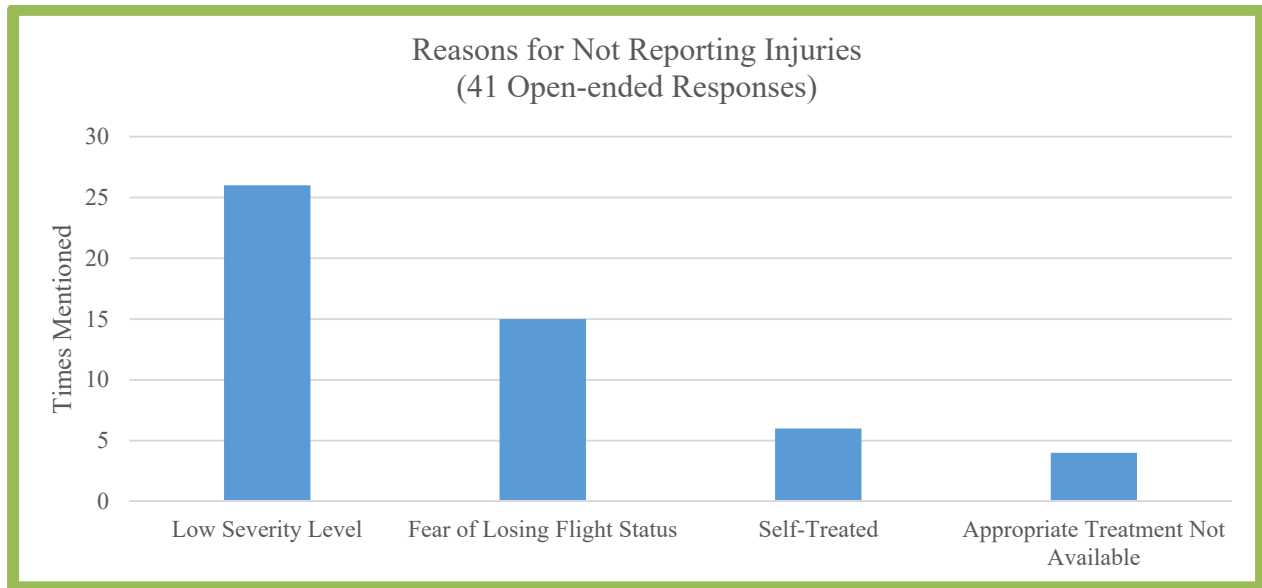


Figure 61. Reasons that respondents chose not to report their injuries.

The most common reason that respondents chose not to report injuries was “Low Severity Level.” Here is a breakdown of the responses to Q42 ranked in order of number of times mentioned from most to least:

- o Low Severity Level – 26 mentions
- o Fear of Losing Flight Status – 15 mentions
- o Self-Treated – 6 mentions
- o Appropriate Treatment not Available – 2 mentions

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Q43. Do any specific postures or tasks cause your primary source of pain? Please explain.

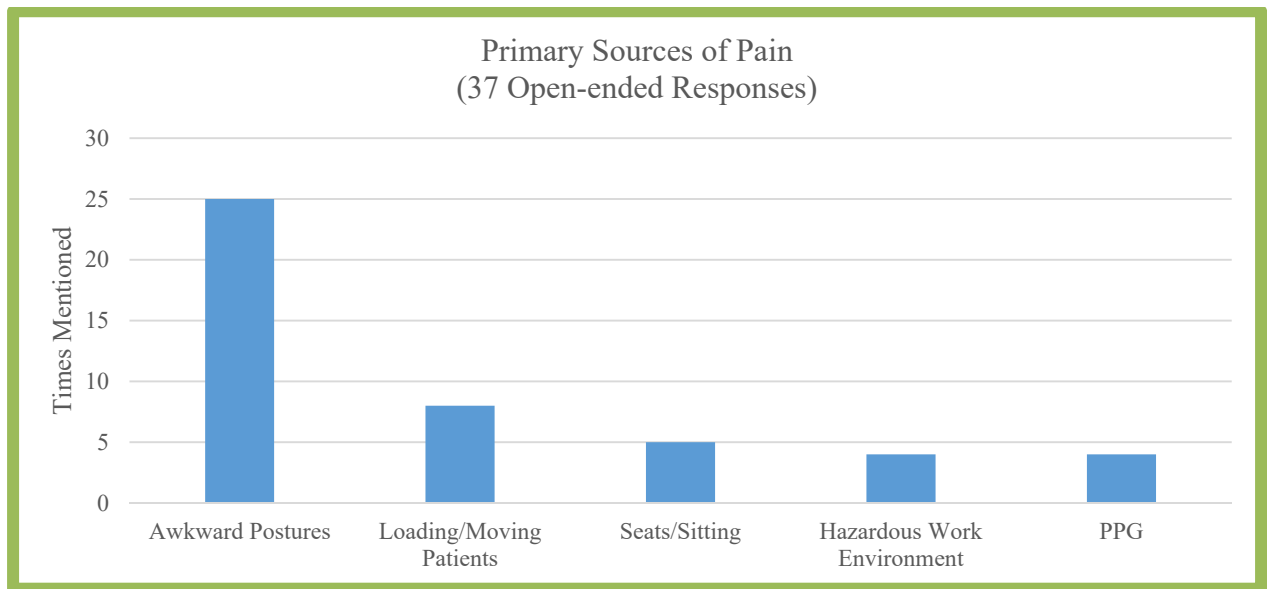


Figure 62. Primary sources of pain.

The most common primary source of pain among respondents was “Awkward Postures.” Here is a breakdown of the responses to Q43 ranked in order of number of times mentioned from most to least:

- o Awkward Postures – 25 mentions
- o Loading/Moving Patients – 8 mentions
- o Seats/Sitting – 5 mentions
- o Hazardous Work Environment – 4 mentions
- o PPG – 4 mentions

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Q44. Please discuss any other injuries you may have experienced related to patient care/loading.

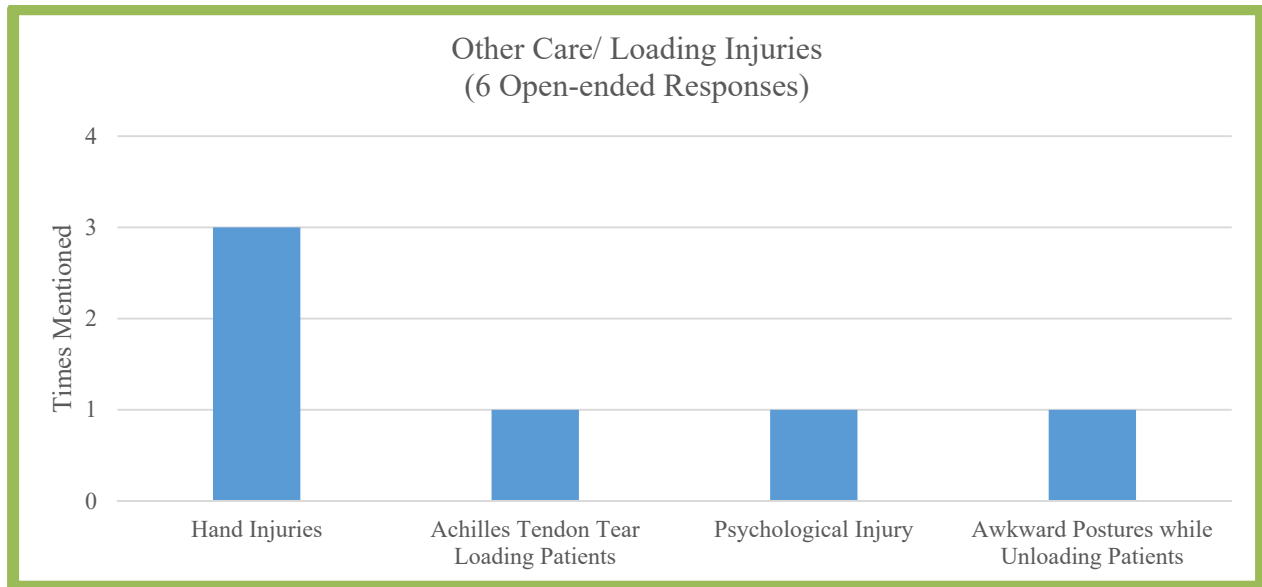


Figure 63. Injuries not listed previously in the survey.

The most common injury that respondents did not mention earlier in the survey was “Hand Injuries.” Here is a breakdown of the responses to Q44 ranked in order of number of times mentioned from most to least:

- Hand Injuries – 3 mentions
- Achilles Tendon Tear Loading Patients – 1 mention
- Psychological Injury – 1 mention
- Awkward Postures while Unloading Patients – 1 mention

ANOVA Analysis

ANOVA analyses were performed by using Excel’s filter tables to sort the data into categories and then performing single-factor ANOVA analysis using Excel’s Data Analysis ToolPak add-in to obtain the *P*-values. RStudio was then used to obtain the power of the sample using the pwr pack function `pwr.t2n.test` with the following parameters.

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Table 27. Parameters Used for RStudio's Pwr.t2n.test Function

Parameter	Value
$N1$	Number of observations in the first group
$N2$	Number of observations in the second group
Significance Level	.05
d	Calculated

The d -value in Table 27 is the observed effect size according to Cohen (1988) and is calculated using the following equation:

$$d = \frac{N1 - N2}{\sqrt{\frac{SD_1^2 + SD_2^2}{2}}}$$

Where SD_1 and SD_2 are the standard deviations of the first and second group, respectively.

The P -values that resulted from ANOVA analyses indicate whether or not there is a statistically significant difference between the means of two groups. If the resulting P -value is less than the significance level used (0.05 in this survey) then there is a statistically significant difference between the groups being analyzed.

Power analyses were run on the ANOVA results after the P -values were calculated. The power value that results from power analysis is equal to $1 - (\text{probability of making a type II error})$, and indicates whether or not the sample size being analyzed possesses sufficient power to yield true results. A power of $P = 0.8$ is typically considered sufficient power (Cohen, 1992).

The confidence intervals were calculated in Excel using the following equations:

$$\text{Confidence Interval Limits} = \bar{x}_1 - \bar{x}_2 \pm t * S_p * \left(\frac{1}{n_1} - \frac{1}{n_2}\right)$$

$$\text{Where } S_p = \sqrt{\frac{(n_1-1)*s_1^2 + (n_2-1)*s_2^2}{n_1+n_2-2}}$$

$\bar{x}_1$ is the mean of group 1

$\bar{x}_2$ is the mean of group 2

t was taken from the 95% confidence value on a standard t -table using $n_1 + n_2 - 2$ degrees of freedom.

n_1 is the number of samples in group 1

n_2 is the number of samples in group 2

The P -values, power values, and confidence interval (CI) limits related to the ANOVA analyses performed are recorded in Tables 28 through 31.

Table 28. ANOVA Results Comparing Heights of Respondents that Had Injuries vs. Those that Did Not

Results Relating Injury to Height, Complete Valid Surveys									
	Neck	Knee	Hip	Shoulder	Ankle	Elbow	Wrist	Upper Back	Lower Back
P-Value	0.90	0.61	0.44	0.10	0.03	0.12	0.09	0.18	0.65
Power	0.052	0.088	0.125	0.365	0.644	0.399	0.478	0.259	0.081
Upper CI Limit	1.88	1.72	1.32	0.29	-0.23	0.47	0.31	0.60	2.11
Lower CI Limit	-2.12	-2.91	-2.97	-3.34	-4.10	-3.87	-3.88	-3.02	-3.35

The respondent's heights were divided into groups based on whether or not the respondent was injured in each location. A statistically significant relation was found between ankle injuries (highlighted in Table 28) and care provider height, but the power value was below .8, so the result does not have sufficient power to detect significance. The comparisons in this category all possess too little power to detect a statistical significance.

Table 29. ANOVA Results Comparing Weights of Respondents that Had Injuries vs. Those that Did Not

Results Relating Injury to Weight, Complete Valid Surveys									
	Neck	Knee	Hip	Shoulder	Ankle	Elbow	Wrist	Upper Back	Lower Back
P-Value	0.90	0.87	0.76	0.75	0.44	0.51	0.31	0.57	0.89
Power	0.052	0.053	0.059	0.061	0.118	0.101	0.187	0.087	0.053
Upper CI Limit	17.68	20.82	20.63	13.04	10.30	12.42	8.73	10.95	24.27
Lower CI Limit	-15.56	-17.73	-15.19	-17.99	-23.44	-24.49	-26.71	-19.57	-21.15

The respondent's weights were divided into groups based on whether or not the respondent was injured in each location. No statistically significant results were produced by this analysis.

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Table 30. ANOVA Results Comparing the Minimum Number of Times a Posture was Required of Respondents that Had Injuries vs. Those that Did Not

Results Relating Injuries to Repetitions of Postures, Complete Valid Surveys										
Posture	Value	Neck	Knee	Hip	Shoulder	Ankle	Elbow	Wrist	Upper Back	Lower Back
Bending	P-Value	0.16	0.07	0.66	0.31	0.65	0.52	0.74	0.72	0.19
	Power	0.284	0.428	0.072	0.170	0.073	0.096	0.062	0.065	0.236
	Upper CI Limit	12.94	16.50	10.15	10.74	9.67	11.35	9.68	8.39	17.23
	Lower CI Limit	-2.15	-0.77	-6.47	-3.53	-6.08	-5.80	-6.96	-5.81	-3.45
Kneeling	P-Value	0.13	0.03	0.78	0.87	0.85	0.63	0.88	0.96	0.19
	Power	0.308	0.530	0.072	0.053	0.054	0.072	0.053	0.050	0.257
	Upper CI Limit	11.71	15.57	6.29	6.85	7.60	5.77	6.77	6.40	15.17
	Lower CI Limit	-1.54	0.58	-8.37	-5.85	-6.29	-9.37	-7.90	-6.12	-3.04
Squatting	P-Value	0.08	0.03	0.25	0.07	0.05	0.13	0.07	0.24	0.07
	Power	0.418	0.622	0.207	0.441	0.499	0.323	0.450	0.216	0.602
	Upper CI Limit	13.78	17.41	12.67	13.02	14.64	14.53	15.00	10.91	19.12
	Lower CI Limit	-0.81	0.78	-3.39	-0.58	-0.16	-1.88	-0.71	-2.78	-0.75
Overex-tending	P-Value	0.16	0.12	0.57	0.02	0.26	0.27	0.47	0.37	0.04
	Power	0.280	0.355	0.092	0.633	0.208	0.208	0.112	0.146	0.747
	Upper CI Limit	12.19	14.70	10.13	13.93	11.59	12.55	10.71	9.72	19.45
	Lower CI Limit	-2.14	-1.84	-5.62	1.02	-3.16	-3.56	-5.00	-3.66	0.36
Reaching Behind You	P-Value	0.24	0.02	0.60	0.09	0.22	0.29	0.36	0.42	0.04
	Power	0.212	0.735	0.081	0.400	0.228	0.173	0.147	0.124	0.785
	Upper CI Limit	10.94	16.55	9.55	11.76	11.41	11.79	10.93	8.99	18.91
	Lower CI Limit	-2.87	1.19	-5.54	-0.93	-2.68	-3.67	-4.06	-3.84	0.69
Straining to Lift a Heavy Weight	P-Value	0.06	0.02	0.40	0.08	0.17	0.33	0.42	0.17	0.06
	Power	0.537	0.782	0.133	0.432	0.268	0.162	0.126	0.280	0.684
	Upper CI Limit	12.06	14.86	9.68	10.86	10.77	10.48	9.57	9.75	16.23
	Lower CI Limit	-0.15	0.88	-3.95	-0.64	-1.98	-3.58	-4.07	-1.73	-0.51

A statistically significant relation was found between knee injuries and the frequency at which care providers utilized the postures kneeling, squatting, reaching behind themselves, and straining to lift a heavy weight. Statistically significant relations were also found between

shoulder injuries and overextending, and between lower back injuries and the postures overextending and reaching behind themselves. All statistically significant values are highlighted in Table 30. None of the relations found in Table 30 can be substantiated, as none of the relations possess sufficient power.

Table 31. ANOVA Results and Power Comparing the Minimum Number of Times a Posture was Required of Respondents ≤ 69.09 in. vs. Those > 69.09 in. Tall

Results Relating Awkward Postures to Height, Complete Valid Surveys						
	Bending	Kneeling	Squatting	Overextending	Reaching Behind You	Lifting
<i>P</i> -Value	0.43	0.22	0.80	0.48	0.05	0.97
Power	0.122	0.217	0.057	0.106	0.560	0.050
Upper CI Limit	4.63	2.52	6.61	4.72	0.01	6.47
Lower CI Limit	-10.70	-10.84	-8.49	-9.85	-13.42	-6.27

There were no statistically significant relations found between the care provider's height and the awkward postures that they had to assume.

Fisher's Exact Analysis

The Fisher's exact analysis was performed in Excel. Fisher's exact for two-by-two tables examines two non-overlapping groups that fit into dichotomous categories and returns a *P*-value that indicates whether or not there is a statistically significant difference between the means of the two groups' answers. Similarly to the ANOVA results, a *P*-value of less than .05 indicates a statistically significant difference between the groups. The results of the Fisher's exact analyses are recorded in Tables 32 through 36.

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Table 32. Fisher's Exact Results Comparing Significant and Insignificant Platform Design Features Between Two Height Groups Complete Valid Surveys

Fisher's Exact Analysis of Groups of Height > 69.09 in. vs. ≤ 69.09 in., Platform Design Characteristics, Complete Valid Surveys				
Platform Design Feature	P-Values	95% Confidence Interval (CI) Lower Limit	95% CI Upper Limit	Odds Ratio
Crew Seats	0.03	0.07	0.94	0.27
Env. Control System	0.04	0.01	1.18	0.16
O ₂ System	0.04	0.03	1.22	0.19
Seat Belts	0.10	0.06	1.29	0.30
Compartment Size	0.33	0.07	2.26	0.46
Communication System	0.50	0.12	2.41	0.53
Patient Loading Capability	0.52	0.11	2.65	0.59
Compartment Configurability	0.70	0.05	3.86	0.60
Lighting System	0.72	0.33	11.22	1.65
Windows	0.75	0.16	2.93	0.69
PPG	0.75	0.28	5.32	1.24
Cabin Ergonomics	1.00	0.22	4.65	1.06
Hoist	1.00	0.19	7.30	1.03
Suction System	1.00	0.17	4.69	0.84
Litter System	1.00	0.14	3.51	0.77
Lack of Litter System	1.00	0.17	4.69	0.84

The Fisher's exact analysis was performed on two groups: care providers above the average height for males in the U.S. Army, and care providers average height or below. The two categories were divided based on whether or not the group found each platform design feature to significantly and negatively affect the mission. A statistical significance was found between these two height groups and whether or not the O₂ system, environmental control system, and crew seats affected the mission negatively. The reference category for this analysis was the group > 69.09 in., so based off of the odds ratios, taller care providers were 73% less likely to find the crew sets to significantly and negatively affect the mission than care providers average height or below, 84% less likely to find the environmental control system to be a negative feature, and 81% less likely to find the O₂ system to be a negative feature.

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Table 33. Fisher's Exact Results Comparing Significant and Insignificant Platform Design Features Between Two Height Groups All Valid Surveys

Fisher's Exact Analysis of Groups of Height > 69.09 in. vs. ≤ 69.09 in., Platform Design Characteristics, All Valid Surveys				
Platform Design Feature	P-Values	95% CI Lower Limit	95% CI Upper Limit	Odds Ratio
Patient Loading Capability	0.04	0.00	1.08	0.14
Lighting System	0.13	0.75	20.45	3.27
O ₂ System	0.16	0.08	1.63	0.36
Seat Belts	0.40	0.16	2.09	0.60
Compartment Size	0.54	0.12	2.45	0.60
PPG	0.56	0.41	5.31	1.48
Litter System	0.75	0.13	2.78	0.67
Cabin Ergonomics	0.76	0.32	5.03	1.31
Env. Control System	0.76	0.20	3.11	0.76
Communication System	0.77	0.21	2.89	0.76
Hoist	0.77	0.32	5.45	1.25
Windows	0.78	0.21	2.62	0.74
Compartment Configurability	1.00	0.14	4.89	0.94
Suction System	1.00	0.21	3.91	0.87
Lack of Litter System	1.00	0.28	4.90	1.11
Crew Seats	1.00	0.26	3.19	0.91

A statistical significance was found between the two groups' answers regarding whether or not they found patient loading to significantly and negatively affect the mission when examining all valid surveys, but not when examining only the complete valid surveys. The crew seats, O₂ system, environmental control system were no longer found to be significant when all valid surveys were examined. Once again, the group > 69.09 in. was the reference group, so based on the odds ratio, tall care providers were 86% less likely to find patient loading capability to be a negative feature that significantly and negatively affected the mission.

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The Fisher's Analysis in Table 34 was performed on male respondents versus female respondents and whether or not they found platform features to significantly and negatively affect missions. No statistically significant differences were found. It is important to keep in mind, however, that the ratio of female to male respondents was quite far from the national ratio.

Table 34. Fisher's Exact Results of Two-by-Two Tables Comparing Significant and Insignificant Platform Design Features Between Males and Females

Fisher's Exact Analysis of Males Vs. Females, Platform Design Characteristics, Complete Valid Surveys				
Platform Design Feature	P-Values	95% CI Lower Limit	95% CI Upper Limit	Odds Ratio
O ₂ System	0.07	0.00	1.94	0.09
Env. Control System	0.19	0.00	3.77	0.18
Windows	0.25	0.32	Impossible to Calculate	Impossible to Calculate
Cabin Ergonomics	0.27	0.19	252.20	4.01
Compartment Configurability	0.49	0.03	46.14	2.14
Hoist	0.53	0.03	34.67	0.54
Communication System	0.54	0.20	Impossible to Calculate	Impossible to Calculate
PPG	0.55	0.16	206.05	3.28
Lack of Litter System	0.56	0.14	Impossible to Calculate	Impossible to Calculate
Seat Belts	0.57	0.01	7.58	0.37
Patient Loading Capability	1.00	0.01	17.49	0.85
Suction System	1.00	0.03	44.21	0.69
Lighting System	1.00	0.04	49.44	0.78
Litter System	1.00	0.02	21.50	1.03
Compartment Size	1.00	0.02	21.50	1.03
Crew Seats	1.00	0.09	117.82	1.88

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The Fisher's Analysis in Table 35 was performed on male respondents versus female respondents. No statistically significant differences were found. Again, the ratio of female to male respondents was quite far from the national ratio.

Table 35. Fisher's Exact Results of Two-by-Two Tables Comparing Significant and Insignificant Platform Design Features Between Males and Females

Fisher's Exact Analysis of Males Vs. Females, Platform Design Characteristics, All Valid Surveys				
Platform Design Feature	P-Values	95% CI Lower Limit	95% CI Upper Limit	Odds Ratio
O ₂ System	0.11	0.00	2.45	0.12
Cabin Ergonomics	0.20	0.25	321.57	5.16
Env. Control System	0.20	0.00	3.98	0.19
Windows	0.25	0.34	Impossible to Calculate	Impossible to Calculate
Compartment Configurability	0.44	0.04	53.04	2.50
Communication System	0.54	0.22	Impossible to Calculate	Impossible to Calculate
Lack of Litter System	0.55	0.17	Impossible to Calculate	Impossible to Calculate
PPG	0.55	0.17	211.96	3.42
Seat Belts	0.59	0.01	8.57	0.42
Patient Loading Capability	1.00	0.02	22.82	1.12
Hoist	1.00	0.04	55.84	0.90
Suction System	1.00	0.03	43.14	0.69
Lighting System	1.00	0.05	60.53	0.97
Litter System	1.00	0.02	27.27	1.33
Compartment Size	1.00	0.02	24.90	1.21
Crew Seats	1.00	0.09	117.84	1.91

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The Fisher's Analysis in Table 36 was performed on male respondents versus female respondents. No statistically significant differences were found. Again, the ratio of female to male respondents was quite far from the national ratio.

Table 36. Fisher's Exact Results of Two-by-Two Tables Comparing Injury Frequency Between Males and Females

Fisher's Exact Analysis of Injuries in Males Vs. Females, Complete Valid Surveys				
Injury Location	P-Values	95% CI Lower Limit	95% CI Upper Limit	Odds Ratio
Neck	1.00	0.02	23.97	1.15
Knee	1.00	0.00	10.44	0.00
Hip	0.14	0.00	2.97	0.14
Shoulder	0.26	0.00	3.60	0.00
Ankle	0.19	0.00	3.77	0.18
Elbow	0.11	0.00	2.61	0.12
Wrist	0.14	0.00	2.97	0.14
Upper Back	0.60	0.01	9.10	0.44
Lower Back	1.00	0.00	17.32	0.00

Skipped Questions Analysis

The skipped sections were also analyzed to check if there were any noticeable trends. The results are displayed in Tables 37 through 38 and Figure 64.

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Table 37. Tally of Respondents that Skipped Each Section and the Number of Respondents that Skipped the Rest of the Survey After Skipping Each Section

Section Content	Number of Respondents that Skipped the Entire Section	Number of Respondents that Skipped Through to End
Basic Information and Demographics	0	0
Platform Design Characteristics that Negatively Impacted Mission Performance	2	2
Items in the Current Aeromedical or Ground Evacuation Medical Equipment Sets Caused Awkward or Painful Postures	8	8
Relation Between Number of Patients and Number of Postures, and Usual Number of Patients	9	9
Frequency of Awkward Posture During Tasks	13	13
Occupational Injuries or Discomfort Associated with Postures During Patient Loading and Patient Care	14	14
Primary Source of Pain and Reasons for not Reporting	14	14

Once a respondent skipped a section, all sections were skipped afterwards, no respondents skipped a single section and continued.

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Table 38. Average Experience Level of Respondents that Skipped Each Section

	Vehicle Design Effects	Equipment	Usual Number of Patients + Increasing Number	Frequency of Awkward Postures	Occupational Injuries	Primary Source of Pain + Reasons for Not Reporting
Average Experience (Years) of Respondents Who Skipped the Section	3.42	6.48	7.09	8.35	7.97	7.97

Note. The sections are ordered sequentially left to right.

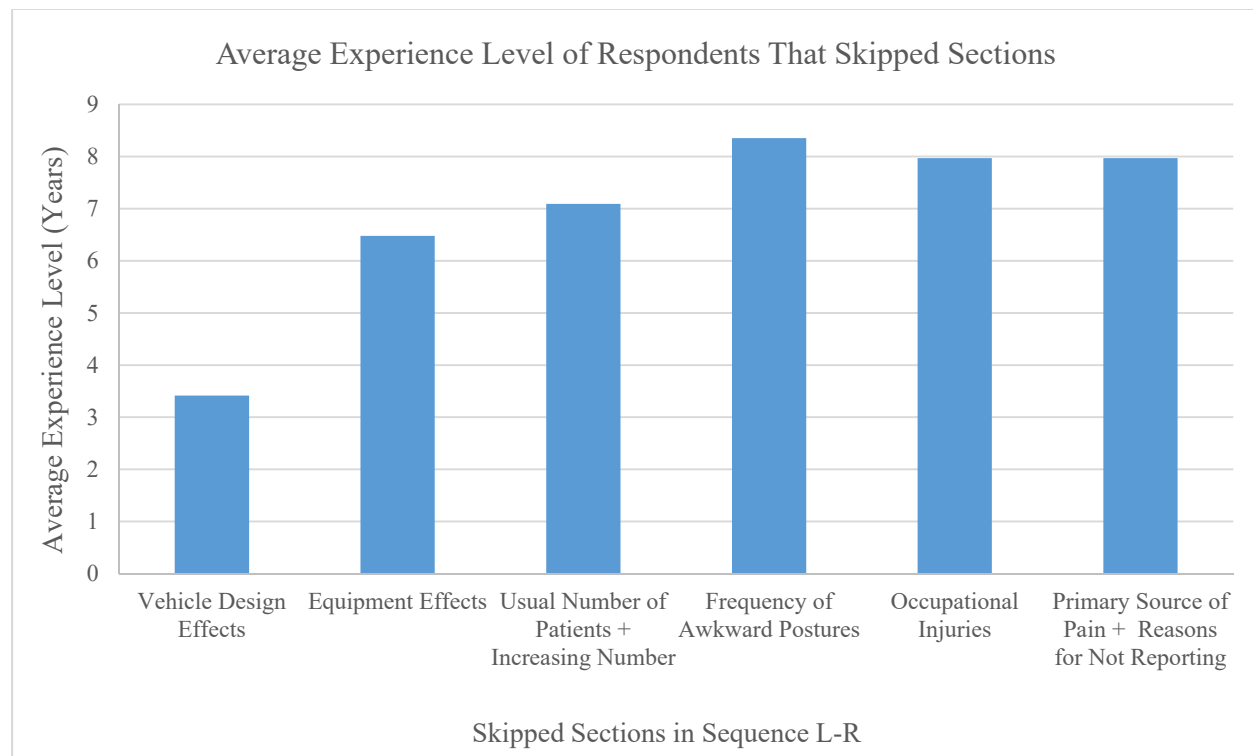


Figure 64. Average experience level of respondents that skipped sections, ordered sequentially from left to right.

As seen in Table 38 and Figure 64, the experience level increased somewhat as the survey continued, meaning the less experienced medics quit responding to the survey earlier.

An ANOVA analysis was performed on the group of complete surveys versus incompletes comparing the number of vehicle design characteristics that the respondents found significant in order to see if those who found more issues with the platforms were willing to complete more of the survey. The result was a P -Value of $P = 0.342$, meaning that there is not a statistically significant difference between the groups.

Discussion

In Section 2, Compartment Configurability, the Litter System, Cabin Ergonomics, Compartment Size, Patient Loading Capability, and PPG were all found to negatively affect mission by over 60% of respondents. Out of those six features, four of them (Compartment Configurability, the Litter System, Cabin Ergonomics, and Patient Loading Capability) had the litter pan system or lifting littered patients as one of the main problems with the feature.

In Section 3, most of the respondents did not find the medical equipment to cause awkward or painful postures. The piece of equipment that caused the most painful postures was the litter, which was cited by 34.8% of respondents when analyzing all valid surveys. The patient monitor, defibrillator, O₂ bottle with regulator, trauma panel, and Sked[®] BRS were all cited as causing painful postures by 21% to 26% of respondents. The factors that all of these items shared that negatively affected the mission was that they caused painful postures, were cumbersome or difficult to use, and were difficult to store properly (the last factor applies to all but the litter).

In Section 4.1, 94% of respondents agreed that an increasing number of patients increases the amount of painful postures that must be utilized by care providers, and in Section 4.2 almost half (49%) of respondents reported usually caring for one patient at a time. The results of this survey indicate that awkward positions, especially bending, are the leading causes of lower back injuries, which 87% of respondents had sustained. Even though almost half of the respondents only care for one patient at a time, the majority of respondents have suffered lower back injuries.

In Section 5, Load/Unload Littered Patients was among the top causes of awkward postures such as bending, overextending, kneeling, and squatting. The majority of participants responded to this section in detail, however it is possible that some participants may have copied their answers across all actions. Four participants provided the same postures required for all actions, and there is no means of telling if those were genuine answers, or if they were simply copied across all actions.

In Section 6, every type of injury had more counts of being unreported than reported. Lower back, knee, neck, shoulder, and upper back injuries were prevalent among respondents. Lower back injuries were the most common among respondents, suffered by 87% of respondents. Awkward positions, especially bending, lifting patients, and flight gear/body armor were the leading causes of lower back injuries among respondents. The leading cause of knee injuries was kneeling/crawling. The leading causes of neck injuries were NVGs and helmets, and many comments cited the combination to be particularly painful. The leading causes of shoulder

injuries were workplace injuries and moving patients. The leading causes of upper back injuries were lifting patients and bending/awkward positions.

Comparing the results of this study to the results of the previously mentioned civilian EMS study (Maguire et al., 2005), the most common occupational injury among survey respondents was to the lower back (87%), similar to the civilian EMS study where the back was also the most injured location. In the civilian EMS study, many injuries were related to the stretcher, and in the survey responses the litters were the second most cited issue, after awkward positioning/bending. Many respondents cited more than one reason for their injuries and some respondents did not give an explanation of the cause of their injuries, so the following percentages are based on the frequency at which an issue was mentioned by the respondents with respect to the total number of reasons for that injury given by all respondents. For lower back injuries among respondents, 30.0% of the cited issues were related to lifting patients and 37.5% were related to awkward positions/bending.

Analysis was not performed to relate platform or job title to injuries or postures used because there was too much data overlap. Since 93.47% of respondents were CCFPs and four of the job title categories only represented approximately 2% to 4% of respondents each, the imbalance was not conducive to obtaining any results related to job title.

Analysis between male and female participants was conducted to see if any correlations could be found and perhaps explored in the future to substantiate them, but those analyses cannot be representative of the entire population due to the low percentage of female respondents.

Note that this survey was not presented to all 68Ws, so it cannot represent the entire population, but rather the subset who responded to it. It is still valuable information that provides insight, but the entire population cannot be accurately represented by the information provided.

Recommendations

Since the studies are in agreement that back injuries are the most prevalent among care providers, it would be prudent to focus on solving issues that cause back problems. According to survey results, finding a way to minimize the stress placed on the care providers while lifting and loading patients would contribute significantly to reducing the amount of back injuries. Also, the current cabin area necessitates that care providers bend and kneel frequently to care for patients. Designing cabin areas and litter pan systems with the intention of minimizing these awkward postures would significantly reduce the amount of back and knee injuries suffered by care providers.

Some recommendations regarding the survey method itself and analyzing the responses are as follows:

- 1) Do not have blanks as possible negatives, request that all respondents clearly state a negative answer so that blanks may be interpreted as a skipped question.

- 2) Put the information that is most valuable at the beginning of the survey so if the respondent grows tired and quits, there is a greater chance that the most important information was collected.
- 3) Have the analysis plan put together at the same time as the survey so the format is best for analysis.
- 4) It may be best to have incentives for longer surveys to encourage complete data sets.
- 5) Technical errors in data recording software and/or presentation of questions led to occasional missing data points, which needs to be further evaluated before selecting a platform for web surveys.

Conclusion

The results of this study may be used in conjunction with other studies to develop mitigation plans in order to reduce the stress factors in the MEDEVAC environment which contribute to injuries and MSDs in care providers.

Lower and upper back injuries sustained from lifting and loading patients are an apparent area of interest for developing mitigation plans, especially since these can be seen in U.S. Army and civilian EMS care providers and could provide opportunity for joint efforts between researchers on both sides.

A frequent issue among respondents was the necessity of kneeling or squatting while caring for patients, which were reported as the leading causes of knee injuries. Mitigation plans which reduce the need for kneeling or squatting, or at least implement knee pads as a standard provision in MEDEVAC platforms, may be able to reduce the number of knee injuries among MEDEVAC care providers.

There are numerous results in this study which could inform future research into mitigation plans, from the combined effects of night vision goggles/head supported mass and helmets in causing neck injuries to the effect of the cabin interior of MEDEVAC platforms in causing painful postures.

References

- Alvarez, T., Semmlow, J., (2002). Short term adaptation exists in the disparity vergence system exhibited by a decrease in the response dynamics. *Annual International Conference of the IEEE Engineering in Medicine and Biology - Proceedings*, 1, 260 – 261.
- Biesbroek, Susan & Teteris, Elise. (2012). Human Factors Review of EMS Ground Ambulance Design. *Symposium on Human Factors and Ergonomics in Health Care*, 1, 95-101.
10.1518/hcs-2012.945289401.016
- Brice JH, Studnek JR, Bingham BL, Martin-Gill C, Custalow C, Hawkins E, Morrison LJ. (2012). EMS provider and patient safety during response and transport: Proceedings of an ambulance safety conference. *Prehospital Emergency Care*, 16(1), 3 – 19.
10.3109/10903127.2011.626106
- Buckle, P., Devereux, J. 2002. The nature of work-related neck and upper limb musculoskeletal disorders. *Applied Ergonomics*, 33(3), 207-17.
- Chaffin, D. B. (1973). Localized muscle fatigue – definition and measurement. *Journal of Occupational Medicine*, 15(4), 346-54.
- Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd Ed.). Routledge: Lawrence Erlbaum Associates.
- Cohen, J. (1992). A power primer. *Psychological Bulletin*, 112(1), 155-159.
- Deros, B. M. et al. (2016). Evaluation on Ambulance Design and Musculoskeletal Disorders Risk Factors among Ambulance Emergency Medical Service Personnel. *Iranian Journal of Public Health*, 43(1), 52-60.
- Gallagher, S., W.S. Marras, K.G. Davis, and K. Kovacs (2002). Effects of posture on dynamic back loading during a cable lifting task. *Ergonomics*, 45, 380-98.
10.1080/00140130210127639
- Gallagher, S. and Unger, R. L. (1990), Lifting in four restricted lifting conditions, *Applied Ergonomics*, 21, 237-245. 10.1016/0003-6870(90)90008-L
- Golob, R., and Sykes, M. (2002). *Workplace guidelines for the prevention of musculoskeletal injuries: a joint initiative*. Victoria, British Columbia: B.C. Government and Service Employees' Union & British Columbia Public Service Employee Relations Commission.
- Gordon C., Blackwell, C., Bradtmiller, B., Parham, J., Barrientos, P., Paquette, S., ... Kristensen S. (2014). *2012 Anthropometric Survey of U.S. Army Personnel: Methods and Summary*

Statistics. Natick, MA: U.S. Army Natick Soldier Research, Development and Engineering Center. Technical Report Number: NATICK/TR-15/007.

- Hogya P, Ellis L. (1990) Evaluation of the injury profile of personnel in a busy urban EMS system. *The American Journal of Emergency Med.* ; 8(4), 308–11. 10.1016/0735-6757(90)90081-a
- Johnos WMS. (2011). Prevalence of Upper Extremity Musculoskeletal Disorders. *Musculoskeletal Disorders*, 5(2), 187-190. 10.1155/2015/517346
- Kinsler, R., and Barazanji, K. (2011). *Assessment of fixed position litter loading in the HH-60M MEDEVAC helicopter*. Fort Rucker, AL: U.S. Army Aeromedical Research Laboratory. USAARL Technical Memorandum 2011-19.
- Kinsler, R., Barazanji, K., Lee, J., Fulton, L., Hatzfeld, J. (2015, August) *Analysis of Two Surveys Examining Enroute Care Technologies, Platforms, and Space Requirements*. Poster Presentation at the Military Health System Research Symposium, Ft. Lauderdale, FL.
- Lester, J.D., Hsu, S., and Ahmad, C.S. (2012). Occupation hazards facing orthopedic surgeons. *American Journal of Orthopedics*. 41(3), 132-139.
- Maguire, B. J. (2005). Occupational Injuries among Emergency Medical Services Personnel. *Prehospital Emergency Care*. 9(4), 405-411. 10.1080/10903120500255065
- The National Institute for Occupational Safety and Health. (2013). *Emergency Medical Services Workers Injury Data*. Center for Disease Control and Prevention.
- Patterson PD, Huang DT, Fairbanks RJ, Simeone S, Weaver M & Wang HE. (2010). Variation in emergency medical services workplace safety culture. *Prehospital Emergency Care*, 14(4), 448 – 460.
- Steiner T.J. (2004). Lifting the burden: the global campaign against headache. *Lancet Neurology*, 3, 204–205.
- Stobbe T.J., Bobick T.G. (1986). Musculoskeletal injuries in underground mining. *Ann ACGIH*, 14, 71-76.
- Toivonen R and Fagerstrom V. (2011). *The effect of patient transport stretchers on work ergonomics among paramedics*. Helsinki, Finland: Finnish Institute of Occupational Health.

Torma-Krajewski, Janet & Wiehagen, William & Etcheverry, Ann & Turin, Fred & Unger, Richard. (2009a). Using Ergonomics To Enhance Safe Production At a Surface Coal Mine - A Case Study With Powder Crews. *Journal of Occupational and Environmental Hygiene*. 6(10), D55-D62.

Torma-Krajewski, Janet & Wiehagen, William & Etcheverry, Ann & Turin, Fred & Unger, Richard. (2009b). Ergonomics. *Journal of Occupational and Environmental Hygiene*. 6(10), D55-D62. 10.1080/15459620903146636.

Appendix

Medical Provider Posture and Injury Survey

This questionnaire is anonymous and voluntary. No information about your identity is collected and there is no way for anyone to link you to participation in the study. The purpose of this research is to gather information from U.S. Army en route medical care providers (air and ground transport) on their experiences related to occupational stressors such as awkward postures, strain, and fatigue. The survey addresses the question, "Do awkward postures and lifting demands associated with confined space medical interiors cause occupational injuries?" Results will be used to identify stressors and injuries, recognize their sources, and recommend solutions to the U.S. Army medical community. U.S. Army Soldiers and their families will benefit from this study.

The survey is mostly comprised of fixed questions and short open-ended responses. Please answer to the best of your ability. The survey will take approximately 10 minutes to complete and gives you a unique opportunity to have your voice heard. We are seeking open and honest feedback.

If you are completing the survey online, your answers will be saved each time you move forward to the next page. Once you have completed the last question, your full survey will be saved when you see a "thank you" message. If completing this survey on paper, please insert it in the envelope included with the survey and mail without your name on the envelope. If you are completing the survey on paper with a study team member, place your survey in the blank envelope and drop it in the designated box located in the room. None of the envelopes will be opened until the research team is in a secure location at USAARL. If you have questions about the research at any time, you should contact Rachel Kinsler at 334-255-6982.

You may decline to participate now, or stop taking part in this research at any time, without any penalty or loss of benefits to which you are entitled. If you are completing the survey online, just close the browser window. If you do not want questions you answered before closing the window to be used in the study, please contact Rachel Kinsler at 334-255-6982. If you are taking the survey on paper, just destroy your survey or insert the survey back into the envelope and drop it in the designated box.

We appreciate your assistance in completing this important study.

Figure A1. Page 1 of the Medical Provider Posture and Injury Survey.

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1. What is your gender?
☐ Male ☐ Female

2. What is your height in inches?

3. What is your age?

3. What is your weight in pounds?

4. In the blanks below, please provide your job position and general platform/location when you performed the majority of your duties as a medical care provider in addition to the length of time you were in that position?

Job Position as Medical Care Provider	Platform/Location	Length of Time You Performed This Job Position

Job position examples: Critical Care Flight Paramedic (CCFP), Flight Nurse (FN), Ground Medic (GM), etc. Please feel free to abbreviate.
Platform/Location examples: hospital or clinic, on an HH-60M, UH-72, UH-1, in a field hospital, in an FLA, Stryker, etc. Specific names of clinics, tail numbers, etc. are not needed.

5. Please select aircraft/vehicle/gear design characteristics from this list that negatively affected your mission performance or caused you to perform your mission as a care provider in awkward or painful postures and discuss the negative impacts.

	Design Characteristic	How This Negatively Impacted You or The Mission
☐	Patient loading capability	
☐	Cabin ergonomics (i.e., crew comfort)	
☐	Cabin/patient compartment configurability	
☐	Hoist	
☐	O ₂ system	
☐	Environmental control system	
☐	Suction system	
☐	Lighting system	
☐	Seat belts	
☐	Litter systems	
☐	Lack of litter system	
☐	Cabin/patient compartment size (dimensions-length, width, height)	
☐	Windows (SMART, etc.)	
☐	Crew seats (please be specific)	
☐	Communication system	
☐	Personal protective gear (body armor/helmet)	
☐	Other:	

Figure A2. Page 2 of the Medical Provider Posture and Injury Survey.

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6. Which of the following items in the current Aeromedical or Ground Evacuation Medical Equipment Sets caused you to use an awkward or painful posture? Use the blank provided to list the posture, such as squatting, kneeling, bending at the waist, twisting, reaching behind you, over-reaching, etc. The blank will expand as you type.

	Item	Awkward/Painful Posture
☐	Monitor	
☐	Defibrillator	
☐	Ventilator	
☐	I.V. pump	
☐	Suction	
☐	EZ-IO kit	
☐	SMEED	
☐	Medical aid bag	
☐	Medication box	
☐	Fluid warmer	
☐	Oxygen bottle with regulator	
☐	Traction splint	
☐	Spine board	
☐	Trauma panel	
☐	SKEDCO	
☐		
☐	Spine splint	
☐	Thermometer	
☐	Glucometer	
☐	Litter	
☐	Litter straps	
☐	Other	

7. Assuming the average transport time will be approximately 30 minutes, would the number of patients cared for increase the likelihood of awkward or painful postures for the care provider?

☐ YES ☐ NO

8. On average, how many patients do you typically provide care for at one time?

Figure A3. Page 3 of the Medical Provider Posture and Injury Survey.

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9. Please read each task and rate the frequency you have experienced each awkward posture during each task listed.

Write in "1" for once per patient

Write in "2" for multiple times per patient per flight

Leave the space blank for never

You may add additional answers at the end

	Bending at waist	Kneeling	Squatting	Overextending arms, legs, or torso	Reaching behind you	Straining to lift heavy weights
Load/Unload patients on a litter						
Loading patients NOT on a litter						
Assessment requiring full patient exposure						
Initiate peripheral IV						
Administer blood / blood products						
Provide care for a suspected spinal injury						
Ventilate a patient with a bag-valve-mask system						
Perform oral suctioning / endotracheal suctioning						
Inserting an endotracheal tube						
Initiate treatment for an open abdominal wound						
Application of tourniquet						
Initiate an EZ Intraosseous device						
Applying splint						
Perform intubation						
Perform a surgical cricothyroidotomy						
Perform a needle chest decompression						
Insert a King LT						
Insert and manage a chest tube						
Initiate treatment for a head injury						
Immobilize the pelvis						
Apply pressure dressing to axillary/femoral wounds						
Using monitor, ventilator, suction, pleurovac together						
Performing a log roll						
Administering CPR						
Dressing wounds						
Utilize warming equipment (such as fluid warmer)						
Apply warming blankets						
Other:						
Other:						

Figure A4. Page 4 of the Medical Provider Posture and Injury Survey.

This space is intentionally blank.

Please remember answers about injuries are anonymous and will not be reported or recorded into your records.		
10. Complete the questions below if you have experienced occupational injuries or discomfort associated with any postures during patient loading and patient care.		
	Injury was not reported	Reported/Treated by a physician
Neck		
What caused this injury/discomfort?		
Knee		
What caused this injury/discomfort?		
Hip		
What caused this injury/discomfort?		
Shoulder		
What caused this injury/discomfort?		
Ankle		
What caused this injury/discomfort?		
Elbow		
What caused this injury/discomfort?		
Wrist		
What caused this injury/discomfort?		
Upper back		
What caused this injury/discomfort?		
Lower back		
What caused this injury/discomfort?		
Other:		
What caused this injury?		
11. For injuries that you did not report, what were your reasons for not reporting?		
12. Do any specific postures or tasks cause your primary source of pain? Please explain.		
13. Please discuss any other injuries you may have experienced related to patient care/loading.		
Thank you for contributing to our study. We appreciate your support.		

Figure A5. Page 5 of the Medical Provider Posture and Injury Survey.

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Acronym/Abbreviation List

ANOVA – Analysis of Variance
BAM – Blackhawk Advanced Medevac
CI – Confidence Interval
EMS – Emergency Management System
ICS – Integrated Communication System
In. – Inches
Lbs. – Pounds
MEDEVAC - Medical Evacuation
MES – Medical Equipment Set
MSD – Musculoskeletal Disorder
USAARL – U.S. Army Aeromedical Research Lab



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