Special article

Evacuation preparedness in full-time wheelchair users with spinal cord injury

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Objective: To analyze and evaluate the efficacy of evacuation plans described by individuals with spinal cord injury (SCI).
Design: Descriptive study from a convenience sample.
Setting: Outpatient population center in Pittsburgh, PA, USA.
Methods: Twenty-one individuals with SCI who previously indicated that they had a plan of evacuation from either their homes, places of work, or towns/cities were contacted via telephone and asked to describe their evacuation plans. The number of critical elements (scale of 0–10 with 10 indicating a more thorough plan) and assistive technology (AT) devices were recorded.
Outcome measures: The number of critical elements (scale of 0–10 with 10 indicating a more thorough plan) and AT devices were recorded.
Results: Median home and town/city evacuation scores were both 3.00 (ranges: 1.0–4.0 and 0.0–8.0, respectively). Median evacuation scores of individuals with paraplegia were higher in home ($P = 0.05$, $r = 0.44$) and town/city ($P = 0.045$, $r = 0.63$) than individuals with tetraplegia. Median evacuation scores of subjects who were employed were higher in home ($P = 0.036$, $r = 0.47$) and town/city ($P = 0.064$, $r = 0.59$) than unemployed.
Conclusion: Low scores indicate that individuals with SCI who believe that they have plans are not adequately prepared for an emergency evacuation. Interventions are needed to improve evacuation readiness and lack of preparedness in a catastrophe should be considered by emergency personnel when responding.

Keywords: Disability, Assistive technology, Emergency preparedness, Natural disaster, Rehabilitation, Spinal cord injuries, Wheelchair, Paraplegia, Tetraplegia

Introduction

The world is no stranger to disaster. From 2000 through 2009, more than two billion people were affected by natural disasters.[1] In 2010, 385 natural disasters in 131 countries killed over 297 000 people and affected over 217 million others.[1] The United States (US) alone saw 99 separate disaster declarations in 2011.[2] The aftermaths of Hurricane Katrina in 2005[3] and the more recent Haitian earthquake in 2010[4] have further revealed the importance of planning for individuals with disabilities during emergencies.

In response, the recent decade has seen efforts to improve emergency preparedness.[5] Yet, more than 49.7 million individuals with disabilities in the US[6] are often not included in these efforts and consequently, generally lack preparedness in emergency situations.[7–10] A large percentage of individuals with disabilities have an impairment that results in a diminished ability to move and function independently.[11] These vulnerabilities could pose a problem when evacuating any location in response to an emergency.[7,12,13] As the population of individuals with disabilities continues to grow, there is demand for work in this area.

Spinal cord injuries (SCI) affect approximately 265 000 individuals in the US.[14] As with many other disabilities, the mobility limitations caused by an SCI can impede an individual's ability to evacuate a given location. McClure *et al.*[10] analyzed data collected from 487 full-time wheelchair users with SCI. Subjects

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completed a questionnaire asking questions about whether or not they felt they would be able to safely evacuate from various locations in response to a disaster and if they had an evacuation plan in place. Sixty-four percent reported having an evacuation plan from their homes, 80% from their work, and around 31% from their towns.[10] While these data give insight into the number of people who report having evacuation plans, to our knowledge there have been no studies that have investigated the comprehensiveness of the actual evacuation plans.

The purpose of this study was to further our previous work[10] by investigating the specifics of evacuation plans reported by individuals with SCI. Identifying what is missing from these plans will provide information on how preparedness in this population can be improved. It was hypothesized that the evacuation plans would not contain critical elements, indicating that our previous study overestimated individuals with SCI who have an effective plan.

Methods

Subjects

Study participants were recruited from individuals who participated in our previous study.[10] To be included in the original study, subjects had to be (a) at least 16 years old, (b) be at least 1-year post-SCI, and (c) use a wheelchair for more than 40 hours per week. To be included in this phase of the study, participants had to be from the University of Pittsburgh Model Center on SCI (UPMC-SCI) location and indicate that they had an evacuation plan. The study was approved by the University of Pittsburgh's Institutional Review Board and subjects provided written informed consent prior to data collection.[10] Participants were contacted by telephone by a study investigator and offered the opportunity to answer additional questions related to their evacuation plans. Individuals who were interested in participating provided verbal consent. As part of the original study, participants completed a questionnaire that provided information on demographics, social behaviors, use of assistive technology (AT), and the presence of an evacuation plan in response to emergency situations.

Data collection

Participants in this study were asked to answer open- and close-ended questions related to their specific plans for evacuation. These questions were designed to determine the degree of evacuation preparedness. Participants were called without advance warning and asked the questions on the questionnaire. They were given no cues by the investigator if they missed any points during their iteration. The goal of this approach was to simulate an emergency situation for which prior warning is not provided, thus eliciting responses that would require quick thinking and accurate recall of evacuation plans, as if giving instructions to evacuation and emergency personnel.

Open-ended questions asked for a detailed description about each subject's evacuation plan for his or her residence, workplace, or city/town, and the AT that would be needed to evacuate these locations. Only 3 out of 21 subjects had plans for their workplaces, thus scores from that location were not analyzed. Each response was transcribed and graded using an 11-point scale of 0–10. One point was given for each of the 10 criteria mentioned by the subject; if the same criterion was mentioned more than once, only one point was assigned. Therefore, total scores reflect the absolute number of criteria mentioned. The criteria on which responses were graded were derived from common themes prevalent in evacuation preparedness publications provided by the American Red Cross (ARC),[15] the Federal Emergency Management Agency (FEMA),[16] and the Center for Disability Issues and the Health Professions (CDIHP).[17] Table 1 lists specific criteria and respective themes from which each one was derived.

Closed-ended questions were asked after open-ended questions. These questions inquired about the frequency with which plans had been implemented or practiced, levels or stories in the building that would potentially be evacuated, and details concerning any human or technology assistance needed to execute the plan.

Data analysis

Independent grouping variables were categorically recoded prior to analysis. Level of injury, sex, employment status, level of education, marriage/living situation, and race were coded into dichotomous variables: tetraplegia (C1–C7) and paraplegia (T1–L5), male and female, employed and unemployed (includes one subject listed as 'student'), high-school diploma/GED or less and post-high school degree (associates, bachelors, masters, or doctorate), married/living with someone and single/living alone, and white and non-white, respectively.

The numbers of AT devices used per subject were summed for both locations. To obtain the number of devices used per individual relative to function, devices were divided into six categories based on their function: wheelchairs, ramps in/out of the location, lifting devices, sliding boards, bathroom supplies, and accessible transportation. Lifting devices included stair, chair,

Table 1 Evacuation plan scoring criteria

Critical elements	Checklist themes
Escape routes (exits, stories in building, and distance to travel)	How will they get out of immediate danger?
Personal support network communication – before event	How will they plan and communicate with personal care assistants, friends, family, co-workers, etc. before the event?
Personal support network communication – after event	How will they plan and communicate with personal care assistants, friends, family, co-workers, etc. after the event?
Supplies/supply kit	Did they account for any medications, food, water, etc. needed for an extended period of time?
Transportation	What method of transportation will be used to evacuate the area?
Assistance needed (human or technology)	What type of human assistance or assistive technologies will they need during and after the emergency?
A meeting place/temporary shelter	Were will they re-locate and be safe from danger during and after emergency?
Vital records and documents	Did they plan to bring with them vital records and documents if they need access to medications, AT, hospital services, etc?
Ability to give clear, concise, and detailed directions to emergency personnel	Did they exude confidence in their explanation and an ability to enact their plan on a moment's notice?
Practice plan	Have they conducted any drills or mock situations in which they can practice their plan?

Left: list of critical elements used to grade responses – one point was given for each criterion mentioned. Right: common themes in evacuation publications (15, 16, 17) used to determine grading scale.

ceiling, and porch lifts, and elevators. Accessible transportation devices included vehicles modified with any AT device such as power doors, hand controls, or chair lifts.

Statistical analysis

Descriptive statistics were calculated for demographics, AT used, plan scores of each location, and which elements were present or absent from the plans. Outcome variables were discontinuous and positively skewed; therefore, non-parametric tests were employed: Phi coefficients to determine correlations between grouping variables; Spearman's rho to determine correlations between scores of both locations and between scores and length of time after injury; Mann–Whitney U tests to determine significant differences of numbers of AT used or plan strength scores between groups or locations. Chi-squared (discontinuous) and independent t-tests (continuous) were used to determine if significant differences existed between demographic data of subjects who did and did not respond. Because this is an exploratory and descriptive study, significance level was set to $P < 0.05$ prior to analysis, with trends reported for $P < 0.10$. All statistical analyses were performed using SPSS version 19.0 (IBM Corp., Armonk, NY, USA).

Statement of ethics

The authors certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research.

Table 2 Subject demographics

	Responders	Non-responders	*P*
Age (mean, SD)	43.5 ± 12.2 years	45.6 ± 18.4	0.682
Years since injury (mean, SD)	9.6 ± 8.7 years	6.2 ± 8.0	0.180
Sex	15 male 5 female	18 male 6 female	1.000
Race	15 white 5 non-white	19 white 5 non-white	0.743
Marriage/living situation	9 married/living with someone 11 single/living alone	6 married/living with someone 18 single/living alone	0.163
Highest level of education	3 with no HS diploma 8 with HS Diploma/GED 8 with post-HS Degree	3 with no HS diploma 13 with HS diploma/GED 6 with post-HS degree	0.532
Employment status	2 employed 18 unemployed (including student)	4 employed 20 unemployed	0.521
Level of injury	12 with paraplegia 8 with tetraplegia	14 with paraplegia 10 with tetraplegia	0.911

Far left: subjects who responded; middle: subjects who did not respond; Far right: *P* values of between-groups differences (based on chi-squared test for categorical variables and independent *t*-test for continuous variables).

Results

A total of 47 subjects from the UPMC-SCI were selected who completed the original study[10] and reported having an evacuation plan for at least one location. An effort was made to contact all qualified subjects and data were successfully obtained from 23 subjects. Data were not collected for 24 subjects: 2 declined to participate, 2 fully recovered from their injuries, 1 was deceased, and the rest could not be reached. Data from 3 subjects were excluded for a total of 20 subjects (2 were not full-time wheelchair users and 1 reported a plan solely for the workplace). Demographic data of this study population are similar to the demographics of individuals with SCI in the US,[14] and are presented in Table 2. No statistical differences existed between demographic variables of those included in the study and those for whom data were not collected. Twenty subjects had plans for the home and 10 had plans for their city/town. No correlation existed between grouping variables. All subjects lived in private residences, and all subjects who reported a town plan also reported a home plan.

Fig. 1 shows numbers of criteria mentioned by subjects in their plans with respect to location. Median number of criteria mentioned for both home and town/city plans were 3.0 (ranges: 1.0–4.0 and 0.0–8.0, respectively). Evacuation plan scores for both locations were not significant between groups based on race, sex, marital/living situation, or level of education. Differences existed between groups based on injury level and employment status, and are listed in Table 3. Town/city and home plan scores were found to be positively correlated ($P = 0.001$, $r = 0.882$).

Commonly used AT were lifting devices with 13 subjects mentioning their use. Eighteen total lifting devices were mentioned: 7 chair lifts, 5 elevators, 4 stair lifts, 1 porch lift, and 1 ceiling lift. The number of AT devices used with respect to location is shown in Fig. 2. Because all participants were full-time wheelchair users, the wheelchairs were not included in Fig. 2, but were included in the analysis of total number of AT used. The number of AT used in home evacuations was significantly greater in subjects with tetraplegia than with paraplegia ($P = 0.036$), but not in town/city evacuations.

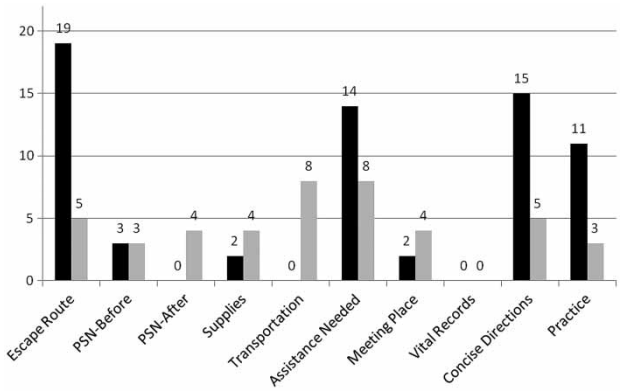

Figure 1 Total number of criteria mentioned per location. Black, home ($n = 20$); gray, town/city ($n = 10$); PSN-Before, Personal Support Network communication before the event; PSN-After, Personal Support Network communication after the event.

Discussion

The results from this study were consistent with previous literature,[7–10] as evacuation plans were found to be missing many critical elements. From their homes, most subjects mapped out an escape route, define any assistance needed, and were able to clearly and concisely iterate directions. While these are important, few subjects mentioned a meeting place after evacuation, how they would transport themselves post-evacuation, planning or communication with their personal support networks (PSNs), or consideration of supplies or vital records that would be needed. From their towns or cities, data were similar to those of the home with the following exceptions: most subjects mentioned modes of transportation necessary to evacuate, while few were able to give clear and concise directions or mentioned that they had practiced their plans.

The level of overall preparedness exhibited by the small group of employed subjects was greater than those who were unemployed. It is possible that employers provide evacuation education that aids not only in the work setting, but also at home. Subjects with paraplegia more often had greater scores than those with tetraplegia. These trends seem to contradict results reported by McClure *et al.*[10] that individuals with disabilities who have lower levels of function were often more prepared. Regardless of subject characteristics, in both groups the scores were low.

These data suggest that forethought is being put into making evacuation plans by incorporating critical elements that subjects intuitively feel are important, including transportation from their towns or cities and escape routes from their homes. However, by not consulting evacuation preparedness literature, such as checklists provided by the ARC,[15] FEMA,[16] and CDIHP,[17] certain critical elements are omitted. An additional resource is the *Report of the Online Forum on Disabled and other Vulnerable People in Natural Disasters*, which reviews contemporary evacuation preparedness practices, posits suggestions for improvement in individual and community emergency response, and

Table 3 Between-groups differences with respect to location

	Home				City/town			
	N	Mann–Whitney ***U***	***P***	***r***	***N***	Marni–Whitney ***U***	***P***	***r***
Paraplegia	12	23.5	0.05	0.44	5	3.0	0.045	0.63
Tetraplegia	8				5			
Employed	2	2.0	0.036	0.47	2	1.0	0.064	0.59
Unemployed	18				8			

Significant differences: $P < 0.05$. Significant trends: $P < 0.10$.

provides a list of publications related to evacuation preparedness for people with disabilities.[18] Promoting awareness of available literature and the importance of being adequately prepared for an evacuation could provide the SCI population with one solution to improve evacuation preparedness.

Perhaps one of the most important elements to an individual's plan of evacuation is communication with their PSNs before and after an evacuation. Data from this study reveal that PSNs are often not included in plans, despite their importance in the evacuation response. Creation of PSNs is one of the first steps in devising a plan of evacuation, and it is recommended that one should be organized for any location where one spends a lot of time.[15] Members of the PSN can be roommates, relatives, neighbors, friends, or co-workers,[16] and can help an individual plan for an evacuation ahead of time, and provide assistance after the event occurs. Multiple resources recommend a PSN of at least three members.[15–17] Individuals with SCI must be made aware that formation of a PSN is one of the most important steps in creating an evacuation plan and can greatly facilitate a successful evacuation.

These data show that individuals with SCI take into account the necessity of including AT devices in the planning process. Lifting devices were a crucial component of the studied evacuation plans, and would be necessary if an individual is not able to independently transfer him- or herself or if members of their PSN are not immediately available. Most subjects who reported having a town or city plan also mentioned the use of accessible vehicles, revealing the importance of owning or having access to modified vehicles in preparation for evacuation. Educational efforts should address specific AT devices that are necessary for individuals with SCI to safely evacuate any location. This education should be extended to those responsible for aiding them in an evacuation,[15–17] as it is evident that PSNs are often not thought about in the initial preparation. In addition to addressing which devices are needed, emergency personnel and members of PSNs must be trained how to properly use the devices in order to facilitate and improve the evacuation response.[15–17]

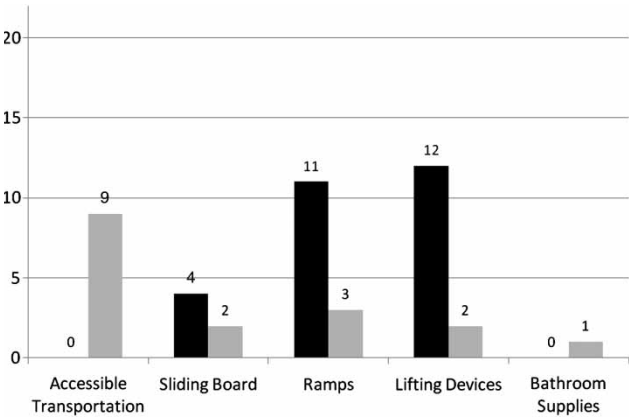

Figure 2 Total number of AT devices with respect to location and type of device. Black, home ($n = 20$); grey, town/city ($n = 10$).

Study limitations

One limitation to this study was the small sample size. A larger sample size would provide a more accurate depiction of the level of preparedness exhibited by this population and improve the statistical power of between-groups tests. Finally, the current design of the study relies on qualitative data collected from subject personal narratives, which makes it difficult for investigators to accurately determine how well the plan would work in a real-world situation.

Conclusions

This study shows that out of those individuals with SCI who feel they would be ready to evacuate, few are adequately prepared and have taken the appropriate steps to facilitate a successful evacuation. Additional educational efforts need to target the community of individuals with disabilities, their PSNs, and emergency personnel. This education should include the necessary elements in an evacuation plan. AT necessary for the safe evacuation of individuals with disabilities should also be included so that emergency personnel and members of PSNs are familiar with their use. The myriad of publications available should be broadly

disseminated to this group and all of those who are involved in the emergency response.

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