ORIGINAL RESEARCH

A Review of Emergency Medical Services Events in US National Parks From 2007 to 2011

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Objective.—Outdoor recreation is growing in the United States, with more than 279 million annual visitors to areas controlled by the National Park Service (NPS). Emergency medical needs in these parks are overseen by the National Park’s rangers within the NPS Emergency Medical Services (EMS) system. This study examines medical and traumatic emergencies throughout the NPS over a 5-year period to better understand the types of events and fatalities rangers encounter, both regionally and on a national scale.

Methods.—This is a retrospective review of the annual EMS reports published by the 7 NPS regions from 2007 to 2011. The following were compared and examined at a regional and national level: medical versus traumatic versus first aid events, cardiac events and outcomes, use of automated external defibrillators, and medical versus traumatic fatalities.

Results.—The national incidence of EMS events was 45.9 events per 1 million visitors. Medical, traumatic, and first aid events composed 29%, 28%, and 43% of reports, respectively. Of medical episodes, 1.8% were cardiac arrests, of which 64.2% received automated external defibrillator treatment; 29.1% of cardiac arrests survived to hospital discharge. Of fatalities, 61.4% were traumatic in nature and the remaining 38.5% were nontraumatic (medical). Regional differences were found for all variables.

Conclusions.—On a national level, the NPS experiences an equal number of medical and traumatic EMS events. This differs from past observed trends that reported a higher incidence of traumatic events than medical events in wilderness settings. Cardiac events and automated external defibrillator usage are relatively infrequent. Traumatic fatalities are more common than medical fatalities in the NPS. Regional variations in events likely reflect differences in terrain, common activities, proximity to urban areas, and access to definitive care between regions. These data can assist the NPS in targeting the regions with the greatest number of incidents and fatalities for prevention, ranger training, and visitor education.

Key words: National Park Service, EMS, Emergency Medical System, EMS events, rangers, National Parks, AED, Automated External Defibrillator

Introduction

The US National Park Service (NPS) is a system of more than 390 public parks that span approximately 84 million acres (131,250 square miles) across 49 states and four territories. The NPS is divided into 7 regions as follows: Alaska (AKR), Intermountain (IMR), Midwest (MWR), National Capital (NCR), Northeast (NER), Pacific West (PWR), and Southeast (SER) (see Figure 1). These re-

gions comprise a diverse system of public land referred to as “units” that range from historical sites, such as battlefields and memorials, to national parks and recreation areas.^{1,2} In 2011, the NPS reported 278,939,216 recreational visits.³ From 2007 to 2011, the NPS averaged approximately 279,251,484 recreational visits per year, with significant variation among the 7 regions (Figure 2).³ Parks typically deal with visitors in both frontcountry and backcountry settings. Frontcountry is defined as areas accessible by car, and backcountry as those areas that are not. Typically, frontcountry areas see a larger number of visitors with a variety of healthcare

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Figure 1. National Park Service regional map, number of visits, and number of emergency medical services (EMS) events for 2007 to 2011 (numbers in parentheses are percent of total EMS events). The National Park Service is divided into 7 regions: Alaska (AKR), Intermountain (IMR), Midwest (MWR), National Capital (NCR), Northeast (NER), Pacific West (PWR), and Southeast (SER).

needs owing to their ease of access, whereas backcountry areas see a younger and overall healthier population of visitors.⁴ The emergency medical services (EMS) system that serves these visitors is covered by the park rangers, some with basic emergency medical technician (EMT)

training and others with more advanced training such as the parkmedic program. In addition, individual parks utilize assistance from local EMS systems, as well as volunteer search and rescue (SAR) organizations. This utilization varies from park to park based on geographical location, proximity to local EMS systems, and individual park need.⁵⁻⁷

The parkmedic program was developed in 1977 by the NPS in response to the growing need for improved EMS for its steadily growing number of visitors. Parkmedics are rangers with advanced EMT training that allows them to perform venipuncture, administer intravenous fluids and medications, use advanced techniques in cardiopulmonary resuscitation, and airway management, and use advanced SAR techniques such as technical evacuations and helicopter rescue.^{5,8} The NPS, its rangers, and its parkmedics cover the EMS for a large number and variety of visitors over a significant square mileage of often remote wilderness.

Figure 2. National Park Service number of recreational visits by region, 2007 to 2011.

Increasing numbers of people participating in wilderness activities is assumed to increase the frequency of wilderness injuries, but few studies have examined this on a national scale. Outdoor recreational injuries require specific epidemiologic attention, as the treatment of such injuries is different from that of injuries in an urban setting, owing to increased response times, limited personnel and resources, challenging terrain and weather, difficulty of transportation, and extended time to definitive care.⁹ These challenges differentiate wilderness EMS care from standard EMS care.² There is a growing body of literature examining the epidemiology of outdoor recreational injuries and SAR in the NPS; however, most studies focus on regions, states, or individual parks within the United States. Some studies have examined the wilderness morbidity and mortality in the states of Utah,¹⁰ New Hampshire,¹¹ California,^{4,7} and Alaska.¹² Others have examined wilderness morbidity and mortality within individual national parks, including Yellowstone,¹³ Mount Rainier and Olympic,¹⁴ Shenandoah,¹⁵ Yosemite,¹⁶ and Sequoia and Kings Canyon.¹⁷ Heggie et al^{2,19,20} previously published a series of papers reviewing NPS fatalities and injuries based on SAR reports, but these data did not incorporate the NPS annual EMS reports in their review.

This paper aims to review EMS events in the NPS on a national and regional scale. Using data from the NPS over 5 years from 2007 to 2011, we sought to determine the overall number of medical and traumatic events, the incidence of EMS events compared to the overall number of visitors, the frequency of cardiac arrests and of automated external defibrillator (AED) use, and the overall incidence of traumatic and medical fatalities. By determining which regions see the greatest number of EMS incidents, as well as what types of incidents, the NPS may be able to better educate visitors in those areas about injury and illness prevention, as well as continue to develop ranger training programs specific to the types of incidents encountered by region.

Methods

This study is a retrospective review of data from the annual EMS reports published by the NPS from 2007 to 2011. Data were collected from the annual EMS reports for all 7 regions in the NPS. The EMS events are divided into trauma, medical noncardiac, medical cardiac, and first aid cases. The traumatic and medical cases are further subdivided into basic life support (BLS) and advanced life support (ALS). The ALS cases were defined as calls that required ALS level intervention such as IV placement, IV fluid administration, medication administration, or advanced airway management. All

other events are classified as BLS cases. All first aid cases were BLS cases encompassing basic first aid such as the application of bandages, ice packs, or similar interventions that did not require transportation or further intervention. The EMS reports further quantified the number of cardiac arrests, the number of patients on which an AED was used, and the number of cardiac arrest victims who survived to hospital discharge. Fatalities were divided into traumatic (those due to accident, injury, or self-inflicted injury), and nontraumatic (those due to a medical cause or natural death).

The annual EMS reports were provided by the NPS Intermountain Regional Office. The data from each annual EMS report was entered into a spreadsheet, and all calculations were performed using Microsoft Excel 2007 software (Microsoft, Redmond, WA). Incidence data were calculated using the reported numbers in the annual EMS reports as the numerator and recreational visits as reported in the NPS public use statistics office as the denominator. Recreational visits are defined by the NPS as entries of persons onto lands or waters administered by the NPS. These do not include nonrecreational visits, including persons conducting business or research in NPS areas, or nonreportable visits, including NPS staff, employees, contractors, tenants, and incidental traffic (pedestrian or vehicular) traveling through NPS areas.²¹ Formal institutional review board approval was obtained from the University of Colorado Medical School. The Colorado Medical Institutional Review Board exempted the protocol as non-human subjects research.

Results

Figure 1 represents an overview of the geography, number of recreational visits, and number of EMS events both by region and for the entire NPS from 2007 to 2011. Figure 2 represents the number of annual recreational visits by region for the years 2007 through 2011. The overall number of visitors to each region generally increased over time for all regions except AKR. The NER, PWR, and SER consistently represented the most visited regions, with more than 50 million annual recreational visits, and Alaska represented the least visited region with fewer than 3 million recreational visitors a year.

From 2007 to 2011, there were 64,045 total EMS events reported in the NPS (Figure 1). Of those events, there were 18,675 (29%) medical events, 17,738 (28%) traumatic events, and 27,685 (43%) first aid events. Nationally, first aid events occurred most frequently whereas medical and trauma events occurred equally (Figure 3). The regions with the highest numbers of EMS events were IMR and NER, and AKR had the fewest. The regions with the highest numbers of medical events

Figure 3. National Park Service number and type of emergency medical services events by region, 2007 to 2011.

and the highest number of traumatic events were IMR and PWR, respectively. The NER had the highest number of first aid events; and AKR had the lowest number of medical, trauma, and first aid events. Overall, the number of EMS events decreased slightly over the 3 years.

Table 1 shows the incidence of EMS events by region. The IMR had the highest incidence of both medical and trauma events and had the second highest incidence of first aid events. The NER had the highest incidence of first aid events.

Table 2 shows the number of cardiac arrests compared to all medical events, the frequency of AED usage, and survival from cardiac arrest in the NPS by region. Nationwide cardiac arrests represented 1.8% of all medical events, an AED was used to deliver electrical cardioversion in just more half of all cardiac arrest cases, and fewer than half of victims survived cardiac arrest.

Table 3 shows the number, incidence, and type of fatalities experienced in the NPS by region. The IMR and PWR had the highest number of fatalities overall whereas AKR had the highest incidence of fatalities per number of recreational visitors. Nationally, traumatic

fatalities in the NPS outnumbered medical fatalities throughout the study period (Figure 4). Of note, the NCR was the only region where medical fatalities outnumbered traumatic fatalities.

Discussion

With approximately 279 million recreational visitors annually during the span of 2007 to 2011, the NPS is responsible for a complex EMS system that deals with a variety of patients and medical events. Although the overall national incidence of EMS events in the NPS is low, at 45.9 events per million recreational visitors, the number of individual EMS events is quite large at approximately 12,809 events per year. The 2007 to 2011 data reviewed here show some regional and national trends that may be useful in allocating resources within the NPS.

Over the course of 2007 to 2011, the IMR had consistently the highest incidence of total EMS events, medical events, and traumatic events; it had almost double the incidence of medical events and traumatic events as the PWR and AKR, which ranked second and third in terms of incidence of both medical and traumatic events. The number and incidence of first aid events in the NER was substantially greater than in all of the other regions. The exact etiology of this trend of higher medical and traumatic events in the IMR and higher first aid events in the NER could not be extrapolated from our data. However, a 2005 review of NPS SAR reports noted a parallel trend of more frequent SAR operations in parks located in the IMR, PWR, and NER.¹⁹ We hypothesize that these trends likely result from the geographical variations between the NPS regions. The NPS regions with higher incidence of EMS events all encompass regions with large areas of more open, rugged, and isolated land compared with the other regions. These geographical

Table 1. Incidence of emergency medical services events by National Park Service region for 2007 to 2011

NPS Region	EMS events per million visits	Medical events per million visits	Trauma events per million visits	First aid events per million visits
AKR	48.1	19.1	15.0	14.0
IMR	101.1	42.9	29.6	28.6
MWR	32.6	8.1	11.2	13.4
NCR	5.4	1.7	1.8	1.9
NER	67.2	5.0	7.5	54.5
PWR	54.1	20.5	21.2	12.5
SER	15.9	4.2	6.5	5.6
Totals	45.9	13.4	12.7	19.8

NPS, National Park Service; EMS, emergency medical services; AKR, Alaska; IMR, Intermountain; MWR, Midwest; NCR, National Capital; NER, Northeast; PWR, Pacific West; SER, Southeast.

Table 2. Cardiac arrest and automated external defibrillator usage data by National Park Service Region for 2007 to 2011

<i>NPS Region</i>	<i>Medical events, n</i>	<i>Cardiac arrests, n</i>	<i>Cardiac arrests of total medical events, %</i>	<i>Patients AED used, n</i>	<i>Cardiac arrests with AED used, %</i>	<i>Cardiac arrest survival, n</i>	<i>Cardiac arrest survival, %</i>
AKR	228	13	5.7%	5	38.5%	0	0.0%
IMR	8915	96	1.1%	66	68.8%	15	15.6%
MWR	804	24	3.0%	7	29.2%	11	45.8%
NCR	389	6	1.5%	1	16.7%	0	0.0%
NER	1351	42	3.1%	24	57.1%	10	23.8%
PWR	5728	95	1.7%	73	76.8%	31	32.6%
SER	1260	51	4.1%	34	66.7%	28	54.9%
Totals	18,675	327	1.8%	210	64.2%	95	29.1%

NPS, National Park Service; AED, automated external defibrillator; EMS, emergency medical services; AKR, Alaska; IMR, Intermountain; MWR, Midwest; NCR, National Capital; NER, Northeast; PWR, Pacific West; SER, Southeast.

differences affect both the likelihood of getting into trouble as well as the ability to get aid quickly to victims of illness and injury. The increased frequency of both SAR and EMS events in these regions may reflect a greater resource need and may help guide decisions regarding funding, resources, targeted ranger training, and visitor safety education.

Conversely, the number and incidence of total EMS events in the NCR was substantially less than that of all the other regions. This finding likely reflects the proximity of the NCR to urban EMS systems, in that visitors have easy access to outside EMS systems. Shenandoah National Park, in the SER, is similarly located in close proximity to a major metropolitan area with access to established EMS systems and hospitals. It also reported fewer injuries and illness per visitors compared with more isolated parks.¹⁵ That is in contrast to the more geographically isolated areas with limited access to established non-NPS EMS systems.

The medical needs of NPS visitors are equal to their trauma needs. Nationally, medical events account for an approximately equal number of EMS encounters as tra-

umatic events. Prior research has indicated that traumatic injuries in the wilderness outnumber medical in all age groups, trip lengths, and settings.^{4,10,11,13–17,22,23} Although direct comparisons between these studies is impossible due to differences in study populations, regions, and mode of data collection, they all similarly found traumatic injuries to be more common than medical in the wilderness. The higher number of traumatic injuries compared to medical emergencies may be due to prior studies focusing on backcountry events whereas our review includes both backcountry and frontcountry events. Presuming there is a higher percentage of medical emergencies in the frontcountry, our review of the NPS data shows a different picture, with the national trend of medical events equaling that of trauma events. Although visitor demographics and activities carried out in national parks vary based on geographic location, on a national level, it appears that overall there is equal need for both medical and trauma EMS education within the park service.

The national incidence of cardiac arrest and AED usage in the NPS during 2007 to 2011 is relatively low

Table 3. Number, percentage, type, and incidence of fatalities by National Park Service region for 2007 to 2011

<i>NPS Region</i>	<i>Recreational visits, n</i>	<i>Total fatalities, n</i>	<i>Nontraumatic fatalities, n</i>	<i>Nontraumatic fatalities, %</i>	<i>Traumatic fatalities, n</i>	<i>Traumatic fatalities, %</i>	<i>Fatalities per million visits</i>
AKR	11,927,667	55	20	36.4%	35	63.6%	4.6
IMR	207,626,567	468	217	46.4%	251	53.6%	2.3
MWR	99,656,666	83	34	41.0%	49	59.0%	0.8
NCR	227,134,478	14	8	57.1%	6	42.9%	0.06
NER	268,793,142	134	38	28.4%	96	71.6%	0.5
PWR	279,498,692	468	176	37.6%	292	62.4%	1.7
SER	301,620,210	258	78	30.2%	180	69.8%	0.9
Totals	1,396,257,422	1480	571	38.5%	909	61.4%	1.1

NPS, National Park Service; AKR, Alaska; IMR, Intermountain; MWR, Midwest; NCR, National Capital; NER, Northeast; PWR, Pacific West; SER, Southeast.

Figure 4. National Park Service number and type of fatalities nationwide, 2007 to 2011.

when compared to national urban EMS statistics and past reports of incidences in the wilderness setting. Although few papers have reported cardiac events in the wilderness, those that did showed a slightly higher percentage of cardiac illness in the wilderness, with 3% to 4.3% of cases having a cardiac etiology.^{10,22} Mortality from cardiac illness in the wilderness setting has been reported to be from 4% to 23.4%.^{4,11,14,16–18} Additionally, Forrester et al¹⁵ reported that chest pain was the most common medical complaint among adult visitors to Shenandoah National Park. We found a lower percentage of cardiac arrest in the NPS as a whole, with only 1.8% of medical events defined as cardiac arrest. Again, making direct comparisons between past studies and our data is limited as definitions of cardiac illness, events, and cardiac arrest may differ between each study. It nonetheless offers further insight to the overall picture of the types of medical events encountered in the NPS.

Similar to cardiac arrest events, AED usage in the NPS was infrequent during 2007 to 2011. An AED was used to deliver electrical shock in just under two thirds of all cardiac arrests and in 1% of all medical events. What remains to be answered is why only 64.2% of cardiac arrest victims received AED intervention, although lack of individual case reports makes this difficult to discern. Use of AED for cardiac arrest may be limited by access to AEDs and training in their use. There are few studies that address the use of AEDs and the epidemiology of cardiac arrest in the wilderness setting. In their discussion of the parkmedic program, Kaufman et al⁸ noted that cardiac cases were the most frequent medial problem encountered by the parkmedics in Sequoia and Kings Canyon National Parks, accounting for 32% of the medical problems reported in 1 study. Although our data and past studies do not settle the debate of utility versus cost of advanced cardiac life support certification for park-

medics, it does indicate that the number of cardiac arrests may not be negligible, particularly in so-called front-country areas of parks, where EMS events may more closely mimic those in an urban environment, with a older and less healthy population.^{5,22}

Fatalities in the NPS were more common in the regions previously discussed as having higher EMS events. The IMR and PWR reported the highest number of total fatalities, and the AKR reported the highest incidence of fatalities with nearly 5 times the national average. The IMR and PWR were second and third in terms of fatality incidence with nearly 2 times the national average. That, again, most likely reflects the remoteness of these regions' parks, less access to established EMS systems, the types of activities pursued by visitors, and a harsher environment. These characteristics hold especially true for Alaska and its unique environment. Of note, the overall incidence of fatalities in the NPS from 2007 to 2011 was very low, at approximately 1 death for every million visitors, which is an attestation to the work the NPS invests in making visits to our nation's wilderness safe.

Traumatic fatalities outnumber medical fatalities in the wilderness. In the NPS from 2007 to 2011, traumatic fatalities accounted for three fifths of all fatalities and medical fatalities made up the remaining two fifths. Studies have reported a similar trend showing larger numbers of traumatic deaths versus nontraumatic deaths experienced in the wilderness.^{4,7,10,11,14,16,18} Prior studies have also shown high rates of motor vehicle accidents and alcohol use as a cause of death on NPS lands.^{2,18} Activities such as hiking, mountaineering, climbing, swimming, boating, and driving have all been associated with wilderness fatalities.^{2,4,11,14,19,20} Falls, drowning, and blunt trauma are reported as the most common causes of death.^{4,11,14,16,18} The NPS experiences a high concentration of persons engaging in these activities who are exposed to the inherent risks associated with such. These activities and the wilderness environment in which they are practiced appear to predispose visitors to traumatic death over medical death.

STUDY LIMITATIONS

This study was limited by the data available from the NPS. More detailed reports or causes of injury and death within the 2 main categories (trauma vs medical) were not available from this data set; thus, it was not possible to examine particular pathologies or trends within each category. The data used also did not distinguish back-country events from frontcountry events, making it difficult to compare our findings with that of previous studies that focused on backcountry or SAR incidences.

It also makes it difficult to make specific recommendations regarding the appropriate placement of medical resources such as AEDs. Going forward, the NPS is introducing a unified reporting system that will, it is hoped, make more detailed research possible in the future.

The overall number of park visitors recorded by the NPS does not include nonrecreational visits or NPS staff, and although these visitors likely account for a small number of EMS events, it is possible that our incidence data are an underestimate of true events. Furthermore, some of the parks and NPS units are located in urban areas with well-established EMS systems, and it is likely that EMS events here were absorbed by the surrounding EMS system and hence were not included in the NPS data. The number of first aid and minor EMS events may also be lower than actually experienced if victims of such events treated themselves and did not report their illness or injury to NPS staff. Finally, not all EMS events that occurred in the NPS during the study period may have been officially recorded on EMS run sheets or reports, which are the basis for the annual NPS EMS reports.

Conclusions

Our aim was to report the epidemiology of EMS events within the NPS to look for regional variations and national trends in the types of cases encountered, fatality rates, and causes of death. Although the NPS has a robust EMS ranger training program and regional curricula developed to educate rangers about problems unique to each area, this data may serve to further develop unique training programs targeted to areas with higher rates of particular events.

Overall, visitors to our national parks have a relatively low incidence of EMS events at 45.9 per million visitors annually. Nationally, the NPS experiences an equal number of medical and trauma EMS events. This trend differs from past trends that reported a higher incidence of trauma events than medical events in wilderness settings. Cardiac events and AED usage are relatively infrequent. Regional variations may point to areas for future research where there are high rates of medical or cardiac arrest deaths and whether increasing AED availability and training would be beneficial. Although there are equal numbers of medical and traumatic events throughout the NPS, traumatic fatalities are more common than medical fatalities, with trauma being the leading cause of fatalities nationwide. The overall incidence of fatalities was very low at approximately 1 death for every million visitors. Regional variations in events may reflect differences in terrain, common activities, proximity to urban areas, and access to definitive care between regions.

These data can assist the NPS in targeting the regions with the greatest number of incidents and fatalities for future prevention and ranger training.

In addition to NPS ranger training, these data may serve as a preliminary guide to improving public education concerning safety when visiting national parks. The national parks already have extensive education goals for the public regarding outdoor precautions and how to enjoy the wilderness safely; however, in areas with particularly high rates of fatalities or extremes of environment, additional public education in the recognition, immediate treatment, and disposition of commonly encountered emergencies may be beneficial. Overall, given the number of visitors to the NPS, the incidence of medical emergencies, cardiac arrests, and fatalities remains very low.

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