



ORIGINAL ARTICLE

Pattern of Passenger Injury and Illness on Expedition Cruise Ships to Antarctica

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Background. Expedition ships to Antarctica travel to remote areas with limited medical support.

Objectives. This study determines the rate and patterns of passenger illness and injuries among those traveling on expedition ships to Antarctica. We hypothesize that severe medical conditions are encountered that require physicians serving on these ships to be skilled enough to care for critically ill or injured patients.

Methods. We performed a retrospective analysis of the medical records of all passengers who were provided medical care on 26 Antarctica voyages from October 2010 to March 2011 (four different expedition ships). A structured system was used to categorize the diagnoses from each patient encounter. The pattern of traumatic injuries was noted, including location of occurrence. Treatments rendered including patient evacuations were documented. The population is described with incidence rates.

Results. A total of 2,366 passengers traveled on 26 trips, for a total of 34,501 person-days. In all, 680 physician visits were done, including 150 consultations for motion sickness preventive care, leaving 530 visits (15.4 visits per 1,000 person-days) for active medical care. Median age was 50 (range 10–90) years and 51% were females. Incidence rates per 1,000 person-days for the most common processes include motion sickness (4.2), infections (3.5), and injury (2.0). Injuries were more likely to occur on the ship (66%, 95% CI: 54–77%) compared to off the ship (34%, 95% CI: 23–46%). Four subjects (0.12/1,000 person-days) were evacuated (three due to traumatic conditions and one due to medical complications) and one person died (medical complication).

Conclusion. Passengers on expedition ships to Antarctica may experience significant illness and injury. Ship physicians should be aware of the patterns of injuries and illnesses that occur on expedition ships and should have appropriate training to treat various medical and traumatic conditions including life-threatening illnesses.

Since the beginning of the modern Antarctic tourism industry in 1969, the number of tourists in Antarctica has increased from a few hundred to more than 30,000 each year. Approximately 55 vessels are registered with International Association of Antarctica Tour Operators (IAATO) for tourism to Antarctica, ranging from yachts to large cruise ships. The regulations placed on the large cruise ships by IAATO prevent vessels carrying more than 500 passengers from landing while in Antarctic waters. Thus, these operators are cruise-only tours.¹ As the majority of tourists traveling to Antarctica desire a continental landing, most tourists travel on smaller expedition ships (fewer than 120 passengers).

Increase in numbers of tourists to Antarctica aboard these small expedition cruise ships continues.

These expedition ships employ a physician for the passengers and are stocked with medical supplies in cases of medical emergency. The medical requirements and physician training needed, however, are not well known because of limited amount of evidence on this topic. This study aims to determine the incidence and pattern of illness and injury on smaller expedition ships to Antarctica.

Methods

Study Design

This was a retrospective review of the medical records of passengers seeking medical assistance on expedition ships to Antarctica. The study was approved by the UC Davis Institutional Review Board.

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Study Setting

Data were obtained from medical records maintained by the ship physicians aboard four different Antarctica cruise ships from October 14, 2010 through March 12, 2011 (late spring, summer, and early fall months). These four ships had limited medical capacity with no laboratory or radiographic capabilities but with an extensive array of equipment and medications for medical treatment. One physician was provided for the passengers in each ship. This physician was required to have training in either emergency medicine or another specialty with experience in critical care. The desired physician training, however, was actively practicing emergency medicine physicians. The physician was recommended to use a medical log template that included patient name, age, gender, nationality, date of visit, chief complaint, medical history, medications, allergies, physical examination, assessment, and plan. Three of the four ships included a Russian physician for the crew. On the fourth ship, the first mate provided the medical care to the crew. The Russian physician shared space and equipment with the passenger physician but did not provide care to the passengers.

Twenty-three different physicians, all practicing emergency medicine physicians, provided medical care on the 26 different voyages. Passengers were required to have a medical screening examination done and medical forms filled out by their primary medical doctor prior to embarkation. The passengers brought their own daily medications. The expedition outfitter reserved the right to deny passage to any traveler on reasonable medical grounds.

Twenty-four of the 26 expedition cruises originated from and returned to the city of Ushuaia, Argentina. This route involves crossing the Drake Passage (2-day transit each way). One originated in Ushuaia and ended in Port Stanley and one started in Port Stanley and ended in Hobart. The expeditions ranged in duration from 10 to 30 days with a mean of 14 days (median 12.5 days).

Study Participants

The study participants included passengers on the expedition ship requesting evaluation by the ship physician and had a medical evaluation form completed by the ship physician.

Study Protocol

Variables were specifically defined prior to onset of abstraction. Demographic data collected included age, gender, nationality, and medical history if provided. The number and types of chief complaints were abstracted. A complaint classification system was used to categorize the presenting complaints. Reasons for the medical visit were placed into one of the following 15 categories: motion sickness treatment, motion sickness prophylaxis, traumatic injury, musculoskeletal/orthopedic (non-traumatic),

infectious respiratory, infectious gastrointestinal, cardiac, pulmonary (non-infectious), ophthalmology/ENT/dental, genitourinary, gastroenterology (non-infectious), neurology/psychiatry, dermatology, immunology/rheumatology, and endocrinology. Demographic and visit classification data were abstracted prior to the abstraction of treatment information.

Data on treatments provided were collected additionally. Major events were defined as medical evacuations or patient death. Patients were considered to undergo medical evacuation if they were removed from the ship for medical reasons based on the ship physician's recommendations.

Data Analysis

Data are described with simple descriptive statistics and 95% CI where appropriate. Incidence rates are presented in events per 1,000 person-days. The incidence rate ratios were calculated where appropriate to compare the rates between genders. A random sample of 33 physician encounters was abstracted by a second reviewer to measure inter-rater reliability. Inter-rater reliability was measured with the kappa statistic.

Results

A total of 2,366 passengers (1,210 males and 1,156 females) on the 26 trips traveled for a total of 34,501 person-days (16,973 male days and 17,528 female days). A total of 680 patient consultations were documented. Of these 680 consultations, 150 were for motion sickness prophylaxis (prior to active motion sickness). Thus, 530 patient consultations for active medical complaints were documented and make up the primary study sample. These 530 patient consultations were made by 519 different patients. The median age was 50 years, interquartile range 40 to 60 years, range 10 to 90 years, and 267/519 (51%) were females. Patients represented 44 different nations. Inter-rater reliability of the data abstraction was excellent ($\kappa = 0.9$).

A total of 530 consultations for active medical complaints were made (incidence rate of 15.4 visits per 1,000 person-days) (Figure 1). Thirty-two (6.0%, 95% CI: 4.2–8.4%) of these events were related to preexisting medical conditions. The overall incidence rate was similar between genders (male = 15.5 visits per 1,000 person-days and female = 15.2 visits per 1,000 person-days). Incidence rates categorized by gender are presented in Figure 2.

The most common complaint was motion sickness ($n = 142$, 27%) with an incidence rate of 4.2/1,000 person-days. Women had a higher rate of visits for motion sickness compared to men, incidence rate ratio = 1.39, 95% CI: 0.99–1.96; $p = 0.05$. The second most common complaint was an infectious process ($n = 122$, 23%) with an incidence rate of 3.5/1,000 person-days. The predominant infectious process was upper respiratory complaints (incidence rate 2.99/1,000

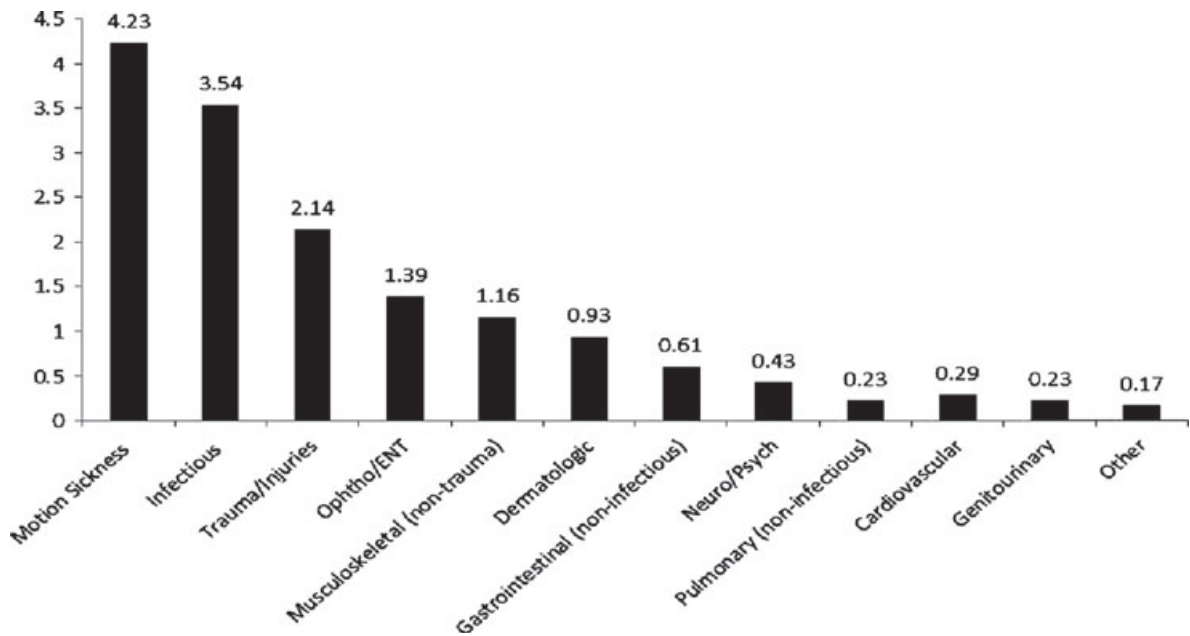


Figure 1 Incidence rates per 1,000 person-days for major categories.

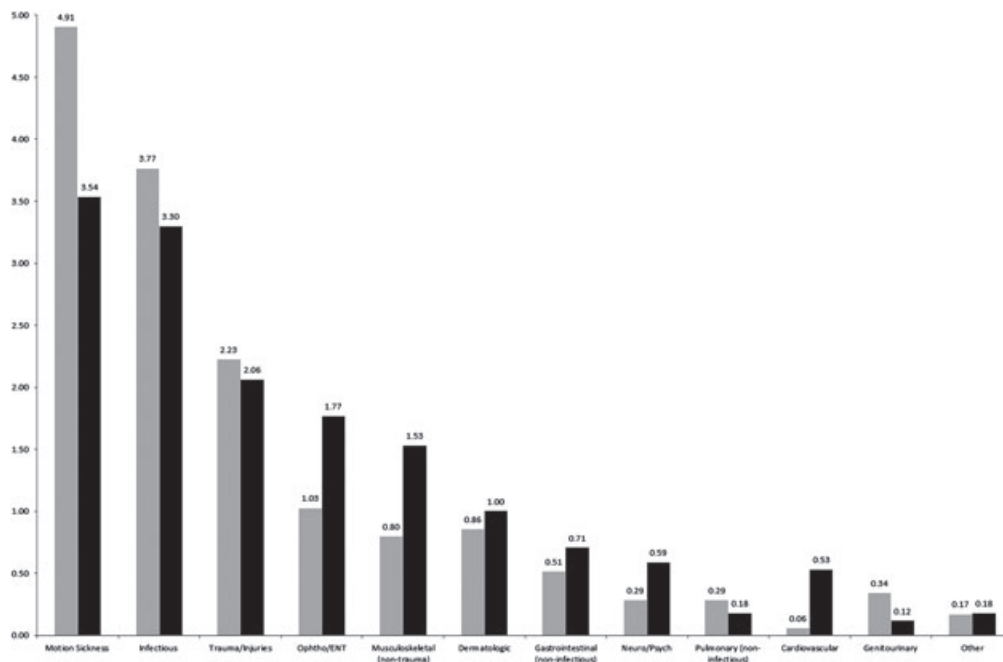


Figure 2 Incidence rates per 1,000 for female (gray) compared to male (black).

person-days) including pharyngitis, simple upper respiratory infections, and bronchitis. Only one case of pneumonia was documented (by clinical examination as no radiographic capabilities were available). Gastrointestinal infections ($n = 21$), including gastroenteritis and diarrhea, occurred at an incidence rate of 0.55/1,000 person-days. Thirty-eight patients were treated with oral antibiotics. Infectious processes treated with oral antibiotics are listed in Figure 3.

Injury was the third most common complaint ($n = 74$, 14%, with an incidence rate of 2.14/1,000 person-days). Injuries were more likely to occur on the ship (49/74, 66%, 95% CI: 54–77%) than off the ship (25/74, 34%, 95% CI: 23–46%). Women had the same risk of injury as men (incidence rate ratio = 0.87, 95% CI: 0.53–1.41; $p = 0.54$). The most common types of injuries were simple contusions, lacerations, and sprains (Figure 4). Cardiovascular events were rare but more common

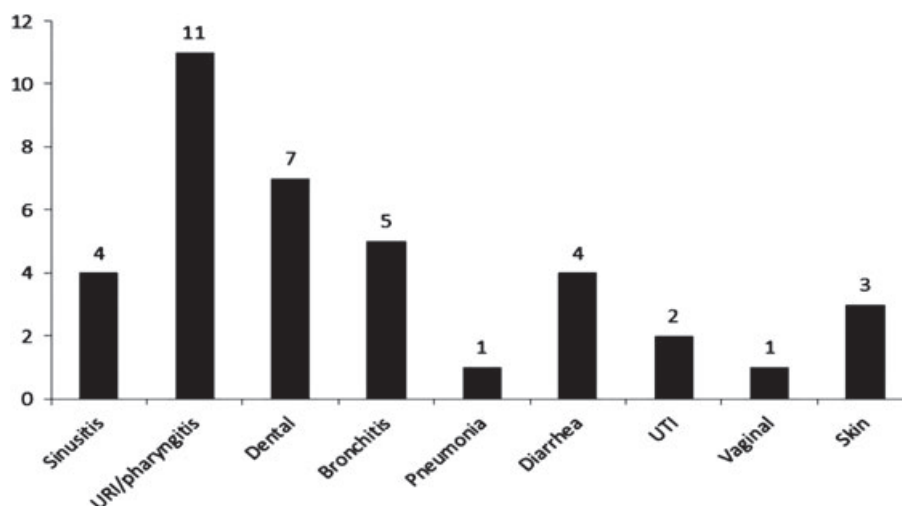


Figure 3 Disease processes treated with antibiotics. URI = upper respiratory infection; UTI = urinary tract infection.

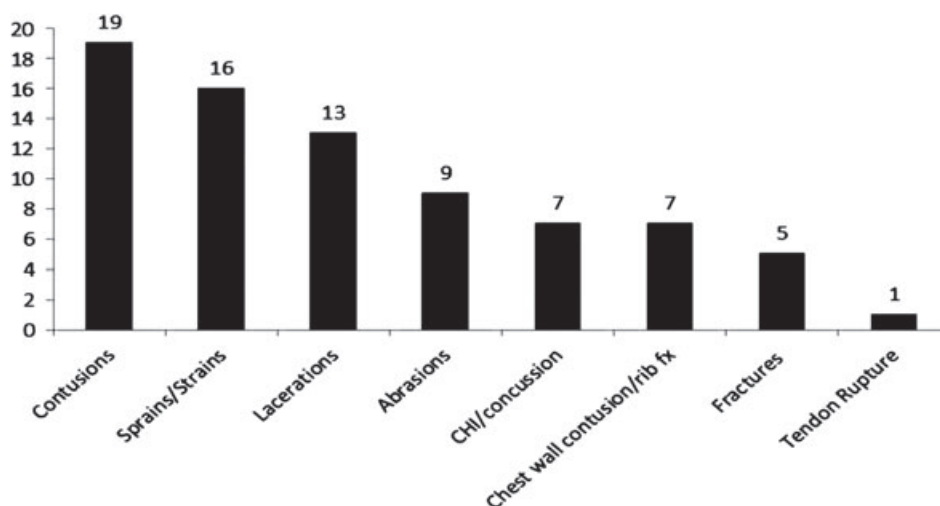


Figure 4 Types of traumatic events documented among 74 patients (several had multiple types of injuries). CHI = closed head injury; fx = fracture.

in men ($n=9$) than in women ($n=1$) (incidence rate ratio = 9.29, 95% CI: 1.29–407, $p=0.01$).

Five major events occurred (0.14 events per 1,000 person-days) including four evacuations (0.12/1,000 person-days) and one death (0.029/1,000 person-days). A 71-year-old male suffered a cardiopulmonary arrest while walking on shore. Life-saving measures including chest compressions were immediately administered but the patient failed to have spontaneous return of circulation despite 30 minutes of resuscitative efforts. A 60-year-old male presented with substernal chest pain and suffered an inferior wall myocardial infarction. He was emergently evacuated from the ship and underwent stenting of his right coronary artery. Three major traumatic events requiring evacuation were documented. A 46-year-old male slid down a hill and suffered a quadriceps tendon disruption and underwent surgery 8 days after the injury. A 76-year-old male sustained a hip

fracture from a fall while on the deck of the ship. An elderly female suffered a hip fracture after a fall in her cabin while the ship was crossing the Drake Passage. Despite the need for emergent evacuation, it was not possible to evacuate her as the ship was crossing the Drake Passage; so she was cared for in her cabin until the ship arrived in Ushuaia and then emergently transported by fixed wing to a Buenos Aires hospital. Evacuations of the other patients involved a series of helicopter and/or fixed wing transports.

Additional significant medical issues documented included two cases of severe allergic reactions treated with epinephrine, severe chest pain (concern for pulmonary embolism and treated with Lovenox), unilateral lower extremity edema (concern for deep venous thrombosis), new-onset atrial flutter, atrial fibrillation requiring additional anti-arrhythmics, multiple

cases of syncope, cases of upper and lower gastrointestinal bleeding, wrist fracture, shoulder dislocation, and multiple cases of blunt head trauma with scalp lacerations.

Discussion

The study demonstrates within a large sample the rate and types of physician encounters on expedition ships to Antarctica. Not surprisingly, the most common reason for physician encounters was motion sickness. Infectious processes and injuries were the next most common reasons. Although critical illnesses and injuries were rare, both occurred, including one fatality.

Tourism to Antarctica has experienced rapid growth throughout the last two decades with 6,512 tourists recorded in the 1992 to 1993 season, increasing to 34,354 tourists during the 2012 to 2013 season.¹ The majority of tourists to Antarctica travel by sea on ships of different sizes but most travel in ships accommodating approximately 100 passengers.¹ Thus, knowledge of the types of medical events that occur on ships of this size is important.

Although a dedicated section on cruise ship and maritime medicine exists within the American College of Emergency Physicians, the majority of experience and research is with larger cruise ships in temperate waters,²⁻⁷ and limited research exists on the medical needs of smaller expedition ships traveling in polar waters.⁸ Notable differences, however, occur in the medical needs and capabilities between large cruise ships and smaller expedition ships. Perhaps, most importantly, the patient populations differ. Antarctica trips require travel in unsettled oceans with unsteady and rugged terrain on the continent itself. Additionally, the weather is often extreme with average low temperatures on the Antarctic Peninsula ranging from -4°C to 0°C with 2 to 4 inch of precipitation per month. In addition, shore-based activities including kayaking, overnight camping, and hikes are offered. The tourists to Antarctica are expected to be in reasonably good health condition and able to tolerate the expected extreme conditions. Health requirements for large cruise ships are not as stringent. This difference in population selection and exposures to certain health risks alters the patterns of illness and injury treated by the ship physicians.

Given the smaller ship size, expedition ships are more prone to motion from unstable seas, and therefore, motion sickness is a larger risk than on larger, more stable cruise ships. Also the majority of Antarctica trips cross the Drake Passage with its notoriously rough seas. In this series, motion sickness prevention was the only preventive reason for passengers to seek medical care. Promethazine was the recommended medication for motion sickness prophylaxis with meclizine being the only other medication for motion sickness on board. Detailed data on the exact medications used for prophylaxis, however, were not available. Furthermore, actual

motion sickness was the most common reason to seek medical care. Although these complaints are the most common, the distribution of these complaints occurs during the time of sea crossing (ie, the Drake Passage). Passengers did not seek care for motion sickness during the actual time around the Antarctica peninsula. A slightly higher risk of motion sickness was identified in the female population. This finding agrees with a previous study suggesting that women are at an increased risk of motion sickness compared to men.⁹

Infection is a great concern on cruise ships because of the small area and ease of transmissibility.^{3,10-13} Gastroenteritis is perhaps the biggest concern. Infection was the second most common complaint, but primarily upper respiratory infections. Thirty-eight of the patient encounters resulted in the use of oral antibiotics. This information can be used to determine the types of antibiotics to stock on these ships. Although no patients were treated with intravenous antibiotics, the potential need and benefit of such antibiotics requires ships to carry these medications as well. The current review identified few cases of gastroenteritis, and when it occurred, strict precautions were undertaken (confinement to cabin) to minimize exposure to other passengers. Gastrointestinal infections are particularly worrisome on any type of cruise ships, especially Norovirus infections that may spread rapidly throughout the ship. Recent evidence, however, suggests that varicella is the most common vaccine-preventable disease reported by cruise ships.¹⁴ Furthermore, cases of rubella, measles, and varicella may occur among the crew as many are not vaccinated and they originate from countries with these diseases.¹⁵ This recent evidence suggests cruise ship physicians should be aware of these possibilities and companies should consider vaccination of cruise ship crew.

Traumatic injuries were the third most common complaint. Most were minor but three events required evacuation. In addition, a reduction of a shoulder dislocation was performed and several patients had concussions after blunt head trauma. Two-thirds of the injuries occurred on the ship, which is the same as a previous study on a large cruise ship.⁷ However, this previous study suggested that the more serious injuries occurred on shore.⁷ A study of injuries from Alaskan cruise ships further elucidates the injuries occurring on large cruise ships and demonstrates that most are due to falls.¹⁶ Surprisingly, the risk of traumatic injuries was similar between genders. Traumatic injuries are more common in the male population, but this finding suggests that the riskier behavior in males is less prevalent on these types of trips.

With regard to the medical facilities themselves, the small ships studied in this paper are staffed with one physician. Although supplied with equipment for basic resuscitation, stabilization, and some diagnostic capabilities (eg, electrocardiogram machines), there is no laboratory or imaging modalities, nor supporting staff aboard the ship. This is profoundly different from

large cruise ships that routinely have laboratory and radiographic capabilities. The more restricted resources limit the evaluation and treatment potentially rendered to patients. Although evacuation plans and communication modalities are well developed, evacuation and transfer of any patient to definitive care may be delayed due to the remoteness of the situation.

On comparing the results of these polar studies with those on the epidemiology of injury and illness aboard larger cruise ships in temperate waters,^{3,4,6} a few important differences were demonstrated. Less motion sickness is documented on the larger cruise ships, which is certainly due to the stability of large cruise ships. Despite the passengers on small Antarctic cruise ships seemingly being at more risk of traumatic injuries, only 14% of complaints were due to trauma/injury on Antarctic ships, while 18% were reported on larger cruise ships. This is likely due to the large percentage of motion sickness complaints on small ships causing a relative decrease in percentage of traumatic injuries. While large cruise ships report 69% of complaints due to medical conditions, it is not clear how many of these are due to preexisting conditions. In this series, only 6% of the visits were due to exacerbation of or related to existing medical conditions.

A similar study published in 2007 aboard a single Antarctic expedition ship evaluated the pattern of injury and illness during a single tourist season (11 trips).⁸ Data from this and the current study can aid in better understanding of the types of illnesses and injuries physicians will encounter on these ships and how the ships can be appropriately prepared. Similarities between these studies included motion sickness as the most common complaint followed by infectious complaints (respiratory primarily), and then injuries. The main difference observed between these studies was no evacuations or deaths occurred in the older, smaller study.⁸ The current study identified four evacuations and one death. These events are thought to be rare, but data are limited.^{8,17,18} Despite the perceived rarity, this study identified multiple cases, likely due to a larger more representative cohort in the current study. Furthermore, two of these events happened on shore, including the cardiac arrest, suggesting that the ship physician must be prepared with a medical shore pack for severe illness or injury while on shore. Evacuation of critically ill or injured patients involves extensive discussion between the ship physician, the expedition leader, and the ship captain. The logistics of such are often difficult and potentially delayed due to the ship location but involve either helicopter or fixed wing transport. Thus, the physician must be prepared to stabilize the patient and then provide continuing care until evacuation can be arranged and completed.

The preparedness of physicians rendering care to patients aboard expedition ships in the future can be improved with these data. The American College of

Emergency Physicians section of Cruise Ship and Maritime medicine has set forth guidelines for medical facilities for cruise ship sailing in international waters and state that the needs are dependent on various variables including ship size and patient characteristics.

As small expedition ships transport only 80 to 120 passengers, ship physicians can expect one to two patient encounters per day. Most of these encounters are urgent care level visits and are easily treated by a person with such training. Five major events, however, occurred (four evacuations and one death). As these trips average 12 days in length, a major event can be expected for every five to six trips. Furthermore, additional significant medical events/complaints occurred but did not result in evacuation/death. This evidence confirms the need for expedition ship physicians to be experienced in and able to provide emergency care. Fortunately, most trips are staffed with emergency physicians,¹⁷ and all trips in this sample were staffed with emergency physicians.

The study has certain limitations. First, this was a retrospective study and restricted by the inherent limitations of that design. We followed accepted guidelines for medical record review, including measuring inter-rater reliability.¹⁹ Second, data were limited to the documentation provided by the treating physicians. Encounters not documented by the clinician would not be included in this analysis. This study was limited to Antarctic travel and did not evaluate travel to the Arctic regions or tropical locations. It is likely that the spectrum of patient complaints is different for expedition ships to tropical locations but further research is needed.

We did not have data on the illnesses and injuries sustained by the ship's crew. Finally, except for the case of myocardial infarction and the quadriceps tendon disruption, no follow-up information was available on patients after the trips were over.

Conclusion

A variety of medical conditions occur aboard expedition ships to Antarctica. Primary complaints include motion sickness, infectious disease, and injuries. Life-threatening events, although rare, also occur. Physicians on these ships must be able to provide a spectrum of medical care including the ability to provide care for life-threatening medical illness or injury.

Declaration of Interests

The authors state that they have no conflicts of interest to declare.

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