

# Patterns of injury amongst cruise ship passengers requiring hospitalisation

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## ABSTRACT

**Background:** The number of commercial cruise ship passengers continues to rise and is projected to reach 27.2 million passengers worldwide in 2018. Accidental injury aboard these ships can result in serious morbidity and mortality. This study examines the injury mechanisms, patterns, demographics, and outcomes of these injuries which are serious enough to require hospitalisation in order to facilitate administrative, financial, and medical decision making to aid in injury prevention and treatment.

**Materials and methods:** This is a cross-sectional, retrospective, registry-based study of adult patients sustaining injury while on a cruise ship admitted to a Level I Trauma Centre in the United States over a 2-year period. Data on demographics, injury type and severity, surgical management, hospital charges, length of stay, mortality, and discharge disposition were recorded.

**Results:** Sixty seven patients were identified and included in the analysis. 70.1% of patients were 65 or older and a majority were female (59.7%). The most common mechanism of injury was a ground level fall (79.1%), and the most common injury encountered was a femur fracture (52.2%) which involved the acetabulo-femoral joint in 85.7% of cases. Traumatic brain injuries were uncommon occurring in 7.5% of cases. There were no fatalities in this series.

**Conclusions:** The most common injuries aboard cruise ships requiring hospitalisation occur in the geriatric population as a result of a ground level fall. Most commonly, the injuries are long bone fractures, with femur fractures occurring most frequently and accounting for over half of all injuries sustained. Resources and protocols for pre-hospital management of cruise ship injuries should prioritise these patients, and fall prevention measures for this demographic should be mandatory aboard all cruise ships.

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**Key words:** cruise ship, travel medicine, trauma, injury

## INTRODUCTION

Trauma is one of the leading causes of hospitalisation and death in the United States [1]. Breakthroughs in research and technological developments continue to advance the health of our aging population. Traumatic injury, however, once considered a major health burden primarily for the young, has seen a dramatic increase in risk in individuals 65 years of age and older as of 2017 [2].

According to Cruise Lines International Association (CLIA) the number of commercial cruise passengers is projected to climb again in 2018 with 27.2 million passengers expected worldwide [3]. According to the current United

States Maritime Administration's cruise statistics report, South Florida is home to the top two busiest passenger cruise ports in the United States: Port Everglades in Broward County and Port of Miami in Miami-Dade County. Together, the two ports service over 8 million cruise passengers a year, with over 50% of cruise passengers between the ages of 50–74 [3, 4]. Aboard the ship poolside activities, dancing, slippery decks, stairs, rough seas, and ship maintenance hazards pose trauma risks to both passengers and staff. Broward Health Medical Centre (BHMC) in South Florida, United States is a primary receiving point for many of these injured passengers. While institutions such as the American

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College of Emergency Physicians and International Council of Cruise Lines have developed preventive protocols for the provision of emergency medical care for passengers [5], effective preventative measures are difficult to implement due to a lack of research on the mechanisms and outcomes of cruise ship traumas. A retrospective analysis on passengers and crew members admitted to BHMC was performed for trauma injuries to characterise the mechanisms of injury and their outcomes to facilitate administrative, functional, and medical decisions to prevent and treat serious cruise ship injuries.

## MATERIALS AND METHODS

This study took place at BHMC in Fort Lauderdale, Florida, and the study population included all patients who presented to BHMC's Level I trauma centre from any passenger cruise ship between the dates of November 1, 2015 to August 31, 2017. The study design is a retrospective, cross-sectional study. Data for this retrospective study was identified through the BHMC trauma registry utilizing the Trauma One® database software.

The following variables and outcomes were studied: gender, age, mechanism of injury, anatomic injury location, Glasgow Coma Scale (GCS) on arrival, Injury Severity Score (ISS), type of surgeries required, transfusions required, mortality, length of hospital stay, total hospital charges, and discharge status. The definition of variables was adopted from the Data Dictionary of the National Trauma Data Standard approved by the American College of Surgeons and from Florida Trauma Registry Manual Data Dictionary [6, 7]. The relevant variables were queried and extracted from the Trauma One® registry and were supplemented by data obtained from patients' electronic medical records available through hospital database.

The study population was defined as all patients transferred to BHMC from passenger cruise ships due to accidents within the above-mentioned period. These criteria yielded a final study population of 67 patients. Because our study population originated out of one medical centre, it excluded patients who may have been transferred to other nearby trauma centres.

## RESULTS

Sixty seven patients were identified and included in the analysis. A majority (70.1%) were 65 years or older (Table 1). Females (40) were more commonly injured than males (27) (59.7% vs. 40.3%, ratio 1.48). A fall from ground level was the most common mechanism of injury (79.1%) (Table 2) with lower extremity injuries being the most common location (67.2%) (Table 3). The most common injury was a femur fracture, occurring in 35 (52.2%) patients. Of these 35 patients, 30 (85.7%) were classified as "hip" or ace-

**Table 1.** Cruise passenger injuries presenting to Broward Health Medical Centre between November 1, 2015 and August 31, 2017 by age (n = 67)

Age groups [years old]	Number (%)
≤ 17	1 (1.5%)
18–64	19 (28.4%)
65–74	21 (31.3%)
≥ 75	26 (38.8%)

**Table 2.** Cruise passenger injuries presenting to Broward Health Medical Centre between November 1, 2015 and August 31, 2017 by mechanism of injury (n = 67)

Mechanism of injury	Number (%)
Ground level fall	53 (79.1%)
Fall down stairs	6 (9.0%)
Pool or water sports accident	3 (4.5%)
Other (burn, impaled by broken golf club shaft, cut by glass, struck by falling object, ATV crash)	5 (7.5%)

**Table 3.** Cruise passenger injuries presenting to Broward Health Medical Centre between November 1, 2015 and August 31, 2017 by location of primary injury (n = 67)

Injury location (primary injury)	Number (%)
Lower extremity	45 (67.2%)
Upper extremity	5 (7.5%)
Intracranial	5 (7.5%)
Spinal	4 (6.0%)
Head injury without intracranial injury	3 (4.4%)
Pelvic	2 (3.0%)
Chest wall/ribs	2 (3.0%)
Vascular (brachial artery)	1 (1.5%)

**Table 4.** Cruise passenger injuries with femur fractures presenting to Broward Health Medical Centre between November 1, 2015 and August 31, 2017 by type of femur fracture (n = 35)

Femur fractures	Number (%)
Acetabulo-femoral joint	30 (85.7%)
Femoral shaft	4 (11.4%)
Distal femur (condyle)	1 (2.8%)

tabulo-femoral joint fractures (defined as intertrochanteric, subtrochanteric, and femoral neck fractures) (Table 4). Orthopaedic operations (44/47 or 93.6%) were the most

**Table 5.** Additional characteristics of cruise passenger injuries presenting to Broward Health Medical Centre between November 1, 2015 and August 31, 2017

Other characteristics	Mean	Median	Range	SD
Age [years]	65	70	7 to 89	19
Length of stay [days]	6.56	7	1 to 41	6.02
Total hospital charges	\$50,178.09	\$45,569.26	\$1,089.00 to \$408,319.76	\$51,011.52
GCS on arrival	14.63	15	3 to 15	2.06
ISS	7.3	9	1 to 17	3.07

GCS – Glasgow Coma Scale; ISS – Injury Severity Score; SD – standard deviation

commonly performed type of surgery. The average length of stay in the hospital was 6.6 days, with average total hospital charges of \$50,178 per patient hospitalisation. Incoming patients had an average GCS score of 14.6, with an average ISS of 7.3. (Table 5). Only 9 (13.4%) patients required a blood transfusion. 64 (95.5%) patients arrived with a GCS of 15, and only 1 (1.5%) patient had an ISS > 15, a marker for a severely injured patient. There were no deaths in this series (Table 6). Discharge disposition is shown in Table 7, but was most commonly to home (37.3%) or to an acute inpatient rehabilitation facility (29.9%).

## DISCUSSION

With the ever-increasing number of commercial cruise ship travellers, traumatic injuries sustained while aboard these ships are becoming a public health concern, particularly among the elderly. Reports describing injury patterns occurring aboard cruise ships are uncommon and largely report on injuries that do not require hospitalisation. Studies specific to series injuries suffered by patients aboard cruise ships are limited in number and have relatively small sample sizes [8]. The studies with larger sample sizes are either not specific to cruise ships [9] or deal with injuries that do not require onshore hospitalisation [10]. This leaves a significant knowledge gap concerning the demographics, comorbidities, mechanism of injury, treatment modalities, and outcomes for patients who are injured seriously enough aboard passenger cruises to require transfer to an onshore hospital.

Our analysis of patients who sustained an accidental traumatic injury warranting hospitalisation found that the geriatric population constitutes a substantial majority of this group (70%), and these injuries occur more often in women (60%). These findings are similar to those of Dahl [10] who found that 62% of all injuries who were treated in their on-board clinic occurred in women and the median age was 72. Bansal et al. [8] reported that 88% of the patients requiring hospitalisation from injury sustained on cruise ships were female and had a median age of 55. The findings of Hudson et al. [9] indicate that 61% of nonresidents of Alaska hospitalised for injuries occurring aboard vessels were from

**Table 6.** Additional characteristics of cruise passenger injuries presenting to Broward Health Medical Centre between November 1, 2015 and August 31, 2017 (n = 67)

Other characteristics	Number (%)
Transfusions required	9 (13.4%)
GCS 15 on arrival	64 (95.5%)
ISS ≥ 15 on arrival	1 (1.5%)
Deaths	0 (0.0%)

GCS – Glasgow Coma Scale; ISS – Injury Severity Score

**Table 7.** Cruise passenger injuries presenting to Broward Health Medical Centre between November 1, 2015 and August 31, 2017 by discharge status (n = 67)

Discharge status	Number (%)
Home	25 (37.3%)
Rehab	20 (29.9%)
Skilled nursing facility	8 (11.9%)
Home health	7 (10.4%)
Other	4 (6.0%)
Left against medical advice	1 (1.5%)
Medivac to home facility	2 (3.0%)

cruise ships, and 34% of those injuries involved patients who were aged 65 and older. Furthermore, our findings indicate that while accidents involving stairs, water sports, etc. do occur, the most common mechanism of injury by a significant margin is a ground-level fall (79%). Bekics et al. [11] likewise found this to be the most common mechanism requiring hospitalisation (49%). The second most common mechanism in both series was fall down stairs, occurring slightly more often (14% vs. 9%) in their series compared to this series [11]. The Bansal et al. [8] series had a majority of their hospitalised patients (63%) suffering from a fall down stairs. Hudson et al. [9] reported that 60% of all injuries in the series were due to a slip, trip or fall.

Lower extremity injuries occurred most frequently and femur fractures accounted for most of these injuries. In fact, more than half (52%) of all patients in our study sustained a femur fracture, and of those, 86% were hip fractures (involving the acetabulo-femoral joint). These findings are similar to Dahl's series in which 63% of patients requiring hospitalisation from onboard injuries were hip fractures [10]. Likewise, Hudson et al. [9] found that femur fractures were the most common injury sustained in all patients hospitalised for injuries aboard water craft. This is a particularly relevant finding given that hip fractures are associated with increased morbidity and mortality in the geriatric population. In the United States of America, patients 65 and older with hip fractures have a 5- to 8-fold increased risk of all-cause mortality during the 3 months after the fracture and almost half of the mortality risk during the first year has been attributed to in-hospital deaths [12].

Relatively few patients in our series sustained traumatic brain injuries (7.5%), and 96% of all patients arrived to our facility with a GCS of 15. The rarity of serious traumatic brain injury is somewhat surprising in an era with so many elderly patients on anticoagulants, but this finding may be somewhat reassuring because these are the injuries with the most serious adverse consequences and those who need the most rapid transport to a trauma centre. These findings are similar to other series in which the range of serious traumatic brain injury was 1–12% of all serious injuries sustained on the cruise ship [8, 10, 11].

The average ISS was also quite low with only 1 patient arriving with an ISS of > 15. Our study saw no patient fatalities. This suggests that the need for rapid and emergent transport mechanisms for serious injury is quite low and most injuries can be stabilised on board and transported urgently with diversion to the nearest port of call without the need for emergent air or sea transport. Despite this lack of necessity for emergent transport, the overall burden on the healthcare system from traumatic injuries aboard cruise ships is significant. It is inordinately expensive to transport, stabilise, treat, and properly discharge these patients to and from a Level I trauma centre. The average length of stay for our study was 6.6 days with average total hospital charges amounting to approximately \$50,000 and an overall cost of hospital stay ranging up to as high as \$400,000. These figures do not include any pre-hospital care and transportation or any post hospital rehabilitation charges. This cost burden alone can be used to justify spending the resources that will be required to improve safety aboard the ships.

Our data reveals that elderly females are by far the most at risk, with ground level falls serving as the most common mechanism. Due to these specific and definitive findings, we believe this data begins to fill the large knowledge gap

surrounding these injuries and can be useful in focusing the preventative efforts of the passenger cruise ship industry, as they develop safety protocols and procedures. It can also guide the preparation and practices of those caring for these patients, in both the pre-hospital stabilisation and transportation and the hospital care. The number of people, particularly the elderly who participate in cruise ship vacations continues to increase. Given this, resources should be allocated to help prevent and care for the injuries that will surely follow. This data can be beneficial in ensuring that those funds are utilised in the most effective manner.

## CONCLUSIONS

Hip fractures among elderly females constitute the lion's share of all injuries sustained aboard passenger cruise ships requiring transportation to an offshore facility. Further studies examining specific sites and circumstances involving injury aboard cruise ships would be helpful to better identify safety measures to assist in prevention of these injuries. Fall prevention workshops have worked in community settings and may be amenable to an onboard education setting as well. Partnerships should be developed between the cruise ship industry and the medical community who care for these patients to promote research gathering and prevention strategies to elucidate specific causes and potential solutions. Given the previous knowledge gap surrounding these injuries, this data can be used to justify and focus the appropriate funds and resources towards safety changes in the passenger cruise industry.

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