January 2013

Incidence Of Injury And Illness In Merchant Seafarers

Rafael Yitzhak Lefkowitz
Yale University, rafael.lefkowitz@yale.edu

Incidence of Injury and Illness in Merchant Seafarers

Rafael Y. Lefkowitz, MD

Abstract:

This retrospective study estimates cumulative incidences of injury and illness in a seafarer cohort using data from one company providing remote medical services and claims auditing for seafarers. There were 3,526 medical events and 16,626 individual medical services in the merchant seafarers covered by these services between 2008 and 2012. The majority of medical events occurred in men, numbering 3,099 (97.5%); median age was 38.9 years (range: 18-80). The total at-risk seafarer population was estimated by utilizing standard crew size for each class of vessel, and this was used to calculate cumulative incidence for injury and illness. The four-year overall cumulative incidence rate (per 100 seafarers) for injuries and illness was equal at 8.5. Cumulative incidence for subcategories of illness was determined. The most significant limitation of this study is that the true at-risk population and demographic distribution of this population are unknown. Important next steps in this research include refining the estimated number of at-risk seafarers, obtaining baseline demographic information for seafarers in this cohort, and understanding other potential risk factors.

I would like to thank the following individuals who made this research possible:

Christina DeSimone, MS, CEO of Future Care, Inc.

for the data used in this dissertation; she has shown true commitment to advancing the health of seafarers.

Martin Slade, MPH and Carrie Redlich, MD MPH

for their personal dedication and mentorship.

My wife Vered

for her support and love.

Table of Contents:

List of Tables:

List of Figures:

Introduction:

The health of seafarers has long been the subject of international interest, probably due to their vital role in trade throughout the world. The International Maritime Organization estimates that over 90% of the world's trade uses marine transport[1]. Estimates of the number of seafarers worldwide range from 1.2 million to 1.5 million[1, 2]. Disease prevention and increasing treatment availability is historically a major focus of seafarer health studies[3]. Nonetheless, the goal of preventing and improving outcomes of injury and illness at sea remains an elusive goal[4]. One barrier to achieving this goal is the lack of studies describing actual incidence of injury and illness in seafarers. This paper reports estimated four-year cumulative incidences of injury and illness by retrospective analysis of a large cohort of merchant seafarers, the Future Care, Inc. database.

It is reasonable that there are distinct risk factors and root-causes mediating health risks in seafarers. Some of these risk factors and root-causes are likely modifiable. Identifying and reducing risk factors and mediators of seafarer adverse medical events may result in significant improvements in health work-status outcomes in seafarers. Review of the published literature reveals a significant dearth of studies detailing incidence of and risk factors for injury and illness among merchant seafarers[4]. With the recent passage of the Maritime Labour Convention, 2006 (MLC), there is additional impetus to close this knowledge gap.

The MLC established updated international standards for seafarer work conditions[2]. This document builds on existing treaties and labor agreements. It was ratified by the required thirty flag states on August 20, 2012, and as such will be effective August 20, 2013. Title 4 of the MLC details seafarers' rights to prevention and treatment of work-related health conditions. In addition to providing health services to seafarers, ship-owners must also provide seafarers with safe work environments; chemical, physical, and biological hazards must be identified and minimized. While these new standards will soon go into effect, many ship-owners have already partnered with companies specializing in managing seafarer health.

The occupational health of merchant seafarers is generally a neglected realm of international shipping[5, 6]. Because they frequently work isolated from medical care, seafarers are also a highly vulnerable workforce. A study by Jaremin and Kotulak described higher rates of early myocardial infarction mortality (death pre-hospital or within one month of hospitalization) among Polish seafarers as compared to the general Polish population[7]. In this study, the usual time to hospital after myocardial infarction was one to three days. Their finding of excess early myocardial infarction mortality was attributed to lack of early interventions at sea. In addition, seafarers may also have poor baseline health status. One study by Hansen and colleagues described increased hospitalization rates in seafarers versus the general population in several disease categories, including cardiovascular, neoplastic, respiratory, gastrointestinal, and musculoskeletal diseases, as well as injuries and acute poisonings[8]. Within disease categories, significant differences in hospitalization rates were found between ship type and seafarer rank. In this study, increased hospitalization rates were attributed to poor baseline health and lifestyle.

There is very little published literature estimating actual injury and illness incidence among merchant seafarers, and in general the literature focuses on injury and illness counts. Some of these studies can provide detailed analyses, with some studies reporting injury and illness counts among seafarers stratified by age, rank, work site, and other work-related factors. This type of report is exemplified in a study of Japanese fishing vessels by Hisamune and colleagues[11]. On these fishing vessels, deck work had the most injury counts, and was attributed to specific risks of handling the fishing catch. The authors identified a variety of potential factors related to elevated injury counts on board, including seafarer age, work site, type of vessel, and rank. However, this study did not estimate the underlying at-risk seafarer population, either aggregate or in age, rank, or job site-specific categories, and therefore could not estimate injury or illness incidence for any group.

Two studies were identified that estimated incidence rates and therefore risk of injury in merchant seafarers. One study identified seafarer age and experience as important risk factors for injuries among seafarers. In a retrospective study of self-reported injuries among Danish fleet seafarers, Jensen and

colleagues[12] found that injuries were significantly more likely to be reported among seafarers age < 35 (IRR=2.16, $p < 0.001$) as compared to age ≥ 35. Serving longer tours of duty (more than 117 days) was protective (IRR=0.23, $p<0.001$) as compared to shorter tours (1-116 days). Deck work (IRR=0.42, $p<0.001$) and service work (IRR=0.50, $p<0.001$) were both found to be relatively low risk compared to the reference machine work group. Injury rates varied significantly by seafarer nationality; however, this analysis did not control for age, job task, type of ship, rank, and seafarer tenure within nationality groups. A later Danish study, after adjusting for ship size, rank, and age, confirmed a "cultural" variability[13]. The study identified seafarers of southeast South East Asian nationality as carrying the lowest injury risk (adjusted IRR=0.29, 95%CI 0.22-0.38), and Eastern Europeans with medium risk (adjusted IRR=0.65, 95% CI 0.50-0.85) as compared to Western Europeans.

Psychological illness in merchant seafarers should also not be neglected. Significant psychological stressors on board merchant vessels are manifold; one study identified separation from family, time pressure, long working days, heat, and insufficient qualification of subordinate crew as important on-board stressors[9]. Depression and suicide remain a significant problem among seafarers[10].

The Role of Telemedicine:

Telemedicine can be broadly defined as the use of telecommunications technologies to provide medical information and services[14]. Telemedicine is thus an important way to deliver expert medical advice to patients remote from live medical providers. Several medical and surgical subspecialties, such as dermatology, psychology, radiology, otolaryngology, internal medicine, and cardiology have utilized telecommunication devices to provide expert medical advice to individuals geographically or socially isolated, (i.e. prisoners)[15]. Home care organizations use remote telecommunications to deliver medical services to their patients[16]. The United States military has also used telemedicine technologies in combat and humanitarian missions[17]. Telemedicine has rapidly expanded with the pace of technology[18], and has

great utility and potential in occupational health services[19]. Such an approach is essential in caring for workers at sea, including seafarers and other off-shore workers[18].

Methods:

The medical databases of Future Care, Inc. were utilized for this study. The claims auditing database and the remote medical advice database for years 2008 through 2012 were available and analyzed using SAS® software[20]. The claims database contained data on seafarer medical events treated in the US, including demographic information, diagnostic coding according to the International Classification of Diseases, 9th Revision (ICD-9), point of service (inpatient or outpatient), location of services, date of service, and medical charges. Vessel name and class were also included. The remote medical management database contained seafarer nationality, job, rank, date of service, as well as type of case (injury, illness, dental, and subcategories). Age at time of the medical claim service was calculated by subtracting the seafarer's date of birth from the date of the claim. In the absence of a noted date of claim, the dates of first service, last service, billing date, or bill modification date were sequentially selected as needed to calculate age. For age group analysis, the seafarers were combined into three 10-year groups between 30 and 60 years of age, one group of age 18 to 30, and one group age 60 and older. Events occurring on cruise ships were excluded from analysis because cruise ships frequently have a medical department with physician on-board. In addition, the occupational risks of cruise ships were considered significantly different from those on tugs, barges, or cargo ships.

The at-risk population was estimated by utilizing standard crew size for each class of vessel. Small tugs and barges were estimated to have 6 persons per vessel, and larger tankers and cargo vessels used estimates of 22 persons per vessel. Each vessel was categorized by class, and therefore assigned a particular crew number. The total crew population was then calculated as the sum of the estimated crew of all individual vessels under contract with Future Care, Inc., excluding cruise ships.

A new medical claim was considered an incident medical event, which entails certain limitations to be discussed later in this paper. Each unique record of a seafarer medical event could include multiple independent medical services with their own attributed ICD-9 code or codes. Each code was translated into its corresponding disease category (cardiovascular, respiratory, injury, etc.). In order to assign a single category of disease to a particular medical event, each medical event was labeled by the disease category appearing most frequently in the claim. In situations where two or more disease categories ranked highest in frequency, one of these categories was assigned by randomization to the medical event. The ICD-9 categories "injury" and "musculoskeletal" were combined into the single category of "injury". The distribution of disease categories for all medical events was analyzed using descriptive statistical measures.

Results:

Baseline characteristics of the seafarers and vessels are shown in Table 1. In total, there were 3,537 separate medical events and 16,711 individual medical services rendered. Excluding cruise ships, there were 3,526 separate medical events and 16,626 individual medical services. The majority of seafarers with incident medical events were male (3,099, 97.54%); mean age was 39.8 years (std. dev. = 12, age range: 18-80). Most events occurred in seafarers age 50 and younger (2,334 events, 76.8%). The most frequent nationality was US nationality, occurring in 13.4% of claims. In total, 37 different nationalities were represented in the database. Injury and illness events occurred most frequently in engine workers (357 events, 38.9%).

Results of statistical analyses are as follows. The number of injury and illness events varied by age group (X^2= 9.75, p= 0.045, df = 4). The distribution of medical events did not differ significantly by gender (X^2= 6.92, p= 0.23, df = 5). Diagnostic category was missing for 21.3% of claims, as no ICD-9 code was associated with those claims.

The estimated at-risk seafarer population was 14,144. Estimated four-year cumulative incidences for major diagnostic categories of injury and illness are presented in Table 2. The four-year cumulative incidence of illness events was equal to that of injury events. The illness categories with highest incidence were dermatologic, neurologic, gastrointestinal, and respiratory disease. Using only the remote medical advice database, the majority of on-board medical inquiries were due to illnesses (Figure 2).

Discussion:

Initial analysis of the Future Care, Inc. databases indicates that a wide range of illnesses have occurred among their cohort of merchant seamen. The number of injury and illness diagnoses varies significantly by age groups but not gender groups. Initial analysis of this database has revealed the distribution of injury and illness counts, as well as estimated the four-year cumulative incidences of injury and illness among the seafarer cohort.

The at-risk population estimate is essential to calculating seafarer medical event incidence, and there are some limitations to the approach described here. The at-risk population was estimated by multiplying standard crew size by number of vessels class in that class. This calculation assumes no annual turnover for the seafarers. If information regarding typical crew turnover was available for these vessels, then person-time for working seafarers could be calculated and incidence rates obtained. Actual incidence rates would allow for valid comparison to injury and illness rates in other industries.

Understanding risk factors for illness and injury in seafarers is posited to suggest interventions to improve health outcomes. However, risk factors for injury and illness can only be surmised with an understanding of the demographic distribution of the full at-risk seafarer population, which was unavailable. In this cohort, most injury and illness events occurred in patients younger than 50. However, the age distribution of the population is unknown and therefore no conclusions can be drawn regarding risk of injury or illness in this cohort. The age, nationality, and job distribution of the baseline at-risk seafarer population would allow for stratified risk analysis and determination of stratified risks; analysis for co-variation would be

further insightful. Gender differences in illness and injury incidence may be similarly revealing, although numbers of women were small in this cohort.

Seafarer nationality has been shown to be associated with injury risk[13]. In this analysis, 1,408 (39.8%) medical events in the claims database were linked to seafarer country of origin. While US nationality was the most common seafarer nationality in the database, there can be no conclusion of excess risk in US seafarers as the distribution of nationalities within the at-risk population is not known. Further analysis of the remote medical advice database may yield more insight into type of injuries and illnesses reported by different nationality seafarers, but without the underlying nationality distribution, incidence by seafarer nationality cannot be determined. Additional studies including such baseline data may yet determine if within this cohort of seafarers carry differential risk of injury or illness based on their nationality.

The distribution of injury and illness events differed between the claims database (Figure 1) and remote medical advice database (Figure 2). The claims database contains only cases which were treated in the US, while the remote medical advice database includes all events at sea. Events occurring at sea may be treated anywhere around the world. Considering the wide range of possible international locations for medical events to occur, the claims auditing database may only be capturing a minority of events, thereby underestimating cumulative incidences for illness and injury in this cohort. In many cases, especially severe injury or illness, the treatment will likely occur closest to where the medical event occurred. Repatriation of US seafarers may occur if necessary, and therefore US seafarers may be over-represented in this cohort. This may partly explain why US nationality is the most common nationality in the database. Seafarers with injury or illness at sea may not need treatment by the time they reach shore; conversely, in case of catastrophic illness, may not reach shore on time. As this analysis utilized diagnosis data originating from the medical claims database, it is limited by the above considerations which may have introduced bias.

Incident cases were counted based on new occurrence of claims in the database. The accompanying limitation to this approach is that some claims may actually not represent new disease. This is more likely for claims occurring earlier in the database. Inclusion of such claims is likely to overestimate the true number of cases, and therefore inflate cumulative incidence. It is possible that this is more representative of illness rather than injury claims, although this cannot be stated with certainty. In addition, there are limitations due to the classification method of injury and illness categories based on ICD-9 coding, including the decision to group injury and musculoskeletal claims in one group called "injury". These groups were combined based on the assumption that musculoskeletal claims were due to musculoskeletal injuries. It is likely that some of these musculoskeletal claims were actually due to chronic musculoskeletal conditions or other diseases, and not due to injury. If the number of such claims was large, this would cause significant differential misclassification and inflate the cumulative incidence of injury events in this cohort.

Another important limitation of this study is that there were a large number of medical events with no listed diagnosis; if diagnostic categories were differentially omitted, this would result in bias. For example, if diagnostic categories were preferentially omitted in cases of medical conditions with simple treatments, such as minor injuries, the results would reflect lower incidence of injury than has truly occurred. However, it is also possible that unlisted diagnoses reflect minor illnesses as well, in which case the misclassification would be non-differential. In addition, since this study does not address the severity of injury or illness within or between claims, the overall health or economic impact of the observed medical events cannot be discerned.

This study has several major strengths. First, the study utilizes medical claims data and its associated objective endpoints. Diagnosis of injury or illness by ICD-9 codes was determined by multiple different health care providers at the time of managing the medical event. Consequently, the diagnoses were likely determined by a medical professional, and not subject to recall bias (as may occur in retrospective cohort trials using questionnaire). There is some subjectivity of classifying diseases into ICD-9 codes which

may vary by medical professional; however, the use of general diagnostic categories in this study limits the impact of this variability. This study is also strengthened by the large number of seafarers in the cohort, as well as the wide range of nationalities represented. By estimating the incidence of injury and illness in a large seafarer cohort, this study serves as a foundation from which to build future prospective studies in seafarer populations.

Conclusions:

Understanding the determinants of seafarer disease is an important step towards improving prevention and treatment of seafarers as an occupational group. Risk factors for seafarer adverse medical events are not well-established and their definition remains a cumbersome task. Nonetheless, informed attempts at this task retain an extremely important role in seafarer occupational epidemiology. This study is significant in reporting seafarer cumulative incidence of injury and illness by estimating the at-risk seafarer population.

The cumulative incidence reported here is based on an estimated at-risk population limited by lack of information regarding the at-risk population age distribution, nationalities, or pre-existing medical conditions. Thus while crude cumulative incidences are reported, stratified risks cannot be ascertained. Obtaining baseline demographic information on all seafarers in this cohort is vital to establish risk factors for injury and illness in this cohort. Future studies utilizing such baseline information would greatly advance the state of knowledge regarding determinants of seafarer health.

References:

1. IMO International Maritime Organization (www.imo.org, and http://www.imo.org/About/events/pages/day-of-the-seafarer.aspx, accessed April 3, 2013).

2. International Labour Organization, "Maritime Labour Convention." (online www.ilo.org/mlc, and http://www.ilo.org/global/standards/maritime-labour-convention/lang--en/index.htm accessed April 3, 2013).

3. Carter T. Mapping the knowledge base for maritime health: 1 historical perspective. International Maritime Health 2011;62:210-6.

4. Carter T. Mapping the knowledge base for maritime health: 4 safety and performance at sea. International Maritime Health 2011;62:236-44.

5. Bhattacharya S, Tang L. Fatigued for safety? Supply chain occupational health and safety initiatives in shipping. Economic and Industrial Democracy 2012 (online before print number 014383X12439760; first published March 14, 2012).

6. Nielsen D, Panayides P. Causes of casualties and the regulation of occupational health and safety in the shipping industry. WMU Journal of Maritime Affairs 2005;4:147-67.

7. Jaremin B, Kotulak E. Myocardial infarction (MI) at the work-site among Polish seafarers. The risk and the impact of occupational factors. International Maritime Health 2003;54:26-39.

8. Hansen HL, Tüchsen F, Hannerz H. Hospitalisations among seafarers on merchant ships. Occupational and Environmental Medicine 2005;62:145-50.

9. Oldenburg M, Jensen H-J, Latza U, Baur X. Seafaring stressors aboard merchant and passenger ships. International Journal of Public Health 2009;54:96-105.

10. Iversen RT, Robert T. The mental health of seafarers. International Maritime Health 2012;63:78-89.

11. Hisamune S, Amagai K, Kimura N, Kishida K. A study of factors relating to work accidents among seamen. Industrial Health 2006;44:144-9.

12. Jensen OC, Sørensen JFL, Canals M, Hu Y, Nikolic N, Thomas M. Incidence of self-reported occupational injuries in seafaring—an international study. Occupational Medicine 2004;54:548-55.

13. Hansen HL, Laursen LH, Frydberg M, Kristensen S. Major differences in rates of occupational accidents between different nationalities of seafarers. International Maritime Health 2008;59:7-18.

14. Perednia DA, Allen A. Telemedicine technology and clinical applications. JAMA: the journal of the American Medical Association 1995;273:483-8.

15. Hailey D, Roine R, Ohinmaa A. Systematic review of evidence for the benefits of telemedicine. Journal of Telemedicine and Telecare 2002;8:1-7.

16. Thobaben M. Change and growth in home care: telehealth care. Home Care Provider 2000;5:47.

17. Garshnek V, Burkle FM. Applications of Telemedicine and Telecommunications to Disaster Medicine: Historical and Future Perspectives. Journal of the American Medical Informatics Association 1999;6:26-37.

18. Ponsonby W, Mika F, Irons G. Offshore industry: medical emergency response in the offshore oil and gas industry. Occupational Medicine 2009;59:298-303.

19. Nicholson PJ. Occupational health services in the UK—challenges and opportunities. Occupational Medicine 2004;54:147-52.

	Number	(%)
Age group		
≤30	772	(25.4)
31-40	833	(27.4)
41-50	729	(24.0)
51-60	574	(18.9)
>60	136	(4.5)
Mean age	39.8	
st. dev.	12.0	
min-max	18-80	
Gender		
Male	3099	(97.5)
Female	78	(2.5)
Nationality		
United States	472	(13.4)
Philippines	272	(7.9)
India	223	(6.3)
Ukraine	120	(3.4)
Russian	30	(0.8)
Other	2403	(68.9)
Job type		
Deck	173	(18.9)
Engine	357	(38.9)
Steward	43	(4.7)
Other	344	(37.5)
Ships		
Large	617	(86.7)
Small	95	(13.3)

Table 1: Baseline characteristics of seafarers and associated vessels with incident medical events.

Disease Category	Number of Events	Cumulative Incidence (per 100 seafarers)
Injury	1388	9.8
Illness	1387	9.8
Dermatologic	242	1.7
Neurologic*	236	1.6
Gastrointestinal	212	1.5
Respiratory	208	1.5
Genitourinary	139	1.0
Cardiovascular	134	1.0
Infectious	91	0.6
Metabolic	50	0.4
Psychiatric	35	0.2
Neoplastic	22	0.2
Hematologic	11	0.1
Missing	752	

Table 2: Four-year cumulative incidence for seafarer injury and illness by ICD-9 code classification of disease categories. (*includes neurological and sensory organ diseases)

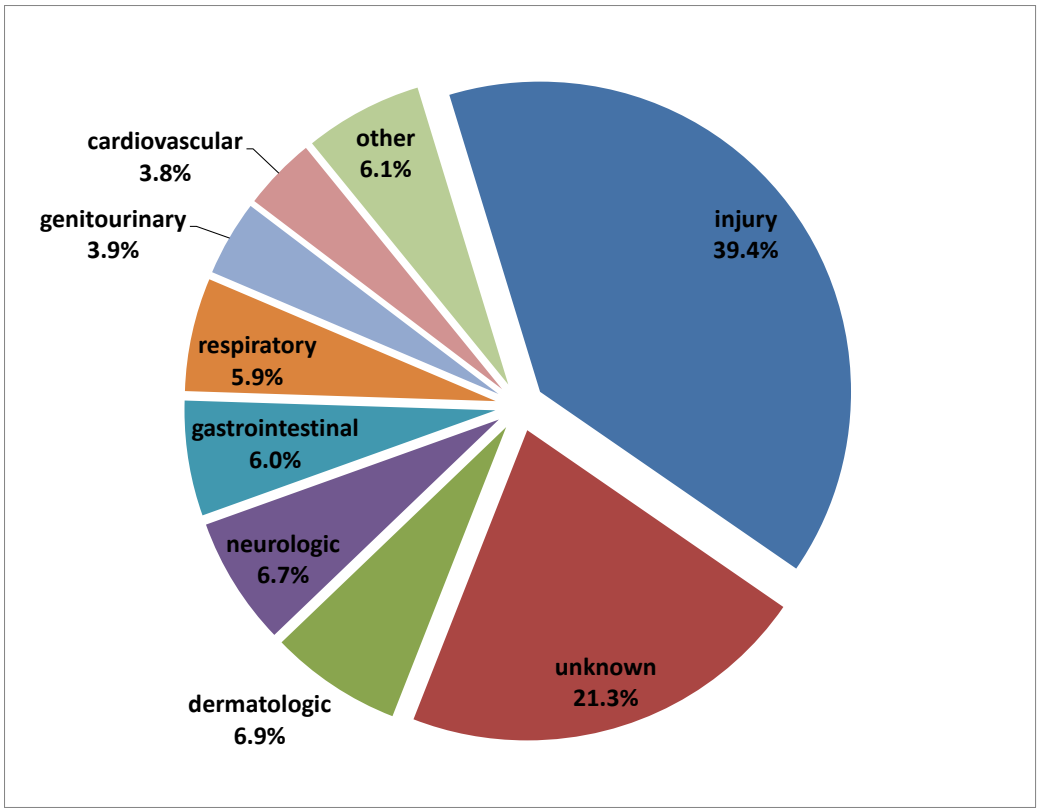

Figure 1: Diagnostic distribution of seafarer medical events by ICD-9 code classification.

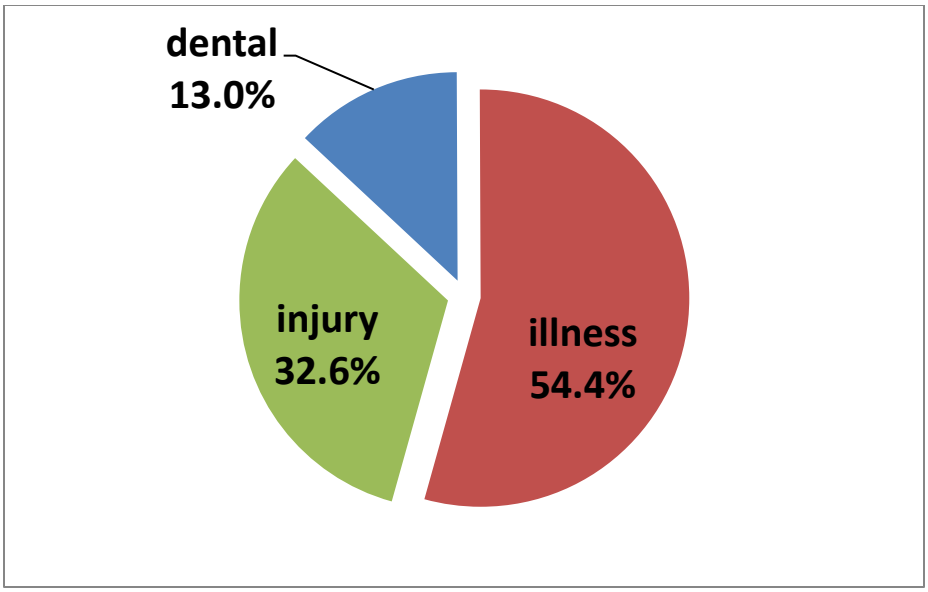

Figure 2: Medical inquiries from on-board merchant vessels (n = 6,714).