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Medical causes of repatriation in commercial seafarers and offshore workers: a scoping review

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REVIEW ARTICLE

Medical causes of repatriation in commercial seafarers and offshore workers: a scoping review

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ABSTRACT

Background: *Workers at sea including commercial seafaring and working in offshore establishments have increased risk for occupational disease and injury. Due to limited medical resources in vessels and platforms, and the remote nature of the work, repatriation to a shore may be required for treatment. The objective of this review was to summarize the literature on medical causes of repatriation among commercial seafarers and offshore workers.*

Materials and methods: *As per (JBI) methodology for scoping reviews, a search for papers in English of Medline, Embase, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Scopus and Oceanic Abstracts was conducted. Studies that reported medical causes of repatriations in commercial seafarers and offshore workers were included. For the purposes of this study, commercial seafarers and offshore workers are defined as persons working in the maritime environment for three or more consecutives days. Recreational seafarers, passengers, and military personnel were excluded. Included papers underwent data extraction and medical causes of repatriation were classified into International Classification of Disease (ICD) 11th Revision codes.*

Results: *The search yielded 33 publications including 27 retrospective studies and 6 case studies. 9 of 27 studies were in offshore workers and 18 included seafarers. The most common causes of medical repatriation reported in the literature were injuries, poisonings, and other consequences of external causes (ICD-22, ICD-23) at 25.2%. Diseases of the digestive system, including dental, (ICD-13) comprised 15.9%, and the musculoskeletal system (ICD-15) was 13.3%.*

Conclusions: *Gaps in the available literature, included a lack of demographic and occupational information reported to properly assess risk factors for occupational illnesses and injuries among seafarers. The data indicate that injuries, diseases of the gastrointestinal system, and musculoskeletal system are the most common literature-reported causes of repatriation in occupational seafarers. This work may support enhancements to onboard medical capability and medical standards for workers in the marine and offshore industries.*

Keywords: marine medicine, occupational medicine, seafarers, offshore, medical evacuation

INTRODUCTION

Each day occupational illnesses and injuries are experienced on board commercial ships and offshore platforms at sea. There are nearly 1.9 million seafarers working on the high seas to enable over 80% of global trade [1]. Due to the remote and specialized nature of the work, limited resources, and distance to shore, challenging decisions must be made regarding how to best manage occupational injuries and illnesses when they arise while also balancing operational considerations. Diagnostic uncertainty and/or insufficient medical management can cause chronic complications or even death in seafarers while waiting until the next port of call (NPOC) for treatment. The lack of diagnostic clarity may also lead to large and

unnecessary costs for the vessels, delays in cargo delivery, and additional risk when transporting patients for advanced medical care [2]. Medical repatriation is generally the final and most costly course of action for a serious injury or illness incurred at sea. This scoping review aims to explore the published literature pertaining to medical causes of repatriation in those who work in the commercial seafaring and offshore industries.

It has been well documented that seafarers who work in a maritime environment experience an increased risk of illness and injury relative to the general population [3]. The severity of the injury or illness can vary greatly, and the impact can range from inability to perform daily tasks up to a requirement for repatriation (delivery of the affected person to a port for medical intervention). In order to advance our understanding of seafaring and offshore operational medical requirements as well as a with a lens toward prevention, a deeper understanding of the repatriation literature is needed. Several studies have been conducted that analyse the causes of repatriations, but these studies have been confined to a geographical location or a specific database. It has been noted that the some of the literature tends to focus on a singular facet of the problem, such as telemedicine usage, which is less likely to address the overarching trends and specific characteristics of medical repatriations [4]. Carter indicated in 2011 [4] that there was limited published data related to medical repatriations in the maritime environment. Since that publication, there have been several studies reported which have helped to further the goal of improving occupational healthcare and screening criteria for those working at sea and offshore.

This literature study aims to serve the working population known as seafarers or sailors. The Maritime Labour Convention of 2006 defines seafarer as “any person who is employed or engaged or works in any capacity on board a ship” [5]. Additionally, the same convention mandates increased medical capabilities on vessels that spend three or more consecutive days at sea [5]. Using these two criteria to establish the population for this study meets the aim of assessing the impacts on the commercial seafaring and offshore industries and allows for the exclusion of passengers on transport, recreational, and military vessels. Offshore workers have also been included due to similarities in the remote nature of the work and onboard medical capabilities, although they are not specifically legislated under the Maritime Labour Convention.

A paper on the knowledge base for maritime health indicated that increased attention to the study of injury and illness at sea could lead to improvements in medical pre-screening, crew medical training, medical facilities on board, as well as better telemedicine and repatriation arrangements [4]. Therefore, by synthesizing all the available published data

herein, this study aims to guide further research on the topics of occupational screening, illness and injury prevention, and crew medical training as applied to the global seafaring and offshore working populations. By categorizing the data into the International Classification of Diseases 11th Revision (ICD-11), we aimed to provide a data set that can be interpreted and applied across various industries in any geographical location and guide future research.

Due to the heterogenous nature of the literature that will be examined, a scoping review methodology was selected. There is no clear body of literature that would support a systematic review. A preliminary search of Medline and Embase was conducted and no current or underway systematic or scoping reviews on the topic were identified.

MATERIALS AND METHODS

OBJECTIVE & REVIEW QUESTION

The objective of this review was to summarize the literature on medical causes of repatriation among commercial seafarers and offshore workers. It was guided by the following specific review question: what are the causes of medical repatriations in commercial seafarers and offshore workers?

INCLUSION CRITERIA

Participants

The participants for this study are defined as anyone who works in a maritime environment, including vessels and offshore platforms, for a duration of three consecutive days or longer, as per increased medical requirements in the Maritime Labour Convention [5]. The age range for this review will was 18–65 years old to represent the general workforce of interest. Passengers on transport vessels and recreational seafarers were excluded from this review. Military populations were also excluded due to the unique nature of their work. There will be no limitation on the size of the study included in this review.

Concept

The concept being investigated in this review is the cause of medical repatriations within the participant population. The causes will be classified as injury or illness and further grouped by type of disease in accordance with ICD-11. Any study that investigates medical repatriations in a maritime environment will be included. Studies that detail deaths at sea where repatriation did not occur will not be included.

Context

The context of this study is to explore the published literature evidence related to medical causes of repatriation in the maritime work environment. Seafaring and offshore workers experience specific occupational risks and this study aimed to identify trends in the literature with the aim of identifying targets for possible improvements in the management of illness and injury at sea.

SEARCH STRATEGY AND REVIEW METHODOLOGY

This scoping review was conducted in accordance with the JBI methodology for scoping reviews [6]. The protocol for this scoping review was registered in the *Open Science Framework Registries* [7]. The text words contained in the titles and abstracts of relevant articles, and the index terms used to describe the articles were used to develop a full search strategy for Embase, Medline, CINAHL, Oceanic Abstracts, and Scopus databases. The search strategy, included all identified keywords and index terms, and was adapted for each database and/or information source. All included studies then underwent citation screening. The grey literature search included the International Maritime Organization (IMO), United States Coast Guard (USCG), and Canadian Coast Guard (CCG) websites for any publications that meet the inclusion criteria of this study. Only studies that are published in English were included. The final search strategy is included in *Supplementary material* (Appendix 1).

All identified sources were uploaded to Covidence (Veritas Health Innovation, Melbourne, Australia) for screening. Titles and abstracts, and subsequently the selected full texts, were screened for inclusion by both authors independently. Any disagreements were resolved through detailed analysis of the article against the inclusion criteria. The results of the search process are reported via a Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for scoping review (PRISMA-ScR) flow diagram (Fig. 1). Data from the included resources was extracted by the two authors. Where studies did not identify ICD codes in reporting their data, the authors classified medical causes and diagnoses into ICD categories. The authors have indicated the studies where medical causes of repatriation were classified into ICD categories. The original raw data extracted from included papers is available upon request or the reader is directed to individual papers listed in Table 1.

RESULTS

SEARCH RESULTS

A total of 33 papers met our inclusion criteria with 27 retrospective studies. There were 18 studies that focused on seafarers and 9 studies that focused on offshore workers. 6 case studies were also included for completeness. Appendix 1 details the search strategy and Figure 1 details the screening and review process. All but one of the studies were obtained through the initial search and the final study was added through a citation search within the included papers. The publication dates of the studies range from 1981 to 2023.

PUBLISHED STUDIES — CHARACTERISTICS

Table 2 details the characteristics of the included studies. Most studies included are retrospective studies focusing on a specific population or geographic area. The literature represented the global population of seafarers with studies included from the Americas, Europe, Middle East, Asia, and Oceania. There were limited sources of data from Africa and South America. 6 of 33 papers included are case studies focusing on one specific medical event and will be discussed separately. Only 12 of 27 (44%) papers included data on the age of the medical evacuees and even fewer, 6 of 27 (22%), reported on occupation description or rank. Some of the studies included sex of the repatriated population but the workforce being studied is overwhelmingly male. Where female seafarers were included, there was limited or no discussion surrounding sex-based risk factors or trends. 18 of 27 (67%) papers discussed evacuations from seagoing vessels, while 9 of 26 (33%) discussed evacuations from offshore platforms.

REPATRIATIONS AND ICD CODES

The studies yielded a total population of 1,041,70 workers and 28,170 medical repatriations. 12 of 27 papers classified disease and injury using the ICD codes and the remainder were classified using other systems that were easily interpreted and converted into ICD classification by the authors for the purpose of tabulation (Table 2). The results indicate that the most common causes of medical repatriation or evacuation are injuries, poisonings, and other consequences of external causes (ICD-22, ICD-23) at 25.2%. This is followed by diseases of the digestive system, including dental, (ICD-13) at 15.9%, and diseases of the musculoskeletal system or connective tissue (ICD-15) at 13.3%. The studies with n > 500 sailors (Abaya 2015, Abaya 2018, Abaya 2023, Bell 2009, Huerte 2023 Norman 1988,

Ponsonby 2009) all align with the total data set showing ICD-13, ICD-15, and ICD-22 as the leading causes of repatriation. This data is represented in Table 2 with disease classification as a percentage of total repatriations. The raw data extracted from included papers is available upon request or the reader is directed to individual papers listed in Table 2.

There were 6 case studies included in this study. The case studies comprehensively describe the case demographics which offer more insight into the specific occupational hazards associated with seafaring. They provide clear examples of how shortcomings in the medical screening process [8] or occupational safety [9] can lead to medical repatriations.

The grey literature review did not yield any studies pertinent to this review.

DISCUSSION

The aim of this study was to map and collate the literature surrounding medical repatriations at sea and answer the question “What are the medical causes of repatriations among commercial seafarers and offshore workers?”. Lucas et al. [10] noted “that for the last forty years, the National Institutes of Occupational Health and Safety in European countries have collected and analysed information on the workers’ environment and health using questionnaires, but seafarers, fishermen, dockworkers, and offshore workers are not represented in these surveys.” The well-documented risks of accident or injury among seafarers coupled with the relative paucity of data to support improvement in screening and treatment delivery add to the vulnerability of this working population. The ILO Guidelines on the Medical Examination of Seafarers [11] were published in 2013 and our current review may assist on the ongoing development and updating of such guidance from an occupational medicine viewpoint.

We noted three major observations from this literature review. Firstly, the published data on repatriations is limited in geographic representation, research methodology, and does not capture the global burden of repatriation among occupational seafarers and offshore workers. Secondly, this is one of the first reports exploring offshore workers and serves as a potential point of future comparison between offshore work environments and seafarers. Finally, we have identified the medical causes of repatriation using ICD-11 codes.

REPATRIATION RESEARCH AND LITERATURE

It is estimated by Faurby et al that 1.7% of deployments end in a repatriation, for medical reasons or otherwise [2]. Even if this number is an overrepresentation of the global seafarer population of close to two million workers, then the population of this study, (n =

28,170 repatriations), covering a span of close to forty years and multiple voyages per year, is a small fraction of the total population exposed to seafaring or offshore work. The total exposure to seafaring and offshore work would be estimated to be the total seafaring population x days at sea per worker. Such global data is not available. The results of this scoping review demonstrate clearly that there is a significant population of seafarers requiring medical repatriation that would benefit from a deeper understanding of the medical and occupational factors contributing to evacuation.

The most common inconsistency in the literature was reporting of demographic and occupational characteristics. The absence of a clearly defined study population limited the number of included papers. For example, there were several studies excluded that blended both commercial seafarers and another population without the ability to differentiate these groups in the published data (e.g. military plus passengers). Only 22% of the included studies reported on the specific occupation of the repatriated seafarer. The array of occupations among seafarers and offshore workers come with differing occupational risks and medical screening should be representative of these risks to identify individual and job-related risk factors for injury or illness. More recent published work has included some additional data on seafarers however as we noted 5 of 14 studies published in 2015 or later provided data on occupation and/or rank as opposed to only 2 of 13 studies published prior to 2015. An example of this improvement is the inclusion of occupation data by Abaya et al. in 2023 [12], as compared to their prior work in 2015 [13]. These studies were very similarly designed but the inclusion of occupational information enhanced the utility of the data from an occupational medicine perspective. Conversely, Huerte et al. [14] did not include demographic data even though the data base was drawn from medical records that would reasonably include at least sex and age. Lefkowitz et al. [15] showed in a study of 61 repatriations that the only significant aggravating risk factor for repatriation was the nationality of the seafarer. Herttua et al. [16] show clearly that age and non-officer occupation (vs officer) were both associated with an increased risk of repatriation. It further showed that the odds ratio between non-officer and officer is highest for repatriations due to external causes, such as physical injuries. They speculate that the difference is influenced by lifestyle factors and occupational hazards. Saguro et al. [3] also addressed this issue and show an increased risk of injury and disease in non-officers compared to officers. It is clear that these demographic and occupational risk factors need to be analysed across a larger population to assist in more robust epidemiology of injury and disease in the seafaring population.

There is a paucity of evidence for females due to the largely male composition of the seafaring workforce. The IMO reports a 45.8% increase in female seafarers since 2015 so this increasing population in the workforce requires additional research [1]. For the benefit of enhancing the data to support proper screening tools, it is suggested that future projects related to medical repatriations focus on ensuring robust reporting of demographic information for their populations. Furthermore, less than half of the studies reported illness in accordance with ICD-11. Due to the international nature of the seafaring, illness and injury should be reported in a manner that is globally recognizable and transferable.

MEDICAL CAUSES OF REPATRIATION

The most common cause of medical repatriation identified in our review was physical injury. This is consistent across most of the large population-based studies. The types of injuries have been studied in detail including by Dethleff et al. [17] and Huerte et al [14]. Huerte et al. [14] breaks down each of the top causes of repatriation, including ICD-22/ICD-23, into more specific diagnoses which adds more depth to the analysis. From this study, hand injury is by far the most prevalent type of injury. From an occupational safety perspective, this is crucial finding in an effort to develop appropriate safety standards or prevention measures to minimize the risk of injury or illness. In contrast to the seafaring workers, some of the studies that assessed offshore platforms showed that injury was not the leading cause of repatriation [18] [19]. In these studies, the leading cause of repatriation was ICD-11 (diseases of the cardiovascular system). There are a few factors that could account for this difference including stability of the working platform and type of work, but there may also be differences in safety culture, medical resources, or access to telehealth between the two work environments and this should be investigated in more depth in future research.

Mental health was not identified in the published literature as a significant cause of repatriations. However, Jonglertmontree et al. [20] recently published a scoping review on mental health of seafarers and concluded that mental illness has long been prevalent among those who work at sea but is understudied. That is consistent with the findings of this scoping review, where only one case study focused specifically on mental health as a cause for repatriation. The case study by Lee et al. [21] demonstrated the benefits of a strong telemedicine construct to assist during mental health crises at sea. Our scoping review shows that only 1.9% of published repatriations were caused by illnesses that fall into ICD-06 which includes mental illness. This may represent underreporting, lack of published research or both.

Our review estimates that diseases of the cardiovascular, respiratory, and gastrointestinal systems accounted for 26.2% of the total medical repatriations. Diagnoses among each of these systems may present with overlapping constellations of clinical signs and symptoms. Furthermore, diagnoses that arise within each organ system could indicate severe or life-threatening disease or could also be relatively benign conditions. Due to the cost and disruption of repatriation [2] ships' crews and companies inevitably face both a clinical and operational decision point. Challenges with differentiating between a benign diagnosis from a severe one could lead to excessive repatriations. Conversely, decisions to not repatriate could arise when a timely and accurate diagnosis of a more serious condition is not identified. In both circumstances the expertise of the crew to make the right decision would be tested. Advances in onboard technology including point of care ultrasound (POCUS), and inexpensive portable electrocardiograms have the potential to improve healthcare outcomes in these populations [22] Many of the papers in this review either studied or referenced telehealth consultations which is another resource that could be utilized on all seagoing vessels that lack adequate medical capability at sea.

LIMITATIONS

There are several limitations to consider in this study. The intent to include a large literature-based global data set led to several studies being included that were not epidemiologically broad in scope. Specifically, some studies focused on a specific medical cause of repatriation, rather than studying 'all medical causes'. For example, the studies by Ballantine et al. [23] and Duffy et al. [24] reported only dental causes of repatriations which does not allow for the relative contribution of ICD-13 classified diseases towards repatriation. In the Duffy et al. paper specifically, the unclassified evacuations were included under "unknown cause" and this study alone contributed over 61% (authors' calculation) of the total "unknown causes" of repatriation tabulated in this review. Latournerie et al. [25] focused specifically on evacuation due to acute injury. The goal of this review was to report on the types of studies and the diagnoses that led to repatriation among seafarers and offshore workers. However, the relative contribution to repatriation of each ICD category is limited to only published repatriation in our review, therefore cannot quantified in further detail.

The authors of this review limited the included studies to those that were published in English. Considering the Philippines, the Russian Federation, Indonesia, India, and China are the largest suppliers of ratings and officers, there may be vast amounts of data published in languages other than English that were not included [1]. Another limitation is the proprietary

nature of the data that needs to be studied. Most of the studies used data from crewing agencies or shipping/cruise lines. This data is not open source so studies may be limited by the amount of data that companies provide. Furthermore, our review retrieved only peer reviewed and published data, which is a limitation in studying workers among global private enterprises.

CONCLUSIONS

This scoping review on the medical causes of repatriations in seafarers and offshore workers demonstrates a large, vulnerable population that was underrepresented in the published literature. The population size in the available research was a small representation of the total demographic that needs to be studied. It highlights the shortcomings in the available literature, most notably, a lack of demographic information to properly assess risk factors for specific occupational illnesses and injuries. The data indicates that injuries, diseases of the gastrointestinal system, and disorders of the musculoskeletal system are the most commonly reported medical causes of repatriation in the literature.

It is recommended that any future epidemiological studies relating to medical causes of repatriation place an emphasis on demographics and specific occupations experiencing injury and illness. It is also the hope that this study will prove useful in continuing to advance medical care for sea-based occupations.

ARTICLE INFORMATION AND DECLARATIONS

Author contributions: Both authors (JB and WSJ) contributed to the conception, protocol development, search, review, drafting and approval of the final version of this paper.
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Conflict of interest: JB and WSJ have no conflicts to disclose.
Supplementary material: We have included our search strategy in Appendix 1 as a supplemental file. If the editor wishes to include this in the paper please advise accordingly.

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Table 2. Characteristics of included studies

Author and year	Study type & data source	Location	Sample size	Number of repats(n)	Sex (% of n)	Age (% of n)	Rank (% of n)	Occupation by Dept. (% of n)	Relevant results or findings
Abaya (2015) [13]	Retrospective study. Collected aggregate data from claims and legal departments of manning agencies. Classified using ICD-10	Philippines	388,963	6579	NR	NR	NR	NR	Top 5 causes of medical repatriation: injuries (21.4%), musculoskeletal (19.4%), gastrointestinal (17.1%), genitourinary (8.9%) and cardiovascular (8.1%) Top 5 = ~75% of all repatriations.
Abaya (2018) [26]	Retrospective study. Data taken from records at Health Metric Inc, a diagnostic clinic providing pre-embarkation medical exams to Filipino seafarers. Classified using ICD-10	Philippines	51,830	840	NR	Similar outcomes across all age groups.	NR	NR	Repatriation rate of 1.6% among cargo ship and passenger ship seafarers who have stayed for more than 200 days at sea, with illnesses as the major cause for both populations (94.5% and 73.9% for cargo and passenger ship seafarers, respectively).
Abaya (2023) [12]	Retrospective study. Data sourced from various manning agencies in Metro Manila. Classified using ICD-10	Philippines	464,418	6526	NR	Mean age: 40.9yrs	NR	Deck: 37.2% Engine: 26.6% Galley/Hotel:36.2%	Top 5 causes of medical repatriation: musculoskeletal (23.2%), gastrointestinal (18.6%), injuries (15.1%), cardiovascular (7.0%), and dermatologic conditions (7.0%) Top 5 = > 70% of all repatriations.
Apostolatos (2017) [27]	Retrospective study. Med Solutions International database. Not classified using ICD codes.	International	44	4	M: 100% F: 0%	NR	NR	NR	Number of confirmed cardiovascular cases was very low. There was only 1 heart attack and 1 pulmonary oedema complicating acute coronary syndrome.
Ballantine (1990) [23] *(Offshore)*	Inspection of workers. Not classified using ICD codes	UK continental shelf	493	38	NR	NR	NR	NR	The study of dental health of offshore workers shows that they have a considerable amount of untreated dental disease.
Bell (2009) [28]	Retrospective study Data from P & O Princess Cruises International Fleet.	Global	25039	507	NR	Mean age: 34	NR	NR	The least likely nationality to be repatriated in this cohort is Filipino. Most common causes of medical repatriation were injury, GI,

	Not classified using ICD codes								psychiatric, GU, and neurological.
Cakir (2021) [29]	Retrospective study. Telemedical Assistance Service of Turkey database. Classified using ICD-10	Turkish Search and Rescue Area	4668	471	NR	< 30: 25% 30-49: 53% ≥ 50: 22%	Officer: 35% Non-officer: 65%	Deck: 63% Engine: 31% Galley: 6%	Incidents on board ships are more likely to lead to medical evacuations for the following characteristics of ships and seafarers: ships sailing in coastal waters, Turkish-flagged ships, and older ships, and seafarers who are non-officers, Turkish nationals, deck personnel, older, diagnosed with circulatory system diseases, and suffering injuries.
Cross (1985) [30]	Retrospective study. Data logs from TSS *Miranda*. Not classified using ICD codes.	Arctic fishing ground	966	170	NR	NR	NR	Report, not correlated with repats.	A total of 170 patients was repatriated, 138 directly from the trawler support ship. Illnesses accounted for 101 repatriations, the largest number being GI followed by MSK disorders, all but one presenting with severe backache. Illnesses most likely to necessitate repatriation were cardiological and psychiatric conditions. 69 trawlermen were repatriated after accidents.
Dethleff (2016) [17] *(Offshore)*	Retrospective study. Data provided by operator of the windfarm and related emergency protocols. Not classified using ICD codes.	Wind farm in the North Sea	39	39	NR	NR	NR	NR	49% of medevacs were related to traumatic injuries, whereas 41% were associated with acute diseases and 10% remained unclear. Cardiovascular and gastrointestinal disorders accounted for 90% of internal medical cases. About 69% of the trauma was related to contusions, lacerations, and cuts. The main body regions injured were limbs (~59%) and head (~32%)
Duffy (1996) [24] *(Offshore)*	Retrospective study Shell data for “medivacs” and	North Sea	3182	3182	NR	NR	NR	NR	Dentivacs are a major cause of medical evacuations for Shell Expro and account for one of the largest

	"dentivacs" from 1988-1994. Not classified with ICD codes.								percentage categories over the reporting period.
Herttua (2021) [16]	Register-based study. Danish-flagged merchant ships using the TMAS and Danish Maritime Authority databases. Classified using ICD-10		72,941	403	M: 97% F: 3%	<30: 18% 30-49: 48% >50: 34%	Eng. officer: 2% Deck officer: 16% Non-officer: 82%	NR	Working as non-officer, older age and non-Danish EU nationality is associated with a higher risk of evacuations irrespective of the cause. In the medical examinations of seafarers, a special focus is needed on cardiovascular health among older employees.
Huerte (2023) [14]	Retrospective study. Medical repatriations using data from medical records from OSM Shipping Company Classified using ICD-11	Global	NR	924	NR	NR	NR	NR	Majority of medical repatriations were attributed to injury (19.91%), MSK (18.4%), GI (16.56%), CV (8.77%), infectious (6.82%), GU (5.3%). Significantly, this study shows a decline in proportion of CV, GI, and GI cases over the span of the study.
Jaremin (1988) [31]	Retrospective 6-month study Cruise ship physician's own records. Not classified using ICD codes	Caribbean Sea and transit to Alaska.	413	4	NR	NR	NR	NR	Most prevalent diseases on a passenger ship were diseases of the respiratory system, diseases of the skin, and injuries. These account for 70% of medical consults.
Latournerie (2023) [25]	Retrospective epidemiological study between 2011 and 2019 Data from consultations with the French TMAS Not classified with ICD codes	French TMAS coverage area	1006	398	M: 100% F: 0%	NR	Officer: 9.5% Non-officer: 90.5%	NR	Five factors were identified as being associated with the decision for disembarkation or evacuation: wound severity, wound location, ship location, photography availability, and staff medical training.
Lefkowitz (2015) [15]	Retrospective study. Data provided by Future Care, Inc., a company that manages the health of seafarers globally and provides telemedicine services.	International	3921	61	M: 98.4% F: 1.6%	< 30: 31% 30-39: 31% 40-49: 21% ≥ 50: 16%	Officer: 46% Non-officer: 49% Unknown: 5%	Deck: 41% Engine: 41% Galley: 10% Other: 8%	61 repatriations over the study period (1.6% of cases). Most repatriations were due to illness (38; 62.3%) as opposed to injury (23; 37.7%). Back injuries and gastrointestinal illness were the most frequent causes of repatriations. Using logistic

	Not classified using ICD codes								regression, nationality was identified as a significant risk factor for repatriation.
Norman (1988) [32] *(Offshore)*	Retrospective study Data extracted from various industrial reports and records as well as questionnaires. Classified using ICD (1997)	UK continental shelf	2162	2162	NR	Mean age (injury): 28.3 Mean age (illness): 34.4	NR	NR	Using the ICD, the digestive system was responsible for most evacuations for illness and of those, about half (115 evacuations) were for dental problems. Suspected fractures were responsible for about one third of those evacuated for an injury but injuries of hands and eye conditions were particularly common, accounting for 25% of all evacuations.
Oldenburg (2014) [33]	Cross-sectional survey 465 nautical officers participating in medical refresher course interviewed about their experience with medical emergencies that requires repatriation at sea. Not classified using ICD codes	Global	133	83	NR	NR	NR	NR	Serious emergencies on board (leading to deviation to an emergency port call) are most frequently related to trauma or cardiovascular diseases.
Oliver (1981) [34]	Retrospective. Data review of company medical records. Classified using “modified” ICD codes	Global	6630	110	NR	NR	Officer: 22% Non-officer: 78%	NR	Reasons for medical repatriation closely correlated those for medical attendance aboard, namely accidents and gastro-intestinal disease as the two major groups.
Ponsonby (2009) [35]	A review of published literature was supplemented with a summary of current practice in the industry. Classified using ICD codes *Data drawn from study from Health & Safety Executive UK	Global	3979	3979	NR	NR	NR	NR	Illnesses were reported to account for 55% of cases and injury for 45% of cases. In the last year of the study, illnesses accounted for 65% of all evacuations. The reasons for this were thought to be due to increased safety management and also a move away from exploration and construction towards operations and maintenance.

Sae-Jia (2020) [36] *(Offshore)*	Retrospective Review of data of medical evacuation among industry from 2016-2019. Classified using ICD-10	Gulf of Thailand	416	416	M: 98.5% F: 1.5%	< 30: 12% 30-39: 47% 40-49: 29% 50-59: 11% > 59: 1%	NR	NR	The top 8 causes of Medevacs in the Gulf of Thailand were influenza 20.19%, injury and wound 7.45%, chickenpox 5.53%, fracture, dislocation, sprain, and strain 4.09%, urolithiasis 3.85%, dental caries 3.13%, acute appendicitis 2.88%, and low back pain 2.88%, respectively
Stilz (2022) [37] *(Offshore)*	Observational prospective cohort study. Data from US offshore installations that had access to telemedicine and offshore installations in UK and Malaysia waters that did not. Classified using ICD-10	Global	645	66	NR	NR	NR	NR	, The availability of telemedicine was associated with a lower medical evacuation rate. A higher medical evacuation rate was associated with age older than 60 years, and contractor workers rather than employed workers, regardless of the availability of telemedicine.
Taylor (1993) [38] *(Offshore)*	Retrospective study Data compiled by the Minerals Management Service of the US Department of the Interior. Not classified using ICD codes	Gulf of Mexico	9	9	M: 100%	Mean age: 35.9	NR	NR	The offshore oil production environment is ideally suited to benefit from the advantages of air medical transport. In addition to typical medical illnesses, patients in this environment are subject to occupation-related injuries and exposure to hazardous materials.
Thibodaux (2014) [18] *(Offshore)*	Retrospective review. Data of medical calls from 102 rigs/platforms in the US Gulf Coast from 2008 through 2012 with specific analysis of medevacs Not classified using ICD codes.	US Gulf Coast	8046	397	NR	NR	NR	NR	Medical evacuations from offshore oil installations are very costly and have significant inherent personal health risks. Inadequate or non-existent medical evaluations prior to deployment and after any significant interval medical change may contribute to the number of medical evacuations.
Tomaszunas (1990) [39]	Retrospective study. Data from Polish Ocean Lines from 1985	Global	NR	354	NR	< 30: 12% 31–40: 31% 41–50: 22%	NR	Deck: 37% Engine: 35% Galley: 25%	Serious disease requiring repatriation occurred about 4 times more frequently than injuries requiring

	to 1989. Not classified using ICD codes.					51–60: 26% > 60: 3% NR: 6%		Other: 3%	repatriation. The most common diseases were diseases of the circulatory system, follow by mental disorders and nervous system, and genitourinary.
Waje-Andreassen (2020) [19] *(Offshore)*	Prospective study. Data collated from the air transport company's (Equinor) medical records and standardized forms filled out by SAR nurses during evacuations. Not classified using ICD codes	North Sea	381	381	M: 88% F: 12%	Mean age: 46	NR	NR	381 persons (88% men) were evacuated during the study period. Twenty-seven percent of missions were due to chest pain and 18% due to trauma.
Westlund (2011) [40]	Retrospective study. Data from Swedish Radio Medical Database. Classified using ICPC-2	Global	1290 (449 infectious)	25	NR	NR	NR	NR	Infectious conditions are a significant contributor to calls to the service and they can be more frequently treated on board than can other conditions.
Yuan (2022) [41]	Retrospective review Data from all civilian SAR and Heli-medivac activations by RSAF over a 5-year period from 2016-2020	Singapore Aviation SAR Region	42	42	M: 92.9% F: 7.1%	Mean age: 47	NR	NR	An analysis of these Heli-medevac cases revealed the 3 most common types of conditions encountered were acute coronary syndromes (26.2%); gastrointestinal conditions (16.7%) such as upper gastrointestinal tract bleeding, acute appendicitis, and intestinal obstruction; and neurologic conditions such as stroke and intracranial haemorrhage (14.3%)
	Case reports & case studies								
Afandiyev (2022) [9]	Case report	Global	42	42	NR	NR	NR	NR	9 seafarers evacuated with signs of poisoning. 3 crew members died on board prior to patrol ship arrival. The cause was due to a failure in ship safety requirements. Also provides data on three other incidents of

									poisoning.
Fernandez-Palacios (2009) [42]	Case report	Canary Islands	1	1	Male	28	NR	NR	The hand had been revascularized thirteen hours after the accident and was still well circulated at repatriation 3 weeks later.
Kulkarni (2019) [43]	Case report	Pacific Ocean	1	1	Male	34	NR	NR	Medical aid to a seriously ill or injured sailor on high seas is always a problem. Means of evacuation and distance from port with medical facilities play a major role.
Kulkarni (2020) [8]	Case report	Arabian Sea	1	1	Male	24	NR	NR	Large number of seafarers hail from South East Asia and China where pork is consumed extensively. Screening every asymptomatic seafarer for NCC is not possible. Instead, all reporting for PEME could be administered tab Albendazole 400 mg as a single dose broad spectrum anthelmintic as a cost effective measure. Food handlers should be additionally treated with anti-amoebic medication.
Lee (2015) [21]	Case report	NR	1	1	Male	48	Rating	NR	Telepsychiatry services may help identify high risk patients, improve quality of care, and potentially reduce costs to the client.
Montocchio-Buades (2018) [44]	Case report	Coastal waters off Djibouti	1	1	Male	26	NR	NR	This case highlights the risks and dangers of injury in the isolated environment of seafaring. It also highlights the importance of first aid trained staff with an emergency kit on board.

Studies on offshore workers indicated under author as *(Offshore)*

Table 1. Types of illness and injury by International Classification of Disease 11th revision codes resulting in repatriation as a percentage of total repatriations

Author and year	**n**	**01: Certain**	**06: Mental,**	**08: Diseases**	**09: Diseases**	**10: Diseases**	**11: Diseases**	**12: Diseases of**	**13: Diseases**	**14: Diseases**	**15: Diseases of**	**16: Diseases of**	**22/23: Injury,**	**Other/unknown**

		Infectious or Parasitic Diseases	behavioural, or neuro-developmental disorders	of the nervous system	of the visual system	of the ear or mastoid process	of the circulatory system	the respiratory system	of the digestive system	of the skin	the MSK system or connective tissue	the genitourinary system	poisoning or certain other consequences of/external causes	
Abaya (2015)	6579	3.6%	1.8%	1.3%	2.9%	1.3%	8.1%	3.0%	17.7%	5.6%	19.1%	8.9%	21.4%	5.1%
Abaya (2018)	840	1% Cargo 3% Passenger	2% Cargo < 1% Passenger	1% Cargo 1.5% Passenger	6% Cargo 7.5% Passenger	4%	4% Cargo 13% Passenger	3% Cargo 1% Passenger	23% Cargo 15% Passenger	10% Cargo 8% Passenger	20%	6% Cargo 7% Passenger	18% Cargo 8% Passenger	< 1% Cargo 7% Passenger
Abaya (2023)	6526	2.8%	2.3%	1.4%	4.1%	1.0%	7.1%	3.2%	19.4%	7.0%	23.3%	6.6%	15.1%	5.6%
Apostolatos (2017)	4	-	-	-	-	-	50%	-	-	-	-	-	25%	25%
Ballantine* (1990)	38	-	-	-	-	-	-	-	100%	-	-	-	-	-
Bell (2009)	507	-	8.2%	4.7%	-	-	-	-	16.0%	-	-	5.7%	39.8%	25.4%
Cakir (2021)	471	-	-	-	-	-	12.7%	4.0%	8.5%	-	2.3%	-	39.7%	32.7%
Cross (1985)	170	2.4%	8.2%	-	-	0.6%	7.6%	7.6%	15.9%	0.6%	11.8%	4.7%	40.5%	-
Dethleff* (2016)	39	-	-	2.6%	-	-	10.2%	2.6%	10.2%	7.7%	7.7%	-	48.7%	10.2%
Duffy*(1996)	3182	-	-	-	-	-	-	-	11.2%	-	-	-	-	88.8%
Herttua (2021)	403	-	-	-	-	-	19%	-	14%	-	-	-	27%	40%
Huerte (2023)	924	6.8%	1.7%	2.4%	3.5%	1.3%	8.8%	3.1%	17.9%	5.2%	18.4%	5.3%	19.9%	5.7%
Jaremin (1988)	4	-	-	-	-	-	-	25%	-	-	25%	-	50%	-
Latournerie (2023)	398	-	-	-	-	-	-	-	-	-	-	-	100%	-
Lefkowitz (2015)	61	-	3.3%	-	3.3%	4.9%	6.6%	22.9%	6.6%	3.3%	8.2%	37.7%	3.3%	-
Norman* (1988)	2162	1.6%	1.9%	4.4%			1.9%	5.4%	11.1%	1.5%	7.2%	1.2%	63.5%	0.2%
Oldenburg (2014)	83	-	-	8.4%	-	-	14.5%	12.1% (ICD 12/14)	15.7%	Incl. in ICD-12	-	4.8%	44.6%	-
Oliver (1981)	110	-	11.8%	-	-	-	13.6%	8.2%	22.7%	-	4.6%	6.4%	28.2%	4.6%
Ponsonby (2009)	3979	4.5%	2.2%	4.7%	-	-	1.5%	7.8%	14.1%	2.1%	9.4%	2.5%	40.1%	8.0%
Sae-Jia* (2020)	416	12.3%	0.7%	2.9%	3.6%	1.4%	2.4%	22.8%	11.8%	5.3%	5.8%	5.8%	15.6%	9.6%
Stilz* (2022)	66	-	-	-	7.6%	-	-	16.7%	7.6%	-	9.1%	-	15.2%	43.9%
Taylor**(1993)	9	-	-	-	-	-	22.2%	-	-	-	-	-	77.8%	-
Thibodaux* (2014)	397	6.6%	0.7%	10.1%	-	-	34.3%	2.5%	11.8%	-	-	0.3%	23.9%	9.8%
Tomaszunas	354	-	16.1%		-	-	21.5%	-	17.8%	-	-	7.9%	18.9%	17.8%
Waje-Andreassen*	381	7.9%	1.0%	7.9%	-	-	36.2%	-	19.7%	-	-	-	17.8%	7.9%

(2020)														
Westlund (2011)	25	8.0%	-	-	4.0%	4.0%	-	12.0%	60.0%	8.0%	-	4.0%	-	-
Yuan (2022)	42	-	-	-	-	-	42.9%	2.4%	16.7%	-	-	-	26.2%	11.9%
Totals	**27773**	**2.9%**	**1.9%**	**1.9%**	**2.2%**	**1.1%**	**6.2%**	**3.8%**	**15.9%**	**4.0%**	**13.5%**	**5.1%**	**25.2%**	**16.58%**
CASE REPORTS														
Author and year	**n**	**01: Certain Infectious or Parasitic Diseases**	**06: Mental, behavioural, or neuro-developmental disorders**	**08: Diseases of the nervous system**	**09: Diseases of the visual system**	**10: Diseases of the ear or mastoid process**	**11: Diseases of the circulatory system**	**12: Diseases of the respiratory system**	**13: Diseases of the digestive system**	**14: Diseases of the skin**	**15: Diseases of the MSK system or connective tissue**	**16: Diseases of the genitourinary system**	**22/23: Injury, poisoning or certain other consequences of/external causes**	**Other/unknown**
Afandiyev (2022)	42	-	-	-	-	-	-	-	-	-	-	-	42	-
Fernandez-Palacios (2009)	1	-	-	-	-	-	-	-	-	-	-	-	1	-
Kulkarni (2019)	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Kulkarni (2020)	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Lee (2015)	1	-	1	-	-	-	-	-	-	-	-	-	-	-
Montocchio-Buades (2018)	1	-	-	-	-	-	-	-	-	-	-	-	1	-

*represents study of offshore workers; other includes most other categories from ICD-11; categories included in other: 02 neoplasms, 03 diseases of the blood or blood-forming organs, 04 diseases of the immune system, 05 endocrine, nutritional or metabolic diseases, 07 sleep-wake disorders, 17 conditions related to sexual health, 18 pregnancy, childbirth or the puerperium, 19 certain conditions originating in the perinatal period, 20 developmental anomalies, 21 symptoms, signs or clinical findings, not elsewhere classified; categories not included 24 factors influencing health status or contact with health services

Figure 1. Preferred reporting items for systematic reviews and meta-analyses_