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Cardiovascular hospitalizations among Danish seafarers: a nationwide register study

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ABSTRACT

Background: *Cardiovascular disease (CVD) is a leading cause of morbidity worldwide, influenced by several risk factors. Seafarers are exposed to CVD risk factors due to their working environment and lifestyle. We investigated hospitalizations among seafarers compared with the Danish working population.*

Material and methods: *This register-based cohort study used Danish nationwide registers. Seafarers aged 18–64 years were compared to the working population for all-cause and CVD inpatient hospitalizations between 1994 and 2016. Negative binomial regression, stratified by sex and adjusted for age, birth cohort, and education, provided incidence rate ratios (IRRs) with 95% confidence intervals (CIs). Further analyses included specific diagnoses and type of seafarer.*

Results: *Male seafarers had increased rates of all-cause (IRR = 1.05, 95% CI: 1.04–1.07) and CVD (IRR = 1.10, 95% CI: 1.06–1.14) hospitalizations. The CVD associations persisted among those working on passenger ferries (IRR = 1.26, 95% CI: 1.18–1.34) and cargo ships (IRR = 1.06, 95% CI: 1.01–1.12). Further analysis revealed increased hospitalizations among male seafarers for pulmonary heart diseases, cerebrovascular diseases, diseases in arteries, arterioles, and capillaries, and diseases in veins, lymphatic vessels, and lymph nodes. Overall, female seafarers did not have increased hospitalization rates but females working on passenger ferries had an increased all-cause hospitalization rate (IRR = 1.04, 95% CI: 1.00–1.08), while those on cargo ships had a decreased rate (IRR = 0.95, 95% CI: 0.92–0.98).*

Conclusions: *Male seafarers had higher hospitalization rates than the reference population, whereas the pattern varied among female seafarers.*

(Int Marit Health 2026; 77, 2: 79–87)

Keywords: cardiovascular disease, hospitalizations, occupational disease, occupational exposure, maritime medicine

INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of mortality and morbidity worldwide, posing significant public health challenges [1]. The development of CVD is influenced by a combination of non-modifiable and modifiable risk factors [2]. Non-modifiable risk factors include genetics and sex, whereas modifiable risk factors include lifestyle choices and environmental factors that can be altered to reduce the risk of developing CVD. Examples of modifiable factors include diet, smoking, physical activity, stress

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management, and work-related factors such as long working hours and shift work [2, 3].

Among various occupational groups, seafarers are particularly vulnerable to CVD due to the unique and often strenuous nature of their work environment [4, 5]. Seafaring is characterized by long working hours, shift work, irregular sleep patterns, physical and psychological stress, and limited access to healthcare, all of which contribute to the increased risk of CVD [2, 4]. Seafarers are exposed not only through working conditions but also through lifestyle-related risk factors such as limited access to healthy dietary options and restricted opportunities for physical exercise onboard [4]. Smoking and alcohol consumption are also common among seafarers [5, 6].

Health and safety of seafarers are crucial not only for the individual workers but also to ensure that global trade operates efficiently [7]. Seafaring plays a key role in global trade, with 80% of goods transported by sea [8]. The health of seafarers can directly impact this [7]. According to maritime law, seafarers must undergo medical examinations every two years to ensure they are fit for work at sea [9]. These health checks aim to maintain a healthy workforce and to improve health and safety on board [9]. In cases of acute illness, staff members are medically trained, and ships are equipped with a medicine chest and radio access to telemedicine services [9]. Despite these measures, a study has shown that survival and recovery after acute illness on board are reduced compared to on land [10]. In acute cardiac events, time is crucial, as delays in receiving treatment can increase the risk of severe complications or mortality [11]. Onboard a ship, the time to react and provide adequate medical care will be prolonged due to the remote nature of the maritime environment [10], where acute events can require either diversion to the nearest port or evacuation by helicopter [6].

We have previously demonstrated that seafarers have increased mortality compared with other workers, where particularly male seafarers have elevated risk of CVD mortality [12]. While some studies support this finding [13, 14], others find contradictory results [15–17]. Regarding CVD morbidity, studies investigating hospitalizations among seafarers have shown mixed results. Some studies indicate a decreased risk [18, 19], while another study has revealed an increased risk [20], and one showed no difference [21], when compared with a reference population. Additionally, one study did not compare seafarers' hospitalizations to those of other workers [19], potentially leading to bias due to a healthy worker effect [22]. However, previous studies only include one hospitalization per worker [18–21], and only one study includes potential confounders such as educational level [18].

This study includes all hospitalizations among Danish seafarers from 1994 to 2016, to provide a complete picture of the hospitalization patterns. This study aims to investigate whether Danish seafarers experience higher overall hospitalization rates and increased hospitalizations due to CVD compared with the working population and identify the most prevalent types of CVD hospitalizations. We hypothesize that seafarers experience higher rates of hospitalization for all-causes and CVD due to exposure to CVD-related risk factors associated with both their work environment and lifestyle.

MATERIAL AND METHODS

DATA SOURCES

The present cohort study was conducted based on data from Danish national registers. The Danish Civil Registration System, which has been operating since 1968, is a nationwide system that assigns each resident a unique identification number, which enables linkage of individuals across all national registers [23]. Data on health outcomes were obtained from the Danish National Patient Registry and National Causes of Death Registry [24, 25]. Occupational information was obtained from the Employment Classification Module [26], while educational status was obtained from the Population Education Register [27].

STUDY POPULATION

The study population included all workers in Denmark aged 18–64 years from January 1, 1994, to December 31, 2016. Individuals with full-time employment for a minimum of one year during the study period were included, while individuals not working or receiving social benefits as their main income were excluded.

The exposure of interest was defined as having worked for at least one year in seafaring during the study period. Once an individual had worked in seafaring, the person stayed in the exposed group for the rest of the study period. Prior to employment as a seafarer, exposure time was attributed to the reference population to avoid immortal time bias. Seafaring is a broad business sector with varying exposure and job demands. Therefore, we categorized seafarers into two groups: those working solely on passenger ferries during the study period and those working on both cargo ships and passenger ferries, referred to as cargo ship workers in this study. This classification follows the approach described in previous research [13]. The study population has been described previously [12].

OUTCOMES

All inpatient hospital contacts after participants entered the study were recorded and classified by the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD10). The main outcomes were hospitalizations due to all-causes and hospitalizations

with the main cause being a CVD (ICD10 I00–99). CVDs were further divided into disease groups: chronic rheumatic heart diseases (ICD10 I05–I09), hypertensive diseases (ICD10 I10–I15), ischemic heart diseases (ICD10 I20–I25), pulmonary heart disease and diseases of pulmonary circulation (ICD10 I26–I28), other forms of heart diseases (ICD10 I30–I52), cerebrovascular diseases (ICD10 I60–I69), diseases of arteries, arterioles, and capillaries (ICD10 I70–I79), diseases of veins, lymphatic vessels, and lymph nodes, not elsewhere classified (ICD10 I80–I89), and other and unspecified disorders of the circulatory system (ICD10 I95–I99). Participants were followed from the date they entered the study until the earliest of three endpoints: emigration, death, or end of follow-up on December 31, 2016, whichever came first.

COVARIATES

The study's covariates included age, sex, educational status, and birth cohort in 5-year intervals from 1926 to 1990, with the last category being 1991–1997. Educational status was based on the highest obtained education according to the International Standard Classification of Education (ISCED), which was grouped into three categories: low (ISCED 1–2), medium (ISCED 3), and high (ISCED 5–8) [28].

STATISTICAL ANALYSIS

Descriptive statistics were used to summarize the characteristics of the population and were presented for categorical data as counts and proportions, and continuous variables were presented as median and interquartile range (IQR). Comparison of educational level was tested using the χ^2 test. We estimated differences in the number of hospitalizations between seafarers and the reference population as incidence rate ratios (IRRs) with 95% confidence intervals (CIs) using negative binomial regression. This method was used due to overdispersion in the Poisson regression. We conducted two models stratified by sex: Model 1 adjusted for age and birth cohort, and Model 2 further adjusted for education. To investigate the robustness of the results, we performed a sensitivity analysis by excluding seafarers who had worked at sea for only one year. Statistical analyses were performed using Stata version 18.

RESULTS

Descriptive characteristics of the seafarer population (n = 51,715) and the reference population (n = 4,181,384) are presented in Table 1. The seafarer population had a larger proportion of male seafarers than female seafarers (71.6% and 28.4%, respectively), and seafarers had, on average, higher education than the reference population. Of the seafarers, 24% worked solely on passenger ferries and 76% worked on cargo ships.

NUMBER OF HOSPITALIZATIONS

Table 2 shows the results for hospitalizations among seafarers for all-causes and CVD. Male seafarers were hospitalized slightly more often overall than the reference population (IRR = 1.05, 95% CI: 1.04–1.07). Additionally, male seafarers showed increased CVD hospitalizations (IRR = 1.10, 95% CI: 1.06–1.14). Female seafarers demonstrated increased CVD hospitalizations in Model 1 (IRR = 1.08, 95% CI: 1.01–1.15). However, when further adjustments were made for education in Model 2, the increase in CVD hospitalizations disappeared.

SEAFARER TYPE

Compared to the reference population, all-cause hospitalizations for male seafarers working on passenger ferries (IRR = 1.19, 95% CI: 1.15–1.23) and cargo ships (IRR = = 1.03, 95% CI: 1.01–1.06) were increased (Tab. 3). The same tendency was observed in female seafarers working on passenger ferries (IRR = 1.04, 95% CI: 1.00–1.08). However, female seafarers working on cargo ships showed decreased hospitalizations for all-causes (IRR = 0.95, 95% CI: 0.92–0.98). The risk of CVD hospitalizations for male seafarers employed on passenger ferries (IRR = 1.26, 95% CI: 1.18–1.34) and on cargo ships (IRR = 1.06, 95% CI: 1.01–1.12) was increased compared with the reference population. No difference in CVD hospitalizations was observed among female seafarers.

CVD DIAGNOSES

When investigating which diagnoses caused the CVD hospitalizations, some differences were observed between seafarers and the reference population (Tab. 4). Male seafarers were hospitalized more often due to pulmonary heart disease and diseases of pulmonary circulation (IRR = 1.21, 95% CI: 1.12–1.30), cerebrovascular diseases (IRR = 1.10, 95% CI: 1.02–1.19), diseases of arteries, arterioles, and capillaries (IRR = 1.43, 95% CI: 1.30–1.56), and diseases of veins, lymphatic vessels, and lymph nodes (IRR = 1.08, 95% CI: 1.01––1.16). Female seafarers showed increased risk of hospitalizations due to diseases of arteries, arterioles, and capillaries (IRR = 1.23, 95% CI: 1.03–1.47), diseases of veins, lymphatic vessels, and lymph nodes (IRR = 1.10, 95% CI: 1.00–1.20), and other unspecified disorders of the circulatory system (IRR = 1.67, 95% CI: 1.10–2.55).

SENSITIVITY ANALYSIS

The sensitivity analysis supported the main findings related to CVD. Among male seafarers, the rate of CVD remained elevated (IRR = 1.08, 95% CI: 1.04–1.12) (Suppl. Tab. 1), whereas no difference was observed among female seafarers. Overall, hospitalization rates were slightly lower than in the main analysis. Notably, female seafarers exhibited

a decreased rate of all-cause hospitalizations compared to the reference population (IRR = 0.96, 95% CI: 0.94–0.98).

DISCUSSION

This large nationwide study found that male seafarers face a higher risk of both all-cause and CVD-related hospitalizations than the remainder of the working population. In contrast, no overall differences in hospitalizations were observed among female seafarers. The increased hospitalization rates for both all-causes and CVD among males were consistent across all types of male seafarers, including those working on cargo ships and passenger ferries. Female seafarers working on passenger ferries experienced a higher all-cause hospitalization rate, while those working on cargo

Table 1. Baseline characteristics for Danish seafarers and the Danish working population

	Seafarers		Reference population	
	Male	**Female**	**Male**	**Female**
Total population	37,014 (71.6)	14,701 (28.4)	2,190,339 (52.4)	1,991,045 (47.6)
Person years	547,444	198,896	37,534,000	34,598,476
Birth year	1966 (53–76)	1972 (62–79)	1965 (51–79)	1966 (52–78)
Education				
Low	5,500 (14.9)	2,296 (15.6)	488,083 (22.3)	408,024 (20.5)
Medium	14,035 (37.9)	6,510 (44.3)	1,017,656 (46.5)	811,529 (40.8)
High	15,833 (42.8)	5,207 (35.4)	608,534 (27.8)	732,445 (36.8)
Unknown	1,646 (4.4)	688 (4.7)	76,066 (3.5)	39,047 (2.0)
Seafarer type				
Passenger ferries	8,899 (24.0)	5,758 (39.2)	NA	NA
Cargo ships	28,115 (76.0)	8,943 (60.8)	NA	NA
Hospitalizations				
All-causes	206,525	103,334	13,626,624	17,256,588
CVD	23,495	4,110	1,521,229	851,406
Diagnoses				
Chronic rheumatic heart diseases	14 (0.1)	×	1,267 (0.1)	1039 (0.0)
Hypertensive diseases	1,494 (6.4)	403 (9.8)	102,990 (11.0)	93,226 (11.0)
Ischemic heart diseases	4,533 (19.3)	396 (9.6)	318,318 (20.9)	108,829 (12.8)
Pulmonary heart disease and diseases of pulmonary circulation	2,570 (10.9)	225 (5.5)	156,568 (10.3)	55,265 (6.5)
Other forms of heart diseases	7,446 (31.7)	1,053 (25.6)	481,937 (31.7)	218,611 (25.7)
Cerebrovascular diseases	1,905 (8.1)	334 (8.1)	129,450 (8.5)	76,867 (9.0)
Diseases of arteries, arterioles, and capillaries	2,898 (12.3)	398 (9.7)	157,318 (10.3)	78,018 (9.2)
Diseases of veins, lymphatic vessels, and lymph nodes	2,558 (10.9)	1,267 (30.8)	168,595 (11.1)	214,695 (25.2)
Other and unspecified disorders of the circulatory system	74 (0.3)	34 (0.8)	4,599 (0.3)	4,629 (0.5)

Note: Values are represented as n (%) except for birth year, which is represented as median and interquartile range (IQR). × — not available due to low counts; CVD — cardiovascular disease; NA — not applicable for the reference population

Table 2. Incident rate ratios (IRRs) with 95% confidence intervals (CIs) for all-cause and cardiovascular disease (CVD) hospitalization among seafarers compared to the Danish working population (reference)

	All-cause hospitalizations				CVD hospitalizations			
	Model 1		Model 2		Model 1		Model 2	
	IRR	95% CI	IRR	95% CI	IRR	95% CI	IRR	95% CI
Male population								
Reference	1.00		1.00		1.00		1.00	
Seafarers	**1.01**	**1.00–1.03**	**1.05**	**1.04–1.07**	**1.05**	**1.02–1.09**	**1.10**	**1.06–1.14**
Age	**1.07**	**1.06–1.07**	**1.07**	**1.07–1.07**	**1.08**	**1.08–1.08**	**1.08**	**1.08–1.08**
Education								
Low			1.00				1.00	
Medium			**0.87**	**0.87–0.88**			**0.88**	**0.87–0.89**
High			**0.71**	**0.70–0.71**			**0.69**	**0.68–0.70**
Female population								
Reference	1.00		1.00		1.00		1.00	
Seafarers	1.00	0.98–1.02	1.00	0.98–1.02	1.08	1.01–1.15	1.06	0.99–1.13
Age	**1.04**	**1.04–1.04**	**1.04**	**1.04–1.04**	**1.07**	**1.07–1.07**	**1.07**	**1.07–1.07**
Education								
Low			1.00				1.00	
Medium			**0.90**	**0.90–0.90**			**0.85**	**0.84–0.87**
High			**0.84**	**0.84–0.84**			**0.70**	**0.69–0.71**

Note: Model 1 is adjusted for age and birth cohort in 5-year intervals, while model 2 is further adjusted for education. Significant results are marked in bold

ships had lower rates. Male seafarers experienced elevated hospitalization rates for pulmonary heart disease and diseases of pulmonary circulation, cerebrovascular diseases, diseases of arteries, arterioles, and capillaries, and diseases in veins, lymphatic vessels, and lymph nodes. Likewise, female seafarers showed increased hospitalizations for diseases of arteries, arterioles, and capillaries and diseases in veins, lymphatic vessels, and lymph nodes, as well as other and unspecified disorders of the circulatory system.

The results of this study conflict with previous findings to some extent. Some studies have reported lower [18, 19] or similar [21] CVD hospitalization rates among seafarers compared with working reference populations. Additionally, another study supports our findings, noting increased CVD hospitalizations among certain groups, particularly non-officer seafarers [20]. One possible explanation for these discrepancies is the variation in statistical methods and the different cohorts used in different studies.

Male seafarers working on passenger ferries and cargo ships showed an increase in all-cause and CVD hospitalizations. However, the tendency is higher among seafarers working on passenger ferries. For female seafarers, the all-cause hospitalization rate among those working on cargo ships was found to be lower than the reference population. Different exposures between the two groups and a selection effect can explain this. On cargo ships, a significant proportion of workers are involved in specialized tasks and few port arrivals [29], whereas a large proportion of workers on passenger ferries are engaged in service-related tasks, such as servicing and cleaning [30]. The combination of high physical workload, strenuous working positions, rapid turnaround times in ports, and frequent interaction with passengers characterizes the daily work on passenger ferries [30]. This could contribute to employees on passenger ships experiencing high levels of exertion [30]. Another possible explanation is that seafarers experiencing poorer health

Table 3. Incident rate ratios (IRRs) with 95% confidence intervals (CIs) for all-cause and cardiovascular disease (CVD) hospitalization among seafarers employed at passenger ferries and cargo ships compared to the Danish working population (reference)

	All-cause hospitalizations				CVD hospitalizations			
	Model 1		Model 2		Model 1		Model 2	
	IRR	95% CI	IRR	95% CI	IRR	95% CI	IRR	95% CI
Male population								
Reference	1.00		1.00		1.00		1.00	
Passenger	**1.18**	**1.14–1.22**	**1.19**	**1.15–1.23**	**1.25**	**1.17–1.33**	**1.26**	**1.18–1.34**
Cargo	0.98	0.95–1.00	**1.03**	**1.01–1.06**	1.00	0.95–1.05	**1.06**	**1.01–1.12**
Age	**1.07**	**1.06–1.07**	**1.07**	**1.07–1.07**	**1.08**	**1.08–1.08**	**1.08**	**1.08–1.08**
Education								
Low			1.00				1.00	
Medium			**0.87**	**0.87–0.88**			**0.88**	**0.87–0.89**
High			**0.71**	**0.70–0.71**			**0.69**	**0.68–0.70**
Female population								
Reference	1.00		1.00		1.00		1.00	
Passenger	**1.05**	**1.01–1.09**	**1.04**	**1.00–1.08**	1.09	0.96–1.24	1.05	0.92–1.20
Cargo	**0.94**	**0.91–0.96**	**0.95**	**0.92–0.98**	1.01	0.90–1.14	1.01	0.89–1.14
Age	**1.04**	**1.04–1.04**	**1.04**	**1.04–1.04**	**1.07**	**1.07–1.07**	**1.07**	**1.07–1.07**
Education								
Low			1.00				1.00	
Medium			**0.90**	**0.90–0.90**			**0.85**	**0.84–0.87**
High			**0.84**	**0.84–0.84**			**0.70**	**0.69–0.71**

Note: Model 1 is adjusted for age and birth cohort in 5-year intervals, while model 2 is further adjusted for education. Significant results are marked in bold

could be more likely to work on passenger ferries due to the shorter trips and the proximity to healthcare.

Previously, using the same cohort, we found increased mortality among male seafarers aged 45 years and older [12]. Male seafarers in different age groups showed increased mortality from ischemic heart disease, other forms of heart diseases, cerebrovascular diseases, and diseases of arteries, arterioles, and capillaries. In this study, these diagnoses were also observed to be associated with increased hospitalization rates among male seafarers and, to some extent, female seafarers. However, rates of ischemic heart disease and other forms of heart disease were comparable to those in the reference population. This suggests that seafarers are affected by some of the same diagnoses in terms of both morbidity and mortality. Typical for these diagnoses, but not excluded to, is that the development is influenced by several risk factors, to which many seafarers are exposed [5]. These conditions are typically influenced by multiple risk factors, many of which are prevalent in the seafaring profession.

High hospitalization rates can lead to increased workplace absences, either due to sick leave or the seafarers' inability to work at sea. This not only affects the individual worker but also impacts the industry. Understanding the specific cardiovascular health challenges faced by Danish seafarers is crucial for developing targeted interventions and policies to improve health outcomes.

The primary strength of this paper lies in the extensive dataset, which covers a nationwide population for 23 years. We obtained comprehensive data using Danish

Table 4. Incident rate ratios (IRRs) with 95% confidence intervals (CIs) for hospitalization due to specific diagnoses of cardiovascular disease (CVD) among seafarers compared to the Danish working population (reference)

	Male seafarers		Female seafarers	
	IRR	**95% CI**	**IRR**	**95% CI**
Chronic rheumatic heart diseases	0.85	0.43–1.68	×	×
Hypertensive diseases	1.04	0.96–1.12	0.95	0.82–1.11
Ischemic heart diseases	1.05	0.98–1.12	0.86	0.71–1.04
Pulmonary heart disease and diseases of pulmonary circulation	**1.21**	**1.12–1.30**	0.92	0.73–1.16
Other forms of heart diseases	1.06	1.00–1.14	1.12	0.95–1.32
Cerebrovascular diseases	**1.10**	**1.02–1.19**	1.03	0.84–1.26
Diseases of arteries, arterioles, and capillaries	**1.43**	**1.30–1.56**	**1.23**	**1.03–1.47**
Diseases of veins, lymphatic vessels, and lymph nodes	**1.08**	**1.01–1.16**	**1.10**	**1.00–1.20**
Other and unspecified disorders of the circulatory system	1.11	0.85–1.46	**1.67**	**1.10–2.55**

Note: Data are adjusted for age, birth cohort in 5-year intervals, and education. Significant results are marked in bold. × — not available due to low counts

registers, resulting in minimal selection bias. Our study contributes to the existing knowledge by investigating newer data and considering multiple hospitalizations per person. This approach offers a more thorough understanding of seafarers' hospitalizations. Additionally, we adjust for factors such as educational level, which is known to impact the development of CVD [31]. We compare the seafarers to other workers to reduce the healthy worker effect, which is often present when studying occupational groups [22].

Despite the high quality of data provided by the Danish registers [32], there are some limitations. One limitation is that seafarers often work internationally; therefore, some hospital contacts may have occurred at hospitals outside Denmark, which would not appear in our data. A study observed Danish seafarers in international and domestic trade and found that those engaged in international trade had a lower ratio of CVD hospitalizations in Danish hospitals than those working in domestic trade [21]. This is expected because CVD hospitalizations are often acute and require admission to the nearest hospital, which could potentially be abroad. In such cases, our dataset will only include instances where patients are transferred to or re-hospitalized in a Danish hospital. While this study does not distinguish between seafarers working in international or domestic trade, we would expect similar findings regarding fewer hospitalization for seafarers in international trade, which would underestimate our estimates.

Another limitation is that the dataset only includes Danish seafarers. The Danish fleet includes international crew members, whom we cannot observe in the Danish registers. Only workers residing in Denmark for three months or more are eligible for a Danish identification number; however, they disappear from the dataset once they leave the country. Therefore, the generalizability of our findings to international crew members remains uncertain.

Individuals were categorized as seafarers if they had at least one year of full-time employment in seafaring during the 23-year observation period. However, this approach may lead to exposure misclassification because it groups individuals with only brief seafaring experience (e.g., one year, early in their careers) alongside those who may have spent decades at sea. This method may not fully reflect cumulative occupational exposure. To assess the robustness of the results, we conducted a sensitivity analysis that excluded individuals with only one year of seafaring employment. The results showed only minor changes with a reduction in overall hospitalization rates, suggesting that seafarers with brief seafaring experience may have higher hospitalization rates than those with longer maritime careers. However, the overall findings regarding CVD remained consistent with the main analysis.

Similarly, the control group consisted of individuals who had at least one year of full-time employment during the study period, which may have introduced heterogeneity. Some individuals may have experienced only minimal or sporadic employment, potentially diluting the contrast between the exposed and unexposed groups.

Although this study compares seafarers with other workers, a healthy worker effect may be present. Seafarers

undergo a mandatory medical examination every two years to ensure they are fit for work at sea [9], a requirement uncommon in other occupations. These regular health checks may confer a health advantage, by potentially allowing early detection of CVD and enabling timely intervention to avoid hospitalization in the long term. Despite this advantage, our study still found a higher hospitalization rate among seafarers. Nevertheless, individuals with poorer health may be less likely to enter or remain in seafaring roles due to the physical demands and medical requirements of the job, which could lead to a healthier cohort of seafarers at baseline and underestimation of the true health risks associated with maritime work, as also suggested by the sensitivity analysis. Future analyses could explore temporal patterns in hospitalization rates before, during, and after seafaring employment and assess whether individuals with early hospitalizations are underrepresented in the seafarer group. These approaches could help clarify the extent to which the healthy worker effect and exposure misclassification influence our findings.

Another limitation is the low count for some diagnosed groups, especially among female seafarers, which prevented us from calculating estimates. Additionally, the low count introduced uncertainties in some estimates, as reflected by the broad CIs.

A consequence of solely using registers for research is the lack of information on lifestyle factors such as smoking, exercise, and diet, which could affect the investigated associations. Studies have indicated that seafarers often smoke, are likely to have a high-fat diet, and are physically inactive [4, 5]. However, it remains unclear whether the observed associations in this study can be explained by these lifestyle factors, work-related factors, or a selection effect of who becomes a seafarer.

CONCLUSIONS

This study found that male seafarers have increased hospitalizations for both all-cause and CVD, and the rates were both increased for those working on passenger ferries and cargo ships. Female seafarers showed no overall change in hospitalization rates; however, the rate of all-cause hospitalizations for those working on passenger ferries was increased, whereas those working on cargo ships had a lower rate. Among male seafarers, CVD hospitalizations were caused by pulmonary heart disease and diseases of pulmonary circulation, cerebrovascular diseases, diseases of arteries, arterioles, and capillaries, as well as diseases in veins, lymphatic vessels, and lymph nodes. The latter two also increased among female seafarers, along with other and unspecified disorders of the circulatory system. Further research is needed to understand these trends and improve seafarers' health outcomes.

ARTICLE INFORMATION AND DECLARATIONS

Data availability statement: The data used in this study are available from Statistics Denmark. The data is not publicly available, and restrictions apply to the availability.

Ethics statement: This study involves secondary analysis of registry data, and no ethics approval is required in Denmark when using data solely for research. The University of Southern Denmark's Research and Innovation Office (SDU RIO reference number 10.419) approved the project.

Author contributions: conceptualization: AUB, RLJ, and LJA; methodology: AUB, SM, RLJ, and LJA; data analysis: AUB, SM, and LJA; writing: AUB and LJA; review and editing: AUB, SM, RLJ, LLF, and LJA.

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Supplementary material: Supplementary Table 1.

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Prescription patterns in the treatment of acutely ill seafarers over a three-year observation period

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ABSTRACT

Background: *The provision of healthcare for seafarers is challenging due to their isolated working conditions and limited access to healthcare. Telemedical maritime assistance relies on pre-stocked medical chests aboard vessels. However, the contents of these medical chests are not globally standardized, and current data on prescription patterns is limited.*

Material and methods: *A retrospective observational cohort study was conducted, analyzing medical records from ships that received telemedical assistance between 2021 and 2023. Data were obtained from medical reports submitted by onboard medical officers and an internal medical record registry.*

Results: *In total, 9,458 individual patients received medical assistance, and 11,698 medications were prescribed. The mean patient age was 38.7 years (range 0–91 years), and patients aged 30–49 years were the most likely to receive medication. Merchant ships were the most common type of vessel requiring medical assistance, and they also had the highest probability for drug prescriptions. Approximately 80% of patients were prescribed medications, and patients required on average 1.24 prescriptions (range 0–6). A total of 266 individual types of medication were available for prescription. Overall, patient demographics and prescription patterns did not change over the three-year period.*

Conclusions: *The prescription patterns in the treatment of acutely ill seafarers are highly variable due to excessive availability of different drugs. The rare use of certain medications suggests potential inefficiencies in the stock management of medical chests, warranting further evaluation. These findings underscore the need for standardizing medical chests based on a data-driven approach.*

Medication use in telemedical care of seafarers is frequent but highly variable. A data-driven standardization of medical chests may improve efficiency and ensure availability of essential drugs.

(Int Marit Health 2026; 77, 2: 88–96)

Keywords: maritime medicine, maritime health, seafarer, medicine chest, medicine use

INTRODUCTION

The provision of maritime medical care presents unique challenges as ships are among the most isolated and hazardous workplaces. Seafarers are particularly vulnerable to workplace accidents and face higher health risks compared to land-based industries [1–5].

Research indicates that seafarers experience poorer overall health [6], a higher risk of cardiovascular disease

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(CVD) compared to other populations, and increased overall mortality relative to other workers [7–10]. Given these heightened health risks, it is crucial to ensure that seafarers receive appropriate health protection and access to medical care equivalent to that available to onshore patients, including timely access to medication, medical equipment, and expertise.

Pharmacological treatment onboard vessels is challenging for several reasons. With the exception of cruise ships, most commercial vessels do not have a doctor or trained medical personnel. Instead, medical advice and prescriptions are provided remotely *via* telemedical services, typically through phone or e-mail consultations. A major obstacle to effective maritime healthcare is the variation in the availability of medications onboard ships.

The collection of medicines and medical supplies on vessels referred to as the "medicine chest" was first described in Europe in the 19th century [11]. Efforts to harmonize regulations on ship healthcare standards date back to 1851, when European regulations mandated that vessels carry a medical chest along with instructions for its use [12]. In 1967, the World Health Organization published the first edition of the *International Medical Guide for Ships*, recommending a standardized medicine list of essential medications for all ships operating in international waters [13]. The third and most current edition was published in 2007 [14], but it is followed by only 86% of maritime stakeholders [15]. While discussions for a fourth edition began in 2021, its development has since been put on hold. Consequently, the 2007 edition and its corresponding medicine list are increasingly regarded as outdated and inadequate [15].

Despite international efforts toward standardization and the introduction of the Maritime Labor Convention 2006, which mandates the provision of medical chests for seafarers, significant discrepancies remain in the contents of these chests across different countries [16]. Their composition varies depending on factors such as vessel size and flag state regulations. This lack of standardization means that the medications prescribed by maritime physicians may not always be available onboard, leading to treatment delays or the need for alternative therapies.

Furthermore, maritime healthcare is evolving due to factors such as the increasing number of female seafarers [17], a growing awareness of mental health challenges among crewmembers [15], and advancements in medical technology, including point-of-care testing and artificial intelligence [18]. The implementation of frequently updated and globally standardized guidelines governing the contents of the medicine chest could significantly enhance onboard healthcare. Such guidelines would require a continuous re-evaluation of both the medications included in the medical chest and their application in practice.

Hitherto, no comprehensive data exist on prescription patterns and use of medications in the maritime setting. This study seeks to address this gap by analyzing prescription trends over a three-year period, examining which medications from the medical chest are frequently used and assessing the characteristics of treated patients.

The objective of this study is to provide a comprehensive analysis of prescription patterns in the treatment of seafarers over a three-year observation period.

MATERIAL AND METHODS

DESIGN

We conducted a retrospective observational cohort study, and a descriptive analysis method was chosen. Based on a general statement of the Danish Medical research Ethics committee, quality improvement projects such as this study do not require approval due to the design of the study. As a result, consent was not obtained. However, the study complies with the strict European General Data Protection Regulation (GDPR) data management rules.

SETTING

Radio Medical Denmark (RMD) is the only official Danish provider of Maritime Telemedical Assistance Service, and it operates as part of the Emergency Department at the University Hospital of Southern Denmark Esbjerg. Medical assistance is provided by maritime physicians on any day and at any time *via* email, telephone, or video contact. On average, more than 4000 individual patients are managed by RMD every year [19]. Radio Medical Denmark offers medical assistance to all types of commercial ships sailing under Danish flag, such as merchant ships, ferries and fishing vessels. Furthermore, in 2023, RMD signed contracts with the offshore platforms International SOS Assistance Services and Responsible Minerals Initiative (RMI), all Torm ships, as well as Maersk ships sailing under the Hong Kong or Singapore flag. All vessels sailing under the Danish flag carry a variant of the Danish medical chest [20].

DATA COLLECTION AND ANALYSIS

All data were collected from medical reports submitted by the on-ship medical officers and the internal medical record registry of RMD. The following data were collected: patient details (age, name, rank, and symptoms), type of vessel, geographical location, diagnosis code, and the prescribed treatment. All data were collected between 2021 and 2023.

Table 1. Age distribution: Patients who contacted Radio Medical Denmark (RMD) grouped according to age, regardless of whether they received medication or not. Values are numbers (percentage)

Age	2021		2022		2023	
18–29	629	(25.0)	683	(23.7)	981	(24.2)
30–39	766	(30.5)	834	(28.9)	1276	(31.5)
40–49	562	(22.3)	602	(20.9)	819	(20.2)
50–65	421	(16.7)	523	(18.1)	719	(17.7)
< 18	13	(0.5)	39	(1.4)	72	(1.8)
> 65	41	(1.6)	71	(2.5)	78	(1.9)
Unknown	83	(3.3)	134	(4.6)	112	(2.8)
Total	2515		2886		4057	

Table 2. Ship type: Type of commercial ship requesting medical assistance, regardless of whether they received medication or not. Values are numbers (percentage)

Ship type	2021		2022		2023	
Merchant ship	1668	(66.3)	1752	(60.7)	2584	(63.7)
Supply ship	474	(18.8)	602	(20.9)	562	(13.9)
Ferry	177	(7.0)	359	(12.4)	494	(12.2)
Fishing ship	82	(3.3)	88	(3.0)	95	(2.3)
Offshore	0		0		183	(4.5)
Other	61	(2.4)	49	(1.7)	86	(2.1)
Training ship	26	(1.0)	21	(0.7)	37	(0.9)
Unknown	26	(1.0)	14	(0.5)	15	(0.4)
Pleasure craft	1	(0.04)	1	(0.03)	1	(0.02)
Total	2515		2886		4057	

RESULTS

PATIENT DEMOGRAPHICS

In total, 9458 individual patients were treated by RMD over the three-year observation period included in the analysis. The average patient age was 38.66 years (range: 0–91).

When analyzed based on age brackets, 30 to 39 years of age was most common, with 30.1% of patients belonging to this group. Patients of age 18–19, 40–49, and 50–65 years were similarly common, with 24.3%, 21.1%, and 17.6%, respectively. Patients either younger than 18 or older than 65 years were extremely rare, accounting for 1.2% and 2.0% of contacts, respectively. The age distribution over the individual years is shown in Table 1.

SHIP TYPE

Overall, 63.5% of patients requiring medical assistance were part of the working crew on merchant ships. Supply ships and ferries accounted for 17.3% and 10.9% of medical cases, respectively. Assistance requests from fishing ships, training vessels, oil platforms, and other ship types were rare overall with less than 3% each. The ship type distribution is shown in Table 2.

PRESCRIPTION PATTERN

In total, 77.9% of patients assisted by RMD were prescribed medication. The probability of receiving medication was highest on merchant ships (81.3%) and lowest for oil platform personnel (64.5%).

Table 3. Prescription frequency: Number of patients receiving medications as well as the number of prescriptions per patient. Values are numbers (percentage)

Received medication	2021		2022		2023	
No	575	(22.9)	607	(21)	904	(22.3)
Yes	1939	(77.1)	2279	(79)	3153	(77.7)
Number of medications						
0	575	(22.9)	607	(21)	904	(22.3)
1	1065	(42.4)	1269	(44)	1722	(42.4)
2	658	(26.2)	780	(27)	1064	(26.2)
3	155	(6.2)	185	(6.4)	299	(7.4)
4	57	(2.3)	34	(1.2)	61	(1.5)
5	4	(0.2)	11	(0.4)	4	(0.1)
6	0		0		3	(0.1)

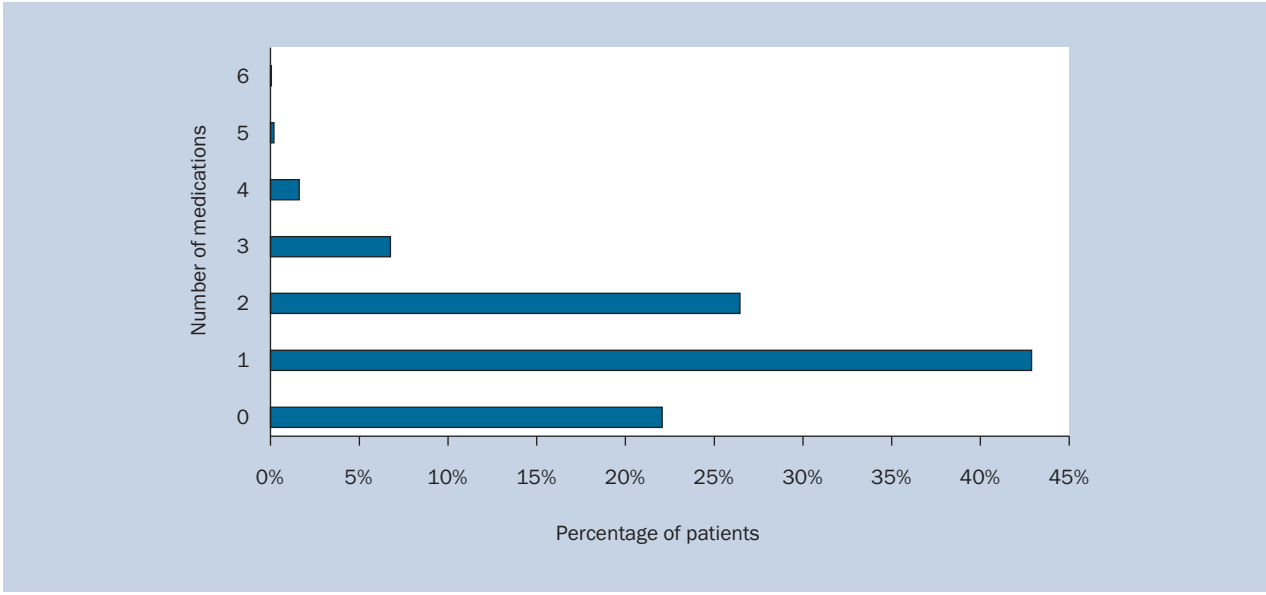

Figure 1. Number of medications prescribed per patient over a 3-year period

In total, 11,698 medications were prescribed over the three-year period. On average, 1.24 (range: 0–6) individual medications were prescribed per patient, as shown in Table 3 and Figure 1, 266 individual types of medications were available through various medical chests. The most common types of medication prescribed were pain relief in 6488 of cases (55.4%), antibiotics (1773, 15.2%), and eye/ear drops (1019, 8.7%). All other types of medicine such as allergy or cardiac drugs accounted for approximately 5% or less of the total prescriptions. The details are presented in Table 4.

Among the medications not used at all during the observation period, the following types of drugs were most common: medicine used for the treatment of poisoning, such as activated charcoal, ethyl alcohol, and phytomenadione. Furthermore, HIV-medication, specific types of malaria treatment, the majority of lotions, and oral rehydration fluids were not administered at all.

Medications not included in the Danish chest were predominantly used in 2023, with 156 prescriptions of that type made that year, increasing from 5 in 2021 and 12 in 2022, respectively.

Table 4. Type of medical product prescribed. Medications with an asterisk are found in the Danish medicine chest. The column # denotes the absolute number of prescriptions from that subtype of medication. The column % denotes the share in percent compared to the total prescriptions over the observation period

Group	%	Subtype	#	Medications included in the medical chests
Allergy	4.0	Shock	8	*Epinephrine
		Steroids	34	*Hydrocortisone, prednisolone, glucocorticoid, fluticasone nose spray, fludrocortisone
		Antihistamine	431	*Acrivastine, *cinnarizine, cetirizine, chlorphenamine, dexchlorpheniramine, loratadine, meclizine, cyclizine, promethazine, hydroxyzine, clemastine, antihistamine (other), diphenhydramine
		Seasickness	0	Hyoscine
Analgesia	55.4	Antipyretics	3500	*Paracetamol
		NSAIDs	2540	*Ibuprofen, *diclofenac, aspirin, NSAID (other), ketorolac, naproxen, celecoxib
		Opioid	380	*Morphine, *tramadol, fentanyl, codeine, dia-morphine, dihydrocodeine, fentanyl nasal spray, nalbuphine, buprenorphine
		Injection	66	*Lidocaine, tetracaine
		Others	2	Codeine + paracetamol, methoxyflurane, eletriptan, sumatriptan, rizatriptan, Bonjela gel, Instillagel, *NSAID gel, deep heat cream, clove oil
Mental	1.1	Sedatives	77	*Diazepam, lorazepam, midazolam, oxazepam, temazepam, *diazepam rectal tube
		Others	4	*Zolpidem, esketamine, procyclidine, melatonin
		Antipsychotics	44	*Haloperidol, olanzapine, prochlorperazine, chlorpromazine
Infection	15.2	Oral antibiotics	1690	*Phenoxymethylpenicillin, *amoxicillin, *erythromycin, *metronidazole, *ciprofloxacin, *flucloxacillin, *sulfamethoxazole/trimethoprim, amoxicillin/clavulanic acid, azithromycin, dicloxacillin, clindamycin, clarithromycin, nitrofurantoin, trimethoprim
		Intravenous antibiotics	18	Benzylpenicillin, *ceftriaxone, cefuroxime
		Antiviral	1	Zidovudine/Lamivudine, oseltamivir, aciclovir
		Malaria	17	*Atovaqone/Proguanil, *doxycycline, *quinine, artemether/lumefantrine, artemether
		Others	47	Revaxis, *tetanus-vaccine, *tetanus immunoglobulin, nystatin, *metronidazole rectally, hydrocortisone/oxytetracycline/polymyxin B, mebendazole, *Fluconazole
Cardiac	1.5	Blood pressure	68	*Atenolol, metoprolol, *furosemide, losartan, amlodipine, captopril, nifedipine
		Anticoagulants	40	*Aspirin, prasugrel, clopidogrel, tenecteplase, enoxaparin, dalteparin, fondaparinux, ticagrelor, heparin
		Others	64	*Glyceryl trinitrate, isosorbide dinitrate, amiodarone, atropine, magnesium sulfate heptahydrate, adenosine
Skin	5.1	Anti-infective	169	*Miconazole, *permethrin, benzyl benzoate, mupirocin, terbinafine, clotrimazole, crotamiton, bacitracin, Hedrin, fluconazole
		Corticosteroids	373	*Glucocorticoid group II, betamethasone, hydrocortisone/miconazole
		Lotions	53	*Silver sulfadiazine, Dermabond, zinc ointment, Unisept, Corsodyl, Vaseline, Mycota, Sudocrem, Savlon, E45 ointment, Gehwol Extra, calamine, carbamide, Cetraben, daktarin, Eurax, KY gel

→

Table 4 (cont.). Type of medical product prescribed. Medications with an asterisk are found in the Danish medicine chest. The column # denotes the absolute number of prescriptions from that subtype of medication. The column % denotes the share in percent compared to the total prescriptions over the observation period

Group	%	Subtype	#	Medications included in the medical chests
Gastrointestinal	5.0	Antiemetics	52	Ondansetron, *domperidone, metoclopramide
		Laxatives	86	*Lactulose, docusate, docusate with Senna, bisacodyl, macrogol, natriumcitrat rectal tube
		Hemorrhoids	81	*Anusol ointment, Scheriproct
		Dyspepsia	282	*Aluminum aminoacetate, ranitidine, *omeprazole, pantoprazole, esomeprazole, Gaviscon, calcium carbonate/magnesium carbonate
		Other	89	*Electrolyte powder, Dioralyte rehydration salts, simethicone, mebeverine, hyoscine butyl bromide, *loperamide
Eyes and ears	8.7	Eye drops	979	*Cinchocaine, *dexamethasone, *pilocarpine, *aciclovir, *Fucidin, *tropicamide, chloramphenicol, tetracycline, hydrocortisone/oxytetracycline, azelastine, atropine, Duratears, Optrex, oxybuprocaine
		Ear drops	40	*Allantoin, parocitin, *ciprofloxacin/hydrocortisone, lidocaine, framycetin/gramicidin, dexamethasone/neomycin, hydrocortisone/acetic acid, cerumenol, neomycin, Coldrex
Pulmonary	2.8	Bronchodilators	46	*Terbutaline, *salbutamol, ketitofen, aminophylline, ipratropium-bromide
		Antitussive	66	*Dextromethorphan, acetylcysteine, Strepsils, noscapine, codeine syrup
		Nasal medication	202	*Xylometazoline, oxymetazoline, Vicks product, Naseptin, Olbas oil, phenylpropanolamine, pseudoephedrine
		Corticosteroids	9	Beclometasone, *budesonide
		Others	0	Contac 600, Day Nurse, guaifenesin, Lemsip
Fluids	0.9	Intravenous fluids	17	*Sodium chloride 0.9%, *glucose + sodium chloride, ringer's lactate, plasma expander, Gelofusine
		Oral fluids	0	Oral rehydration solution, Revolyt, dextrose gel
		Disinfectants	98	Chlorhexidine/ethanol, chlorhexidine, povidone iodine, ethanol 70%, chloroxylenol, Hibicet
Other	< 0.1	Various	19	*Oxygen, insulin aspart, insulin glulisine, metformin, multivitamin, Optilube, methylergometrine, ergometrine/oxytocin, misoprostol, malathion, nicotine, diethyltoluamide, tranexamic acid
		Antidotes	6	*Naloxone, *glucagon, *atropine, *calcium gluconate, *calcium lactate gluconate, *charcoal, *ethyl alcohol, *phytomenadione, Cyanokit, flumazenil, sodium nitrite, vodka, Norit Carbomix, Hexafluorine

DISCUSSION

KEY FINDINGS

We conducted an observational cohort study to examine the current prescription patterns in the treatment of acutely ill seafarers over a three-year observation period. Most cases involved working-age individuals on merchant ships. Approximately 4 out of 5 patients were treated with prescription drugs, and patients required on average 1.24 prescriptions. A total of 111 individual types of medication were used at least once. Overall, patient demographics and prescription patterns did not change over the three-year period.

STRENGTHS AND LIMITATIONS

This study offers a comprehensive analysis with nearly 100% of data available, making it a highly robust contribution to the field. To our knowledge, it is the first publication of its kind, providing a detailed examination of prescription patterns aboard seagoing vessels.

Our study has several limitations. The analysis is limited by its single-center design, which may affect the applicability of the findings to other countries and maritime health centers. Nevertheless, research of this type is rarely conducted in international collaborations because few centers of

maritime health of this size exist. Additionally, the retrospective nature may introduce certain biases. Lastly, the observation period of the study covers the year 2023, during which RMD signed new contracts with companies whose vessels sail under flags other than the Danish flag. These vessels do not employ the Danish medical chest and are the main reason behind the increasing number of patient contacts in 2023, and they could have influenced our findings.

RELATIONSHIP WITH PREVIOUS STUDIES

To our knowledge, this is the first study to explore the prescription pattern in maritime health on the basis of specific, individual medications.

Previous studies described the differences and similarities between national medical chests [16] or highlighted the use of off-label drugs and prescribed medications according to various diagnoses [12]. Another study explored the prescription pattern of a specific drug type, benzodiazepine, in the maritime setting. This type of drug was prescribed in 3.29% of cases, which is three times the rate we report here [21]. Another study by Herttua et al. [22] suggested that the age group of 30–49 years had the lowest risk of physical injuries, which is in contrast to our findings, which showed that this group had the highest probability of receiving medication (data not shown).

While there are no directly comparable studies, the consensus across the literature is that harmonization of medical chest contents is necessary. Our findings align with this consensus, emphasizing the need for standardization to improve healthcare delivery aboard ships, which in turn can contribute to minimizing seafarers' unequal access to healthcare.

PRESCRIPTION PATTERN

The study revealed great variation in the specific medications used from similar drug groups, mainly due to differences in the composition of medical chests across ships. At least 266 different medications were available to the maritime physicians on call, which by far exceeds the needs in the acute care setting. Furthermore, such a large array of medication is a potential source of medical errors, due to lower familiarity with dosing and side-effects of such a large number of medications, which applies to both ship personnel and the prescribing physician.

While most medications in the medical chests were used regularly, some were prescribed only once or not at all over the three-year period. Medications such as naloxone, atropine, activated charcoal, ethyl alcohol, and phytomenadione cannot realistically be removed from the medical chest despite their irregular use, given the life-threatening nature of the conditions treated with these items. But others, such as quinine and zidovudine/lamivudine, could be considered for removal. The necessity to have these medications on board is highly questionable, as the likelihood to diagnose a seafarer with new-onset human immunodeficiency virus (HIV) is extremely rare, and quinine is redundant in the presence of other antimalarial drugs. When considering which drugs were potentially missing in our data set, we were surprised that neither direct oral anticoagulants or low-molecular-weight heparin were available in the Danish medical chest. Similarly, alternative forms of administrating medicine, such as intranasal analgesia, is mostly absent in maritime health, despite their much simpler handling compared to intravenous treatment, which is especially relevant for medical officers without formal medical training [23].

Furthermore, the data suggests a significant overlap within certain medication groups. When treating allergic reactions, 13 different types of antihistamine were available. In the case of severe pain, 8 specific types of opioid could be chosen from. Similarly, a significant overlap was shown for antibiotics, even when excluding topical forms such eye drops, where at least 17 types of oral or intravenous medications were prescribed. The overlap clearly stems from the different contents of medical chests on board ships sailing under a non-Danish flag. This suggests that although most drug types in the stock are relevant, there may be opportunities to optimize chest contents by reducing the number of drugs within groups.

STUDY IMPLICATIONS

Our study shows that, even within a single maritime health center, the prescription pattern of medicine is extremely variable, as confirmed by the excessively high number of 266 individual medications reported. Moreover, the variation must be even greater in a global context, since standardization of medical chests between countries is entirely lacking. Several medications were so rarely utilized that removal from any medical chest should be considered, and overlap within medication groups should be part of any evaluation of future contents of medical chests. An international effort to standardize the medical chests is paramount to improve maritime healthcare, but the effort must be evidence-based. Regular updates based on actual usage data could improve efficiency by identifying redundant drugs, and it could ensure essential drugs are always available.

CONCLUSIONS

In conclusion, this study reveals highly variant prescription patterns in the treatment of acutely ill seafarers. Patient demographics and ship types did not change over the three-year observation period. However, the substantial variation in prescribed medications due to differences in medical chest contents highlights the need for greater standardization. It is recommended that an international

research collaboration be established to investigate current practices and prescription patterns, forming the basis for a global effort to standardize medical chests in the maritime industry.

ARTICLE INFORMATION AND DECLARATIONS

Data availability statement: The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Ethics statement: Based on a general statement of the Danish Medical Research Ethics Committee, quality improvement projects such as this study do not require approval due to the design of the study. As a result, consent was not obtained. However, the study complies with the strict European GDPR data management rules.

Author contributions: HT collected data, interpreted data, and wrote the paper. LELL designed the study and interpreted the data. JV designed the study and interpreted the data. Kimmo Herttua designed the study but died during the conduction of the project. LLF interpreted the data. PB designed the study, interpreted the data, and wrote the paper. All authors were involved in critically revising the paper.

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Conflict of interest: The authors declare that they have no conflict of interest.

Supplementary material: None.

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VIA MEDICA

REVIEW ARTICLE

Medical evacuations from offshore oil and gas installations — an exploratory scoping review

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ABSTRACT

Background: *Medical evacuations (MEDEVACs) from offshore installations are both costly and disruptive. Enhancing worker well-being may help reduce evacuations due to illness or injury, thereby maintaining the smooth operation of offshore activities and lowering financial burdens.*

Objective: *This scoping review aims to identify whether illness or injury is the predominant cause of MEDEVACs from offshore oil and gas installations and to determine the most common types of illnesses or injuries involved. Additionally, the review outlines a future research agenda focusing on offshore worker health and well-being.*

Material and methods: *A comprehensive structured search was conducted across the Scopus, PubMed, and Web of Science databases, as well as through reference lists and grey literature. Studies were included if they addressed MEDEVACs from offshore oil and gas installations. Eleven articles met the inclusion criteria.*

Results: *Articles indicate that non-occupational illnesses are more frequent causes of MEDEVACs than injuries. Among these, chest pain, cardiovascular issues, and dental problems were disproportionately represented. Contractor personnel were more likely to require evacuation than company employees. Additionally, younger workers were more likely to be evacuated due to injuries. Chronic health conditions were more common reasons for MEDEVACs among older workers. The review highlights the significant role of non-communicable diseases in contributing to MEDEVACs, as opposed to occupational exposures.*

Conclusions: *Investing in preventive health management, targeted research, and workforce education may substantially reduce the prevalence of non-communicable diseases in the offshore environment, lowering MEDEVAC rates, associated costs, and operational disruptions. Further investigation into the underlying causes of ill health among offshore workers is needed to enhance overall workforce well-being.*

(Int Marit Health 2026; 77, 2: 97–107)

Keywords: medical evacuation, MEDEVAC, oil and gas, occupational health, worker well-being

INTRODUCTION

Offshore oil and gas installations are found in more than 50 countries, in 2015 they contributed 30% of global crude oil production, producing more than 27 million barrels of oil per year [1]. A number of workers are employed in the offshore oil and gas sector; working day and night, year-round, in remote locations, and often challenging conditions [2]. In the UK in 2021 alone, some 11200 people worked offshore in oil and gas production [3], a modest proportion of the global offshore workforce.

Offshore oil and gas installations offer a unique working environment, presenting the industrial and occupational health hazards normally found in high-risk chemical industries onshore, with the additional challenges presented

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by being in an offshore setting, challenges such as isolation, harsh conditions, and logistical difficulties [4]. While the health challenges workers face are similar to those working onshore, their remoteness from secondary or tertiary health resources and the challenges of patient transport means that accessing medical treatment poses challenges not normally encountered onshore [2]. This may mean that a relatively minor health issue onshore may be a significant issue for an offshore worker.

Although offshore installations typically maintain staffed and well-equipped clinics, those clinics are intended to treat minor ailments or emergency cases. In emergency cases, the medic may provide care to stabilize the patient until evacuation can occur. Even if the medic can stabilize the patient evacuation can be significantly delayed due to resource availability or adverse, preventing helicopter operations [2]. Clinics are not for the long-term care of patients, and minor ailments may necessitate that the patient is transferred to shore by helicopter for further (even if minor) treatment. Equally, personnel suffering from minor ailments or illness who cannot work may be returned to shore to release bed space, which is always in high demand and short supply [5].

Medical evacuations (MEDEVACs) may be classified as "routine" or "emergency" [6]. The distinction between the categories is that an emergency medical evacuation would be carried out using either a state-funded search and rescue helicopter or a designated MEDEVAC helicopter maintained by the operating company, distinct from a crew transport helicopter. Routine medical evacuations would be where the patient has a minor ailment and is transported by the next scheduled helicopter. A third possible category that may be largely unrecognized is the return to shore of workers on medical grounds near the scheduled end of their offshore rotation. In such instances, they may be moved to an earlier flight. This way, the person is returned to shore on medical grounds but may fall outside any medical reporting system as they would be moved within the flight booking system. Regardless of the method employed, any form of medical evacuation results in the premature disembarkation from the installation and should be avoided whenever possible.

Medical evacuations are not without risks for helicopter crews, patients, and offshore installations [7, 8]. They can be costly, not only in terms of the transportation of the patient but also in terms of lost work time, lost opportunity costs, administration and medical costs. Furthermore, it can disrupt work being carried out on installations and divert national resources depending on where the installation is located [5]. As such, medical evacuations need to be reduced to a level as low as reasonably practicable to reduce unnecessary or untimely patient evacuation to shore for medical assessment and treatment [9].

Beyond the economic issues associated with medical evacuations, analysis is required to understand the underlying health issues that necessitate medical evacuations in the first place. Such analysis should include investigating the prevalence of injuries, chronic diseases, access to healthcare resources, working conditions, and the constraints or norms that may affect the health condition of offshore workers. By identifying such issues, targeted interventions to improve health outcomes may be developed.

This review seeks to map the breadth and scope of current research concerning medical evacuations from offshore oil and gas installations, to determine whether illness or injury is the predominant reason for medical evacuation, and which forms of illness or injury predominate. Such mapping is crucial for policy decisions, helping to determine management priorities and effective resource allocation. As an exploratory scoping review, it identifies research gaps that may shape a future research agenda. A further aim is to determine if any research has been carried out focusing on oil and gas operations in the Danish sector of the North Sea.

MATERIAL AND METHODS

SEARCH PROTOCOL

This scoping review was undertaken, applying the processes defined by Arksey and O'Malley [10]. The scoping review protocol was registered with the Open Science Foundation. The Condition, Context, and Population (COCOPOP) framework was used to define the inclusion and exclusion criteria for article screening, as outlined in Table 1 [11]. The database search was carried out in September 2024. No limits were placed on publication dates. The searches were limited to articles published in English.

SEARCH STRATEGY

After defining the inclusion and exclusion criteria, search terms were determined. A search string was developed and tested in the PubMed database, it was deemed suitable when it produced consistent results, effectively retrieving relevant literature specific to the topic of interest. Furthermore, the search string was required to return key studies and reviews that aligned with the research objectives of the review, thereby ensuring effective coverage of the subject.

The final search string was translated using Polyglot Search Translator [12] and applied to the Scopus and Web of Science databases. The search strings employed are reproduced in Table 2.

A review of references in the articles returned from the searches, and from articles previously identified was carried out using the Connected Papers website (https://www.connectedpapers.com/). One additional article was identified in this manner: Gibson Smith K, Paudyal V, Klein S,

Table 1. Inclusion and exclusion criteria

	Inclusion criteria	Exclusion criteria
Condition	Medical evacuation (illness or injury)	Military medical evacuations
	Aeromedical evacuation (MEDEVAC/MEDIVAC*)	Evacuations related to combat or military operations
	Casualty evacuation (CASEVAC)	Mountain rescue
	Helicopter evacuation (offshore) Dental emergencies	Routine transport without urgency or remote challenges
	Patient transport (urgent, non-routine)	
Context	Offshore oil and gas personnel (fixed/mobile platforms, FPSOs)	Seafarers (merchant ships, non-oil and gas workers)
	Remote locations requiring specialised medical transport (e.g., long distances, harsh conditions)	Windfarm workers or similar with easier access to medical facilities
	Helicopter or specialised transport due to remoteness or lack of onshore care	Military personnel in combat or non-civilian operations
Population	Offshore oil and gas workers (e.g., rigs, FPSOs)	Seafarers (merchant navy, fishing vessels)
	Personnel in remote offshore facilities with limited medical infrastructure	Windfarm or land-based workers Military personnel
Design	Quantitative studies English language	Review articles Non-English language

*MEDIVAC is a less commonly used variant of MEDEVAC — Medical Evacuation: the transportation of injured or ill individuals to medical facilities, typically using helicopters; FPSO: Floating Production, Storage, and Offloading, a floating offshore oil processing vessel normally permanently anchored — used to process and store oil and gas extracted from subsea reservoirs

Table 2. Search strings used

Source	n	Search string
PubMed	134	[(„offshore") AND („medical evacuation" OR „emergency medical care" OR „medical care" OR "MEDEVAC" OR "MEDIVAC" OR „injuries" OR „illness" OR „telemedicine" OR „self-care" OR „behaviour change interventions")]
Scopus	104	TITLE-ABS-KEY (offshore) AND (medical AND evacuation OR emergency AND medical AND care OR medical AND care OR medevac OR medivac OR injuries OR illness OR telemedicine OR self-care OR behaviour AND change)
Web of Science	99	TS = [(offshore) AND („medical evacuation" OR „emergency medical care" OR "MEDEVAC" OR "MEDIVAC" OR „medical care" OR „workplace injuries" OR illness OR telemedicine OR self-care OR „behaviour change interventions")]

MEDEVAC — medical evacuation; TS = Topic: searches for topic-related terms in title, abstract, keywords

Stewart D. Medical evacuations and work absences in offshore oil and gas industry personnel. Self-care. 2019 Oct 31;10(4):105–115.

A search of grey literature was also carried out using the Google search engine. Employing the search: Medical evacuation* OR MEDEVAC AND offshore AND oil AND gas filetype:pdf. The search was limited to "filetype:pdf" to narrow the search to reports, white papers and similar articles.

One article was found for inclusion: Offshore Energies UK (OEUK). Health, Safety and Environmental (HS&E) Report 2023: Health, Safety and Environmental Reporting for the UK's Offshore Energy Industry. United Kingdom: Offshore Energies UK; 2023 [13].

Previous annual reports in the same series were used for background information, though not included in the scoping review to limit the sources to a manageable quantity. This approach ensured a focused analysis while providing relevant context from established literature.

SCREENING AND SELECTION

The results of the searches were assessed using Covidence software [14]. Duplicate articles were automatically removed in this process. Articles were screened for inclusion based on an initial assessment of the title and abstract. Where the title and abstract indicated that an article was likely to fulfil the inclusion criteria, the full text was reviewed.

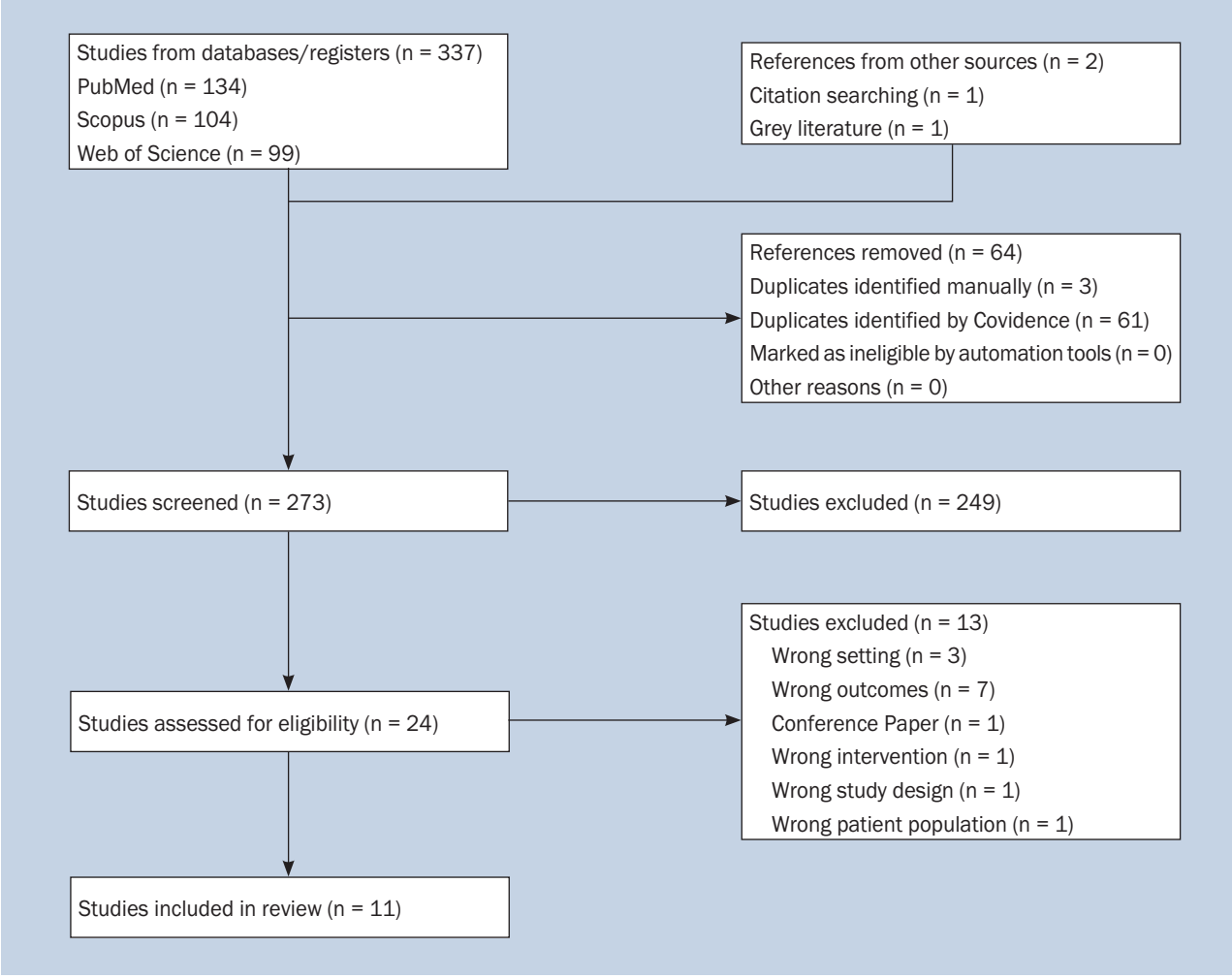

Figure 1. PRISMA diagram for the article selection process

Due to the exploratory nature of this review, only one reviewer was required.

The results of the screening process are shown in Figure 1.

RESULTS

After the screening and selection process, 11 documents were selected for inclusion in the scoping review. The included articles are listed in Table 3.

The key findings of the articles included in this review are summarized in Table 4. In all cases, the studies were conducted exclusively among populations of offshore oil and gas workers.

RISK OF BIAS WITHIN STUDIES

Bias within individual studies was assessed and found not to have any adverse effect on the results of this review. Given that the primary focus of this review is to understand the scope of existing research concerning medical evacuations, sources of bias have minimal impact on the results of this review.

STUDY CHARACTERISTICS

A summary of study characteristics is presented in Table 4. The articles reviewed were published between 1988 and 2023, in either a North Sea setting [13, 15–17], Thailand [18], Brazil [19] or in the Gulf Coast of the United States [20, 21]. While the studies by Gibson Smith et al. [22] and Ponsonby et al. [2] were not restricted to one location. No articles were identified that specifically addressed oil and gas operations in the Danish sector of the North Sea. However, the results obtained offer generalizable insights applicable to offshore environments.

All of the studies included in the review, except those by Ballantine et al. [23] and Duffy et al. [15], made some assessment of the differences in the number of evacuations due to illness or injury. Both research groups specifically investigated health and evacuation issues related to dental

Table 3. Articles included in the scoping review

Primary author	Year	Title
Ballantine B.N. [15]	1990	A Survey of The Dental Health of the Workers On 2 Groups of Offshore Installations
Benevides A.G.M. [16]	2023	Offshore Medical Evacuations Due to Non-Occupational Illnesses
Duffy B. [17]	1996	Dental Problems in the Offshore Oil and Gas Industry: A Review
Gibson Smith K. [18]	2019	Medical Evacuations and Work Absences in Offshore Oil and Gas Industry Personnel
Norman J.N. [19]	1988	Medical Evacuations from Offshore Structures
OEUK [13]	2023	Health, Safety and Environmental (HS&E) Report 2023: Health, Safety and Environmental Reporting for The UK's Offshore Energy Industry
Ponsonby W. [2]	2009	Offshore Industry: Medical Emergency Response in the Offshore Oil and Gas Industry
Sae-jia T. [20]	2020	Medical Evacuations Among Offshore Oil and Gas Industries in The Gulf of Thailand
Taylor D.H. [21]	1993	Air Medical Transport of Patients from Offshore Oil and Gas Facilities. Historical Accident Data and Initial Experience
Thibodaux D.P. [22]	2014	Medical Evacuations from Oil Rigs Off the Gulf Coast of The United States From 2008 To 2012 Reasons and Cost Implications
Waje-Andreassen A. [23]	2020	A Prospective Observational Study of Why People Are Medically Evacuated from Offshore Installations in The North Sea

health among offshore workers and were therefore not concerned with other causes of MEDEVACs.

Norman et al. [24] identified a changing trend in this ratio of evacuations caused by injury or illness. At the start of their study, illness accounted for 25% of MEDEVACs, in subsequent years of the study, this situation altered, illness, and injury MEDEVACs became approximately balanced by 1984 (the end of their study).

Thibodaux et al. [25] found non-occupational illness and injury accounted for 77% of MEDEVACs, with occupational illness injuries accounting for the remaining 23%. Chest pain was identified as the most frequent reason for MEDEVACs accounting for 26% of all MEDEVACs. Cardiovascular issues were significantly represented in the study of Thibodaux et al. [21], they did not feature prominently in the findings of Norman et al. [24], whose study found 41 cases were evacuated for cardiac health issues, which amounted to 1.89% of all MEDEVACs in the study period. This picture changed in the intervening years, with statistics from OEUK [13] indicating that in the UK sector of the North Sea, cardiac health issues accounted for 27% of medical evacuations in 2023, furthermore, the report outlines that there were 337 MEDEVACs carried out in 2022, the number of MEDEVACs having doubled since 2017. The primary causes for MEDEVACs and their relative prevalence in offshore settings were examined and are shown in Table 5.

Similarly to chest pain and cardiac issues, the impact of avoidable dental issues on MEDEVAC rates is significant. Norman et al. [17], found that disorders of the digestive system were the most prevalent type of illness leading to medical evacuation 239 evacuations (39.2% of all illness--related MEDEVACs), of this category, approximately half (115) were dental issues, 5% of all MEDEVACs. Gibson Smith et al. [22] found dental issues accounted for 11.4% of MEDEVACs, Ponsonby et al. [2] 15%.

Dental issues and cardiac health issues are of significance in the context of offshore oil and gas production because they are not only non-communicable health issues that can be largely managed or avoided through lifestyle modification and timely health intervention; many non-communicable diseases are also associated with high mortality rates [26].

Regarding occupational injuries resulting in MEDEVAC, Norman et al. [24] found that suspected fractures were the most numerous cause — 442 cases (20%). This figure was mirrored by Ponsonby et al. [2] (29%), and Waje--Andreassen et al. [27] (18%). Only Sae-jia et al. [18] found a significantly lower level of MEDEVACS due to fractures at 4.09%.

According to Norman et al. [17] eye and hand injuries were numerous, accounting for 25% of all evacuations, with eye injuries alone accounting for 10%. Thibodaux et al. [25], found a much lower percentage of 3.77% for eye injuries, these disparities may be explained by changes in offshore health and safety practices such as mandatory use of protective glasses, introduced in the period between the two studies.

Table 4. Study characteristics

Primary author	Year	Study design	Location	Key findings
Ballantine B.N. [15]	1990	Dental examinations	UK North Sea	Dental issues are significant among offshore workers. 8% evacuated for dental reasons; 36% in high-risk groups
Benevides A.G.M. [16]	2023	Database analysis	Brazil	Non-occupational illnesses were found to be the primary cause of evacuations at 86.6%
Duffy, B. [17]	1996	Database analysis	UK North Sea	Dental pathology is a significant issue in offshore workers
Gibson Smith K. [18]	X	Cross-sectional survey	Global	Medical evacuations primarily result from injuries. Short-term illnesses contribute to medical evacuations Dental problems account for many illness-related medevacs
Norman J.N. [19]	1988	Analysis of offshore evacuation data	UK North Sea	The majority of evacuations were due to illness, especially dental issues Age influenced evacuation reasons: older evacuees had more illnesses
OEUK [13]	2023	Annual report	UK North Sea	In 2022, 337 MEDEVACs were conducted Medevac rates doubled in five years Cardiac incidents were the leading cause of medevacs 27%
Ponsonby W. [2]	2009	Analysis of offshore evacuation data	Global	55% of all evacuations were due to illness. Telemedicine enhances emergency care in remote locations
Sae-jia T. [24]	2020	Analysis of offshore evacuation data	Thailand	The majority of evacuations (84.13%) were due to illness 40% of cases were preventable
Taylor D.H. [21]	1993	Analysis of offshore evacuation data	US Gulf Coast	Aeromedical transport is essential in offshore oil production for both illnesses and injuries
Thibodaux D.P. [22]	2014	Analysis of offshore evacuation data	US Gulf Coast	The majority of evacuations were due to non-occupational illnesses Heart disease is the leading chronic condition causing medevacs The average evacuation cost is approximately $49,250
Waje-Andreassen A. [23]	2020	Prospective observational study	Norway North Sea	Illness causes three times more evacuations than trauma Cardiac issues are the most common reason for evacuation Fridays and Saturdays are typically the busiest days for medevacs

MEDEVAC — medical evacuation

Table 5. Causes of illness-related evacuation, along with their reported prevalence from different sources

Cause of evacuation	Prevalence range (%)	Mean (%)	Sources
Dental issues	3.13–15	8.12	[2, 16–19, 24]
Cardiac health issues/Chest pains	1.9–45	19.6	[2, 13, 16, 19, 22, 23]

Few of the studies reported the age of workers sent ashore by MEDEVAC. Norman et al. [24], reported that the mean age of MEDEVAC patients was 28.3 years for injury cases and 34.4 years due to illness. Thibodaux et al. [25], illustrated trends related to age, injury and MEDEVAC showing a direct relationship between age, injury, and illness; older workers primarily returning to shore for illness, and younger workers for injury.

Contractors accounted for 90.6% of MEDEVACS in the study by Norman et al. [24]. Ballantine et al. [23], found that contractors were at the highest risk of dental issues. 19% of short-term contractors fell into the highest dental risk category compared to 11% of operating company employees.

None of the papers reviewed linked the phase of operation with illnesses, injuries, or medical evacuations, i.e., whether the offshore platform is in a construction, operation, or decommissioning phase.

A notable finding from Norman et al. [24], was that, of the MEDEVACs carried out, only 4% required immediate hospital admission.

DISCUSSION

This review aimed to determine the main reasons for medical evacuations (MEDEVACs) from offshore oil and gas installations and to understand the primary causes of these evacuations. It included 11 articles. A narrative discussion of the study findings is presented.

The number of research articles returned from the searches was limited, though their contents provided valuable insights into the causes of MEDEVACs. Many of the studies are dated, and this may reduce their relevance in contemporary contexts, care must therefore be taken when applying their findings. The number of peer-reviewed studies identified in this review is relatively small considering the number of offshore workers. The range of the populations studied was limited, potentially limiting the generalizability of the findings, yet still suggestive of prevailing trends.

The studies reviewed generally indicate a change in MEDEVAC trends. Where injury-related evacuations were once predominant [24], more recent reports indicate that non-occupational illnesses now account for a greater proportion of MEDEVACs [23, 24, 28].

Excluding the articles that focused on dentistry [15, 16], all but one of the studies [22] concluded that illnesses prevail over injury as the prime cause of premature disembarkation. The trend of increased illness over injury is similarly reflected in grey literature and conference papers [29–31] though this may vary depending on several factors, including the platform's operational phase, local conditions, reporting requirements, and workforce demographics.

Gibson Smith et al. [22], described that their study design may have contributed to their divergent outcome — concluding that injury is a more significant cause of medical evacuation than illness. The study design required participants to report MEDEVACs from any point in their career offshore, which, as the authors note, could account for a considerable period; potentially decades and again this may not be reflective of current issues offshore. One significant point made by Gibson Smith et al. [22] is that the absence of workers on health grounds is predictive of MEDEVACs to some extent. Personnel who are absent from the workplace based on health-related issues appear to be significantly associated with subsequent medical evacuation. This may help with predictive modelling for the likelihood of offshore workers requiring MEDEVACs during their careers.

Improvements in safety management, risk recognition, and offshore health provision, as well as developments in technology, have all contributed to changing trends in incident and accident rates, as well as the prevalence and effects of illness offshore [32]. Offshore injuries have declined in both number and severity since the earlier studies reviewed [29]. The data presented by Norman et al. [24] presents a list of injuries which required MEDEVAC, the quantity of such severe injuries may not be reflective of the current offshore safety approaches, and may be unreliable in the contemporary offshore setting.

Gibson Smith et al. [22] noted a female population of 3.7% in their cross-sectional survey. The industry body Oil and Gas UK, reports that over the last 10 years, the proportion of female workers offshore (in the UK sector) has not changed significantly [33] and is approximately 3.5% — in line with Gibson Smith et al. [22]. The exposure of those female workers to injury offshore may vary subject to their occupation. Although women are not restricted in their job roles, many work in catering, housekeeping, medical, or support operations. Catering roles expose workers to significant risk of injury including slips, trips, falls, musculoskeletal issues, burns, and mechanical injuries. The relationship between female job roles and premature MEDEVACs is an area which should be considered for future research.

From the studies, there are trends regarding the type of illness and injury for which MEDEVACs are required. Where the type of illness or injury was discussed in the studies selected [17, 18, 20, 21, 27] the results were classified differently, meaning that direct comparisons were not always possible. Meta-analysis from these studies was therefore not feasible; however, a generalised picture of MEDEVAC trends was possible.

Norman et al. [24] found that digestive and dental issues were the predominant cause of MEDEVACs from offshore installations. Of 790 illness-related MEDEVACs, 239 (39.2%) were for digestive disorders (which also included dental issues), and dental issues accounted for approximately half of those evacuations (112 MEDEVACs). Ballantine et al. [23], noted the generally better dental health among company employees, people in management positions and those with higher levels of education [23] when compared to contractor personnel. This may be significant for targeting health education efforts to workers, particularly contractors. Given

the age of the study, caution should be used in interpreting its validity in the contemporary setting; however, there is sufficient evidence in the included articles to determine that dental issues among offshore workers remain a significant cause for MEDEVACs.

Cardiac health issues leading to MEDEVACs are reported as 5.2% of all MEDEVACs by Norman et al. [24]. Chest pain in the study of Thibodaux et al. [25] accounted for 45% of MEDEVACs, with 21% of chest pain MEDEVACs being due to myocardial infarction, coronary stent placement, coronary bypass surgery or unstable angina; a total of 9.44% of the study population. Norman et al. [24], found 1.26% of all evacuations were related to myocardial infarction or ischaemia, other sources also point to similar levels of cardiac health issues [29–31]. Differences between the two studies may be due to demographics, reporting, changes in treatment, or other factors. The 20-year difference between the studies, and the effects of political geography may also factor significantly in this difference. It should also be borne in mind that there may have been differences in fitness to work criteria between the study populations, which, may have imparted effect. Oil and Gas UK reported in 2019 [34] that emergency medical evacuations from offshore installations were required 241 times, 21% of these MEDEVACs were for cardiac health issues this figure rose to 27% in 2023 [13]. Cardiac health issues therefore present the highest single cause of illness-related MEDEVACs in the UK offshore sector. These conditions often necessitate longer recovery periods for workers, with some being unable to return to work offshore. Cardiac health issues can lead to premature departure from the industry and pose a heightened risk of death while offshore.

Medical transportation for psychological ill health accounted for 1.9% of the evacuations studied by Norman et al. [24]. According to OEUK [13], year-on-year evacuations for mental health-related issues in the UK sector of the North Sea have remained relatively stable, accounting for approximately 2.5% of medical evacuations since 2017. There may be significant underreporting of MEDEVACs for psychological issues [35]. Reasons such as perceived stigmatization may contribute to psychological issues not being openly reported [36]. Personnel may also return to shore with psychological issues without them ever being recorded. They may wait until the end of an offshore trip and then report sick, deciding not to return for their next rotation. This would therefore not be classified as a MEDEVAC but could potentially skew overall health statistics and undermine the understanding of mental health challenges in offshore environments.

Riethmeister et al. [35], noted that the absence rate on health grounds among offshore populations is generally low, but also that this was not reflective of the health status of the workforce as a whole. Machismo, stoicism and other masculine behavioural norms are common in male-dominated workforces [36] potentially meaning offshore workers may report for work despite being ill. These behaviours may add to the potential for MEDEVACs. While legally workers and companies must report injuries, workers may choose not to report illness. They may choose to wait until the point where it is perceived to be worthy of reporting [36]. Reithmeister et al. [35], also report that 67% of offshore workers reported living with chronic health issues, primarily musculoskeletal issues or cardiovascular issues and that 44% of those reporting chronic illness had to adapt their work to take account of their health issue (e.g. working more slowly). Health policies and education to strengthen open and honest health cultures offshore may reduce MEDEVAC rates.

The age of workers and medical evacuation appears to be linked to both the reason for, and the number of medical evacuations. Younger workers appear to be more likely to undergo MEDEVAC due to injury, while older workers appear more likely to be evacuated due to illness.

The correlation between age and medical transport was similarly noted in the study of Norman et al. [24], however, they found that in the over 55 age group illness and injury evacuations were approximately equal. This despite significant differences in illness and injury evacuation rates for all age groups up to 45 years of age where injury was the predominant cause. Such findings may be accounted for by improvements in safety procedures and processes since the study of Norman et al. [24] that have led to an overall reduction in injury rates [32].

Older workers may be subject to fewer injuries as experience has taught them how to carry out tasks safely [24], they may act in supervisory roles to younger workers (even if in an unofficial capacity), or in an administrative or leadership role, resulting in a disproportionately high injury exposure for younger workers. Commonly the higher the job level of the worker in the offshore hierarchy, the lower the prevalence of both illness and injury reported [37]. Associations between job level, illness and injury were not possible to conclude from the included studies.

While included articles indicate that those over 45 years of age have fewer MEDEVACs for both illness and injury compared to younger workers [24, 25]. Data from the UK Health and Safety Executive [38], shows that sickbay visits offshore for illness for the 45–49.9 age group, are disproportionately high when compared to their representation in the offshore population.

After 50 years of age the number of sickbay visits for illness fell considerably. This may indicate a healthy worker effect where workers with illness cannot obtain a fitness-to-work certificate, excluding them from working offshore. Alternatively, the demands of working offshore may be

incompatible with the health status of the worker, and they may elect to stop working offshore. The reasons behind workers failing offshore fitness-to-work examinations should be researched as this may also reveal important health trends in offshore populations.

Modern sedentary lifestyles and the obesogenic [39] nature of offshore oil and gas installations may aid the development of some non-communicable diseases. A report from Oil and Gas UK [40] found that the weight of male offshore workers had increased by 19% between 1985 and 2009. Kuovenen et al. [41] found that increasing worker obesity rates could be correlated to an increase in injury rates. Upstream health interventions may reduce the prevalence of obesity and non-communicable diseases [42], and potentially may alter MEDEVAC rates for both illness and injury.

Dental pathologies offer an area of difficulty for offshore workers and offshore medics. The offshore treatment of dental issues is beyond the scope of many medics and available facilities, therefore rendering pain management and MEDEVAC the only viable options. The costs of dental care and access to that care can also be prohibitive for workers. Upstream health education and a holistic health management approach may significantly reduce MEDEVAC costs for dental reasons and be of benefit to worker health. The use of dental insurance and company dental schemes may be beneficial; however, such schemes would need to be extended to or implemented by contracting companies to be truly beneficial.

The job role of evacuees was not recorded in the reviewed studies. The nature of the work that an evacuee undertakes will determine their workplace exposures — not all offshore workers are equally exposed; maintenance, construction, and drilling workers offshore are more susceptible to injury than many other offshore workers [29]. The studies included in this review indicate that contractors are more likely to be evacuated to shore for both injury and illness. This may be not only due to exposure but also due to the generally higher population of contractors offshore compared to employed workers [32].

None of the papers reviewed highlighted either the nature of the installation (whether an FPSO, a fixed installation or a drilling rig) or the phase of operations when medical evacuations occurred. Norman et al. [24] did discuss the changes in injury types from the construction phase to the operating phase, but this is not explicitly reflected in the study data. Thibodaux et al. [25] alluded to amputations and upper extremity injuries stating that such injuries are more likely during drilling and construction phases, though the study does not explicitly link evacuation data with either installation type or operational phase. As such it is difficult to conclude if the number of MEDEVACs is proportional to the drilling and construction operations carried out, or if the installation type has any effect, though it remains likely.

LIMITATIONS OF THE STUDY

The review focused on those published peer review studies available in English, which may have excluded some potentially valuable research. Literature in this area of research is limited, with differences in categorization and recording of data making direct comparisons across articles difficult, however, this review intends to identify the research available, not to conduct meta-analysis. The age of some studies questions the applicability of earlier studies in contemporary settings.

CONCLUSIONS

This review revealed that illness is typically the primary cause of medical evacuation from offshore oil and gas installations.

This review identified a limited number peer-reviewed studies regarding medical evacuations from offshore installations. It was possible to draw sufficient information from the studies to fulfil the stated aims. This review identifies that non-occupational illnesses are the primary reason for MEDEVACs and that non-communicable diseases predominate; with dental and cardiovascular issues contributing significantly to medical evacuation numbers.

In the short term, there is a pressing need for robust, methodologically sound research to accurately assess the status of medical evacuations, injuries, and worker health on offshore platforms. Applying a recognized classification system, such as the WHO International Classification of Diseases (ICD), would facilitate more comparable reporting across studies.

Only by recording the experiences of a statistically valid number of offshore workers, using a structured classification system for illnesses and injuries can a clearer understanding of workplace conditions, and worker health be developed. This, in turn, could shed further light on the factors leading to premature disembarkation from offshore installations.

Links between worker role, age, health status, psychosocial factors, shift patterns, lifestyle choices and MEDEVACs should be further explored. Future research should consider longitudinal studies, which could provide insights into the development of chronic illnesses among workers and their impact on MEDEVAC rates.

Prioritizing upstream health education and interventions in the offshore environment is essential, fostering a positive health climate may lead to a reduction in MEDEVACs due to illness, research into this area is recommended. A holistic health approach covering recruitment, diet, fitness, exercise, ergonomics, and psychosocial aspects should be favoured above reliance on fitness-to-work screening.

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First detection of *Vibrio vulnificus* and other potentially pathogenic *Vibrio* species on different types of waste material in the Gulf of Gdańsk

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ABSTRACT

Background: Vibrio *bacteria, including pathogens like* Vibrio vulnificus *(*V. vulnificus*) and* Vibrio cholerae *(*V. cholerae*) (typical for tropical regions), are increasingly reported in the Baltic Sea, with rising infections linked to climate change. In our study, we examined the presence of* Vibrio *species on waste materials floating in the coastal zone.*

Material and methods: *Seventy-five waste items were collected. Samples were rinsed, homogenized, and cultured on CHROMagar* Vibrio *and thiosulfate-citrate-bile salts-sucrose (TCBS) agar.* Vibrio *isolates were tested for their tolerance to salinity and susceptibility to antibiotics.*

Results: Vibrio *contamination was most common on medical waste (46.15%), followed by plastic film (16%), and both cigarette butts and other waste (14.28%). No* Vibrio *was detected on food packaging. Two of the 25* Vibrio *isolates (*V. cholerae/mimicus*) showed resistance to cefotaxime (CTX), piperacillin-tazobactam (TZP), trimethoprim-sulfamethoxazole (SXT), and imipenem (IMP). Salinity strongly influenced growth: all isolates grew best at 2% salinity, with reduced growth at 5% and minimal growth at 10–15%.*

Conclusions: *The detection of* V. vulnificus *on medical waste such as band-aids raises concerns for individuals with open wounds, who should avoid seawater exposure during summer and replace wound dressings after swimming. Additionally, the presence of antibiotic-resistant* V. cholerae/mimicus *underscores the need for ongoing monitoring and further research into environmental reservoirs of pathogenic and drug-resistant* Vibrio *species.*

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Keywords: *Vibrio vulnificus*, *Vibrio cholerae*, medical waste, plastic film, marine environment

INTRODUCTION

Vibrio spp. are Gram-negative, curved-rod bacteria that belong to the *Vibrionaceae* family [1]. Within this group, several important pathogens can be distinguished, including the bacterium causing cholera — toxigenic *Vibrio cholerae* (*V. cholerae*) O1 and O139. Infections caused by these toxigenic strains result in disease characterized by watery diarrhea, which may lead to severe dehydration. Other pathogenic *Vibrio* species, such as *V. vulnificus*, non-toxigenic *V. cholerae* (non-O1/non-O139), *V. parahaemolyticus*, and *V. alginolyticus*, are collectively referred to as non-cholerae *Vibrio* spp., and are the main cause of infections in the Baltic Sea region, leading to diseases known as vibriosis [2, 3].

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Vibrio vulnificus occurs commonly in tropical regions in brackish waters, at temperatures above 15°C, and it is an opportunistic pathogen [4]. One of the ways humans can get infected with this bacterium is by consuming contaminated seafood. Typical symptoms include fever, diarrhea, nausea, and vomiting. Another possible way of infection by *V. vulnificus* is direct contact of an open wound with contaminated seawater. In this case, patients develop painful cellulitis, swelling with bullae around the wound, and fever [1]. *Vibrio vulnificus* is considered one of the deadliest foodborne pathogens. Older people, as well as those with liver diseases, diabetes, or immune disorders, are most likely to be infected. Infections are characterized by a short incubation period of 16 hours for wound infections and 26 hours for septicaemias [4, 5].

Non-O1/non-O139 *V. cholerae* (NOVC) are usually responsible for skin and wound infections or gastrointestinal disease [6]. The predominant clinical manifestations are hyperthermia, diarrhea, and abdominal pain, while skin infections may present as necrotizing fasciitis and cellulitis [7]. Transmission of NOVC occurs through the consumption of raw seafood and contact with water [8]. Infections with this bacterium most often affect immunocompromised individuals with underlying liver disease [6].

Infections caused by *V. parahemolyticus* are most commonly associated with the consumption of contaminated food, particularly shellfish [9]. Clinical symptoms typically include diarrhea, abdominal pain, headache, and vomiting. Wound infections are relatively rare and occur mainly in immunocompromised patients with liver diseases [10]. *Vibrio alginolyticus* is an opportunistic pathogen that can cause ear and wound infections in individuals exposed to seawater (swimmers) [11].

Climate change, especially heatwaves, allows *Vibrio* spp. to inhabit new marine areas. For example, in the Baltic Sea area, in the last decade, there have been an increasing number of cases involving *Vibrio* species and subsequent infections [12, 13]. The years with especially warm summers (e.g., 2014 and 2018) were also the ones with the largest numbers of vibriosis cases reported. In 2018, 445 cases of vibriosis were reported in Norway, Denmark, Sweden, Finland, Poland, and Estonia, 45 of which were caused by *V. vulnificus* and 100 by non-toxigenic *V. cholerae* [13]. A group of hemolytic *Vibrio* strains was isolated from the surface water of the Baltic Sea in 1995 [14]. In the summer of 2020, *V. vulnificus* was first identified in the coastal water in the Gulf of Gdańsk (Poland) [15]. According to scientific publications (Poland does not gather official data), between the years 2018 and 2021, there have been 8 documented cases of vibrosis in Poland, six of which were *V. cholerae* and two *V. vulnificus* [3].

As of 2016, it was estimated that 150 million metric tons of plastic waste were circulating in the marine environment [16]. Marine bacteria, including *Vibrio* species, can exist in biofilms as communities attached to surfaces such as animal carapaces, algae, ship hulls, and — especially — plastic waste. All microbial communities that can live on plastic surfaces in the marine environment have been named the "Plastisphere." *Vibrio* biofilms have been found on many marine water surfaces of both micro- and macroplastics. This enables the bacteria to reach new regions and poses a danger for animals, which can accidentally ingest plastic particles along with the bacterial biofilm [17, 18].

Due to the excessive use of antibiotics, mainly in medicine and agriculture, many bacterial genera have developed antibiotic resistance or even multiple antibiotic resistance, which poses a great threat to human health. *Vibrio* spp. are usually susceptible to most antibiotics. However, based on recent reports, the number of *Vibrio* strains resistant to clinically utilized antibiotics is increasing [19]. What is interesting, the resistance can vary in different countries. For example, in the United States of America, it was discovered that *V. vulnificus* was the most resistant to chloramphenicol, in Italy — to ampicillin, and in China — to cefazolin [20].

The aim of this study was to detect the presence of *V. vulnificus* and other potentially pathogenic *Vibrio* spp. on the surface of different types of waste collected in coastal waters of the Gulf of Gdańsk (Baltic Sea, Poland) and to determine their antibiotic susceptibility and salinity preference.

MATERIAL AND METHODS

SAMPLING

From April 25th to August 22nd of 2023, a total of 75 samples of waste and debris were collected in 10 different sites of the Gulf of Gdańsk. Collection sites included: Gdańsk Brzeźno, Gdańsk Jelitkowo, Oliwski Stream, Sopot, Gdynia Orłowo, Gdynia, Puck, Władysławowo, Kuźnice, and Hel (Fig. 1).

Samples that had characteristics indicating prolonged presence in the sea environment were collected either directly from coastal waters or wet sand, using sanitized forceps. The waste was put in aseptic containers and immediately transferred to the laboratory. In most cases, it was not possible to identify the polymers or organic materials that those samples were made of. Therefore, samples were divided into five categories characterized by their use: medical (included used dressings, gloves, and cotton gauze), plastic film, food packaging, cigarette butts, and others (including plastic caps, shoelaces, festival bracelets, fishing nets, and clothing labels).

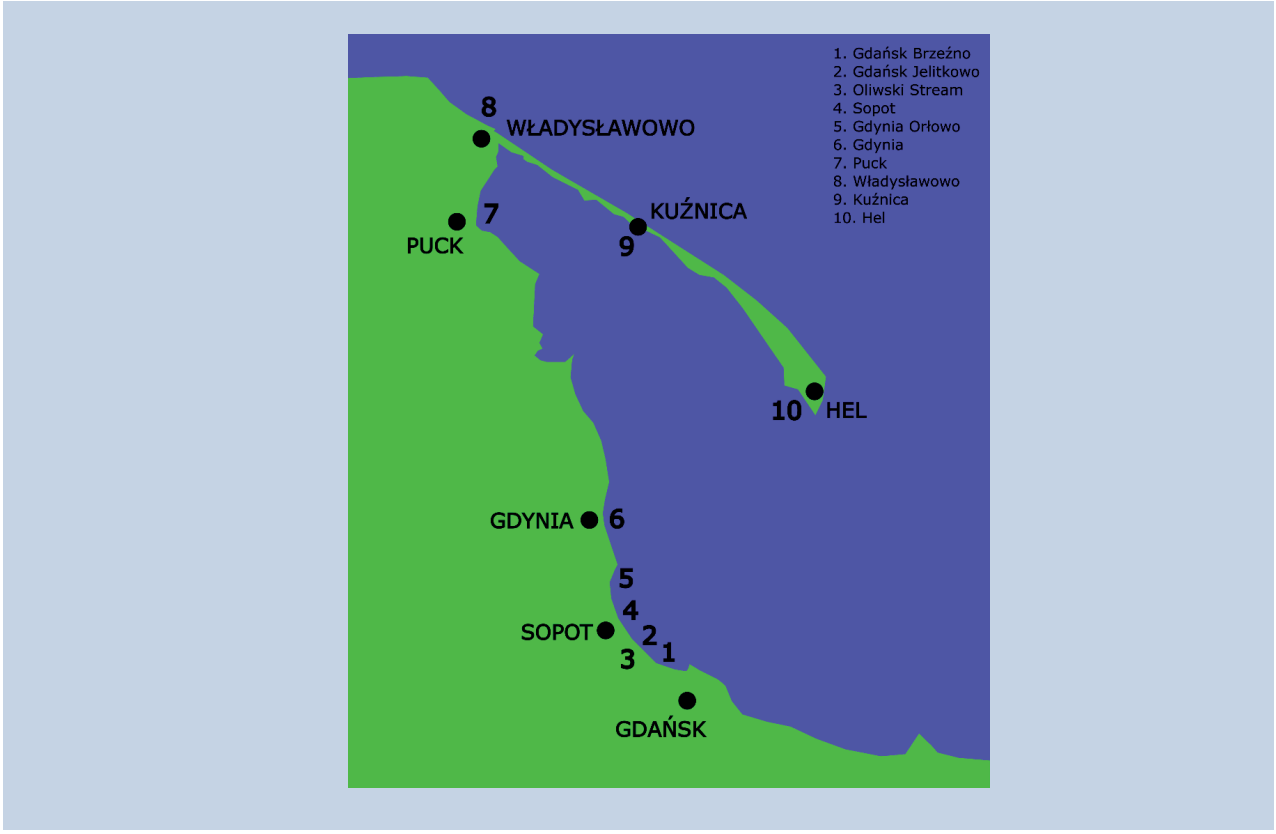

Figure 1. Map indicating sampling locations for waste collection (Gulf of Gdańsk, Poland)

ISOLATION OF *VIBRIO* SPP.

Each sample of waste or debris was first cleaned two times by putting it into a dish with sterile water and shaking it gently. This process eliminates bacteria found solely in water that are not part of the biofilm on the surface of the sample. In the next step, using BagMixer 400 (Interscience, France), samples were homogenized for a total of 60 seconds in 10 mL of Zobell medium.

First, 200 µL of homogenized solution was plated on the CHROMagar Vibrio (CHROMagar, France) and incubated in usual conditions at 37°C for 18–24 hours (POL-EKO APARATURA, Poland). Colonies with a characteristic turquoise blue color, which indicates the growth of the bacteria from *V. cholerae* or *V. vulnificus* species, were transferred onto chromogenic thiosulfate-citrate-bile salts-sucrose (TCBS) medium (Merck, Germany) and incubated in usual conditions at 37°C for 18–24 hours. The purpose of this step was to differentiate between blue-green colonies of *V. vulnificus* and dark yellow colonies of *V. cholerae* on TCBS. Chosen strains were isolated, purified, and stored at –80°C. The experimental workflow is shown in Figure 2.

MALDI-TOF IDENTIFICATION

For matrix-assisted laser desorption/ionization — time of flight (MALDI-TOF) testing, a portion of a pure bacterial colony (~1 µL) was transferred onto a MALDI sample plate, overlaid with 1 µL of a saturated solution of alfa-cyano-4--hydroxycinnamic acid in acetonitrile (28%), which was allowed to dry at room temperature. For each isolate, a mean spectrum was constructed with at least 50 m/z spectra profiles and used for identification by comparison with the spectra contained in the Saramis database (bioMérieux, France). Identification was defined as > 99% match to the species--specific m/z profiles in the database. *Escherichia coli* (*E. coli*) American Type Culture Collection (ATCC8739) (bioMérieux, Marcy l'Etoile, France) was used as a standard for calibration and quality control.

ANTIMICROBIAL SUSCEPTIBILITY TESTING

Disk diffusion assays for all isolates and reference strains were performed according to the protocols specified in the European Committee on Antimicrobial Susceptibility Testing (EUCAST) guideline and breakpoints for imipenem

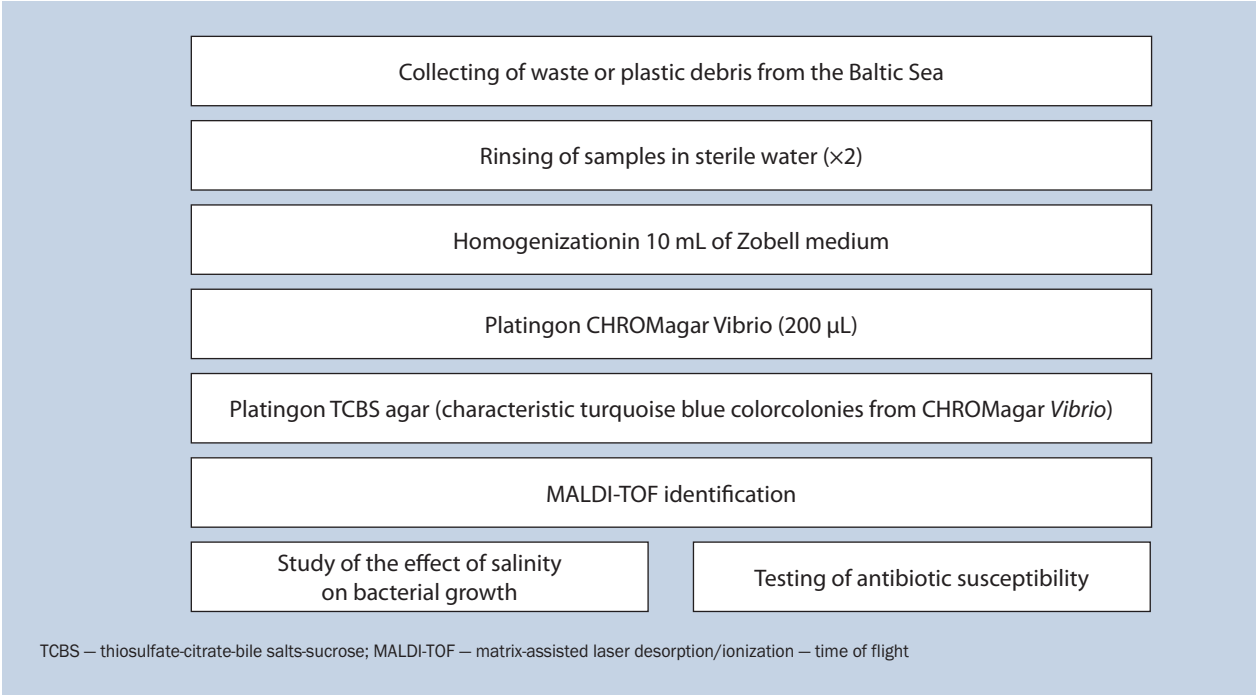

Figure 2. Schematic representation of the experimental workflow

(IMP) from a publication written by Bier et al. [21]. The assay was performed using unsupplemented Mueller-Hinton agar (Biomaxima, Poland). The plates were incubated at 35°C for 20 hours. After incubation, the inhibition zones were measured. *E. coli* ATCC 25922 was used as a quality control. Eight types of antimicrobial disks (Oxoid, UK) were used, containing different antibiotics: gentamicin (CN 10 µg), trimethoprim-sulfamethoxazole (SXT 25 µg), tetracycline (TE 30 µg), levofloxacin (LEV 5 µg), piperacillin/tazobactam (TZP 36 µg), ciprofloxacin (CIP 5 µg), cefotaxime (CTX 5 µg), and IMP (10 µg). Among the tested substances, CTX and CIP were mentioned in reported cases as possible treatments for infection caused by *V. vulnificus* [1, 22, 23]. Other antibiotics used for the treatment of *V. vulnificus* infections include doxycycline and ceftazidime, and this study tested both TE and a 3rd generation cephalosporin.

SALINITY SUSCEPTIBILITY TESTING

The experiment was conducted to evaluate the growth of *Vibrio* isolates at different salinity levels, with seven distinct concentrations of sodium chloride (NaCl): 0%, 0.5%, 1%, 2%, 5%, 10%, and 15%. The bacterial cultures were grown in nutrient broth (Biomaxima, Poland) as the growth medium (The medium did not contain any salts in its base composition). A 100 µL suspension of bacterial cells, adjusted to 0.5 McFarland (McF), was added to each tube containing the respective medium and salt concentrations.

To assess the growth level of the cultures, culture density measurements (McF, DEN-1B Biosan) were taken at two time points: immediately after inoculation and after 24 hours of incubation (37°C, without shaking). The initial culture density measurement was subtracted from the final value, with the resulting difference representing the growth level of the bacterial cultures.

DATA ANALYSIS

Data analyses for this study were conducted using Microsoft Excel and the R software. The heatmap was generated using the R packages pheatmap and ggplot2. Hierarchical clustering was performed using Ward's method with squared Euclidean distances to group the isolates based on similarities in their growth patterns across different salt concentrations. The growth of *V. vulnificus* and *V. cholerae/ /mimicus* was statistically compared to assess whether there was a significant difference across different salt concentrations. For this analysis, the Mann–Whitney U test was performed ($\alpha = 0.05$). Excel was utilized for initial data organization and basic calculations, while R provided the tools for advanced statistical analysis and heatmap creation [24].

RESULTS

Seventy-five samples of waste were collected. Samples were divided into 5 categories: cigarette butts, food

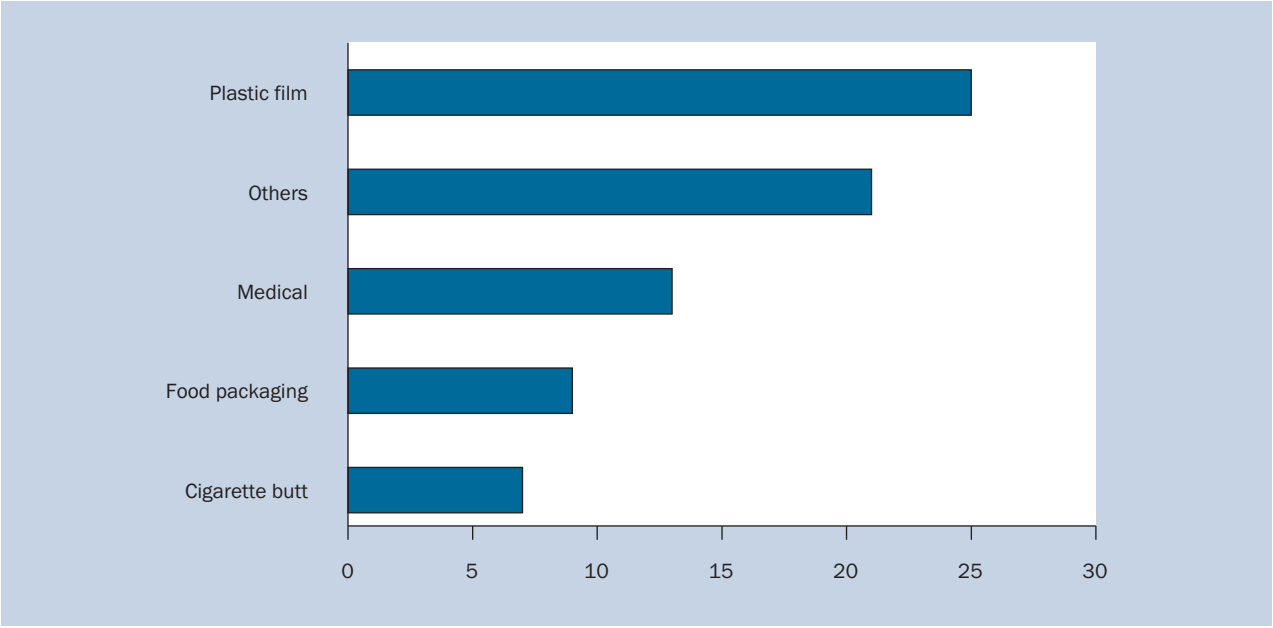

Figure 3. Distribution of collected samples across categories. The bar chart illustrates the number of samples collected in each category: plastic film, others, medical, food packaging, and cigarette butts

packaging, medical waste, plastic film, and others. The most numerous category was plastic film (33.3%), followed by others (28%). The least common category was cigarette butts (9.3%) (Fig. 3).

Each sample was tested for the presence of species of the *Vibrio* genus. The occurrence of *V. vulnificus* on waste obtained from the Gulf of Gdańsk was confirmed in 7 samples, four of which were collected on the beach in Sopot, two on the beach in Brzeźno, and one on the beach in Hel. Moreover, *V. cholerae* was identified in one sample, *V. cholerae/mimicus* in six, and *Vibrio* spp. in three of seventy-five samples. Waste samples in which *Vibrio* was identified were all collected in July, except for the band-aid (number 6), which was collected in April and confirmed to be contaminated with *Vibrio* spp. (Tab. 1).

More than one *Vibrio* species was detected in 2 of 75 samples (2.7%). On one band-aid (number 56), both *V. vulnificus* and *V. cholerae/mimicus* were found. Three *Vibrio* species were identified on one of the foil samples (number 57): *V. vulnificus*, *V. cholerae*, and *V. cholerae/mimicus*. The sample analyzed was a piece of foil with a structure resembling parafilm. These samples (56 and 57) were collected in Sopot on the 16th of July, when the water temperature was 18 °C.

The analysis of the prevalence of the *Vibrio* genus across various sample groups revealed notable differences in contamination levels. The medical group showed the highest contamination rate, with 46.15% of the samples testing positive for *Vibrio* species. This was followed by the plastic film group, in which 16% of the samples were contaminated. The other and cigarette butts groups each had a contamination rate of 14.28%. No bacteria from the *Vibrio* genus were detected on food packaging. In the cigarettes category, one isolate of *V. vulnificus* was detected. *Vibrio* spp. were found mostly on medical waste. In this category, 3 isolates of *V. vulnificus*, 2 isolates of *V. cholerae/mimicus,* and 2 isolates of *Vibrio* spp. were found. The second most numerous category is plastic film, on which 3 isolates of *V. vulnificus* were identified, as well as 1 isolate of *V. cholerae/mimicus*, 1 isolate of *Vibrio cholerae,* and 1 isolate of *Vibrio* spp. However, most isolates of *V. cholerae/mimicus* were identified on waste classified as other. Apart from *V. cholerae/mimicus* in the category, two isolates of *V. vulnificus* were also found.

ANTIBIOTIC SUSCEPTIBILITY OF *VIBRIO* SPP.

Out of the 25 isolates obtained from the collected waste, only two (PV359 and PV360) demonstrated antibiotic resistance. Both isolates were identified as *V. cholerae/mimicus* and exhibited multidrug resistance. Specifically, these strains were resistant to the following antibiotics: cefotaxime (third-generation cephalosporins, β-lactams), piperacillin/tazobactam (β-lactam/β-lactamase inhibitor combination), trimethoprim-sulfamethoxazole (folate pathway inhibitors), and imipenem (carbapenems, β-lactams). The resistance to cefotaxime, piperacillin/tazobactam, and trimethoprim-sulfamethoxazole was determined using the EUCAST breakpoints. Resistance to imipenem was assessed based on the breakpoints proposed in a study by Bier et al. [21].

Table 1. Occurrence of *Vibrio* bacteria on analyzed waste samples

Waste sample number	Isolate ID	Type of bacteria found on the waste sample	Collection date	Collection site	Water temperature [°C]	Type of waste	Waste category
23	PV180	*V. vulnificus*	16.07.2023	Brzeźno	18	Medical gauze	Medical
56	PV195	*V. vulnificus*	16.07.2023	Sopot	18	Band-aid	Medical
	PV196	*V. cholerae/mimicus*					
60	PV192	*V. vulnificus*	16.07.2023	Sopot	18	Mask	Medical
41	PV188	*V. cholerae/mimicus*	16.07.2023	Gdynia	18	Band-aid	Medical
6	PV135	*Vibrio spp.*	25.04.2023	Brzeźno	7	Band-aid	Medical
70	PV374	*Vibrio spp.*	16.07.2023	Brzeźno	19	Band-aid	Medical
32	PV181	*V. vulnificus*	16.07.2023	Sopot	18	Black foil	Plastic film
57	PV197	*V. vulnificus*	16.07.2023	Sopot	18	Foil	Plastic film
	PV198	*V. cholerae/mimicus*					
	PV199	*V. cholerae*					
73	PV383	*Vibrio spp.*	16.07.2023	Brzeźno	19	Foil	Plastic film
	PV384						
63	PV273	*V. vulnificus*	20.07.2023	Hel	18	Sticker	Other
	PV262						
44	PV189	*V. cholerae/mimicus*	16.07.2023	Brzeźno	18	Bottle cap	Other
59	PV201	*V. cholerae/mimicus*	16.07.2023	Sopot	18	Festival arm-band	Other
	PV202						
	PV203						
	PV204						
67	PV359	*V. cholerae/mimicus*	16.07.2023	Brzeźno	19	Hard plastic PET	Other
	PV360						
	PV363						
	PV364						
46	PV263	*V. vulnificus*	16.07.2023	Brzeźno	18	Cigarette	Cigarette butt

IMPACT OF SALINITY ON *VIBRIO* SPP. GROWTH

Culture density was measured and expressed in McF units, which served as a parameter to assess culture growth. The McF values reached a maximum of 7.13 McF. Most isolates showed the highest growth in medium supplemented with 2% NaCl — 11 out of 25 isolates (44%). Eight isolates (32%) grew best at 5% salinity, five isolates (20%) at 1%, and one isolate (4%) showed optimal growth at 0.5% salinity. At salinities of 10% and 15%, no significant growth in the microbiological culture was observed. It should be noted that in the case of isolates number PV263, PV181, PV192, PV195, PV180, PV383, PV384, PV196, and PV374, there was a lack of growth in the control medium (without salt) (Fig. 4).

Furthermore, regardless of the species, the growth capability of most of the analyzed *Vibrio* isolates increased as

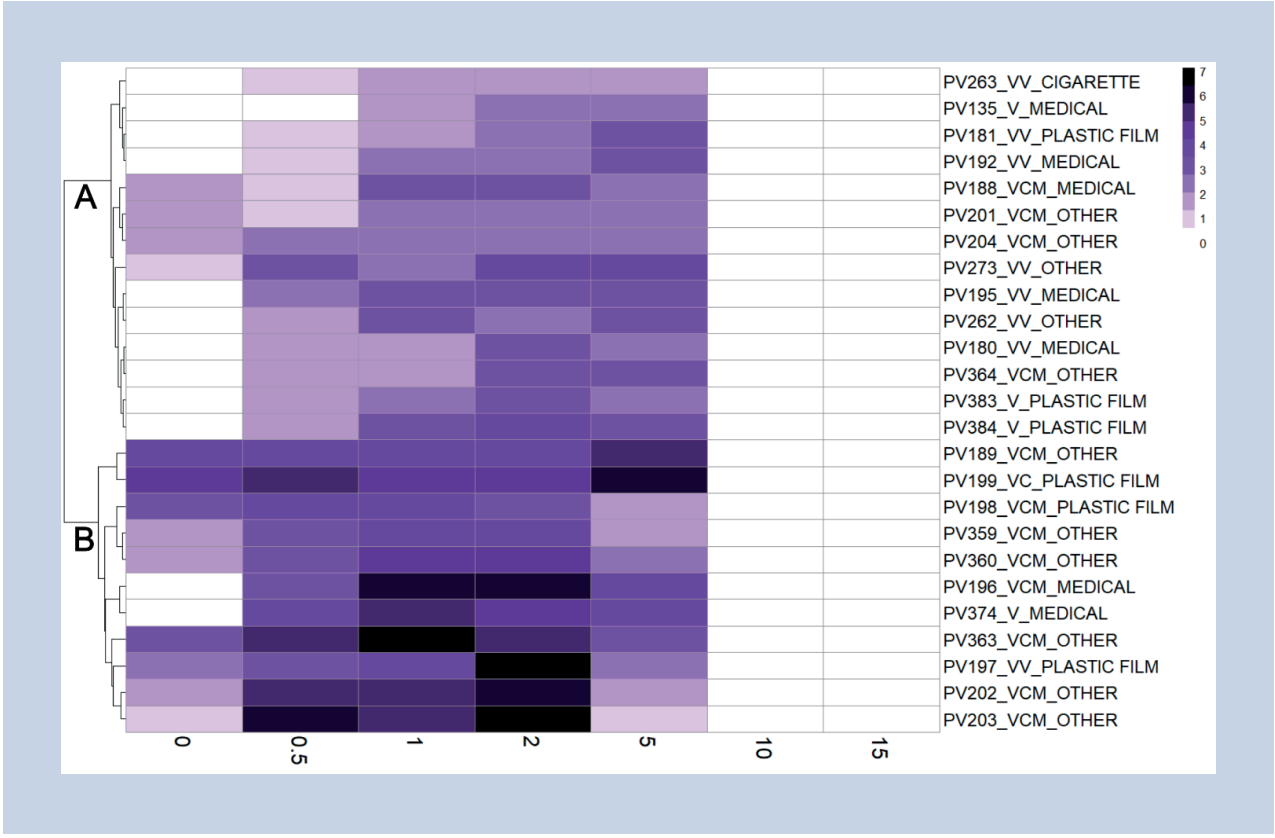

Figure 4. Heatmap and cluster analysis of *Vibrio* isolates growth under varying salt concentrations. The heatmap depicts the growth levels of isolates at different salt concentrations in the medium, with intensity indicating the extent of growth. Hierarchical clustering, Ward's method with squared Euclidean distances, organizes the isolates based on similarities in their growth patterns. V — *Vibrio* (general genus); VC — *Vibrio cholerae*; VCM — *Vibrio cholerae* (non-O1/non-O139) or mixed strain; VV — *Vibrio vulnificus*

the salinity reached a maximum at 2%, and then sharply decreased at 5%, with results approaching zero at 10% and 15% salinity. A noticeable variation in results was also observed depending on the species. Based on the clustering analysis (Fig. 4), the strains were grouped into two large clusters: Group A and Group B. It was observed that isolates from the same waste source did not always cluster together, even when they belonged to the same species. For example, *V. cholerae/mimicus* isolates from waste samples 59 and 67 showed different clustering patterns. In the case of sample 59, isolates PV202 and PV203 were positioned closely together in Group B, while isolates PV201 and PV204 clustered together in Group A. A similar pattern was observed in sample 67, where isolates PV359 and PV360 were grouped closely in Group B, while isolate PV363 was also in Group B but positioned farther away. Meanwhile, isolate PV364 was placed in Group A.

The average growth levels in various salinities were evaluated depending on the species. *V. vulnificus*, *V. cholerae/mimicus*, and *Vibrio* spp. were compared. The average for all isolates was also included in Figure 5. Under laboratory conditions, at salinities of 0%, 0.5%, 1%, and 2%, *V. cholerae/mimicus* isolates had the best growth. At salinities of 0.5%, 1%, and 2%, *V. vulnificus* showed the worst growth. At 0% salinity, isolates that were identified only as *Vibrio* spp. exhibited the worst growth, indicating that they are the most sensitive to the absence of an appropriate NaCl concentration in the environment. In contrast, at 5% salinity, growth results were more similar, with *Vibrio* spp. growing the best (3 McF), followed by *V. vulnificus* (2.88 McF) and *V. cholerae/mimicus* (1.63 McF). Statistical analysis comparing growth values between *V.vulnificus* and *V. choleare/mimicus* using the Mann–Whitney U test revealed significant differences between the two species in media without added salt (0%), 0.5%, 1%, and 2%, with corresponding p-values of 0.021, 0.034, 0.028, and 0.041. In media with a salt concentration of 5%, the difference was not statistically significant ($p = 0.316$).

DISCUSSION

The presence of *Vibrio* species in the Baltic Sea has been documented in several bordering countries, indicating their widespread distribution in the region [15, 25–27]. In Poland, *V. vulnificus* and *V. cholerae-mimicus* were reported

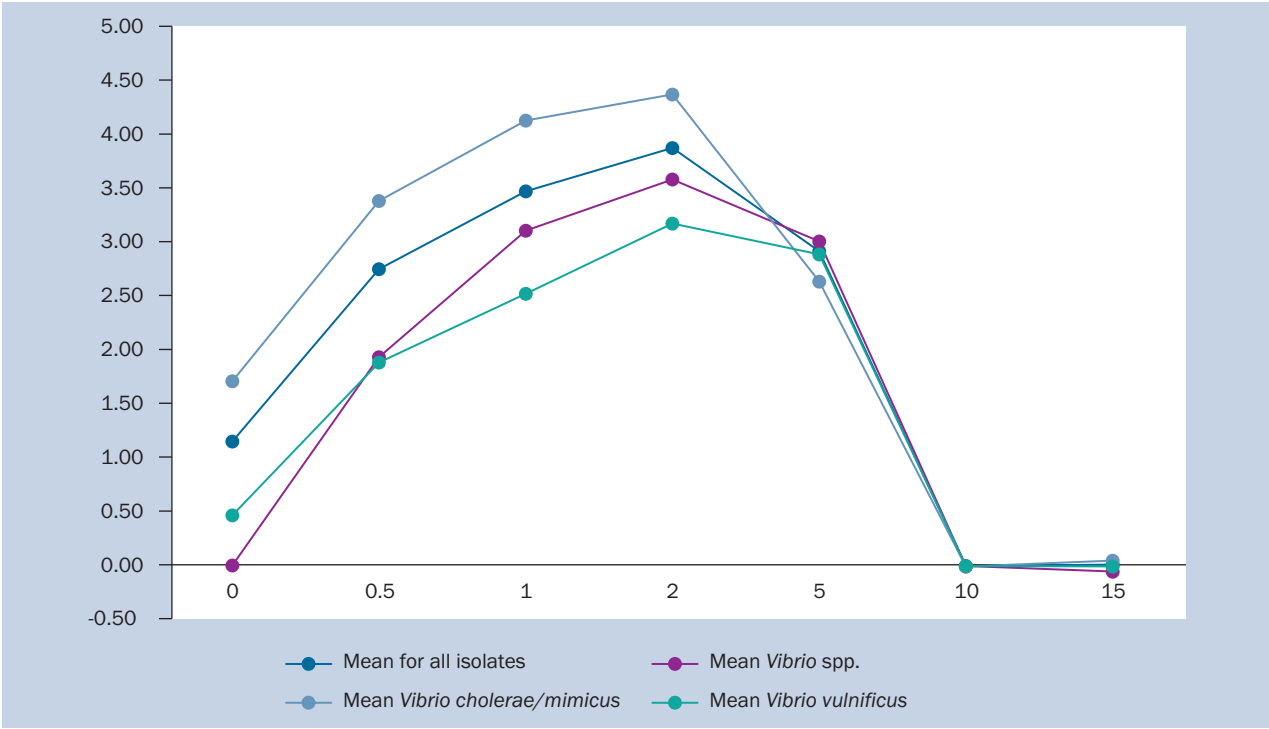

Figure 5. The mean growth of the bacteria of *Vibrio* species in different salinity

for the first time in the Gulf of Gdańsk by Kurpas et al. in 2020 [15]. In the context of *Vibrio* occurrence in Poland, a study published in 2024 documented a case of infection caused by *V. vulnificus* and *V. mimicus* in an aquarium fish. This finding expands our understanding of the potential reservoirs of these bacteria. In this study, *Vibrio* species were found to be susceptible to piperacillin and cefotaxime, with some strains exhibiting intermediate resistance to imipenem. These findings highlight the growing concern of pathogenic *Vibrio* species being present in both environmental and animal reservoirs [28].

Our detection research confirms previous findings that bacteria of the *Vibrio* genus can adhere to plastic waste [29–31]. This phenomenon has been demonstrated in both *in vitro* and ecological studies. Leighton et al. [18] observed that *Vibrio* species exhibit a higher affinity for binding to plastic than to glass, potentially due to the hydrophobic nature of their extracellular polymeric substances (EPS). In their study, biofilms formed rapidly on plastic waste [18]. Laverty et al. [17] also demonstrated significantly higher concentrations of *Vibrio* species on plastic compared to surrounding waters. Combined with the durability of plastics, this highlights the colonization of plastic waste as a critical mechanism for concentrating *Vibrio* species in the environment. Recent studies by Kolda et al. [32] have highlighted the remarkable capacity of plastic waste to serve as a substrate for microbial colonization.

Vibrio species have been localized in different types of waste and plastic debris, occurring not only in the marine environment but also in terrestrial settings. It should be noted that waste accumulated on waste piles can be washed into the rivers and water reservoirs [33]. A detailed summary of publications, including the sources of *Vibrio* spp. isolation, is presented in Table 2.

To date, there have been no publications directly investigating the presence of *V. vulnificus* and other potentially pathogenic *Vibrio* species on medical waste in aquatic environments. In our findings, wound dressings were prominently featured among the debris contaminated with *Vibrio* species. We hypothesize that this is due to the porous and absorbent nature of these materials, making them conducive to bacterial colonization [40, 41]. This leads us to recommend replacing wound dressings that have been exposed to seawater, as they may harbor *V. vulnificus* pathogens close to their preferred entry point — open wounds.

We tested antibiotic resistance in *Vibrio* isolates following EUCAST guidelines. Most strains were susceptible, except two multidrug-resistant (MDR) *V. cholerae/mimicus* strains (PV359 and PV360), resistant to cefotaxime, piperacillin/tazobactam, trimethoprim-sulfamethoxazole, and imipenem. Due to the absence of genome sequencing, we were unable to determine the precise mechanisms of resistance. However, their resistance to carbapenems is intriguing and may point to a metallo-beta-lactamase,

Table 2. Overview of publications reporting the occurrence of *Vibrio* species on various types of waste and plastic debris in marine and terrestrial settings

Source of isolation	Country/region (year)	Sampling place	Species	Source
Wet wipes	Scotland, UK (2021)	Marine environment	*V. alginolyticus*, *V. parahaemolyticus*	[34]
Cotton bud sticks		Marine environment	*V. alginolyticus*, *V. cholerae*, *V. vulnificus*	
Plastic debris (1 cm^2)	Spain — Mallorca (2024)	Marine environment	*V. alginolyticus*, *V. vulnificus*, *V. parahaemolyticus*	[35]
Plastic debris	North Sea, Baltic Sea	Marine environment	*V. parahaemolyticus*, *V. fluvialis*, *V. alginolyticus*	[36]
Plastic debris	France (2015)	Marine environment	*V. aestuarianus*, *V. splendidus*	[37]
Fishing nets, feather, foams, floats	China (2018)	Marine environment	*Vibrio* spp.	[38]
Plastic litter PET	Tanzania — Zanzibar (2018)	Freshwater streams	*V. cholerae*	[39]
Fabric	Malawi (2022–2023)	Urban waste piles	*V. cholerae*	[33]
Hard plastic		Urban waste piles	*V. cholerae*	

PET — polyethylene terephthalate

which was already found in *V. vulnificus* [42]. The enzyme Vmh, distinct from other known MBLs, is effective against a broad range of beta-lactam antibiotics, including imipenem. Resistance to imipenem is particularly concerning, as it is regarded as one of the most potent antimicrobial drugs for treating *Vibrio* infections [43]. *Vibrio* species have also been shown to express plasmid-encoded carbapenemases, such as bla genes [44]. In studies conducted on isolates from the North Sea and the Baltic Sea, Bier et al. [21] reported that 5% of *V. cholerae* non-01/non-0139 isolates were resistant to imipenem. Similarly, in our study, 2 out of 25 isolates (8%) exhibited resistance to this antibiotic.

The occurrence of resistance to cefotaxime is also concerning, as this antibiotic has been employed as one of the therapeutic agents in *V. vulnificus* infection treatment [1, 22, 23]. For instance, cefotaxime was utilized in combination with gentamicin in the treatment of a patient infected with *V. vulnificus* after swimming in Lübeck Bay (Baltic Sea) [45]. Significant proportions of *Vibrio* strains resistant to cefotaxime have been reported in various studies. Research by Sudan et al. [46] demonstrated that out of 200 isolates collected from inland saline shrimp culture farms in India, 93% are resistant to cefotaxime. In contrast, de Menezes et al. [47] reported a much lower prevalence of resistance, with only 0.5% of 197 isolates from estuarine environments in Ceará, Brazil, being resistant to this antibiotic. In studies conducted on isolates from the North Sea and the Baltic Sea, Bier et al. [21] demonstrated that none of the tested *Vibrio* isolates exhibited resistance to cefotaxime. In our study, 2 out of 25 *Vibrio* isolates (8%) were resistant to cefotaxime. This resistance rate, though lower than the findings of Sudan et al. [46], is considerably higher than those reported by de Menezes et al. [47]. The variability in resistance rates could be attributed to differences in geographic location, environmental conditions, or selective pressures from antibiotic use in aquaculture and other industries. These findings underscore the importance of regional surveillance and highlight the need to understand the factors contributing to the emergence and dissemination of cefotaxime resistance among *Vibrio* species.

In our studies, the detected *Vibrio* strains displayed variability in salt (NaCl) sensitivity. Some were obligate halophiles and showed no growth in nutrient broth without NaCl, while others grew well in 0% salt solutions. On average, *V. cholerae/mimicus* strains performed best in low to moderate salt concentrations but showed the poorest growth at higher salinity levels. Conversely, other *Vibrio* species were more halophilic and showed minimal growth at 0% salinity and optimal growth at 5%. Previous studies have shown that *V. cholerae* can grow in salinity levels up to 8% [48], whereas most strains analyzed by other researchers grew at 5% but not 6%. Additionally, *Vibrio* species from shrimp ponds, including *V. vulnificus*, were unable to grow at 0% salinity but demonstrated some growth at 10%, with optimal growth occurring at 2–4% salinity [49].

A potential limitation of this study is the use of classical microbiological methods (selective media for isolation of *Vibrio* spp.), which may result in an underestimation of the occurrence of *Vibrio* spp. in samples. However, this approach was chosen to obtain pure isolates, which in turn allowed for more detailed analysis of strains.

CONCLUSIONS

The conducted study demonstrated that potentially pathogenic bacteria from the *Vibrio* genus, like *V. vulnificus* and *V. cholerae*, can be found on floating waste in the coastal zone. *V. vulnificus* is a microorganism responsible for wound infections, and open wounds are the primary entry point for this pathogen. Therefore, the presence of *V. vulnificus* on band-aids is particularly concerning. The absorbent material of bandages may facilitate the accumulation of these microorganisms. We suggest that people with open wounds should avoid swimming during periods of increased *Vibrio* presence in the Baltic Sea. If such an exposure occurs, it is essential to change the dressing and disinfect the wound. Failing to change dressings after swimming could result in prolonged contact between the pathogen and the wound, thereby increasing the risk of infection.

Another significant finding is the detection of MDR *Vibrio* strains (*V. cholerae/mimicus*) on waste samples. These strains could contribute to the horizontal transfer of resistance genes. Particularly alarming is the resistance to cefotaxime, an antibiotic commonly used in the treatment of *V. vulnificus* infections, and to imipenem, which is often used as an alternative in cases involving isolates resistant to first-line antibiotics. These findings highlight the importance of monitoring and managing coastal waste to mitigate the risk to humans.

In summary, the study suggests that *V. vulnificus* on band-aids may pose a risk for wound infections, and that antibiotic-resistant *V. cholerae/mimicus* may represent a potential health risk to humans.

ARTICLE INFORMATION AND DECLARATIONS

Data availability statement: The data presented in this study are available on request from the corresponding author.

Ethics statement: Ethical approval was not required for this study, as it did not involve human participants, animals, or identifiable personal data.

Author contributions: MP — project conceptualization, methodology, sample collection, data analysis, writing of the manuscript; KG — sample collection, data analysis, writing of the manuscript; AS — sample collection, data analysis, writing of the manuscript; JM — sample collection, data analysis, writing of the manuscript; MK — project conceptualization, methodology, supervision, data analysis, writing of the manuscript.

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Conflict of interest: The authors declare no conflicts of interest.

Supplementary material: None.

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VIA MEDICA

CASE REPORT

Schistosomiasis in a child presenting with atypical spinal lesions in a non-endemic country — a case report

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ABSTRACT

Schistosomiasis is an uncommon disease in European countries, such as Poland. However, the rare occurrence of this disease in the modern era, which is characterized by increased opportunities for migration, may start to pose a risk over time due to the diagnosis of this condition in patients who have imported it from its endemic areas.

We report the case of a 9-year-old boy of Cameroonian origin who recently resided in Poland and who presented with recurrent hematuria, abdominal pain, and eosinophilia. Persistent symptoms and comprehensive diagnostics revealed Schistosoma haematobium *infection, confirmed by the detection of eggs in urine sediment. In addition, imaging tests revealed renal asymmetry, calcium lesions in one of the ureters, and spinal lesions that are not characteristic of the* Schistosoma *infection. The patient was treated with two courses of praziquantel, resulting in clinical improvement and absence of* S. haematobium *eggs in the follow-up urine test.*

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Keywords: schistosomiasis, hematuria, eosinophilia, spinal lesions, Poland

INTRODUCTION

Schistosomiasis (bilharziasis) is one of the most common neglected tropical diseases, and it continues to pose a serious threat to public health in many developing countries in tropical and subtropical regions. Approximately 240 million people are currently affected by schistosomiasis worldwide, and additional 700 million present high risks of contracting the disease [1]. Schistosomiasis remains a significant public health challenge, and it causes substantial socioeconomic burden in regions with inadequate disease control programs and poor sanitation infrastructure; these issues are particularly pertinent among impoverished populations [2]. *Schistosoma* species typically inhabit freshwater environments, with aquatic snails serving as intermediate hosts in their life cycle [3].

Children are particularly susceptible to infection because they are exposed to cercariae when they play in cercariae-contaminated water. Cercariae are the free-swimming larval stage forms of the parasite, and they are able to penetrate intact human skin [3, 4]. Schistosomiasis is caused mainly by three species of blood-living parasites of the genus *Schistosoma*: *S. haematobium* (responsible for urinary schistosomiasis), *S. mansoni* and *S. japonicum* (both causing intestinal schistosomiasis). The clinical manifestations of the disease are closely related to species-specific egg laying sites and overall parasite burden [3]. Urinary

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schistosomiasis is usually characterized by hematuria, which is the hallmark symptom, and it is often associated with fibrosis of the bladder and the urethra, as well as hydronephrosis in chronic cases. In advanced stages of schistosomiasis, bladder cancer may be a potential complication [5]. Clinical symptoms of the intestinal form of the disease include abdominal pain, diarrhea, and the presence of blood in the stool. In severe cases, hepatosplenomegaly is common, and it is often associated with ascites and other symptoms of portal hypertension [6].

Although schistosomiasis mainly affects people residing in tropical and subtropical areas, the disease is increasingly common in regions where it is not endemic. This trend has been associated with increased globalization, migration, and travel. Recognizing the disease under these conditions is crucial for early diagnosis and treatment preventing long-term complications. The aim of this report was to describe a case of schistosomiasis in a pediatric patient in a nonendemic country, including diagnostic difficulties and complex clinical presentation.

CASE REPORT

We report the case of a 9-year-old boy of Cameroonian origin who had resided in Poland for 4 months. Two years before relocation to our country, the patient lived in a rural area at his grandmother's house, where he frequently bathed in a nearby river. He was admitted to the Department of Children's Infectious Diseases of the Hospital for Infectious Diseases in Warsaw due to recurrent hematuria, abdominal pain, and coexisting eosinophilia.

The boy complained of abdominal pain with periodic nausea for several months. In October 2023, approximately one month before admission, the boy consulted the Emergency Department for urethral pain during micturition, hematuria and vomiting. A urinary tract infection was diagnosed, which was treated with cefuroxime with a positive outcome. Due to the recurrence of complaints, the boy was hospitalized in the Department of General Pediatrics several weeks later. On admission, neutropenia (1100 com/μL) and eosinophilia (2900 com/μL) were detected, and a general urinalysis revealed erythrocyturia and leukocyturia. Urine cultures were taken twice, and both were sterile; additionally, a daily urine collection revealed low calcium and potassium levels. Parasitological examination of the stool revealed *Giardia lamblia* cysts. Abdominal ultrasound revealed kidney size asymmetry of more than 10% (right 81 mm, left 101 mm). An abdominal computed tomography (CT) scan revealed a suspected small, calcified deposit in the right ureter at L5, numerous small calcifications in the bowel, a herniated nucleus pulposus with a gas bubble, and separation of a small bony fragment at Th12. Following intravenous contrast administration in the computed tomography scan, no contrast enhancement of the described lesion was observed. The diagnosis was expanded with magnetic resonance, in which a deepening of the lumbar lordosis, semiparallel alignment of the sacrum, confirmation of the disc herniation detected on a CT, and a Th11/12 disc reduction with features of dehydration were found. The patient received surgical and neurosurgical consultation, and further observation was recommended. Despite a sterile urine culture, empirical treatment for a urinary tract infection was initiated with amoxicillin-clavulanic acid due to the presence of dysuric symptoms and leukocyturia, resulting in clinical improvement. Additionally, metronidazole was administered for *G. lamblia* infection.

Symptoms recurred despite these treatments. Therefore, the boy was referred to our department. On admission, a physical examination revealed multiple trauma scars on the skin, abdominal tenderness upon palpation and palpable fecal masses in the left iliac fossa. Laboratory tests revealed low levels of inflammatory markers, with peripheral blood analysis indicating neutropenia (0.95 G/L) and eosinophilia (3.42 G/L, 39%). The ionogram and liver and kidney parameters were unremarkable. HBV, HCV, HIV and tuberculosis infections were excluded. A rapid antigen test for malaria was negative, as confirmed by microscopic examination of a thick blood smear. Urine and stool cultures revealed no growth of pathogenic bacteria. Parasitological examination of the stool was negative. General urinalysis revealed erythrocytes and leukocytes, and parasitological examination detected live and dead eggs of *Schistosoma haematobium* in the urine (Fig. 1).

A diagnosis of schistosomiasis was made, and a request for the targeted import of praziquantel (PZQ) was submitted. Two courses of antiparasitic treatment were initiated at 6-week intervals. Laboratory tests conducted during two subsequent hospitalizations in the department revealed an increase in the number of neutrophils and a decrease in the number of eosinophils. The boy reported a gradual reduction in pain symptoms. Prior to the second course of treatment, no *S. haematobium* eggs were detected in the urine.

Radiological diagnostics were repeated. An ultrasound of the abdomen revealed a somewhat heterogeneous spleen with poorly defined areas in the parenchyma, which exhibited mixed echogenicity, as well as kidney size asymmetry (right kidney — 97 mm, left kidney — 108 mm). The left kidney showed single small calcifications up to 3 mm. A computed tomography scan of the abdomen and pelvis revealed no abnormalities in the spleen, liver, kidneys, or bladder; however, an 8.6 × 4 × 12 mm defect with a sclerotic margin was noted in the anteroposterior portion of the body of the Th12 vertebra (Fig. 2), and an irregular contour of the lower plate of the Th11 vertebra was observed. The space between the Th11 and Th12 vertebrae

Figure 1. *Schistosoma haematobium* egg containing a larva (miracidium)

was narrowed, suggesting potential postinflammatory changes. The boy was referred to the Trauma and Orthopedic Clinic for further management.

DISCUSSION

The life cycle of *S. haematobium* involves humans as the definitive host and freshwater snails as intermediate hosts. Unlike other schistosomes that release eggs into the digestive tract, *S. haematobium* discharges its eggs into the urinary tract, for them to be excreted with urine. In freshwater, the eggs hatch within 15 minutes, releasing miracidia [7]. These larvae swim actively, searching for snails of the *Bulinus* species [8]. Upon entering the snail, miracidia shed their cilia and transform into sporocysts, which undergo division and produce cercariae. After about a month, the cercariae are released into the water. Cercariae swim to find a human host, attaching to the skin and using proteolytic enzymes to penetrate, losing their tails and transforming into schistosomulae. These larvae enter the bloodstream, travel to the heart and liver, and then enter the portal vein to reach other body sites. In *S. haematobium*, schistosomulae migrate to the vesical vessels via anastomotic channels and mature in the bladder's venous plexus [9]. Adult worms, with males carrying females in their gynaecophoric canal, reach sexual maturity 4–6 weeks post-infection [10]. A female worm can lay 500–1,000 eggs daily, to release them into the bladder via small venules [11].

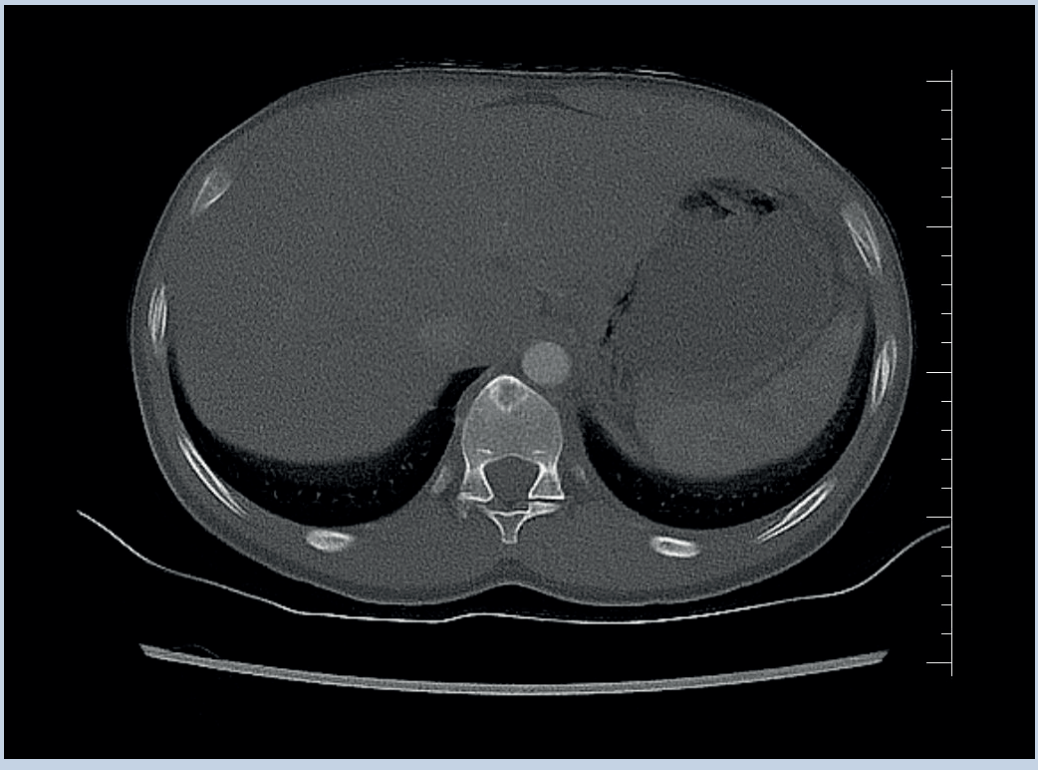

Figure 2. Computed tomography showing a sclerotic defect in the anterior portion of the Th12 vertebral body

The eggs penetrate the bladder mucosa using proteolytic enzymes and terminal spines. While most eggs are excreted, some get trapped in the bladder wall, causing granuloma formation and pathological lesions, which can lead to fibrosis, bladder cancer, and other complications [12]. The female worm lays eggs for 3–4 years, continuing the cycle.

Schistosomiasis is a significant health problem in tropical and subtropical regions, especially in sub-Saharan Africa, including Cameroon, where our patient is from. Schistosomiasis is caused by parasites of the genus *Schistosoma*, and it is the second most common parasitic disease in the world after malaria. *Schistosoma haematobium* most commonly affects the genitourinary tract, leading to chronic inflammation and scarring that can cause a number of organ complications. The case in this study is consistent with data in literature, which indicates that *S. haematobium* infection most often manifests in the urinary tract and causes hematuria, calcification, and bladder or kidney damage.

The reporting of schistosomiasis in Cameroon is limited, and the scarcity of incidence studies significantly hinders a comprehensive epidemiological assessment. The national epidemiological survey conducted between 1985 and 1987 identified the presence of three species of schistosomes: *S. haematobium*, *S. mansoni*, and *S. guineensis*. It is estimated that more than 5 million people are at risk of schistosomiasis infection, with approximately 2 million infected. The highest transmission levels of schistosomiasis were observed in the savannah areas of northern Cameroon and school-aged children were infected the most often [13]. To combat this disease, the World Health Organization (WHO) recommends a comprehensive strategy encompassing three complementary approaches: snail control and environmental management, improvements in water, sanitation, and hygiene (WASH) combined with behavioral change, and preventive chemotherapy (PC) through the large-scale distribution of PZQ to at-risk populations [14].

In 2004, Cameroon adopted a strategic plan for the control of schistosomiasis and soil-transmitted helminthiasis (STH). Since 2007, national deworming campaigns have been conducted annually. School-aged children have received treatment with mebendazole nationwide, while PZQ has been distributed exclusively in regions with high endemicity of schistosomiasis [15]. This strategy has contributed to the reduction in the prevalence of these parasitic diseases in endemic areas, particularly in the western regions, where studies have documented a decline in prevalence [13], in contrast to the findings of Tchuem Tchuenté et al. [16], who reported an increase in schistosomiasis transmission. In January 2021, WHO launched a new roadmap to guide efforts against neglected tropical diseases and established targets to be attained by 2030, including the elimination of schistosomiasis as a public health threat in all endemic countries, including Cameroon.

Schistosomiasis is not endemic in Poland, which means that this disease is rarely considered in differential diagnoses, especially among children. However, with increased migration and more frequent international travel among citizens, including travel to the endemic regions of Africa, the risk of importing cases of the disease is increasing. For example, a recent review revealed that up to 24% of sub-Saharan immigrants in nonendemic countries may have schistosomiasis, which often remains undiagnosed [17]. Numerous authors have emphasized the importance of increased diagnostic vigilance in nonendemic countries, such as Poland, based on the mobility of the global population [18]. Our case provides evidence of the need for diagnostic vigilance in the face of global epidemiological changes, especially regarding tropical diseases.

In our patient, *S. haematobium* eggs were detected in the urine by parasitological examination, which is typical for urogenital schistosomiasis. Symptoms such as hematuria, lower abdominal pain, and calcifications in the urinary tract are characteristic of this form of infection. Imaging findings such as calcifications in the kidneys and asymmetry in their size further indicated advanced changes associated with chronic infection. An interesting feature of this case is the presence of a spinal lesion at the Th11-Th12 level, which may be a rare extrasystemic manifestation of *S. haematobium* infection or a result of the accompanying inflammatory processes. Establishing a clear causal relationship between the observed vertebral lesions and *S. haematobium* infection remains challenging. To the best of our knowledge, no previous cases have documented similar spinal involvement in the context of schistosomiasis. However, osseous manifestations, particularly in long bones, have been documented [19]. Additionally, cases of spinal cord involvement, including intramedullary lesions, have been reported in the literature [20].

A potential pathogenic mechanism underlying parasitic osteomyelitis may involve hematogenous dissemination of *S. haematobium* eggs. In children and adolescents, parasitemia can lead to seeding of the metaphyseal regions of long bones, resulting in acute osteomyelitis through toxic or embolic mechanisms. They are followed by granuloma formation and progression to chronic osteomyelitis [19]. Regarding spinal lesions, retrograde migration of eggs through Batson's venous plexus — an anatomical connection between the pelvic venous system and the vertebral venous plexus — may facilitate direct seeding of spinal structures, particularly in the context of urogenital schistosomiasis [19, 21]. This anatomical pathway provides a plausible mechanism by which *S. haematobium* eggs from the bladder could reach the vertebral column, potentially contributing

to inflammatory or granulomatous spinal lesions. To date, no cases of vertebral body involvement in *S. haematobium* infection have been reported. Therefore, while the observed lesions in our patient may suggest an association, the direct causal relationship remains hypothetical and should be interpreted with caution.

The standard diagnostic procedure for schistosomiasis is the detection of parasite eggs in urine or fecal samples. Despite a negative stool parasitological examination in this case, urinalysis revealed the presence of live and dead *Schistosoma haematobium eggs*, which confirmed the diagnosis. Additional laboratory tests revealed significant eosinophilia (3.42 G/L, 39%), which is a common indicator of parasitosis, including schistosomiasis. The presence of neutropenia could have been the result of a chronic inflammatory process or the result of bone marrow suppression in the context of ongoing infection.

Praziquantel is the treatment of choice for schistosomiasis, demonstrating efficacy against all *Schistosoma* species. Although its exact mechanism of action remains incompletely understood, PZQ is known to be effective primarily against adult worms, with limited activity against juvenile stages [22]. Due to limited antiparasitic activity of PZQ against the immature stages, a two-cycle treatment regimen administered six weeks apart was implemented in accordance with current recommendations. The response to the treatment was positive, as evidenced by the patient's subjective feelings (a reduction in pain) as well as improvements in laboratory parameters, such as an increase in the neutrophil count and a decrease in eosinophilia. The absence of *Schistosoma* eggs in the urine sample prior to the second course of treatment does not confirm the cure, as egg excretion is not continuous. Therefore, follow-up testing should be performed 1–2 months after the completion of treatment to ensure accurate assessment.

This case highlights the importance of early diagnosis and treatment of schistosomiasis before irreversible organ changes develop. Inflammatory and fibrotic changes in the kidneys or chronic bladder damage can lead to serious complications, including kidney failure and bladder cancer. Early administration of PZQ can significantly reduce these complications. Moreover, long-term monitoring after treatment is necessary to prevent possible recurrences and to control possible late organ complications.

In conclusion, this case of a 9-year-old Cameroonian patient with schistosomiasis exemplifies the typical clinical picture of this disease with concomitant atypical spinal lesions. A comprehensive diagnostic and therapeutic approach is needed, and the efficacy of PZQ treatment has been confirmed both clinically and in the laboratory. This case highlights the need to consider tropical diseases, such as schistosomiasis, in the diagnosis of patients traveling from areas with a high prevalence of parasitic diseases.

ARTICLE INFORMATION AND DECLARATIONS

Ethics statement: Data protection principles were followed in the case report. All identifying information of the patient was removed to ensure full anonymity.

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Depression and anxiety among seafarers in Canada during the COVID-19 pandemic

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ABSTRACT

Background: *Seafarers in the international maritime industry face longstanding mental health challenges due to the remote and demanding nature of their occupations. During the COVID-19 pandemic, these challenges were exacerbated by extended contracts, limited shore leave, and restricted access to essential services ashore. This study presents the first exploration of seafarers' mental health in Canada during the pandemic.*

Material and methods: *A cross-sectional survey was conducted between February and December 2022 utilizing the Patient Health Questionnaire-9 (PHQ-9) for depression and the Generalized Anxiety Disorder-7 (GAD-7) scale for anxiety. Eligible participants were those who worked in Canadian waters since the declaration of the COVID-19 pandemic in March 2020.*

Results: *Among 581 participants, 31.8% screened positive for anxiety and 39.4% for depression. Despite the high prevalence of symptoms, 77.2% to 80.8% reported good to excellent self-perceived mental health, indicating the need to interpret findings through a dual-continuum perspective that considers mental health and mental illness as distinct yet interconnected constructs.*

Conclusions: *The findings underscore the necessity for proactive policy interventions to enhance mental health promotion in the maritime industry. By advocating for a dual-continuum approach that incorporates both mental illness and mental health, this study contributes to the growing recognition of mental health as a critical component of seafarers' overall well-being and productivity. Adapting Canadian mental health policies could improve the well-being and retention of a workforce essential to the national and international maritime industry.*

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Keywords: seafarers, mental health, COVID-19, Canada, depression, anxiety, maritime industry, dual-continuum model

INTRODUCTION

Transporting over 80% of the world's trade and contributing $345 billion to the Canadian economy in 2022, the maritime industry is vital for sustaining Canadian and international supply chains [1, 2]. Despite this importance, no studies have explored the mental health of Canadian seafarers. As essential workers operating marine transportation 24/7, seafarers endure high risks of depression and anxiety associated with demanding work requirements in confined spaces, isolated from families and society, and with limited access to high-speed internet, healthcare, physical fitness, and leisure services available on land [3–5]. Before the pandemic, Lefkowitz and Slade [6] found that 17% of a sample of international seafarers screened positive for anxiety and 25% for depression, with a higher likelihood among females compared to males. Key factors associated with

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depression, anxiety, and suicidal ideation among seafarers included non-caring company culture, workplace violence, and lack of job satisfaction.

The WHO World Mental Health Report showed a 25% increase in the prevalence of depression and anxiety globally during the COVID-19 pandemic [7, 8]. Similarly, studies internationally have found an increased prevalence of depression and anxiety among seafarers associated with increased physical and mental fatigue in the workforce due to public health and travel restrictions during the COVID-19 pandemic [4, 9–12]. Research with matched samples from before and during the pandemic showed that longer work periods and lack of inspections of flags of convenience vessels were significant factors contributing to increased symptoms of depression and anxiety among seafarers working under COVID-19-related restrictions [11]. Other pandemic-related factors impacting seafarers' mental health included loneliness, feelings of disrespect, lack of support, concerns about finances and family, unreasonable workloads, fatigue, further access limitations to essential supplies like food and vaccines, as well as additional limitations in accessing port-based welfare services, health care, shore leave, and repatriation [4, 12–15].

While there are no data on depression and anxiety among Canadian seafarers, the Public Health Agency of Canada [16] found that in early 2021 23.3% of the Canadian general population screened positive for either depression, anxiety, or both, increasing to 27.8% among women, 30.1% among frontline workers, and 37.4% among people aged 18–34. Similarly, Canadian Coast Guard (CCG) workers who regularly face potentially psychologically traumatic events displayed 16.4% positive screenings for anxiety, 23.6% for depression, and 45.3% for any anxiety or mood disorder amid the COVID-19 pandemic [17].

Canada stands as a leader in both shipping and mental health, with policy advancements such as the *National Standard for Psychological Health and Safety in the Workplace* (*National Standard*), its participation in the IMO Council, and the establishment of its National Seafarers' Welfare Board [2, 18, 19]. The *National Standard* provides a framework for the low-cost implementation of a comprehensive psychological health and safety management system (PHSMS), with special provisions for high-risk populations such as post-secondary students and paramedics [19, 20]. It places a strong emphasis on mental health promotion and leveraging the mental health dual continuum model, which understands 'mental illness' (and the lack thereof) and 'mental health' as distinct and interconnected concepts [20–22].

The mental health dual continuum model provides evidence of the benefits of increased mental health promotion by demonstrating that individuals with positive mental health can maintain functioning and well-being despite experiencing symptoms of mental illness [21, 22]. Benefits include lower healthcare utilization, fewer missed days at work, and reduced risk of cardiovascular and chronic physical disease with age while enjoying healthy psychosocial functioning and few limitations on daily living activities [21]. The inclusion of positive mental health reduces concerns about loss of employment for seafarers burdened with mental illness, especially considering that depressive and anxiety disorders rank second and sixth among the top ten global causes of years lived with disability, resulting in the loss of 12 billion workdays annually [7].

This paper presents the first study to explore the mental health of seafarers residing in Canada through a cross-sectional survey exploring symptoms of depression and anxiety. The implications are discussed in the context of Canada's advancements in mental health policy, which offer new opportunities to improve seafarers' well-being, retention, and productivity.

PARTICIPANTS

Eligible participants were seafarers who worked in Canadian waters since the declaration of COVID-19 as a pandemic in March 2020 [23] until the end of the data collection period in December 2022, regardless of their nationality. Unionized and non-unionized crew members and officers from various ranks and departments, such as deck, engineering, and galley, were eligible to participate. Exclusion criteria included seafarers who did not work during this period and those without sufficient proficiency in English or French to complete the survey.

MATERIAL AND METHODS

MATERIAL

The survey was conducted using Qualtrics, an online software that creates, collects, and analyzes survey responses. It was available in English and French, and participants reported their gender, choosing from male, female, non-binary/third gender, prefer not to say, and other. Results are aggregated and presented as male, female, and other/undisclosed to protect participants' anonymity. Self-perceived mental health was assessed in line with the 2020 Canadian Community Health Survey [24].

Participants were screened for depression with the Patient Health Questionnaire 9 (PHQ-9) and for anxiety with General Anxiety Disorder 7 (GAD-7). While GAD-7 and PHQ-9 have excellent correlation with psychiatric diagnosis, this study follows a community health perspective, with no intention of diagnosing major depressive disorder or generalized anxiety disorder among individuals. Positive screenings were marked at a score of 10 in both questionnaires and screening categories are presented in Table 1, which

Table 1. Score ranges to classify depression and anxiety

Depression	Score	Anxiety	Score
No to minimal depression	0–4	No to low risk of anxiety	0–4
Mild depression	5–9	Mild anxiety	5–9
Moderate depression	10–14	Moderate anxiety	10–14
Moderately severe depression	15–19	Severe anxiety	15+
Severe depression	20–27		

aligns with methodologies from cited studies [6, 16, 17]. Among the general population, a cutoff point of 10 provides the PHQ-9 with 88% sensitivity and specificity for major depressive disorder and the GAD-7 with 89% sensitivity and 82% specificity for generalized anxiety disorder [25, 26].

METHODS

Participation was voluntary and promoted via Canadian seafarer unions, Facebook, and LinkedIn. An incentive in the form of a lottery for three 50 CAD Amazon gift cards was offered to participants. The survey link opened in February 2022 and closed in October 2022 — soon after the Government of Canada removed the COVID-19 border and travel restrictions [27]. Supplementary Table 1 provides further details on the survey's design and implementation, following the Checklist for Reporting Results of Internet E-Surveys [28].

Although sampling was non-probabilistic, the survey aimed to recruit at least 372 participants from a population of about 11,652 active seafarers in Canada in 2021 [29]. The sample size was calculated using Cochran's formula for finite populations, with a 95% confidence level, a z-score of 1.96, and a 5% margin of error [30]. A p-value of 0.05 was chosen due to the lack of specific data on the mental health of Canadian seafarers. Initially, 1455 responses were collected. After rigorous data cleaning, 581 responses were retained for descriptive statistical analysis using SPSS. Responses were removed for reasons such as duplicate entries, logically or biologically impossible responses [31], hasty responses, and poor completion rates (Suppl. Tab. 1, 2).

Descriptive statistics were used to summarize the demographic, occupational, and mental health characteristics of the sample. PHQ-9 and GAD-7 severity categories and self-perceived mental health were presented as frequencies and percentages. In addition, individual symptoms from PHQ-9 and GAD-7 were reported based on their frequency of occurrence.

Two logistic-regression models with PHQ-9 ≥ 10 and GAD-7 ≥ 10 as dependent variables were estimated to identify risk factors for positive depression and anxiety screens using SPSS (version 29). Screening-positive depression and anxiety were defined as PHQ-9 ≥ 10 and GAD-7 ≥ ≥ 10, respectively. The initial set of independent variables included age, gender, marital status, region of residence, operational region, rank, years of experience, months away from home during the most recent contract, access to shore leave since 2020, department, vessel type, work-shift rotation pattern, and self-perceived mental health (five-point scale, treated as ordinal-continuous). Some response options were consolidated to simplify analysis and avoid very small subgroups: vessel type was grouped into five functional categories (dry cargo/container/reefer, passenger, tanker, government /research, tug /other); gender was coded as male, female, and other/undisclosed (pooling "other, non-binary, prefer not to say"; n = 18). In the initial model run, the galley subgroup in the department variable produced unstable estimates (PHQ-9 OR = 11.8, 95% CI: 1.23–112.6; GAD-7 OR = 4.5, 95% CI: 0.45–45.6), consistent with sparse-data bias. Galley was therefore combined with other service as galley/other service, which reduced imprecision while leaving conclusions unchanged. Prior to estimation, 50 partially completed records were removed by listwise deletion. All predictors were entered simultaneously in a single-block (forced-entry) model; no automated stepwise selection was used. Goodness-of-fit was evaluated using the Hosmer–Lemeshow (H–L) chi-square test, and overall explanatory power was estimated with Nagelkerke R^2. Odds ratios (ORs) and 95% confidence intervals (CIs) are reported throughout. The initial full model was then compared with a reduced specification. Rank, operational region, region of residence, and marital status contributed little explanatory value (all Wald p > 0.40, Nagelkerke R^2 < 0.01), and their removal did not materially alter remaining coefficients (< 10% change). These four variables were therefore excluded together, increasing

the events-per-variable ratio from 6.1 to 12.3 in the depression model and from 5.2 to 9.6 in the anxiety model, consistent with recommended thresholds for logistic regression [32].

RESULTS

SAMPLE DESCRIPTION

Of 581 participants, 115 (19.8%) identified as female, 448 (77.1%) identified as male, and 18 (3.1%) either did not disclose their gender or identified outside the gender binary. Their places of residence were geographically dispersed across Canada: most lived in the Atlantic provinces (37.2%), followed by Ontario (21.7%), British Columbia (15.2%), Quebec (13.3%), and the Prairie provinces (7.9%). Smaller proportions of participants resided in Yukon, Nunavut, or the Northwest Territories (4.0%), reported other regions (0.7%), or did not disclose their place of residence (0.2%).

Participants worked on various types of vessels. Dry cargo, container, and reefer ships were the most common workplaces (33.6%), followed by passenger ships and ferries (20.3%), tankers (20.1%), and bulk carriers (19.1%). A smaller subset worked on government, navy, coast guard, research, or icebreaker vessels (4.3%), tugboats (0.7%), or other or undisclosed vessel types (1.9%). Nearly half of respondents served in the deck department (41.7%), while a substantial portion were employed in engineering (35.6%) or the galley (20.5%), with few in other or undisclosed departments (2.2%). Their ranks included engineering officers (26.5%), masters and chief engineers (21.3%), cooks (20.1%), deck officers (19.1%), ratings (11.0%), and other or undisclosed positions (1.9%).

Although participants were most commonly from the Atlantic provinces, female participants were more prevalent in British Columbia (23.5% of all females, compared with 13.0% of males) and the Prairie provinces (15.7% of females, compared with 6.0% of males). Male participants accounted for a larger share in the Atlantic region (39.7% of males, compared with 29.6% of females). Among respondents outside the gender binary or with undisclosed gender, comparatively lower proportions were recorded in Quebec (5.6%) and the Prairie provinces (5.6%). Females were more frequently found in the galley department (33.0% of females, compared with 17.2% of males) and often served as cooks (31.3% of females, compared with 17.4% of males). Meanwhile, male participants were more evenly distributed across deck and engineering roles. Nearly half of those outside the traditional gender categories were engineering officers (44.4%), and one-third served as master or chief engineers (33.3%), a distribution distinct from both male and female groups.

DEPRESSION AND ANXIETY SCREENING

Among the 581 participants, 31.8% screened positive for anxiety (GAD-7) and 39.4% for depression (PHQ-9). Twenty-four percent of participants screened positive for both conditions, including 16.5% of women, 26.1% of men, and 22.2% of those of other or undisclosed gender. The proportion of positive screenings for at least one of these conditions was 47.1% among all participants: 46.2% among males, 49.6% among females, and 55.6% among participants of other and undisclosed genders. The remaining 52.8% tested negative or had undisclosed results, displaying relatively similar distributions across gender groups.

By gender, positive anxiety screening occurred among 24.4% of women, 33.5% of men, and 38.9% of those outside the gender binary. Depression screening presented similar rates across groups: 41.8% among women, 38.8% among men, and 38.9% among participants of other and undisclosed gender. Nonetheless, gender was not independently associated with a positive screen after adjustment for covariates.

Table 2 summarizes the logistic-regression results for each screening instrument. For the depression model, each additional month away from home increased the odds of screening-positive for depression by 6% (OR = 1.06, 95% CI: 1.02–1.10, $p = 0.005$), whereas a one-step improvement on the self-perceived mental-health scale halved the odds (OR = 0.50, 95% CI: 0.40–0.62, $p < 0.001$). Compared with deck crew, engineering department personnel were more likely to screen positive for depression (OR = 1.79, 95% CI: 1.12–2.86, $p = 0.015$), while employment on government or research vessels was associated with reduced risk of depression compared to dry-cargo/container/reefer vessels (OR = 0.27, 95% CI: 0.09–0.78, $p = 0.015$). All other covariates, including galley service and shift-rotation pattern, were non-significant. The model correctly classified 67% of cases.

For the anxiety model, the relationship between time away from home and anxiety mirrored the model observed for depression (PHQ-9), with odds of anxiety increasing by 5% per month (OR = 1.05, 95% CI: 1.01–1.09, $p = 0.019$). Better self-perceived mental health again showed a protective effect (OR = 0.56, 95% CI: 0.45–0.70, $p < 0.001$). No department, vessel-type, rotation, or demographic variable achieved statistical significance in this model, which correctly classified 71% of observations.

SEVERITY CATEGORIZATION

Table 3 presents anxiety screenings by severity, according to categories of the PHQ-9 and GAD-7. For anxiety, mild and no-to-low-risk anxiety were the most common severity categories overall. Women were more often found

Table 2. Multivariable logistic-regression models for positive depression (PHQ-9 ≥ 10) and anxiety (GAD-7 ≥ 10) screens among Canadian seafarers (n = 473)

Predictor	Category	PHQ-9 OR (95% CI)	GAD-7 OR (95% CI)
Age (per year)		1.00 (0.99–1.01)	1.00 (0.99–1.02)
Months away from home (per month)		1.06 (1.02–1.10)*	1.05 (1.01–1.09)*
Self-perceived mental health (per level increase)		0.50 (0.40–0.62)**	0.56 (0.45–0.70)**
Shore-leave access	*Yes* vs. *No*	1.07 (0.69–1.65)	0.96 (0.62–1.50)
Years of experience (per year)		1.03 (1.00–1.05)***	1.02 (0.99–1.05)
Gender	**Male**	*REF*	*REF*
	Female	1.25 (0.74–2.12)	0.75 (0.43–1.32)
	Other/Undisclosed	0.47 (0.13–1.79)	0.71 (0.19–2.60)
Department	**Deck**	*REF*	*REF*
	Engineering	1.79 (1.12–2.86)*	1.36 (0.84–2.21)
	Galley/Other	0.87 (0.50–1.51)	1.00 (0.56–1.77)
Vessel type	**Dry-cargo/Container/Reefer**	*REF*	*REF*
	Passenger/Ferry/RO-RO	0.95 (0.57–1.61)	1.25 (0.73–2.13)
	Tanker (Oil, Gas, Chemical)	0.84 (0.48–1.45)	1.44 (0.83–2.50)
	Government/Navy/Research	0.27 (0.09–0.78)*	0.55 (0.19–1.59)
	Tug/Supply/Other	0.55 (0.15–1.93)	1.17 (0.34–4.03)
Shift rotation	**12 h/12 h**	*REF*	*REF*
	4 h/8 h	1.09 (0.61–1.97)	1.10 (0.61–1.99)
	6 h/6 h	0.96 (0.56–1.63)	0.80 (0.47–1.37)
	Other	0.54 (0.21–1.35)	0.44 (0.16–1.18)

Model diagnostics: PHQ-9: Nagelkerke R^2 = 0.207, Hosmer–Lemeshow p = 0.166; GAD-7: Nagelkerke R^2 = 0.156, Hosmer–Lemeshow p = 0.631. All odds ratios are mutually adjusted for every predictor listed. * p ≤ 0.05, ** p ≤ 0.001, *** p ≤ 0.01

CI — confidence interval, RO-RO — Roll-on/Roll-off

Table 3. Anxiety screening breakdown by severity and gender (GAD-7)

Severity	Female		Male		Other/undisclosed		Total	
Undisclosed	6	5.2%	15	3.3%	0	0.0%	21	3.6%
No low risk	25	21.7%	146	32.6%	4	22.2%	175	30.1%
Mild	56	48.7%	137	30.6%	7	38.9%	200	34.4%
Moderate	26	22.6%	118	26.3%	6	33.3%	150	25.8%
Severe	2	1.7%	32	7.1%	1	5.6%	35	6.0%
Grand total	115	100.0%	448	100.0%	18	100.0%	581	100.0%

Table 4. Depression screening breakdown by severity and gender (PHQ-9)

Severity	Female		Male		Other/undisclosed		Total	
Undisclosed	6	5.2%	28	6.3%	3	16.7%	37	6.4%
No to minimal	25	21.7%	114	25.4%	3	16.7%	142	24.4%
Mild	36	31.3%	132	29.5%	5	27.8%	173	29.8%
Moderate	36	31.3%	103	23.0%	3	16.7%	142	24.4%
Moderately severe	12	10.4%	55	12.3%	3	16.7%	70	12.0%
Severe	0	0.0%	16	3.6%	1	5.6%	17	2.9%
Grand total	115	100.0%	448	100.0%	18	100.0%	581	100.0%

in the mild anxiety category, while men had higher proportions at no-to-low risk and severe ends. Participants of other or undisclosed gender presented a more even spread, with notable proportions in mild and moderate anxiety.

For depression (Tab. 4), a majority of screenings provided scores reflective of mild and moderate categories. The scores for women largely clustered in these mid-range categories and with no severe depression screenings. Male participants' scores broadly reflect the overall pattern but included a severe subset. Individuals of other or undisclosed genders exhibited more varied distributions, including relatively higher rates of moderately severe and severe depression, as well as more frequent non-disclosure.

SYMPTOMS OF DEPRESSION AND ANXIETY

Table 5 presents a detailed, item-level distribution of anxiety and depression symptoms from the GAD-7 and PHQ-9, organized by the frequency of symptom occurrence. A considerable proportion of respondents experienced some symptoms more than half the days or nearly every day — especially feeling tired, having trouble relaxing, and staying asleep or sleeping too much. Notably, during their last voyage, 13.3% of respondents experienced suicidal or self-injury ideation more than half the days, with 3.1% experiencing these thoughts nearly every day.

SELF-PERCEIVED MENTAL HEALTH

Approximately 8 out of 10 participants indicated good, very good, or excellent mental health. This pattern emerged across all gender groups, although males showed a slightly higher proportion in these categories. Individuals identifying as other or undisclosed gender recorded a somewhat greater percentage of reporting poor mental health (Tab. 6).

When considering the pandemic's impact, most respondents indicated either 'no significant impact' or a 'moderate negative effect' (with 'significant' reflecting question wording rather than statistical inference). Although only a small proportion indicated a 'significant negative impact,' this response category was somewhat more common among those identifying as other or undisclosed gender, followed by male participants, and was less frequently reported by females (Tab. 7).

DISCUSSION

The present analysis identifies prolonged rotations and poorer self-perceived mental health as consistent correlates of both depressive and anxious symptomatology among Canadian seafarers during the COVID-19 pandemic. Each additional month at sea raised the likelihood of a positive PHQ-9 or GAD-7 screen by approximately five to six percent, whereas for a single level higher on a five-point scale measuring self-perceived mental health reduced risk by roughly half (higher level equated to more positive self-perceived mental health).

WORKING WITH DEPRESSION AND ANXIETY

In this study, participants presented notably higher rates of positive screenings for depression and anxiety compared to a similar pre-pandemic measurement among international seafarers [6]. This increase is consistent with the worldwide rise in mental health challenges during the COVID-19 pandemic in the *World Mental Health Report* [7]. Participants also presented higher rates of depression and anxiety than the general Canadian population amid the pandemic, as measured by Statistics Canada with similar screening tools [16]. Such a difference suggests that the maritime work played a central factor, which can be supported by the close resemblance in the proportion of positive screenings for either or both conditions in the present study with the proportion of CCG workers screening positive for any anxiety or mood disorder during the pandemic [17].

Table 5. Depression and anxiety symptoms, according to GAD-7 and PHQ-9

Anxiety Symptoms (n = 581)	Not at all	Several days	More than half the days	Nearly every day	Not disclosed
Becoming easily annoyed or irritable	33.4%	37.0%	22.9%	5.5%	1.2%
Being so restless that it is hard to sit still	37.4%	35.1%	21.2%	5.7%	0.7%
Feeling afraid as if something awful might happen	37.5%	32.0%	23.1%	6.0%	1.4%
Feeling nervous, anxious or on edge	26.5%	41.8%	25.8%	5.7%	0.2%
Not being able to stop or control worrying	34.8%	34.4%	25.5%	5.0%	0.3%
Trouble relaxing	27.5%	38.0%	26.0%	7.2%	1.2%
Worrying too much about different things	29.6%	38.0%	24.8%	6.5%	1.0%
Depression Symptoms (n = 581)	**Not at all**	**Several days**	**More than half the days**	**Nearly every day**	**Not disclosed**
Feeling bad about yourself — or that you are a failure or have let yourself or your family down	44.2%	31.2%	17.9%	4.3%	2.4%
Feeling down, depressed, or hopeless	30.1%	40.6%	23.8%	3.1%	2.4%
Feeling tired or having little energy	19.1%	44.4%	25.3%	8.3%	2.9%
Little interest or pleasure in doing things	30.6%	40.8%	20.7%	6.0%	1.9%
Moving or speaking so slowly that other people could have noticed? Or the opposite — being so fidgety or restless that you have been moving around a lot more than usual	43.2%	30.8%	19.6%	4.5%	1.9%
Poor appetite or overeating	34.3%	33.7%	21.9%	7.1%	3.1%
Thoughts that you would be better off dead or hurting yourself in some way	62.0%	20.0%	13.3%	3.1%	1.7%
Trouble concentrating on things, such as reading the newspaper or watching television	34.3%	37.4%	20.8%	5.3%	2.2%
Trouble falling or staying asleep or sleeping too much	24.3%	36.8%	27.5%	9.3%	2.1%

Table 6. Self-perceived mental health by gender: In general, how would you describe your mental health?

Answer	Female		Male		Other/undisclosed		Total	
Excellent	11	9.6%	53	11.8%	1	5.6%	65	11.2%
Very good	39	33.9%	160	35.7%	8	44.4%	207	35.6%
Good	42	36.5%	149	33.3%	5	27.8%	196	33.7%
Fair	17	14.8%	68	15.2%	2	11.1%	87	15.0%
Poor	6	5.2%	17	3.8%	2	11.1%	25	4.3%
Undisclosed	0	0.0%	1	0.2%	0	0.0%	1	0.2%
Grand total	115	100.0%	448	100.0%	18	100.0%	581	100.0%

Yet, despite the elevated symptom burden, the majority of participants still perceived their mental health as good, very good, or excellent. Such an apparent discrepancy suggests that many seafarers may navigate symptoms of mental illness while continuing to view themselves as functioning and resilient. This complexity aligns with the principles behind the mental health dual continuum model, which conceptualizes mental health and mental illness

Table 7. Self-perceived COVID-19 impact by gender: How would you describe the impact of the pandemic on your mental health?

Answer	Female		Male		Other/undisclosed		Total	
A significant positive impact	2	1.7%	10	2.2%	2	11.1%	14	2.4%
A moderate positive impact	23	20.0%	63	14.1%	4	22.2%	90	15.5%
No significant impact	34	29.6%	131	29.2%	4	22.2%	169	29.1%
A moderate negative impact	48	41.7%	180	40.2%	4	22.2%	232	39.9%
A significant negative impact	8	7.0%	63	14.1%	3	16.7%	74	12.7%
Undisclosed	0	0.0%	1	0.2%	1	5.6%	2	0.3%
Grand total	115	100.0%	448	100.0%	18	100.0%	581	100.0%

as distinct but interrelated dimensions [21, 22]. In large longitudinal cohorts, upward mental health shifts predict substantially lower incidence of mood and anxiety disorders [33, 34]. Moreover, Iasiello et al. [35] found that individuals who maintained or gained the highest levels of positive mental health were 27.6 and 7.4 times more likely to recover from depression or anxiety, respectively, when compared to those who maintained the lowest level of positive mental health. Similarly, our study found a roughly 50% reduction in the odds of depression or anxiety for each one-step rise in self-perceived (positive) mental health, demonstrating a protective pattern in a maritime workforce, although causality cannot be inferred from our cross-sectional data. Monitoring positive mental health alongside symptom severity may therefore enrich occupational-health surveillance at sea and enable upstream approaches to help seafarers with mental illness, since there is evidence that gains in mental health decrease the odds, and losses of mental health increase the odds of the incidence of mental illness [34].

Similarly, the *World Mental Health Report* endorses a dual continuum perspective, defining mental health as an instrumental resource that enables individuals to cope with life's stresses, realize their abilities, work effectively, and contribute actively to the community, influencing every aspect of life [7]. Such insights align with participants' responses on mental health and mental illness, depicting a community that fulfilled their duties at sea under strenuous pandemic-related circumstances and a high prevalence of symptoms of depression and anxiety.

Notably, recent findings indicate that seafarers internationally begin experiencing work-related difficulties at lower symptom thresholds — GAD-7 scores of 7 and PHQ-9 scores of 4 — than the commonly employed cutoff of 10 [36]. Such findings suggest that the ship environment may impact seafarers' ability to cope with symptoms of depression and anxiety compared to the general population. Thus, it emphasizes the importance of prioritizing upstream research and policy interventions focused on mental health promotion through systemic, community-level strategies.

MENTAL HEALTH PROMOTION AT SEA

Maritime stakeholders traditionally emphasize reactive individual-centred mental health support even though seafarers increasingly advocate for broader, systemic interventions [37]. Given the global surge in mental illness following the pandemic and persistent gaps in mental health care [7], shifting towards proactive mental health promotion is now critical, enabling seafarers to preserve their well-being and productivity.

In this study, all gender groups showed a high prevalence of positive depression and anxiety screenings. Internationally, Lefkowitz and Slade [6] found that women were statistically significantly more likely to experience mental illness. In contrast, our results did not find statistical differences among males and females, suggesting differences in working standards for females in the present study compared to samples internationally. In line with these findings, Canada ranks as top 10th best place to be a working woman among 38 member countries of the Organisation for Economic Co-operation and Development (OECD), according to the Economist' glass ceiling index in 2023 [38]. Nonetheless, although female participants generally reported milder issues, their rates still exceeded general population benchmarks. Individuals outside the gender binary reported particularly frequent symptoms of anxiety, a significant negative pandemic impact, and poorer self-reported mental health. Further research is needed to better understand the experiences of female and two-spirit, lesbian, gay, bisexual, transgender, queer/questioning, and other sexual and gender minorities among seafarers in Canadian waters.

In this research, after adjustment for demographic and work-pattern variables, engineering department

personnel exhibited greater odds of depressive symptoms than deck crew, a relationship that emerged only after the rank variable was removed from the statistical model. This shift suggests that hierarchical status may have concealed department-specific stressors in earlier models. The reduced odds of depression observed on government and research vessels may reflect shorter voyages, enhanced staffing levels, or superior welfare amenities; however, the small size of this subgroup warrants cautious interpretation. Nonetheless, such a variation suggests that mental health promotion efforts should adapt to the needs of a diverse maritime workforce, prioritizing those facing severe illness to help them maintain functioning despite illness symptoms.

Nevertheless, enhancing mental health promotion at sea extends beyond industry commitment. It involves adapting evidence-based, land-originated promotion strategies to a mobile maritime workforce, a challenge Canada is well positioned to address. By developing an adaptation of the *National Standard for Psychological Health and Safety in the Workplace* specific to the maritime industry, stakeholders can align with best practices in occupational health and safety — demanding a thorough multidisciplinary approach, management commitment, employee involvement, and an emphasis on organizational and environmental factors [19, 39]. Such a standard requires collaboration among the Mental Health Commission of Canada (MHCC), the Canadian Standards Association (CSA), and the Canadian National Seafarers Welfare Board, leveraging Canada's expertise to craft tailored, sustainable solutions that reflect seafarers' unique conditions at sea.

LIMITATIONS

The study's non-probabilistic sampling limits generalizability; cross-sectional data restrict causal inference; and modest pseudo-R^2 values indicate that additional psychosocial and organizational variables (such as employment company) warrant investigation. Additionally, while standardized instruments like the PHQ-9 and GAD-7 were used to assess symptoms of depression and anxiety, the study adopts a community health perspective with no intention of diagnosing individual seafarers. Although there were limitations in implementing the Sex and Gender Equity in Research (SAGER) guidelines in the present study, they acted as a valuable framework to enhance the gender-based understanding of participants' mental health and illness symptoms [40].

CONCLUSION

This study responds to the growing demand to provide insight into the mental health of seafarers and provides the first attempt to characterize the mental health among Canadian seafarers. The significant participation from female seafarers provides a gender-based foundation for future research.

To the best of the authors' knowledge, this is also the first study to discuss a dual-continuum view of mental health and illness among seafarers, along with its practical implications for the industry. While research exploring psychopathology among seafarers remains valuable, future research should incorporate tools focused on mental health, such as the Mental Health Continuum Short Form [41]. Embracing both aspects of mental well-being promises a more comprehensive understanding of seafarers' mental health and can lead to increased productivity and well-being.

Maritime mental health research during the COVID-19 pandemic underscores the profound connection between seafarers' living conditions at sea and their mental health. The pandemic increased the urgency to address a long-standing need for strengthened workplace mental health promotion and prevention against illness. This study identified policy opportunities to advance seafarers' mental health internationally by leveraging Canada's policy advancements and positioning them as a leader in the field.

ARTICLE INFORMATION AND DECLARATIONS

Data availability statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics statement: The proposal for this research has been reviewed by the Interdisciplinary Committee on Ethics in Human Research (ICEHR) and found to comply with Memorial University's (MUN) ethics policy.

Author contributions: Hugo Rojas: conceptualization, methodology, formal analysis, investigation, writing original draft, review and editing, visualization. Cory Ochs: formal analysis, reviewing and editing, visualization. James Valcour: conceptualization, methodology, review and editing, supervision. Jennifer Shea: methodology, review and editing, supervision. Shree Mulay: conceptualization, methodology, review and editing, supervision. Desai Shan: conceptualization, methodology, investigation, review and editing, supervision, project administration, funding acquisition.

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Supplementary material: Supplementary Tables 1 & 2.

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VIA MEDICA

Lessons from Madagascar: implications of neglected tropical diseases for Northern Philippines

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Dear Editor,

The article *Neglected tropical diseases in East Africa on the example of Madagascar* by Wilczyńska et al. [1] emphasizes how (1) weak health systems, (2) extreme poverty, and (3) ecological vulnerability, drive the burden of neglected tropical diseases (NTDs) in Madagascar. As a full-fledged professor in ecology and conservation biology based in the Philippines, I find valuable and interesting parallels between Madagascar and remote regions in Northern Philippines, particularly in the Cordillera Administrative Region and in the Cagayan Valley.

The authors reported that diseases like soil-transmitted helminthiases (STHs) and schistosomiasis affect over 90% of local groups in some parts of Madagascar due to proximity to contaminated environments, unsafe water, and open defecation [1]. Disturbingly, similar socio-economic and environmental conditions exist in the rural areas of Northern Luzon, Philippines. According to the Department of Health (DOH), STHs persist, endemic among children of school age, despite nationwide deworming, due to sanitation gaps and reinfection risks [2].

Schistosomiasis, while frequently linked with sub-Saharan Africa, is a tenacious threat in Philippine provinces like Leyte, Samar, and various parts of Northern Luzon, where irrigation and snail habitats abound. Like Madagascar, these endemic zones also face health-seeking behaviors and limited health infrastructure [3].

Madagascar's mass drug administration (MDA) exertions and vector control programs, despite inadequate resources, serve as a resilient model for integrated interventions. Wilczyńska et al. [1] rightly underscore that beyond medication, sustainable NTD control necessitates WASH (Water, Sanitation, and Hygiene) interpositions, regular surveillance, and school-based health education. In the Philippine setting, these perceptions can reinforce our Barangay Health Programs and National Deworming Day campaigns.

Climate vulnerability is another shared burden. Madagascar faces typhoon-induced floods that spread water-borne and vector-borne illnesses. Northern Philippines, being along the typhoon belt, suffers analogous seasonal outbreaks of leptospirosis and dengue [4]. Empowering of local climate-adaptive health systems is a vital takeaway from the Madagascar experience.

Furthermore, the social impression of NTDs — expressly productivity loss, school absenteeism, and cognitive impairment — highlights the urgency of multi-sectoral and multifaceted solutions. These comprise livestock control (to manage zoonoses like cysticercosis), community-based sanitation drives, and integrated NTD mapping to target interventions where they are most desired.

In conclusion, Madagascar's case is both an admonitory tale and a roadmap. The Northern Philippines must not wait for NTDs to deteriorate into foremost public health crises. Proactive, community-based, and climate-resilient approaches are indispensable to prevent the marginalization of our most vulnerable populations.

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LETTER TO THE EDITOR

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Pandemic on ships: lessons from the COVID-19 outbreak for future preparedness

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The COVID-19 pandemic highlighted the unique vulnerabilities of ships as confined environments conducive to rapid disease transmission. Cruise ships and cargo vessels, characterized by close living quarters and prolonged interpersonal interactions, became hotspots for outbreaks. The Diamond Princess incident in February 2020 underlined these challenges, with over 700 passengers and crew members infected due to delays in implementing testing and containment measures [1, 2]. The pandemic revealed critical lessons for future pandemic preparedness in the maritime industry.

One of the most significant lessons is the necessity of rapid diagnostic testing and early detection. Ships must be equipped with onboard testing capabilities, enabling timely identification of infected individuals. Complementary telemedicine systems can provide real-time expert guidance for managing potential outbreaks. In addition, isolation and quarantine protocols must be improved. During the pandemic, many ships lacked sufficient facilities to separate infected individuals from healthy passengers and crew [3]. Retrofitting ships with dedicated isolation areas and enhancing ventilation systems in cabins are essential measures to mitigate onboard transmission in future pandemics.

Effective communication and collaboration between ship operators, health authorities, and port states are equally vital. The delays in disembarkation during COVID-19 were largely attributed to poor coordination and unclear decision-making [4]. Establishing pandemic contingency agreements between international maritime organizations and port authorities will ensure smoother processes for disembarkation and access to medical care during emergencies. Furthermore, proactive measures such as pre-arranged health protocols and clear lines of communication will help avoid delays and reduce confusion.

Vaccination and other preventative measures also played a pivotal role during COVID-19 but revealed significant logistical challenges in their implementation. Maritime workers, as essential personnel, should be prioritized for vaccinations in future pandemics, with robust supply chain systems ensuring timely delivery of vaccines and personal protective equipment (PPE). Routine health screenings and the use of digital health tools, such as wearable devices, can provide real-time health data, enabling early detection of potential outbreaks. Ships should also integrate advanced health surveillance systems to monitor the health status of passengers and crew regularly [5, 6].

The pandemic further emphasized the need for enhanced training and preparedness among maritime personnel. Crew members should be trained in outbreak management, including the use of PPE, isolation protocols, and decontamination procedures. World Health Organization (WHO) and Centres for Disease Control and Prevention (CDC) guidelines on outbreak management provide detailed protocols that should be incorporated into crew training programs [7, 8]. Clear guidelines and simulations of potential pandemic scenarios can prepare crews to act swiftly and effectively when faced with a public health crisis. Investment in these measures will not only protect the health of passengers and crew but also maintain the continuity of maritime operations, which are critical to global trade and economy.

The COVID-19 pandemic provided a sobering reminder of the risks associated with outbreaks in the maritime sector. By implementing rapid testing, isolation protocols,

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effective communication strategies, vaccination prioritization, and health surveillance systems, the maritime industry can better prepare for future pandemics. Collaborative efforts between industry stakeholders, health authorities, and governments are crucial to ensuring the safety of maritime operations in an increasingly interconnected world.

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Learning from Complexity: Clinical Decisions at Sea

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Editorial

by James A. Denham

Dear Readers,
Welcome to this new issue of the International Maritime Health Magazine.
Maritime medicine often advances not in times of stability but through the careful analysis of events that test existing systems. Whether we are managing a complicated medical repatriation, responding to an infectious disease outbreak, or striking a balance between clinical requirements and operational realities, dealing with a difficult situation will provide us with a lesson.
This issue reflects that principle. An analysis of the outbreak onboard the MV Hondius included in this issue goes beyond the clinical aspects of infectious disease to examine the more general issues of operational decision-making, international coordination, communication, and public health responsibility at sea. Events such as this one remind us that, at times, the effectiveness of international frameworks depends not only on their existence, but also on how they perform under the pressures of real-world operations.
This issue also marks the introduction of our new *The Decision Deck* section. The aim of this section is to encourage reflection and clinical reasoning, particularly in situations where decisions must be made with limited resources or conflicting operational priorities.
In many respects, both the analysis of the MV Hondius and the case presented in *The Decision Deck* reflect the same principle: maritime medicine evolves through the continuous examination of difficult situations. Through this process of reflection and debate, our field continues to strengthen and adapt to a complex and constantly evolving maritime environment.
We hope that this issue will foster an ongoing dialogue among the various disciplines that contribute to our maritime and hyperbaric medicine community.

THE MV HONDIUS HANTAVIRUS OUTBREAK: A LESSON FOR MARITIME INFECTIOUS DISEASE PREPAREDNESS

by James A. Denham

MV Hondius, IMO 9818709.
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ABSTRACT

The MV Hondius outbreak in 2026 highlighted persistent issues in international cooperation and preparedness for maritime outbreaks. Health authorities, laboratories, evacuation services, and government organizations from several countries soon became involved in what started out as a medical emergency on board.
Due to the potential for human-to-human transmission of hantavirus, the detection of the Andean variant raised further concerns. Instead of considering the outbreak as a singular epidemiological event, this essay examines it as a case study in maritime outbreak preparedness. It addresses the issues of the pathogen's delayed identification, the ship's limited capacity for advanced diagnostic testing, the complexity of expedition operations in remote locations, the usual barriers to disembarkation, and fragmented international coordination.
The article also examines the responsibilities of the International Maritime Organization (IMO), the World Health Organization (WHO), flag States, and maritime physicians in supporting preparedness for infectious disease at sea.

Keywords: hantavirus, Andes virus, maritime medicine, cruise ship outbreak, maritime infectious disease, infectious disease preparedness, international health regulations, shipboard outbreak

INTRODUCTION

The expedition cruise ship MV Hondius became the subject of an international inquiry into an outbreak between early April and late May 2026 after a number of passengers developed severe symptoms linked to hantavirus infection. What began as an isolated onboard medical issue rapidly developed into a global public health response involving maritime authorities, infectious disease specialists, and health agencies from multiple countries.

The first passenger died on board the ship on 11 April while it was still on the high seas. At that time, the cause of death was unknown. The passenger's body was disembarked in St. Helena on 24 April during repatriation arrangements, accompanied by his wife. That same day, a British expedition guide developed fever and pneumonia, prompting medical evacuation to South Africa. Shortly afterward, on 27 April, it was reported that the wife of the first passenger had become seriously ill during her return journey and had subsequently died. Laboratory tests performed later identified a variant of hantavirus.

The following day, a German passenger developed a fever and died on board the ship on 2 May. At the time, the exact cause of death remained unclear.

Within days, health authorities, laboratories, and maritime institutions from several countries became involved in the response to the outbreak. It appeared that this was not simply a self-limiting illness typical of those frequently seen on cruise ships, but a matter of particular concern due to the identification of a variant of the hantavirus similar to that found in the Andes. This Andean strain of hantavirus is one of the few known to be transmitted from person to person under conditions of close contact. The extent of onboard transmission remains uncertain.

Beyond the outbreak itself, the events on board the MV Hondius raised broader concerns about the maritime sector's preparedness for future infectious disease emergencies.

WHY THE MV HONDIUS INCIDENT MATTERS

Because large groups of people live together in shared quarters, often for extended periods of time, and occasionally distant from specialized medical care, ships remain particularly vulnerable to the spread of infectious diseases. Outbreaks may spread before they are fully identified due to limited isolation space and diagnostic capability.

Because of their remote itineraries and limited evacuation options, expedition ships present significant operational challenges. They frequently operate in remote areas, far from tertiary medical facilities, which limits evacuation options and may result in prolonged stays with limited access to medical facilities capable of managing complex medical conditions. As a result, the interval between the onset of symptoms, diagnosis, and definitive care can be significantly prolonged.

Outbreaks of maritime diseases are rarely confined to a single jurisdiction and, by their nature, test the coordination capacity of the international health system itself. The MV Hondius outbreak illustrated how quickly a medical situation on board can extend beyond the ship itself. Within days, health authorities, laboratories, repatriation services, and surveillance systems across three continents were involved in the response.

Experiences during the COVID-19 pandemic have already shown that outbreaks at sea can easily develop into wider operational and humanitarian crises. The outbreak on the MV Hondius reinforced the view that many structural vulnerabilities identified during the pandemic have not yet been fully resolved.

OPERATIONAL VULNERABILITIES REVEALED BY THE INCIDENT

1. DELAYED RECOGNITION OF EMERGING PATHOGENS

The COVID-19 pandemic showed that delayed recognition of unusual infectious syndromes can rapidly lead to an operational crisis. One of the most important lessons from the MV Hondius outbreak concerns the difficulty of recognizing an emerging infectious disease in a maritime environment. The first death on board the vessel occurred before hantavirus was diagnosed. This situation inevitably raises complex operational questions. It remains difficult to determine exactly how clinical decisions were made during the early stages of the outbreak on board.

It can reasonably be argued that no maritime doctor could have diagnosed hantavirus immediately in the isolated environment of a ship. This argument has some validity, especially if the initial presentation resembled a common respiratory illness. Since advanced diagnostic resources and infectious disease specialists are not readily available on board, the outbreak illustrated the inherent difficulty of making an early diagnosis. Under such circumstances, the ship's doctor may be required to make important decisions in the face of considerable diagnostic uncertainty, far from specialist support and definitive laboratory testing.

However, an important lesson may not be the inability to identify the specific pathogen at an early stage, but rather the lack of a structured response whenever a severe "unknown" respiratory illness or death occurs in a maritime setting.

Such a response could trigger enhanced surveillance, isolation measures, the use of protective equipment, and infection-control measures while communication with public health authorities helps establish a definitive diagnosis. The MV Hondius incident therefore suggests that vulnerabilities similar to those observed during the COVID-19 pandemic may still persist in the maritime sector.

2. PORT RELUCTANCE AND HUMANITARIAN GAPS

The outbreak also raises an important policy question regarding uncertainty surrounding humanitarian port access for sick passengers and crew during an infectious disease emergency. Although international regulations encourage cooperation and the provision of public health assistance during maritime emergencies, it remains unclear whether current frameworks provide sufficient guidance when a vessel carrying potentially infectious passengers requires urgent medical support. This challenge may become acute in such circumstances. The nearest port may not always have the resources to manage a complex outbreak safely. Conversely, continuing a voyage in search of a better-equipped destination may prolong the risk of exposure, delay definitive medical care, and complicate outbreak-control measures.

The MV Hondius outbreak demonstrated the value of established international networks, designated points of entry, and close cooperation between maritime and public health authorities. At the same time, the incident invites further discussion regarding how ports with appropriate public health and medical capabilities can be identified, supported, and coordinated during future maritime infectious disease emergencies, particularly when vessels operate in remote regions far from major medical centres. Delays in disembarkation and medical evacuation, such as those seen during the COVID-19 pandemic, may arise not only from medical uncertainty, operational constraints, and resource limitations, but also from the complexity of coordinating multiple authorities and jurisdictions.

During the pandemic, some ships faced difficulties accessing ports, even when passengers or crew required urgent medical care. A widely discussed example occurred in March 2020, when the Panama Canal Authority allowed the transit of the MS Zaandam and the MS Rotterdam after several South American ports had refused them entry due to suspected cases of COVID-19 on board.

The transit took place under strict sanitary measures coordinated with the Panamanian health authorities and the US Centers for Disease Control and Prevention. This episode showed that humanitarian maritime access could still be maintained during a major infectious disease emergency when authorities were willing to coordinate practical public health measures. The international frameworks developed by the IMO, WHO, and the International Health Regulations (2005) encourage cooperation and information sharing during public health events at sea. In practice, however, an infectious disease emergency may still present difficult operational decisions if public health concerns, limited resources and political pressures intersect. Therefore, protected humanitarian access mechanisms to ports, specifically designed for infectious disease emergencies, may be required during future outbreaks to help reduce any delays in disembarkation and treatment.

WHAT CAN THE IMO DO?

Major outbreaks can quickly expose shortcomings in the organization and coordination of infectious disease preparedness in the maritime sector. Although the World Health Organization remains the leading international authority on infectious disease response under the International Health Regulations (2005), the International Maritime Organization (IMO) can play a significant supporting role by strengthening maritime outbreak preparedness and promoting operational guidance for infectious disease emergencies at sea. This may include issuing circular letters, facilitating communication among maritime stakeholders, participating in international task forces, disseminating WHO guidance, and coordinating with governments, industry, and other United Nations agencies.

WHO guidance documents, such as the *Handbook for Management of Public Health Events on Board Ships*, already address escalation procedures for unusual outbreaks on board ships, including severe respiratory illnesses, unusual clusters of deaths, and suspected zoonotic diseases. However, voyages to remote areas involving multiple jurisdictions may still reveal significant gaps between formal guidance and operational response.

Better integration between maritime authorities, telemedical services, laboratories, port health authorities, and international notification mechanisms could improve the response to outbreaks during complex multinational incidents. The MV Hondius outbreak highlighted the importance of reliable communication systems capable of rapidly connecting ships with specialist medical advice, public health authorities, and international reporting networks. Even brief delays in communication can complicate outbreak response. Expedition cruises and polar operations may particularly benefit from robust communication pathways and more rigorous assessments of outbreak preparedness due to their limited access to advanced medical infrastructure.

WHAT CAN WHO AND NATIONAL HEALTH AUTHORITIES DO?

Early detection systems capable of identifying outbreaks of unusual diseases at sea remain essential to prevent further international spread. The relative isolation of cruise ships and expedition vessels can complicate the surveillance of infectious diseases, particularly during prolonged voyages involving multiple jurisdictions. The incident also showed how quickly coordination challenges arise when multiple countries, health authorities, and ports become involved in outbreak response decisions.

It also demonstrated the need for prompt international laboratory collaboration. Timely support from South African laboratories proved crucial during the investigation, particularly given concerns about a potentially rare or emerging pathogen.

Existing international health regulations provide comprehensive guidance for managing public health risks; however, their practical implementation at sea can prove difficult during prolonged multinational outbreaks.

To improve coordination in future events, practical coordination exercises involving ports, flag States, laboratories, and maritime health authorities could help identify operational weaknesses.

Existing programs, such as the European Union's SHIPSAN ACT initiative, have already provided valuable experience in preparing the maritime sector for biological, chemical, and radiological health threats and could serve as a useful operational model for improving international coordination in the response to infectious diseases at sea.

THE ROLE OF FLAG STATES

Events such as the MV Hondius outbreak show that the role of flag States extends well beyond routine regulatory oversight during a major infectious disease incident. The outbreak highlighted how the involvement of the flag State can rapidly shift from administrative oversight to active operational coordination during infectious disease emergencies.

Ships operating in remote regions may require clearer contingency plans for outbreaks, particularly with regard to onboard isolation, medical evacuation decisions, and communication with port health authorities. Such operations may force onboard medical teams to make difficult diagnostic decisions with limited resources, making specialized telemedical support particularly valuable.

The outbreak also raises questions as to whether current training requirements for onboard medical staff regarding infectious disease remain adequate. However, the effectiveness of these measures may vary substantially depending on the administrative and medical capabilities of each flag State.

THE ROLE OF MARITIME PHYSICIANS

The COVID-19 pandemic forced the maritime sector to address the risks of infectious diseases more directly, but long-term preparedness remains uneven.

Onboard physicians can serve as an important early warning system when unusual disease outbreaks begin to emerge on the high seas. In some cases, the first sign of an emerging maritime outbreak may come from an onboard doctor communicating through TMAS or international reporting channels.

Maritime doctors are often well prepared to manage trauma, cardiac emergencies, common surgical conditions, and gastrointestinal illness at sea; however, in many countries far fewer maritime practitioners have direct experience managing emerging zoonotic infections, severe respiratory outbreaks, haemorrhagic fevers, or prolonged quarantine situations. Additional training in outbreak management, isolation procedures, infectious disease reporting, and crisis communication would likely strengthen maritime medical preparedness.

The outbreak reinforced how maritime doctors increasingly operate at the intersection of clinical medicine, public health, and international maritime regulation.

THE ETHICAL DIMENSION

Beyond its operational consequences, the outbreak drew attention to unresolved ethical issues in maritime health governance. Situations such as these force authorities to make difficult decisions. While governments may seek to protect national public health, delaying disembarkation may increase the risk to seriously ill individuals.

One unresolved issue is to what extent coastal states should restrict access to ports during outbreaks, while still fulfilling their humanitarian responsibilities toward passengers and crew on the high seas. In certain circumstances, alternative containment measures, such as offshore quarantine facilities or medically equipped isolation vessels, may offer a temporary operational solution.

Even now, the maritime community has not fully resolved the ethical and legal boundaries of quarantine, denial of port access, and compulsory isolation during major infectious disease events. These are not simply logistical problems; they reflect persistent tensions between disease-control measures, state authority, and humanitarian obligations toward people at sea.

CONCLUSION

The outbreak aboard the MV Hondius was not simply an isolated incident. Instead, it highlighted continuing gaps in maritime infectious disease preparedness, even after the lessons of COVID-19. The incident also showed how quickly a medical problem on board a single vessel can escalate into a complex international operation requiring laboratory testing, evacuation planning, port negotiations, public health authorities, and humanitarian considerations. Although important epidemiological questions remain under investigation, several operational lessons have already become apparent. The maritime sector must be better prepared for emerging infectious disease events involving remote operations, delayed diagnosis, uncertain transmission dynamics, and politically sensitive disembarkation decisions. Any complex future outbreaks could be far more difficult to contain unless maritime health systems improve contingency planning, enhance international coordination, and strengthen humanitarian response capacity. At the same time, the response to the MV Hondius outbreak demonstrated the value of established international networks, laboratory collaboration, designated points of entry, and coordinated action between maritime and public health authorities when managing complex infectious disease events at sea.

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News

contributed by Nebojša Nikolić

FROM WHO

EBOLA OUTBREAK

On June 5, 2026, the Africa Centres for Disease Control and Prevention (Africa CDC) and the World Health Organization (WHO) launched a joint **Continental Preparedness and Response Plan** on the ongoing Ebola outbreak caused by the Bundibugyo virus. The plan aims to raise US$ 518 million to support African countries together with partners to prepare for, rapidly detect and respond to the outbreak.

The six-month plan, covering June to November 2026, brings together governments, partners and communities under a unified 'One Response' approach to strengthen outbreak response measures, including emergency coordination, disease surveillance, laboratory testing, infection prevention and control, clinical care, community engagement, research, logistics and support for essential health services.

The plan complements national response plans launched by the Governments of the Democratic Republic of the Congo and Uganda.

The plan also focuses on protecting vulnerable populations, strengthening cross-border collaboration, and supporting countries to respond quickly to new cases. At a time when there are no licensed vaccines or therapeutics specifically approved for the Bundibugyo species of Ebola, the plan aims to strengthen health systems to ensure resilience even as countries respond to acute health emergencies.

Implementation of preparedness and response activities is already underway across affected and at-risk countries. Furthermore, in 10 priority countries critical measures are being strengthened to enhance public health emergency preparedness and ensure early detection and swift response.

This coordinated effort comes as response operations accelerate in the Democratic Republic of Congo, where authorities, with support from Africa CDC, WHO and partners, are ramping up efforts to curb the spread of the virus and end the outbreak. Through the joint preparedness and response plan, the continent is mobilising its collective expertise and resources to reinforce response measures, acting as one to control the outbreak and protect communities across the region. Its successful implementation will require strong political commitment, sustained investment and close collaboration among governments, health workers, communities and partners.

Available at: https://www.who.int/news/item/05-06-2026-africa-cdc-and-who-launch-joint-continental-ebola-response-plan

FROM ILO

THE IMPLEMENTATION OF THE MARITIME LABOUR CONVENTION IN TIMES OF CRISIS

The Maritime Labour Convention (MLC) celebrates its 20th anniversary this year. It is considered a model of strong and effective cooperation between seafarers and the global shipping industry. Since its adoption, the Convention has helped establish a global framework for decent work and living conditions at sea and has created fairer competition across the maritime sector.

But as the shipping industry continues to face unprecedented pressures, such as pandemics, geopolitical conflicts, and disruptions to global trade routes, implementing the MLC has become more crucial than ever. On its portal, the ILO launched a podcast featuring several distinguished experts from the maritime community who speak about the MLC and current challenges: Mr. Max Johns, former shipowner, Vice-Chair of the Special Tripartite Committee of the MLC, and Professor Maritime at HSBA, Hamburg; Mr. Carlos Muller, Secretary General of CONTTMAF National Confederation of Workers, Brazil, and Chair of the ITF Sustainable Transport Committee; Mr. Jainal T. Rasul, Undersecretary, Department of Migrant Workers, Philippines; and Mrs. Beatriz Vacotto, Head of the Maritime Unit, International Labour Standards Department, ILO.

The podcast is available at: https://podcast.ilo.org/episode/the-implementation-of-the-maritime-labour-convention-in-times-of-crisis.

FROM IMO

AUTONOMOUS SHIPPING

IMO adopted a new International Code of Safety for Maritime Autonomous Surface Ships (MASS Code) in May 2026, marking a major regulatory milestone for autonomous shipping. The Code will take effect from 1 July 2026.

Technological innovation within the maritime industry is leading to rapid developments that will see the commercial use of autonomous ships, whether controlled remotely or fully autonomous. Such change requires robust regulation to ensure the safety of life at sea, as well as the safety of cargo on board and of the vessel itself.

In 2021, IMO conducted a regulatory scoping exercise on Maritime Autonomous Surface Ships designed to assess how existing IMO instruments might apply to ships using varying degrees of automation. The regulatory scoping exercise (RSE) for safety treaties was finalized at the 103rd session of the MSC in May 2021 and, for treaties under the purview of the Legal Committee, at its 108th session in July 2021. The FAL Committee approved the outcome of the RSE for treaties under its remit at FAL 46 in May 2022.

The scoping exercise was seen as a starting point that touched on an extensive range of issues, including the human element, safety, security, liability and compensation for damage, interactions with ports, pilotage, responses to incidents, and protection of the marine environment.

The outcome highlighted several high-priority issues, cutting across several instruments, that would need to be addressed at a policy level to determine future work. These involved the development of MASS terminology and definitions, including an internationally agreed definition of MASS and clarification of the meaning of the terms “master,” “crew,” and “responsible person,” particularly in Degrees Three (remotely controlled ship) and Four (fully autonomous ship).

Other key issues identified included the need to address the functional and operational requirements of the remote-control station/centre and the possible designation of a remote operator as a seafarer.

Further common potential gaps and themes identified across several safety treaties related to provisions involving manual operations and alarms on the bridge; provisions related to actions by personnel, such as firefighting, cargo stowage and securing, and maintenance; watchkeeping; implications for search and rescue; and information required on board for safe operation.

Available at: https://www.imo.org/en/mediacentre/pressbriefings/pages/imo-adopts-mass-code.aspx.

FROM LLOYD’S REGISTER

GLOBAL MARITIME TRENDS 2050

The maritime industry will transform over the coming decades, driven by technology adoption, the climate agenda, and intensifying geopolitical and macroeconomic shifts.

Global Maritime Trends responds to the demand for robust insights into the drivers of transformation within the industry. With a holistic approach to tackling complex maritime challenges, this initiative provides a clear, data-driven vision of what lies ahead. Powered by comprehensive analysis from the Global Maritime Trends 2050 Report by Economist Impact, the program sets the stage for future maritime scenarios, helping leaders and policymakers make informed decisions about the industry’s future.

Report is available at: https://insights.economistenterprise.com/ocean/global-maritime-trends-2050/.

FROM THE SEAFARERS’ CHARITY

NEW FISH SAFE FILM LAUNCHED

The Seafarers’ Charity launched a new film on its portal: *Stay Afloat — Choosing the Right Lifejacket for Fishing*. Man-overboard incidents remain one of the leading causes of fatalities in the fishing industry. The right lifejacket is a critical last line of defence.

The fact is that one lifejacket does not fit every job at sea, and choosing the right one can make the difference between life and death. Developed with fishers, for fishers, and based on research with UK fishing communities, the film focuses on practical safety at sea.

This new FISH SAFE film explores how comfort, fit, buoyancy, durability, and freedom of movement all influence whether a lifejacket is worn on deck and how effectively it performs when it is needed most.

The full film is available at: https://www.youtube.com/watch?v=SATsdi6ZDKs.

Communication

REPORT ON THE IMHF STRATEGIC DEVELOPMENT WORKSHOP

by Nebojša Nikolić
International Maritime Health Foundation

From May 4 to 5, 2026, the International Maritime Health Foundation held a two-day Conference/Workshop in Bergen, Norway, featuring presentations, strategic discussions, group work, and official governance meetings. During the Workshop, participants delivered individual presentations and contributed to sessions and plenary discussions.

The workshop focused on topics previously identified as priorities, including a review of the implementation and outcomes of the IMHF Strategic Plan 2022–2024/25, followed by open discussion on current challenges and future directions for both the International Maritime Health Foundation and the International Maritime Health Journal.

During the strategy development sessions, participants were divided into two working groups to analyze documents, discuss future priorities, and formulate proposals for the continued development of IMHF activities and the IMH Journal.

On day two of the workshop, official meetings of the IMHF Management Board and the Board of Governors were conducted in closed session, during which the proposals were reviewed, discussed, and formally considered.

Following the event, the rapporteur prepared the final report in accordance with the workshop objectives.

CRUISE SHIP PANAMA CREW FORUM 2026

by Dr. Natasha Diaz and Fulvia Sucre

On April 28, Panama hosted the Cruise Ship Panama Crew Forum 2026, which brought together representatives from the cruise industry, government agencies, maritime organizations, healthcare professionals, students, and others interested in maritime-related professions. The forum provided an opportunity to discuss recent developments in the cruise sector and the workforce challenges facing the industry.

During the discussions, speakers explained how the cruise industry continues to grow and remains an important source of maritime employment worldwide. Although cruise ships represent a small portion of the global commercial fleet, the industry generates many jobs, both onshore and on board. Delegates from leading cruise companies also discussed their efforts to strengthen crew training programs and create opportunities for professional growth and career progression among seafarers.

Several presentations focused on the growing demand for skilled workers within the cruise industry. Speakers noted that the majority of the world's cruise fleet is now managed by a relatively small group of large corporations, which operate under various international brands and employ hundreds of thousands of seafarers worldwide. Participants also highlighted how rapidly the number of mega-cruise and luxury cruise ships has grown over the past decade. To maintain 24-hour operations on board, each new ship requires large multidisciplinary crews. With more than 50 large cruise ships reportedly under construction or on order, the industry will continue to depend heavily on recruitment, training, and workforce development.

From a medical perspective, physicians emphasized that maritime medical examinations should be performed by approved professionals with a thorough understanding of the realities of life at sea. Prolonged periods of isolation, multicultural crews, demanding working hours, and limited medical resources on board can increase health risks for seafarers. For this reason, human resources departments, recruitment agencies, and shipowners must pay particular attention when selecting providers, not only for pre-employment medical examinations (PEMEs), but also for port-based medical care. Inadequate medical assessment and poor clinical management continue to cause avoidable complications, costly evacuations, and, in some cases, deaths. Improving the quality and consistency of maritime medical care promotes crew members' well-being, safety on board ships, and the long-term sustainability of the industry.

The forum illustrated the rapid expansion of the industry and the strong recovery of the cruise sector following the COVID-19 pandemic. The challenge of recruiting and training sufficient qualified personnel to support this growth was emphasized and identified as key during many of the debates. Participants also underscored that the increasing complexity of cruise operations will require a more robust professional support system, including experienced maritime healthcare services capable of meeting the specific medical realities of work and life at sea.

Particulars

DOCKSIDE DIALOGUES: A CHAT WITH MARITIME HEALTH EXPERTS

An interview with Dr. Klaus H. Seidenstücker

Few maritime physicians have had the opportunity to experience the field from as many different perspectives as Dr. Klaus H. Seidenstücker. Over more than five decades, his professional journey has taken him through some of the most challenging, rewarding, and unexpected corners of maritime medicine. The result is a perspective shaped not only by study and observation, but by direct experience. In this edition of *Dockside Dialogues*, Dr. Seidenstücker reflects on the experiences that shaped his career, the lessons he learned along the way, the challenges that continue to face maritime medicine, and the advice he would offer to those entering the field today.

1. You once told me about your lifelong connection with the sea and Germany's maritime regions. Looking back, what first drew you toward maritime and naval medicine, and how much do you think those early influences shaped your professional journey?

I grew up and lived all my life in Germany's coastal areas, with the North Sea on one side and the Baltic on the other — a truly maritime environment indeed. But when I graduated from high school, my choice was to go into medicine, with no idea of tying my profession to the maritime environment. It was not until I left university that my brother-in-law gave me a tour of a naval airwing where he served as a pilot. I then signed up for six years initially, and the Navy sent me for flight surgeon's training in Pensacola, Florida. That was quite an experience to witness how a large navy organizes and executes medicine integrated into a primary military/nonmedical objective. I felt inspired by the way best medical practice was delivered to keep soldiers healthy and at the same time enable them to sustain the demands of their jobs.

2. Your professional journey has spanned so many areas. You have worked across aviation medicine, naval operations, maritime medicine, diving medicine, and NATO operational environments. Looking back, it is remarkable how many different dimensions of maritime and operational medicine you have experienced throughout your career. How did these different experiences shape your understanding of maritime health?

It was the side-by-side experience in situations often remote from medical facilities, and sharing the environment of those we served, that created a unique challenge for me as a physician. This was true in aviation medicine, but even more so during my time with the fast patrol boats in the Baltic.

At the Naval Medical Institute, my work focused on supporting operations and conducting research to identify the health risks of seafaring and develop measures to preserve seafarers' health and well-being. Later, as Command Surgeon of the German Fleet, I was responsible for medical support to fleet operations worldwide, including medical evacuation, equipment, education, and organizational preparedness. Quite often, medical necessities collided with operational demands, and we had to find ways to achieve both medical and operational objectives.
Throughout my naval career I maintained close contact with the civilian maritime medical community. Following retirement, I continued this engagement through IMHA, IMHF, teaching, publishing, and international collaboration. These different exposures over almost fifty years gave me the opportunity to appreciate the broad spectrum of maritime and diving medicine. I carry that experience as a treasure and remain thankful for the opportunity. I only hope I was able to pass some of that knowledge on to the next generation.

3. I hesitate to ask such a personal question, but when you reflect on your professional life, is there anything you wish you had pursued differently, or perhaps opportunities you had to set aside along the way? Also, are there any particular moments, missions, or experiences at sea that remained especially memorable to you?
No, I do not think I missed out on any opportunities. I wish I had been more successful in some areas, but that simply leaves challenges for the next generation. Achieving meaningful improvement in what William Langewiesche and Ian Urbina have described as "the last untamed frontier" remains a formidable task.

4. Maritime medicine has changed so much during our professional lives. Which developments do you consider the most important or transformative during your career?
I sort of doubt that maritime medicine has really changed much during our professional lives. Compared with the progress of medicine in general, the maritime sector still lags behind both its possibilities and the needs of people working and living at sea. Do we truly comply with the requirements of Title 4 of the ILO Maritime Labour Convention?
While shore-based services, including pre-employment medical examinations and port clinics, generally provide care that reflects current medical standards, leaving port still results in a significant decline in the availability and quality of healthcare in almost every respect.
At the same time, we have witnessed remarkable advances in prehospital emergency care that could substantially improve the management of medical events at sea. It would be worthwhile to examine the progress achieved by military medical services in remote medical support, as well as emerging technologies. These include real-time video telecommunication capable of bringing a virtual doctor onboard, wider use of internet-based medical support, and artificial intelligence to assist crews in assessing and responding to medical situations.
Following the military example, this would require shore-based medical structures integrated with, or working closely alongside ship operators and the coordinating centres responsible for offshore installations and sea rescue services.

5. Historically, many of the major institutions and regulatory influences in maritime medicine emerged from Europe. Today, the field is far more globally distributed. In your opinion, what are the greatest challenges maritime medicine is currently facing internationally?
Regulation and enforcement remain major challenges in an environment that operates largely beyond immediate state influence. For those interested in understanding these issues, I would recommend Leon Fink's Sweatshops at Sea and Helen Sampson's Sea-Time. Both provide valuable insights into the realities of maritime labour and the challenges faced by seafarers. We hope initiatives such as the joint SHS–IMHA–IMHF work on key performance indicators may contribute to address some of these longstanding shortcomings.

6. Your career included operational deployments, leadership roles, research, and editorial responsibilities. Which of these roles did you personally find the most rewarding or meaningful?
I couldn't really pinpoint a single period of my life as the most rewarding or meaningful. Each role made its own unique contribution to my professional development, and each new assignment built upon the previous one. Consider it like climbing a mountain, with the last assignment presenting the top (most rewarding?). After retirement, I probably lived from what I had experienced before. But there was still enough new information that kept me busy learning, and probably even today I did not yet arrive on the mountaintop.

7. Throughout your career, you have been deeply involved in professional organizations, international collaboration, and the development of maritime medicine as a specialty. Looking back, are you able to see the impact of those efforts? And what role do you believe organizations such as IMHA and IMHF should play in shaping the future of maritime medicine?

A professional organization is one of the pillars of any medical specialty. It plays a predominant role in defining the content of a specialty and the conditions under which it should exist. Ideally, it should be supported by university representation, research, education, and authoritative textbooks that define the scope and learning objectives of the field.

In this regard, I do see the results of my work. But aside from the military, I continue to observe a serious lack of implementation throughout much of the maritime sector. IMHA and IMHF are important institutions, although their cooperation is relatively new and their respective roles continue to evolve. In my view, the two organizations should cooperate as closely as possible and continue working together to address these shortcomings while engaging with other stakeholders to strengthen both regulation and enforcement. At the same time, each organization can contribute in its own way. IMHF can focus on defining, collecting, and disseminating knowledge, while IMHA can serve as the professional interest group representing maritime health practitioners.

Together, these organizations help maintain the cohesion of the maritime health community and bridge the gap between research and practice. The International Maritime Health journal, conferences, workshops, educational initiatives, and emerging digital platforms all contribute to collecting expertise and carrying knowledge into everyday professional practice. Looking ahead, both organizations should continue to work together and coordinate their representation before international bodies such as IMO, ILO, and potentially WHO. Maritime medicine remains a small specialty facing large challenges, and collaboration will be essential if we are to improve health protection for those who live and work at sea.

8. Many younger physicians today enter maritime medicine through specialized pathways. Do you think something has been gained, or perhaps lost, compared with earlier generations of maritime physicians? Do you think modern maritime medical training provides enough direct exposure to ships, crews, and operational maritime environments? What kinds of experiences do you believe younger maritime physicians benefit from the most?

I am not sure what are the pathways physicians or other medical personnel take to access maritime medicine. Actually, I believe that far too few doctors are attracted to a career in the maritime industry, and IMHA as well as IMHF fail to reach them. Maybe that changes with our web portal and our presence on social media. I am not sure whether we can extend beyond that into the general media and the wider community of services catering to maritime health needs (advice/assistance services, rescue and telemedicine, tele education). We should also establish educational elements at universities, training centres, and similar institutions for doctors as well as medical assistance personnel, thus establishing a standard pathway into maritime medicine.

9. What advice would you give to younger maritime and diving physicians beginning their careers today?

I would advise to 1) join one of the national or (better) international professional organizations; 2) gain some maritime exposure by sailing or, better, taking a tour on board of a ship, an offshore installation or a similar setting; and 3) do some voluntary work in a seafarers' club in their nearest port. If they then make a serious decision to pursue maritime medicine, they should adjust their education and specialty training to that purpose.

10. After such an active professional life, you are now enjoying a quieter life. How has this transition changed your perspective on work, medicine, and life more generally?

I remained actively engaged until health reasons required me to withdraw. My life is now centred around family, home, and garden. It is a much quieter life, less demanding, and I enjoy every minute without obligation.

11. Finally, when you reflect on your professional journey as a whole, what gives you the greatest sense of satisfaction?

The greatest sense of professional satisfaction probably stems from my time at German Fleet Command, where I stayed long enough to establish structures and procedures to bring the full range of preventive as well as clinical medicine to the deck plates, including the procurement and introduction into service of a containerized hospital on board one of our support vessels. It was also gratifying to have all these often very engaged discussions with our line officers about their responsibility for the health and fitness of their crews, and then to see them giving in to the notion of how much health protection would do to help them fulfil their task. And then to have them dropping by (occasionally), when they planned for their next mission and felt that they would benefit from a well-planned medical support.

The most interesting and demanding events I remember: The sinking of a Polish ferry in the Baltic and the ensuing rescue operation. A number of dramatic medevac operations for traumatized and infected crew, including repats of intensive care patients by airplane. The medical evacuation of a crew member from a nuclear submarine in the middle of the Gulf of Arabia. The handling of an outbreak on board of one of our tenders. The detachment of our onboard container-hospital to support the population of Banda Aceh after a tsunami had hit the island.
Also, I shall always remember that flight surgeon training with the US Navy included flight training, and I had to do 20 hours actually flying a small jet plane — Yippiehh! I also had an hour of familiarization in a helicopter. It felt like riding on a plum pudding.

EDITOR'S REFLECTION

Having read and reread Dr. Seidenstücker's responses, I found myself reflecting not only on the breadth of his professional experience but also on the perspective that emerges between the lines. His career spans so many areas, yet throughout this exchange, I was struck by how rarely he focused on positions or achievements. Instead, he returned to service, collaboration, education, and the unfinished work still required to improve health at sea.
Equally striking is his humility. Even when reflecting on his five decades of involvement in maritime medicine, he spoke less about personal accomplishments than about the opportunities he was given and the people with whom he worked. His evident gratitude for the opportunities he encountered, his willingness to embrace new challenges, and his conviction that knowledge must be passed to the next generation merit respect.
For me, it was hard to avoid noticing his deep curiosity, which extends beyond medicine itself. His references to maritime history, labour, regulation, and life at sea reveal a belief that maritime medicine cannot be understood in isolation from the people and environments it serves.
This interview has left me with a lasting impression: Beyond Dr. Seidenstücker's professional titles, organizations, and achievements stands a physician who never lost sight of the human side of maritime medicine and who continues to challenge us to bridge the gap between what is possible and what is actually delivered to those who live and work at sea.

Dr. James A. Denham
Editor, IMH Magazine

BEYOND COMPLIANCE: THE FUTURE OF SEAFARER HEALTH

In his article, Tim Carter examines how healthcare regulations for seafarers have developed over the years and how these changes have helped raise standards across the maritime industry. At the same time, he explains how regulations alone cannot guarantee effective healthcare at sea. He points to continuing problems in the practical application of these rules and discusses the need for better operational data, wider use of telemedicine, and greater involvement of seafarers in managing their own health. The article encourages us to look beyond regulatory compliance and consider how maritime healthcare systems must continue adapting to the realities of modern shipping operations.
The article is available at: https://www.seanews.co.uk/maritime/professor-tim-carter-seafarer-healthcare-rules-have-evolved.

The Decision Deck

In this section of *The Decision Deck*, we explore the operational, ethical, and clinical complexities that arise in maritime and hyperbaric medicine when decisions must be made under uncertainty, resource limitations, or challenging environments. The goal is not to provide definite answers, but to encourage critical thinking and professional discussion around the realities of practice.
Readers and members are invited to contribute to this section. Submissions may include case-based lessons, operational experiences, emerging concepts, decision-making frameworks, ethical dilemmas, and practical approaches relevant to clinicians working in remote, austere, or safety-critical environments.
In the following article, we present a case-based analysis of complex repatriation decision-making in maritime medicine.

STRESS-TESTING THE TRI-THRESHOLD FRAMEWORK IN MARITIME REPATRIATION

In our previous edition of the IMH Magazine, we introduced a Tri-Threshold Decision-Making Framework for seafarer medical repatriation as a structured clinical manual for maritime physicians. The question now is whether such a framework can withstand the complexity of actual clinical practice. Let's look at the following case.

Keywords: Maritime medicine; Telemedical Assistance Service (TMAS); Medical repatriation; Fitness to travel; Occupational fitness; Aeromedical transport; Decision-making; Threshold distortion

A 38-year-old Filipino chief cook on board a vessel presented with a 6-day history of mild tachypnoea, a productive cough, right-sided pleuritic chest pain, and oxygen saturation levels fluctuating between 92% and 98%. Additional oxygen, an antibiotic, and inhaled salbutamol and budesonide were included in the initial care. As the vessel awaited clearance for canal transit, the captain requested a shoreside assessment to rule out pneumonia and determine whether the seafarer could safely continue the transit.

Medical evacuation or repatriation is frequently necessary when the medical condition of a sick or injured seafarer exceeds the diagnostic, therapeutic, or monitoring capabilities available on board a vessel or at the nearest port-based medical facility. Although ships are equipped with medical supplies as required by international regulations, onboard care may be limited for long-term management. In addition, some port-based medical facilities may lack the specialized resources needed to deal with complex cases, making this decision particularly challenging.

The Tri-Threshold Framework serves as a practical cognitive tool for TMAS physicians to assess the need for evacuation or repatriation under operational checks. The three key elements (thresholds) we will evaluate in this case are:

1. Threshold 1: Was the decision for medical disembarkation preferable to continued management on board?
2. Threshold 2: After stabilization, should repatriation be delayed pending further studies?
3. Threshold 3: Does being fit to travel also mean being fit for maritime duty?

Threshold 1

After disembarkation, the patient was taken to a secondary-level hospital, where simple chest imaging revealed a large right pleural effusion and probable collapse of the right lung. Due to the severity of these findings, he was transferred to a tertiary care centre for further evaluation by a pulmonologist and thoracic specialist. A chest CT scan was performed, confirming a massive right pleural effusion and near-complete collapse of the right lung, indicating a chronic pulmonary condition. A pleural drain was inserted, evacuating more than 3 litres of fluid. Following this procedure, the patient required close monitoring in a step-down unit or ICU. This demonstrated that the first threshold had been crossed, not due to the certainty about a definitive diagnosis, but because onboard medical capabilities were no longer adequate to safely manage the patient's worsening respiratory condition.

Threshold 2

Over the following days, the patient's respiratory status gradually improved, leading to a decrease in oxygen requirements and a reduction in pleural drainage. A bronchoscopy was performed, and biopsies were taken. Discussions with the shipping company regarding repatriation planning also began. At one point, the treating physician tentatively considered the patient "fit to fly" under strict travel precautions. However, because ongoing assessments showed persistent oxygen dependence, unresolved pleural disease, and a continued risk of respiratory decompensation during air travel, travel clearance had to be deferred. Although the patient showed clinical improvement, this did not indicate that he was stable enough for transport. This situation highlighted the importance of resisting premature transfer decisions based on excessive optimism or apparent short-term recovery.

Threshold 3

The case illustrated that assessing fitness to travel is fundamentally different from determining fitness for maritime duty. Although medical repatriation remained an option after the patient's stabilization, it was evident that the individual had become unfit for continued maritime service much earlier in the clinical course. This was due to respiratory failure, dependence on oxygen, a suspected diagnosis of lung cancer, and severe pulmonary compromise.

While this case raised several challenging questions — such as how long a decision to wait can remain acceptable before it becomes harmful, whether the risk of transport is always greater than the risks associated with continued hospitalization, who defines acceptable risk, and how access to air ambulance transport might alter the clinical equation — one point became clear: in maritime medicine, the ability to tolerate transport should not be mistaken for the ability to safely return to a safety-critical occupational environment.

CONCLUSION

This case illustrates how various factors, such as diagnostic uncertainty, operational pressure, patient expectations, and changes in physiology, can distort the perception of clinical risk during decisions about maritime repatriation. The tri-threshold framework can help maintain decision integrity by clearly distinguishing between the need for evacuation, stabilization for transport, and determination of occupational fitness. Furthermore, it demonstrates that these thresholds may overlap in time rather than occurring in a strictly sequential order.

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Letter to the Editor

Dear Editor,

The IMH journal's Magazine has become an integral part of the IMH Foundation's mission to disseminate knowledge to those carrying responsibility for the health of people at sea! The recent issue — once again — features an extensive CME component. It therefore goes beyond mere information and into education.

While the former may have more immediate relevance, the latter certainly has a longer-lasting impact and probably matches that of the articles in the scientific part of the journal. It would be wise to publish such magazine articles in a way that allows for easy retrievability through literature searches.

Some comments on the magazine's section on repatriation:

— The term "Journal Club" usually refers to a journal article and briefly reflects its content while adding a comment.
— For clarity, it would be necessary to distinguish between "medical evacuation" and "repatriation for medical reasons." The former usually involves first aiders on board, TMAS, and maritime rescue services, whereas the latter additionally involves maritime medical support services and organizational elements such as those mentioned in the article. It would probably be wise to publish another CME article on medical evacuation.
— Under "limitations," it is necessary not only to acknowledge limited skills and equipment — although there may be doctors on board — but also to recognize the limitations faced by TMAS and others ashore in establishing a clear picture of the situation and interacting with actors on site.
— The situation also deserves consideration of legal responsibility. It must be clear that TMAS — as the name implies — offers advice. Decision-making lies with those carrying general responsibility on site (and, perhaps, in shore-based ship operation centres). In long-haul repatriation, especially for patients in need of medical attention, the use of a medical support service should be mandatory.

To finish with an outlook: the magazine, and perhaps the journal's scientific part, might consider reflecting further on technological progress and how, for instance, wearable sensors, real-time video, and possibly artificial intelligence can help ease the present problems of managing medical problems far from specialized medical facilities.

Dr. med. Klaus H. Seidenstücker

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INFORMATION FOR AUTHORS

The International Maritime Health will publish original papers on medical and health problems of seafarers, fishermen, divers, dockers, shipyard workers and other maritime workers, as well as papers on tropical medicine, travel medicine, epidemiology, and other related topics.

Typical length of such a paper would be 2000–4000 words, not including tables, figures and references. Its construction should follow the usual pattern: abstract (structured abstract of no more than 300 words); key words; introduction; participants; materials; methods; results; discussion; and conclusions/key messages.

Case Reports will also be accepted, particularly of work-related diseases and accidents among maritime workers.

All papers will be peer-reviewed. The comments made by the reviewers will be sent to authors, and their criticism and proposed amendments should be taken into consideration by authors submitting revised texts.

Review articles on specific topics, exposures, preventive interventions, and on the national maritime health services will also be considered for publication. Their length will be from 1000 to 4000 words, including tables, figures and references.

Letters to the Editor discussing recently published articles, reporting research projects or informing about workshops will be accepted; they should not exceed 500 words of text and 5 references.

There also will be the section Chronicle, in which brief reports will be published on the international symposia and national meetings on maritime medicine and health, on tropical parasitology and epidemiology, on travel medicine and other subjects related to the health of seafarers and other maritime workers. Information will also be given on training activities in this field, and on international collaborative projects related to the above subjects.

All articles should be submitted to IMH electronically online at www.intmarhealth.pl where detailed instruction regarding submission process will be provided.

Only English texts will be accepted.

Manuscripts should be typed in double line spacing on numbered pages and conform to the usual requirements (Ref.: International Committee on Medical Journals Editors. Uniform Requirements for Manuscripts Submitted to Biomedical Journals, JAMA, 1997; 277: 927–934).

Only manuscripts that have not been published previously, and are not under consideration by another publisher, will be accepted.

Full texts of oral presentations at meetings (with abstracts printed in the conference materials) can be considered.

All authors must give written consent to publication of the text.

Manuscripts should present original material, the writing should be clear, study methods appropriate, the conclusions should be reasonable and supported by the data. Abbreviations, if used, should be explained.

Drugs should be referred to by their approved names (not by trade names). Scientific measurements should be given in SI units, except for blood pressure, which should be expressed in mm Hg.

Authors should give their names, addresses, and affiliations for the time they did the work. A current address of one author should be indicated for correspondence, including telephone and fax numbers, and e-mail address.

All financial and material support for the reported research and work should be identified in the manuscript.

REFERENCES

References should be numbered in the order in which they appear in the text. At the end of the article the full list of references should give the names and initials of all authors (unless there are more than six authors, when only the first three should be given followed by: et al.).

The authors' names are followed by the title of the article; the title of the journal abbreviated according to Medline; the year of publication, the volume number; and the first and last page numbers. **Please note:** References you should include DOI numbers of the cited papers (if applicable) – it will enable the references to be linked out directly to proper websites. (e.g. Redon J, Cifkova R, Laurent S et al. Mechanisms of hypertension in the cardiometabolic syndrome. J Hypertens. 2009; 27(3): 441–451, doi: 10.1097/HJH.0b013e32831e13e5.).

Reference to books should give the title, names of authors or of editors, publisher, place of publication, and the year.

Information from yet unpublished articles, papers reported at meetings, or personal communications should be cited only in the text, not in References.

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