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CONTENTS

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The relationship between individual characteristics and musculoskeletal disorders in tuna fishermen in Pelita Jaya Hamlet, West Seram Regency, in 2024

Jeremy Theophilus Mailuhu, Parningotan Yosi Silalahi, Samuel Maruanaya, Bertha Jean Que, Is Ikhsan Hataul, Nathalie Elischeva Kailola, Marthen Yoseph Matakupan

Faculty of Medicine, Universitas Pattimura, Ambon, Indonesia

ABSTRACT

Background: *Indonesia is a country with vast marine areas. It is also part of the world's coral reef triangle, which means that Indonesia has various types of coral reef species. This gives Indonesia a very strong maritime potential. Consequently, many Indonesians work as fishermen. In Pelita Jaya Hamlet, the majority of people work as tuna fishermen. Fishing is a job with high physical activity, so fishermen have the potential to experience musculoskeletal disorders. Musculoskeletal disorders are problems that occur in the human muscular and skeletal systems, characterized by pain, numbness, and limited movement.*

Material and methods: *This was an analytical observational study with a cross-sectional design approach, involving a sample of 68 people.*

Results: *Based on the analysis of this study, there was no significant relationship between individual characteristics and musculoskeletal disorders, with a p value of 0.808 for age, 0.190 for BMI, 0.357 for work duration, 0.618 for work period, and 0.733 for smoking habits (> 0.05). However, a significant relationship was found between age and musculoskeletal disorders of the back, with a p value of 0.028.*

Conclusions: *There is no significant relationship between individual characteristics and musculoskeletal disorders, However, there is a significant relationship between age and disorders of the back in tuna fishermen in Pelita Jaya Hamlet, West Seram Regency.*

(Int Marit Health 2025; 76, 4: 241–246)

Keywords: musculoskeletal disorders, tuna fisherman, Nordic Body Map

INTRODUCTION

Musculoskeletal disorders are one of the factors that cause many people to experience decreased productivity. According to data from the World Health Organization (WHO) [1], in 2019, around 1.7 billion people were affected by musculoskeletal disorders, making them the leading cause of disability worldwide. Information from the Maluku Provincial Health Office [2] indicates that musculoskeletal disorders rank third among all diseases in Maluku Province, with a total of 4,000 cases reported in 2022. Occupational factors can contribute to musculoskeletal disorders, with the fishing profession occupying the 4th position in terms of prevalence in Indonesia [3].

Jeremy Theophilus Mailuhu, Faculty of Medicine, Universitas Pattimura, 85VQ+H7J, Poka, Kec. Tlk. Ambon, Kota Ambon, Maluku, 97233 Ambon, Indonesia, e-mail: jeremytheophilus26@gmail.com

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Indonesia is one of the countries that has great opportunities in the field of fisheries because it has a large marine area and is the largest archipelago in the world [4]. This is one of the reasons why many Indonesians, around 2 million people, work as fishermen [5]. The high fish production in Indonesia is also linked to the fact that it is part of the coral triangle [6].

Maluku is a province located in the center of the coral triangle, giving it great opportunity in the field of fisheries. This is evidenced by the high production of tuna fish in Maluku Province, which ranks second in Indonesia for tuna production [7]. This demonstrates that the fisheries sector in Maluku Province can significantly improve people's welfare, leading many to work as fishermen. Approximately 157 thousand people in Maluku Province are employed as fishermen [5].

The high incidence of musculoskeletal disorders in Maluku Province correlates with the large number of people in Maluku Province who work as fishermen. The same situation exists in Pelita Jaya Hamlet in West Seram Regency. Based on preliminary data,, the majority of people in Pelita Jaya Hamlet are tuna fishermen because the natural resources from the sea are far greater and more abundant than those from land.

People in Pelita Jaya Hamlet who work as tuna fishermen use traditional methods that only use bamboo and hooks. The catch begins by spreading live bait first around the boat, then when the tuna approaches and eats the hooks owned by fishermen, they will quickly pull and throw the fish into the boat. The existence of strenuous physical activity carried out in a certain position for a long time and light physical activity carried out not only once in a long period of time can be a contributing factor to the occurrence of musculoskeletal disorders [8]. In addition, musculoskeletal disorders can also be influenced by individual characteristics that is age, work period, work duration, work environment that does not facilitate ideal body posture, smoking habits. These things make tuna fishers in Pelita Jaya Hamlet have many risk factors for experiencing musculoskeletal disorders [8]. The objectives of this study are to determine the individual characteristics [age, work duration, work period, smoking habits and body mass index (BMI)] of tuna fishers in Pelita Jaya Hamlet, West Seram Regency, to determine the characteristics of the location of musculoskeletal disorders based on the Nordic Body Map (NBM) in tuna fishermen in Pelita Jaya Hamlet, West Seram Regency, to determine the relationship of individual characteristics (age, work duration, work period, smoking habit and BMI) with musculoskeletal disorders in tuna fishermen in Pelita Jaya Hamlet, West Seram Regency. The research hypotheses is that there is a relationship between individual characteristics and musculoskeletal disorders in these fishermen.

MATERIAL AND METHODS

Respondents in this study totaled 68 people, tuna fishermen in Pelita Jaya Hamlet (one of the hamlets located in West Seram Regency). They only worked as tuna fishermen, ensuring the study results were not biased by other occupations. Respondents were asked to sign a consent form and fill out a questionnaire. The research was conducted at the fish harbor in Pelita Jaya Hamlet from May to June 2024. The questionnaire was divided into 2 parts: the first part recorded individual characteristics (age, BMI, work duration, work period, and smoking habits), while the second part, the Nordic Body Map (NBM) section, recorded the location and intensity of musculoskeletal pain in the patient's body. Respondents answered the questions in the presence of the researcher [9]. The researchers recorded the answers and the results were input into Microsoft Excel. The data were later analyzed using the Statistical Package of the Social Sciences (SPSS) version 25 program, with the chi-square test. For data that did not meet the chi-square requirements, the Fisher test was used.

METHOD DECRIPTION

This study aimed to determine whether respondents experienced musculoskeletal disorders, characterized by pain in their muscles, bones or joints, and to investigate the relationship between these musculoskeletal disorders and the individual characteristics of patients (age, BMI, work duration, length of work, and smoking habits). Musculoskeletal disorders in patients were measured using the NBM questionnaire, which assessed the location and intensity of pain felt by respondents after work (performing physical activity as a fisherman). The pain intensity in this questionnaire is categorized into 4 levels: no pain, mild pain, pain and severe pain. The pain location was determined by dividing the body into 28 parts starting from the upper neck to the feet. The data analysis involved correlating the individual characteristics of the respondents with the musculoskeletal disorders they experienced. To fulfill the requirements of the chi-square test, researchers focused on the 3 body parts with the highest incidence of musculoskeletal disorders and combined the categories of mild pain, pain and severe pain.

ETHICAL CONSIDERATIONS

Ethical permission to conduct research titled "The Relationship between Individual Characteristics and Musculoskeletal Disorders in Tuna Fishermen in Pelita Jaya Hamlet, West Seram Regency in 2024" was obtained from the Ethics Commission of the Faculty of Medicine, Pattimura University (letter of recommendation for ethical approval to conduct research in Pelita Jaya Hamlet, ref. 038/FK-KOM. ETIK/VII/2024. IX/4040, 05 July 2022).

RESULTS

Based on Table 1, respondents were evenly distributed between the two age categories, with 34 people in each. The majority of respondents fell into the obesity category in terms of BMI (29 people). Most respondents worked at least 8 hours a day (63 people), and the majority had been working for 11–20 years (29 people). In terms of smoking habits, most respondents were classified as heavy smokers (39 people).

Based on the Table 2, most tuna fishermen are experienced musculoskeletal disorders in the right shoulder (52 people), followed by the left shoulder (38 people) and the back (23 people).

In this study, the independent variables were individual characteristics (age, BMI, work duration, length of work, smoking habits), while the dependent variable was musculoskeletal disorders in tuna fishermen, based on the three locations with the highest pain frequency according to the NBM. For data analysis, the categories of mild pain, pain and severe pain were grouped into one category.

Based on the Table 3, the results of data tests related to age showed the following p values: $p = 0.808$ ($p > 0.05$) the left shoulder, $p = 0.190$ ($p > 0.05$) for the right shoulder, and $p = 0.028$ ($p < 0.05$) for the back. For BMI, the p values were $p = 0.190$ ($p > 0.05$) for the left shoulder, $p = 0.104$ ($p > 0.05$) for the right shoulder, and $p = 0.204$ ($p > 0.05$) for the back. For work duration the p values were $p = 0.357$ ($p > 0.05$) for the left shoulder, $p = 0.656$ ($p > 0.05$) for the right shoulder, and $p = 0.602$ for the back. For work period, the p values were $p = 0.618$ ($p > 0.05$) for the left shoulder, $p = 0.506$ ($p > 0.05$) for the right shoulder, and $p = 0.602$ ($p > 0.05$) for the back. For smoking habits the p values were $p = 0.733$ ($p > 0.05$) for the left shoulder, $p = 0.894$ ($p > 0.05$) for the right shoulder, and $p = 0.279$ ($p > 0.05$) for the back. From this information, it can be concluded that there is no relationship between individual characteristics and musculoskeletal disorders in respondents. However, there is a relationship between one of the individual characteristic variables (age) with one of the musculoskeletal disorder variables (back).

Table 1. Individual characteristics of tuna fishermen in Pelita Jaya Hamlet

Characteristics		Amount	
		n = 68	% = 100
Age	Adult	34	50.0
	Elderly	34	50.0
BMI	Normal	17	25.0
	Overweight	22	32.4
	Obesity	29	42.6
Work duration	Less than 8 hours	5	7.4
	More than or equal to 8 hours	63	92.6
Work period	1–10 year	17	25.0
	11–20 year	29	42.6
	> 20 year	22	32.4
Smoking habits	Non smokers	8	11.8
	Light smokers	21	30.9
	Heavy smokers	39	57.4

BMI — Body Mass Index

Table 2. Characteristics of musculoskeletal disorders based on Nordic Body Map from highest to lowest frequency

Characteristics	Amount	
	n = 68	% = 100
Right shoulder	52	76.5
Left shoulder	38	55.9
Back	23	33.9
Waist	22	32.4
Right upper arm	18	26.5
Left upper arm	13	19.2
Upper neck	9	13.3
Hips	9	13.3
Buttocks	9	13.3
Right wrist	8	11.8
Right elbow	6	8.9
Left wrist	6	8.9
Left hand	6	8.9
Left thigh	6	8.9
Right thigh	6	8.9
Left calf	6	8.9
Right hand	5	7.4
Right calf	5	7.4
Left feet	5	7.4
Left elbow	4	5.9
Left forearm	4	5.9
Right forearm	4	5.9
Left knee	4	5.9
Right feet	4	5.9
Right knee	3	4.5
Left ankle	2	2.95
Right ankle	2	2.95
Lower neck	0	0.0

Table 3. Relationship between individual characteristics and musculoskeletal disorders in tuna fishermen

Individual characteristic		Musculoskeletal disorders											
		Left shoulder				Right shoulder				Back			
		No pain	Pain	Total	*p* value	No pain	Pain	Total	p value	No pain	Pain	Total	p value
Age	Adult	17	17	34	0.808	8	26	34	0.120	29	5	34	0.028
	Elderly	18	16	34		14	20	34		21	13	34	
	Total	35	33	68		22	46	68		50	18	68	
BMI	Normal	12	5	17	0.190	9	8	17	0.104	15	2	17	0.240
	Overweight	10	12	22		5	17	22		16	6	22	
	Obesity	13	16	29		8	21	29		19	10	29	
	Total	35	33	68		22	46	68		50	18	68	
Work duration	< 8 hours	4	1	5	0.357	2	3	5	0.656	3	2	5	0.602
	≥ 8 hours	31	32	63		20	43	63		47	16	63	
	Total	35	33	68		22	46	68		50	18	68	
Work period	1–10 years	7	10	17	0.618	4	13	17	0.506	13	4	17	0.787
	11–20 years	16	13	29		9	20	29		22	7	29	
	> 20 years	12	10	22		9	13	22		15	7	22	
	Total	35	33	68		22	46	68		50	18	68	
Smoking habits	Non smokers	3	5	8	0.733	2	6	8	0.894	6	2	8	0.279
	Light smokers	11	10	21		7	14	21		18	3	21	
	Heavy smokers	21	18	39		13	26	39		26	13	39	
	Total	35	33	68		22	46	68		50	18	68	

BMI — body mass index

DISCUSSION

CHARACTERISTICS OF MUSCULOSKELETAL DISORDERS BASED ON NORDIC BODY MAP

Based on observations made by researchers, tuna fishers often perform shoulder flexion movements to lift fish from the sea to the boat. This shoulder flexion and extension movement occurs due to activation of the deltoideus muscle, which pulls the hand from below towards the top. Repeated activation with a high frequency coupled with a load can injure the deltoideus muscle, causing pain in the shoulder. Additionally, the majority of fishermen are right-handed, so the right side shoulder muscles are more at risk of musculoskeletal disorders [10]. Furthermore, fishermen often sit on the side of the boat and lift fish from the sea, which causes compression on the back. This compression can lead to back pain [8].

RELATIONSHIP BETWEEN AGE AND MUSCULOSKELETAL DISORDERS

H_0 is accepted and H_a is rejected. However, there is a significant relationship between age and back pain, which means H_0 is rejected and H_a is accepted. This is in line with research conducted by Aulia Tjahayuningtyas [11], who stated that there was no significant relationship between age and musculoskeletal disorders. Similarly, Ninik Nur Wulandari [12] found no relationship between age and musculoskeletal disorders. However, the relationship between age and back pain is consistent with research conducted by Syalsabila [13], who reported a relationship between age and back pain complaints.

Based on the results of conversations during data collection, there was no relationship between age and musculoskeletal disorders in the shoulder. This could be due to the fact that the majority of tuna fishermen have been engaged in physical activity since a young age, resulting in good muscle endurance. This aligns with Apri Agus [14], who noted that fishermen's habit of performing physical activities from a young age helps maintain muscle and bone endurance. However, as age increases, there is a decrease in bone stability and muscle strength. Unlike the shoulder muscles, which are directly trained by fishermen, the back muscles are not. This leads to weakening of the back muscles with age, causing back pain [13].

RELATIONSHIP BETWEEN BODY MASS INDEX AND MUSCULOSKELETAL DISORDERS

H_0 is accepted and H_a is rejected. The test results indicate that there is no significant relationship between BMI and musculoskeletal disorders in tuna fishermen in Pelita Jaya Hamlet, West Seram Regency. This finding is consistent with research conducted by Fanjaniaina Sophia et al. [15], which also found no significant relationship between BMI and musculoskeletal disorders.

Based on theory, BMI can cause musculoskeletal disorders due to the body's inability to support its own body weight [16]. However, discussions with tuna fishermen in Pelita Jaya Hamlet revealed that they consistency eat healthy foods, such as boiled fish and green vegetables, which are high in protein and low in fat. This diet can aid the muscle recovery process and may influence the relationship between BMI and musculoskeletal disorders [17].

RELATIONSHIP BETWEEN WORK DURATION AND MUSCULOSKELETAL DISORDERS

H_0 is accepted and H_a is rejected. The test results indicate that there is no significant relationship between work duration and musculoskeletal disorders in tuna fishermen in Pelita Jaya Hamlet, West Seram Regency. This finding is consistent with research conducted by Atthariq Wahab [18], which also found no significant relationship between duration of work and musculoskeletal disorders.

Based on the researchers' observations, the duration of work of tuna fishermen is not related to musculoskeletal disorders due to the variable nature of their working hours. Working hours of more than 8 hours are calculated from the time they leave the dock until they finish unloading. However, if calculated only when fishing activities, the duration of work is only 1–2 hours. This may explain the absence of a significant relationship between work duration and musculoskeletal disorders.

RELATIONSHIP BETWEEN WORK PERIOD AND MUSCULOSKELETAL DISORDERS

H_0 is accepted and H_a is rejected. The test results indicate that there is no significant relationship between work period and musculoskeletal disorders in tuna fishermen in Pelita Jaya Hamlet, West Seram Regency. This finding is consistent with research conducted by Faridah F. [19], which also found no significant relationship between work period and musculoskeletal disorders.

Based on the discussions with tuna fishermen, it was found that their bodies adjust to the activities they perform. This is in accordance with Krisdianto's [20] observation that there is no relationship between tenure and musculoskeletal disorders, due to physical adjustment to prolonged physical activities.

RELATIONSHIP BETWEEN SMOKING HABITS AND MUSCULOSKELETAL DISORDERS

H_0 is accepted and H_a is rejected. The test results indicate that there is no significant relationship between smoking habits and musculoskeletal disorders in tuna fishermen in Pelita Jaya Hamlet, West Seram Regency. This

finding is consistent with research conducted by Krisdianto [20], which also found no significant relationship between smoking habits and musculoskeletal disorders.

Smoking habits can contribute to musculoskeletal disorders. However, based on the results of data collection conducted by researchers, the number of non-smoking fishermen is significantly lower than those who smoke. Most of the fishermen who smoke fall into the mild and moderate categories, with only a small number classified as heavy smokers. This distribution may affect the results of this study. Additionally, the impact of smoking is typically chronic, so the symptoms may not have manifested at the time of the study [20].

CONCLUSIONS

The individual characteristics of tuna fishermen in Pelita Jaya Hamlet are mostly in the adult age category with a BMI classified as ist obesity. Most work duration exceed 8 hours a day, with a work period of around 11–20 years, and the majority of smokers fall into the heavy smoker category. According to the NBM questionnaire, tuna fishermen most commonly experience musculoskeletal disorders in the right shoulder, left shoulder and back. There is no significant relationship between individual characteristics and musculoskeletal disorders in tuna fishermen in Pelita Jaya Hamlet, West Seram Regency, as indicated by a p value > > 0.05 in the relationship between age, BMI, work duration, work period, and smoking habits with left shoulder, right shoulder, and back. However, there is a significant relationship between age and back pain, with a p value < 0,05.

ARTICLE INFORMATION AND DECLARATIONS

Author contributions: PYS — contributed to the conceptualization, contributed to study methodology, provided advice on data analysis, reviewed and edited the final manuscript; MYM — contributed to the conceptualization, contributed to study methodology; JTM — contributed to study methodology, performed formal analysis, prepared the original draft of the manuscript, contributed to the data analysis and writing of the original draft, reviewed and edited the final manuscript; SM — contributed to study methodology, provided advice on data analysis, reviewed and edited the final manuscript; BJQ — provided advice on data analysis; IH — provided advice on data analysis; NEK — provided advice on data analysis. All authors have read and approved the final manuscript.

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ORIGINAL ARTICLE

Chest radiography in dockworkers

Anselmo López-Guillén[1, 2], Sergio Rovira[2], Beatriz Calvo[1], Amador Prieto[2, 3], Alicia Mesa[2, 3], Maria Luisa Canals[4], Pere Sanz-Gallen[1]

[1]Unit of Occupational Medicine and Toxicology, School of Medicine and Health Sciences of Barcelona, University of Barcelona, Barcelona, Spain
[2]4LAR-Laboral Advanced Radiology, Barcelona, Spain
[3]Radiology Department, Hospital Universitario Central de Asturias, Oviedo, Spain
[4]Sociedad Española de Medicina Marítima (SEMM)/University of Cadiz-FundUCA/MAHRE-net Medicina Marítima, Tarragona, Spain

ABSTRACT

Background: *Dockers are occupationally exposed to respirable particles derived from organic dust, inorganic dust and/or diesel combustion particles.*

Objective: *To analyse chest radiological findings in a group of dockworkers and the influencing factors.*

Material and methods: *Descriptive study of dockers in a port whose main activity is loading and unloading sand. Applying the specific Health Surveillance Protocol for exposure to silicosis, chest X-rays were taken in situ with a mobile unit. Radiographic data taken between 2016 and 2023 are included. The interpretation of the images was performed according to the ILO Guidelines, by radiologists with expertise in this technique.*

Results: *Of the 268 workers (258 men and 10 women), with a median age of 40 years and an average length of service of 16 years, 43% were smokers and 18% were ex-smokers. Chest radiological abnormalities were observed in 22 workers (8.2%), all males. There were no cases of silicosis. Profusion 1/0 was observed in 5 workers (all smokers, in 4 the profusion changed from 0/1 in 2019 to 1/0 in 2023 and in 1 it was detected in the initial health examination) and in 6 the profusion was 0/1. The rest of the alterations are findings in soft tissue, skeleton or residual pleuroparenchymal lesions.*

Conclusions: *The absence of established silicosis indicates that the preventive measures carried out in this group are effective. Of the relevant radiological findings, two are possible tumours and in cases of progression of images suggestive of pneumoconiosis, all of them are smokers. It is necessary to insist on anti-smoking campaigns among workers.*

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Keywords: naval medicine, dockers, pneumoconiosis, silicosis, epidemiology, diagnostic imaging, chest X-ray, sand, clays

INTRODUCTION

Stevedores are workers in seaports, responsible for the loading and unloading of goods from ships or vessels, using specialised machinery to move these cargoes. They carry out transport, planning, coordination, supervision, and repair and are responsible for handling cargo safely and efficiently to ensure their stability. Their work is key to the movement of the national and international markets. Generally speaking, they have safety, ergonomic, psychosocial and hygienic (physical and chemical) risk factors [1, 2]. In the course of their work they may inhale chemicals and respirable environmental particles, including those from organic dust (grain, seeds), fumigants (methyl bromide, phosphine, formaldehyde, chloropicrin, 1,2-dichloroethanol, ethylene oxide) [3], inorganic dust (crystalline silica, asbestos) [4, 5] and diesel combustion particles from vehicles used in the working environment [6].

Pere Sanz-Gallen, Unit of Occupational Medicine and Toxicology, School of Medicine and Health Sciences of Barcelona, University of Barcelona, C/Casanova, 146, 08036 Barcelona, Spain, e-mail: 17039psg@comb.cat

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It is well known that any process involving the earth moving of silica-containing products can expose workers to free crystalline silica particles. In dockworkers, exposure to these respirable environmental particles occurs in the performance of sand loading-unloading and sandblasting tasks. In their working environment, dockworkers are also exposed to other environmental chemical agents which, due to their physic-chemical characteristics, are considered potentially hazardous to health and have toxic and carcinogenic effects. These include mineral fibres and asbestos fibres (in insulation work), vapours (from spraying paints, coatings, solvents and thinners), particulate emissions (from autogenous welding, cutting and soldering with bronze or tin) and gases (generated from various welding, cutting and heating processes), products from the chemical industry (cutting and heating processes), toxic chemicals (lead paints, oils, greases, pigments, epoxy resins, tin and copper paints, organic solvents among others), and mainly used in spaces where ventilation is insufficient [7–10].

In the so-called "ceramic triangle" (Fig. 1), located between Vila-real, Onda and l'Alcora, in the province of Castelló, 80% of the Spanish ceramic industry is concentrated, with sands and clays being the main raw materials used in its manufacture. Most of this material is loaded and unloaded in the nearby port of Castelló, constituting a large percentage of the overall activity in this port.

Figure 1. Geographical location of the Ceramic Triangle (Castelló, Spain)

The dockers of this port carry out, as part of their work activity, tasks of unloading oil and oil derivatives, as well as loading and unloading of raw bulk (sands). These specific tasks are likely to suspend respirable crystalline silica dust (RCS), which can be inhaled by this group of professionals and reach the pulmonary alveoli. Inhalation of RCS is associated with the development of lung diseases such as silicosis (Fig. 2) and lung cancer (Fig. 3), among others. In this group of workers, previous asbestos exposure, frequent in the past, must be assessed, and diaphragmatic pleural plaques are very characteristic of such exposure (Fig. 4).

It should be noted that to date there are no reliable figures on the working population exposed to inhalation of crystalline silica, so the real prevalence of silicosis is unknown, even more so in dockworkers.

Among the risk factors that influence the development of silicosis are extrinsic factors (characteristics of the dust, shape and size of the particles, duration and intensity of exposure) and individual factors (individual susceptibility due to genetic causes, smoking, lung diseases, etc.).

As established by current Spanish regulations [11], silicosis is classified as an occupational disease in jobs where there is exposure to inhalation of free silica dust. Although work activity in the ceramics industry is included in the list of occupational diseases, neither port activity nor dockers are specifically mentioned, but dry work, crushing, sieving and handling minerals or rocks are included, where dockers could be included.

The adoption of preventive measures has proved to be very effective in preventing silicosis and, for this reason, the national and international bodies involved, as well as trade unions and employers' associations, have drawn up guides and guidelines aimed at disseminating the accumulated knowledge about the disease and emphasising prevention as the essential tool for eliminating or reducing the disease [12, 13].

There is abundant literature on the prevalence and incidence of pneumoconiosis in different occupational activities. However, after a review of the literature in the PubMed/MEDLINE, Web of Science and Scopus databases, no scientific studies on the incidence of silicosis in dockworkers were found.

OBJECTIVE

The main objective of this study is to describe the abnormal findings found in chest X-rays of a group of dockworkers associated with exposure to inhalable environmental particles in the work environment, especially crystalline-free silica. The secondary objective is to identify the factors influencing these findings.

Figure 2. Illustrative radiographic image of progression to 1/0

Figure 3. Illustrative radiographic image suspicious of lung cancer in the right lung midfield

MATERIAL AND METHODS

This is a cross-sectional longitudinal descriptive study. The study population consisted of active dockworkers from several companies in the port of Castelló, Spain, to whom the specific health surveillance protocol [12] for exposure to inorganic dust due to inhalation of respirable crystalline silica was applied, with the corresponding posteroanterior and lateral chest radiographs (X-rays). Dockers with X-rays taken between 2016 and 2023 were included.

These X-rays were taken with the frequency recommended by the protocol, *in situ*, using a mobile unit travelling to the workplaces, which has radiological equipment with a direct digital acquisition technique.

The interpretation of the radiological images was carried out by radiologists with experience in occupational

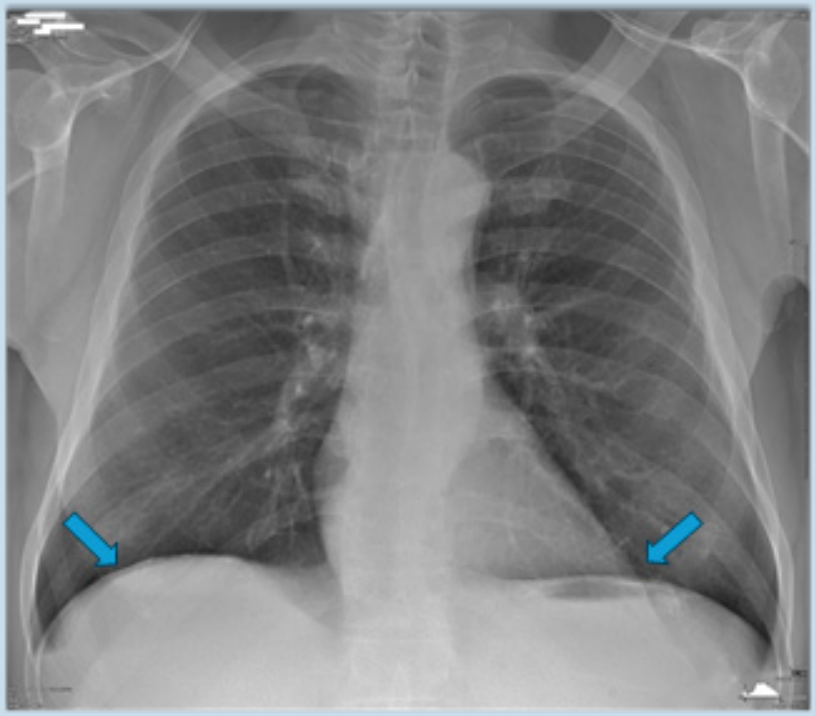

Figure 4. Illustrative radiographic image of pleural plaques (arrows)

pneumology, using screens and elements necessary for proper reading (viewfinders and screens ≥ 3 Mpx). Both the capture (acquisition) of the images and their reading and interpretation were carried out by the guidelines of the International Labour Office (ILO) [13]. Methodological quality criteria were applied and the following characteristics were assessed: radiological technique, parenchymal alterations (shape and size, extension, profusion in twelve categories), pleural abnormalities and symbols. Following the specific surveillance protocol for silicosis of the Ministry of Health, the diagnosis of silicosis is established when the profusion of images is 1/1 or higher [12].

The dependent variable was the radiological alteration detected on chest X-ray (normal, profusion 0/1, 1/0, 1/1 or higher, other abnormal). Independent variables were age (< 30 years, 30–39, 40–49, 50–59 and > 60 years), sex (male, female), years of exposure (< 10 years, 10–20 and > 20 years), smoking (no, yes, ex-smoker). The statistical package SPSS v.25 was used to analyse the results.

Table 1. Description of the population included in the analysis (n = 268)

Variable	Number	Proportion [%]
Sex		
Male	258	96.3
Female	10	3.7
Age [median, years]	40	
Average time worked [mean, years]	16	
Smoking habit:		
Yes	104	39
No	115	43
Former smokers	49	18
Chest X-ray result:		
Normal	246	91.8
Abnormal	22	8.2
Total	268	100

RESULTS

Table 1 shows some characteristics of the study population, sex, age, and years of exposure and smoking habits. The population studied is 268 workers (258 men and 10 women), and the median age is 40 years, with the age group over 40 years being the most prevalent (74.75%). The average length of service is 16 years. There was a higher proportion of smokers (43%) and ex-smokers (18%), while the proportion of non-smokers was 39%. 22 (8.2%) were found to have radiological findings, all of them in men.

In workers with abnormal radiological findings (n = 22), as shown in Tables 2 and 3, the median age is 40 years, with

Table 2. Descriptive analysis of workers with radiological findings (n = 22)

Variable	Number	Proportion [%]
Sex:		
Males	22	100
Females	0	0
Age range [years]		
30–39 years	13	59.1
40–49 years	5	22.7
50–59 years	3	13.6
> 60 years	1	4.6
Average time worked [mean, years]:	13.6	
< 10 years	4	18.2
10–20 years	16	72.7
> 20 years	2	9.1
Chest X-ray abnormalities (n = 22):		
Profusion 0/1	6	27.3
Profusion 1/0	1	4.5
Progress 0/1 to 1/0	4	18.2
Profusion 1/1 or higher	0	0
Residual pleural parenchyma	2	9.1
Calcific pleural plaques	1	4.5
Skeleton	4	18.2
Thyroid soft tissue	2	9.1
Possible lung tumour	2	9.1
Total	22	100

the age group between 30 and 39 years being the most prevalent (59.1%). The average length of service is 13.7 years, with the most prevalent group of years of exposure being between 10 and 20 years (72.7%). In 4 workers a progression from 0/1 to 1/0 was observed, in 5 workers a profusion of 1/0 was observed and in 6 workers a profusion of 0/1 was observed. No findings with profusion indicative of silicosis (profusion of micronodular images 1/1 or higher) were observed. Two cases were observed with possible lung tumours and one case with calcified pleural plaques. The rest are soft tissue, skeletal or residual pleuroparenchymal lesions.

Among the 5 workers with 1/0 profusion, all male and smokers, a progression of profusion from 0/1 in 2019 to 1/0 in 2023 is observed in 4 of them. The other case was detected at the initial health examination. The mean years of exposure to CRS in workers with radiological findings with 1/0 profusion (n = 5) and radiological progression is 10.8 years.

DISCUSSION

This study has been carried out in a very specific area, the so-called "ceramic triangle", where 80% of the manufacture of ceramic products in Spain is concentrated. These products include tiles, slabs, earthenware, porcelain and other ceramics, whose raw material is clay, of which crystalline silica is one of the main components.

It is important not to forget that specific health surveillance, secondary prevention or early diagnosis, does not prevent the appearance of pneumoconiosis, including silicosis, but only detects it early when it is already visible [14, 15].

Despite the use of diagnostic methods such as chest X-rays and high-resolution computed tomography, early detection of silicosis remains a challenge. We currently lack biological or other markers to detect it at earlier stages. However, there are lines of research to detect the disease at earlier stages when radiological images are not yet visible. Routine blood tests have shown promise in detecting inflammatory markers associated with this disease. The study of García-Blanco et al. [16] shows that some inflammatory biomarkers, readily available from routine blood tests, are present in patients with silicosis due to exposure to artificial stones, even several years after cessation of exposure to silica dust, and could help in understanding the progression of the disease. In the study by Lombardi et al. [17], platelet/lymphocyte ratio (PLR), lactate dehydrogenase (LDH), soluble tumour necrosis factor II (sTNFRII) and macrophage inflammatory protein-4 (MIP-4) were associated with silicosis. In our country, there are initiatives aimed at achieving these objectives of early detection, through easy and accessible processes for all professionals interested in silicosis [18].

Table 3. Descriptive analysis of results with 1/0 profusion (n = 5) and radiological progression according to International Labour Office (ILO)

Worker	Average time worked (years)	Smoker (yes, no)	Chest X-ray (2019)	Chest X-ray (2022)	Chest X-ray (2023)
1	15	Yes	0/1	–	1/0
2	10	Yes	0/1	–	1/0
3	11	Yes	0/1	–	1/0
4	8	Yes	0/0	–	1/0
5	10	Yes	–	1/0	1/0

Using artificial intelligence (AI) and machine learning techniques, it is possible to effectively differentiate between healthy individuals and people with simple silicosis or massive pulmonary fibrosis. Among the blood biomarkers that could detect a chronic inflammatory state and potentially serve as a support tool for diagnosis, monitoring and early detection of silicosis progression are the percentage of lymphocytes, angiotensin-converting enzyme (ACE), lactate dehydrogenase (LDH) revealed, among others. These biomarkers would only allow discrimination between healthy and sick people, providing support not only for diagnosis but also allowing classification between different degrees of the disease (simple silicosis or massive pulmonary fibrosis). However, they are non-specific biomarkers that could be affected by deviations in the health status of patients attributable to conditions other than silicosis, so they would be additional supporting data.

Firstly, the data obtained in the present study, which shows an absence of silicotic disease in this group of dockworkers, indicates that preventive measures have been effective. Primary prevention through the implementation of collective and individual preventive measures in the maritime sector is essential, with emphasis on the correct and consistent use of personal protective equipment when collective measures are not sufficient.

Secondly, specific health surveillance is essential to verify that preventive measures do not affect health or, failing that, to detect damage to health at an early stage, as well as to identify workers who are particularly sensitive to certain risks.

Thirdly, and last but not least, it is important to stress the importance of health promotion in terms of healthy lifestyle habits, setting up health promotion campaigns in seaports to avoid tobacco consumption, encouraging smoking cessation where appropriate and thus the synergic effect that tobacco produces in workers exposed to environmental particles with a risk of pneumoconiosis.

CONCLUSIONS

Information and training among seafarers regarding occupational risks and lifestyle and work-related diseases, as well as the importance of the correct use of individual (personal protective equipment) and collective preventive measures, is essential [14, 15]. It is necessary to continue promoting health promotion campaigns on smoking cessation among workers, both from the public health system and from the company itself, as well as to reinforce the implementation of specific individual and collective health surveillance. It is also necessary to incorporate into future lines of research the necessary data for learning algorithms that will allow us to make correct use of artificial intelligence and biomarkers, which will enable the early detection of silicosis, improve the prognosis of the disease and facilitate its follow-up.

ARTICLE INFORMATION AND DECLARATIONS

Data availability statement: The data was obtained as part of research previously accepted by the company, the workers and the centres where the tests were carried out.

Ethics statement: The study has been reviewed by the ethics committees of the centres that have participated in the research.

Author contributions: All authors contributed to the design, data analysis and production of the publication.

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Conflict of interest: There is no conflict of interest.

Supplementary materials: None.

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A descriptive retrospective study on the various uses of hyperbaric oxygen therapy

Mendy Hatibie Oley[1], Maximillian Christian Oley[2], Billy Johnson Kepel[3], Eko Prasetyo[2], Ferry Kalitouw[4], Laurens Kalesaran[4], Deanette Michelle R. Aling[5], Marcella Tirza Tulong[5], Andi Asadul Islam[6], Muhammad Faruk[7]

[1]Division of Plastic Reconstructive & Aesthetic Surgery, Department of Surgery, Faculty of Medicine, Sam Ratulangi University, Manado, Indonesia
[2]Division of Neurosurgery, Department of Surgery, Faculty of Medicine, Sam Ratulangi University, Manado, Indonesia
[3]Department of Chemistry, Faculty of Medicine, Sam Ratulangi University, Manado, Indonesia
[4]Department of Surgery, Faculty of Medicine, Sam Ratulangi University, Manado, Indonesia
[5]Hyperbaric Centre, Siloam Hospital, Manado, Indonesia
[6]Department of Neurosurgery, Faculty of Medicine, Hasanuddin University, Makassar, Indonesia
[7]Department of Surgery, Faculty of Medicine, Hasanuddin University, Makassar, Indonesia

ABSTRACT

Background: *Hyperbaric oxygen therapy (HBOT) can be used as a therapeutic modality for conditions other than decompression diseases, including wound healing in gangrene, compromised grafts and flaps, crush injuries, thermal burns, and intracranial abscesses. Beginning more recently, HBOT has also been used as an alternative treatment strategy for respiratory conditions in patients with COVID-19. This study aimed to determine the use of HBOT in the healing processes of the above-listed conditions.*

Material and methods: *For this descriptive retrospective study, the authors used the data of patients who received HBOT at Manado Regional Hospital in Indonesia from January 2017 to December 2020. Patients were identified retrospectively according to their ICD-10 codes.*

Results: *Of the 128 patients who had received HBOT, 60 had received it for decompression sickness (46.87%), 29 for thermal burns (22.65%), 19 for diabetic ulcers (14.84%), six for crush injuries, six for skin grafts, six for pre- or post-amputation (4.68%), and two for gangrene (1.56%).*

Conclusions: *Used for decompression sickness in 46.87% of cases and for wound healing in 50.13% of cases, HBOT is not only for decompression sickness but can be used as a therapeutic modality for other conditions as well.*

(Int Marit Health 2025; 76, 4: 254–258)

Keywords: decompression, wound healing, hyperbaric oxygen therapy

INTRODUCTION

Hyperbaric oxygen therapy (HBOT) is defined by the Undersea and Hyperbaric Medical Society as a therapy in which patients breathe 100% intermittently in a chamber at a pressure above sea level (1 absolute atmosphere, ATA) [1–3]. For decompression diseases, recompression therapy is intended to suppress the physiological effects of systemic gas bubbles, reduce their size, and release excess bubbles as well as dissolved gases [4].

Drager first used HBOT to successfully treat decompression sickness in the 1930s. The golden age of HBOT, however, began in the late 1950s with the publication of Boerema et al.'s "Life Without Blood," which demonstrated that unanesthetized pigs behaved normally with

Muhammad Faruk, Department of Surgery, Faculty of Medicine, Hasanuddin University, Perintis Kemerdekaan KM 11, 90245 Makassar, Indonesia, e-mail: muhammadfaruk@unhas.ac.id

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an average hemoglobin of 0.45 g/dL while breathing 100% oxygen in a pressurized chamber at 3 ATA [5]. In the last 40 years, HBOT has been recommended and used to treat a wide range of medical conditions, including as an abating therapy for wound healing [6].

Non-healing wounds, a major object of study for hyperbaric physicians, can also be treated with HBOT, as demonstrated in various studies and trials [6]. *Non-healing wounds* are wounds that have failed to heal within the proper period despite adequate treatment. The etiology of those wounds is usually hypoxia, against which HBOT can be highly effective, given its capacity to improve angiogenesis via a multifactorial mechanism. HBOT has also been effective as a primary or complementary therapy to treat infections due to its bactericidal and bacteriostatic effects against both aerobic and principally anaerobic bacteria [7]. Hyperbaric oxygen has also been shown to have direct and indirect antimicrobial activity, which especially increases leukocytes. Decreased edema due to vaso-systemic constriction facilitates the diffusion of oxygen and nutrients through tissues and reduces pressure on surrounding vessels and structures [6].

Some indications for the use of HBOT in addition to decompression sickness include arterial gas embolism, carbon monoxide poisoning, gangrene, compromised grafts and flaps, crush injury, idiopathic sudden sensorineural hearing loss, intracranial abscess, necrotizing soft tissue infection, osteomyelitis, severe anemia, and thermal burns [8, 9].

Beginning more recently, HBOT has also been used as an alternative treatment for respiratory conditions in patients with COVID-19. Because HBOT may provide a novel means of treating or at least ameliorating respiratory conditions associated with COVID-19, it is theoretically possible that it can also provide adequate blood oxygenation in the near-total absence of lung–blood interaction [10].

The city of Manado, Indonesia, where the study's institution, Manado Regional Hospital, is located, boasts one of the world's best underwater tours, namely to the island of Bunaken. For that reason, the hospital has maintained facilities for HBOT since October 1995, although their use was initially restricted to patients with decompression sickness. With advances in medical science, however, HBOT has come to be used as a therapeutic modality for wound management. In that case, researchers need information on how, when, and to what extent to use HBOT to treat wounds.

MATERIAL AND METHODS

The present descriptive study with retrospective analysis was conducted in the Hyperbaric Unit of Manado Regional Hospital in Manado, Indonesia, and involved using administrative data representing the 4-year period from January 2017 to December 2020.

STUDY POPULATION

Data of interest concerned patients who had received HBOT for ICD-10 code T70.3XXA (i.e., decompression sickness), T31 (i.e., burns classified according to the extent of body surface involved), T30.0 (i.e., burn of unspecified body region and degree), E11.621 (i.e., type 2 diabetes mellitus with foot ulcer), S67 (i.e., crush injury of wrist, hand, and fingers), 86.6 (i.e., free skin graft), 86.7 (i.e., pedicle graft or flap), Z89 (i.e., acquired absence of limb), and A48.0 (i.e., gas gangrene). Data were ultimately taken from the medical records of 128 patients who had received HBOT as an additional therapeutic modality at the institution during the study period.

STATISTICAL ANALYSIS

These data were processed using the SPSS program version 21.0 (IBM Corp., Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.). The data are analyzed descriptively and presented in tabular or narrative form.

RESULTS

Based on administrative data regarding patients treated in the hospital's Hyperbaric Unit from January 2017 to December 2020, at least 128 patients — 75 male and 53 female — received HBOT as a therapeutic modality (Fig. 1).

Of the 128 patients who received HBOT, 60 received it for decompression sickness (46.87%), 29 for thermal burns (22.65%), 19 for diabetic ulcers (14.84%), six for crush injury, six for skin graft, six for pre- or post-amputation (4.68%), and two for gangrene (1.56%), as shown in Table 1.

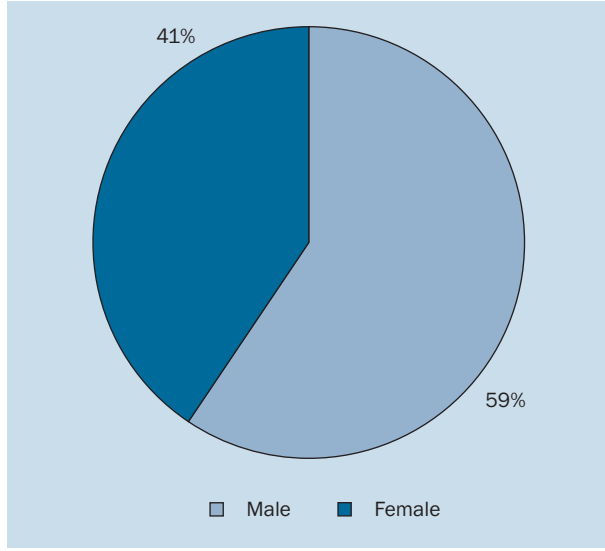

Figure 1. Gender ratio of patients who received hyperbaric oxygen therapy

Table 1. Use of hyperbaric oxygen therapy by diagnosis

Diagnosis	Year				Σ	%
	n1	n2	n3	n4		
Decompression sickness	14	15	19	12	60	46.87
Thermal burn	4	9	7	4	29	22.65
Diabetic ulcer	6	5	6	2	19	14.84
Crush injury	–	2	3	1	6	4.68
Skin graft	1	2	2	1	6	4.68
Pre- and post-amputation	2	1	2	1	6	4.68
Gas gangrene	–	–	2	–	2	1.56

Table 2. Patient's compliance during hyperbaric oxygen therapy by diagnosis

Diagnosis	Σ	Frequency of therapy (times)		
		> 10	6–9	< 6
Thermal burn	29	–	18	11
Diabetic ulcer	19	–	4	15
Crush injury	6	–	1	5
Skin graft	6	–	1	5
Pre- or post-amputation	6	–	1	5
Gas gangrene	2	–	–	2

The data in Table 2 also indicate the frequency of the use of HBOT according to diagnosis and severity of the disease. According to the data, all patients received HBOT fewer than 10 times.

DISCUSSION

Since 1995, Manado Regional Hospital has maintained a hyperbaric therapy room (i.e., multiplace chamber), first used in the treatment of decompression sickness. In its operation, the hyperbaric chamber requires two doctors, four nurses, and two technicians. Starting in 2010, the facility began to be used for clinical diseases, especially wound healing.

In that setting, the authors sought to determine the pattern of HBOT use based on the patient's indication or diagnosis and whether the use of HBOT for each indication or diagnosis significantly increased year over year. Based on data representing the 4-year period from January 2017 to December 2020, as many as 128 patients used HBOT as an additional therapeutic modality. Over that period, no meaningful increase in the use of HBOT occurred with each passing year. Data based on diagnosis (Tab. 1) show that 46.87% of the 128 patients received it for decompression sickness and 50.13% for wound healing.

Based on the data obtained for indications other than decompression sickness, however, most patients did not complete HBOT in full as recommended (Tab. 2). Although the study's hospital recommends using HBOT at least 6 to 9 times, data from the Hyperbaric Unit revealed that not all patients underwent the recommended number of therapy sessions. The cause of non-compliance is often the patient's lack of finances and/or time, as transportation in the area remains an obstacle to undergoing sufficient therapy for patients living on the island. In some cases, the patient may perceive that their condition has improved after fewer than 6 therapy sessions and that they therefore do not need follow-up therapy.

A dose of HBOT is the application of 100% pressure of oxygen greater than the continuous pressure of pure oxygen in the body, with a pressure of 2–3 ATA. The dosage used in HBOT should not exceed 3 ATA due to safety risks for patients [10].

Hyperbaric oxygen therapy can be used for several indications, including arterial gas embolism, carbon monoxide

poisoning, gangrene, compromised grafts and flaps, crush injury, idiopathic sudden sensorineural hearing loss, intracranial abscess, diabetic foot ulcers, necrotizing soft tissue infection, osteomyelitis, severe anemia, and thermal burns [8, 9, 11]. HBOT can help to repair angiogenesis via the multifactorial mechanisms of fibroblast proliferation and collagen synthesis depending on oxygen (i.e., collagen is the basic matrix for angiogenesis), stimulating factors involved in angiogenesis (e.g., vascular endothelial growth factor), and other mediators of the process [12]. Another study has demonstrated that HBOT also facilitates wound healing by inducing hypoxia inducible factor 1 alpha expression [8, 13].

Hyperbaric oxygen therapy for hypoxic wound healing is usually delivered at 5.2–9.1 ATA in sessions lasting 90–120 min each [14]. According to theory, HBOT for wound healing should be performed at least 10 times, while chronic wounds will require 15 to 20 treatments [6].

Side effects in patients treated with HBOT are quite rare. The effect that arises most often is the barotrauma of the middle ear, which is associated with the patient's experience in the use of the hyperbaric chamber [15]. Barotrauma is an injury to the body due to barometric changes or significant water pressure adjustment. Injuries to the middle ear and sinuses typically occur due to pressure differences between the external environment and the tympanic membrane [16]. Contraindications for HBOT often refer to disease, although absolute contraindications include untreated pneumothorax, a history of spontaneous pneumothorax, or chemotherapy with certain agents such as bleomycin, cisplatin, doxorubicin, disulfiram, or mafenide [17]. Meanwhile, relative contraindications include seizure disorder and possibly cocaine use. High fever, retinal or middle ear surgery, congestive heart failure, cataract exacerbation, systemic viral infections, spherocytosis, and optic neuritis are other conditions in which using HBOT demands caution [12, 18].

During the COVID-19 pandemic, HBOT has been used as an alternative treatment strategy for respiratory conditions in patients with COVID-19. In humans, coronaviruses are thought to cause mild to severe respiratory infections and acute respiratory distress syndrome [19]. In response, HBOT allows the delivery of oxygen at high partial pressure oxygen in circulating plasma, which can reverse hypoxic conditions and promote cell metabolism [20].

Some treatments with HBOT have the potential to reduce inflammation and restore normal defense mechanisms, thereby reducing the adverse effects of oxygen needs in pneumonitis in patients with COVID-19 [20, 21]. For hypoxic patients with COVID-19 who are seriously ill and in critical care, HBOT can increase arterial 02 levels. The increased concentration of O_2 sent to cells in t circulating plasma during HBOT at 2.4 ATA provides signals for cells to induce two strong transcription factors, Nrf-2 and macrophage activating factor mRNAs, to stimulate the production of hundreds of cell defense proteins that participate in oxidative stress responses and thus cause cells to produce additional defense proteins that are also anti-inflammatory [20].

CONCLUSIONS

No longer used only for decompression diseases, HBOT can now be used as a modality for wound healing thanks to advances in medical science. As the present study has revealed, HBOT was used for decompression sickness in 46.87% of cases and for wound healing in 50.13% of cases at Manado Regional Hospital from 2017 to 2020.

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: All procedures for human experimentation have been approved by the Institutional Review Board of the study's institution, number: 242 / EC-KEPK / XII / 2020.

Author contributions: All authors participated in the acquisition, analysis, or interpretation of data. Concept and design by MHO, MCO, EP, AAI, and BJK. Drafting of the manuscript by FK, LK, and DMR. Statistical analysis by MTT. Administrative, technical, or material support by MF. All authors have read and approved the final manuscript.

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ORIGINAL ARTICLE

Results of treating patients with diabetic foot ulcers with hyperbaric oxygen

Nam Bao Nguyen[1], Tam Nguyen Van[1, 2], Ha Nguyen Thi Hai[3], Son Nguyen Truong[1]

[1]Institute of Maritime Medicine, Hai Phong, Vietnam
[2]Hai Phong University of Medicine and Pharmacy, Hai Phong, Vietnam
[3]Ministry of Health, Hanoi, Vietnam

ABSTRACT

Background: *Diabetic foot ulcers (DFU) are a common and severe disease with vascular and/or neurological complications, affecting the patient's health and quality of life. Hyperbaric oxygen (HBO) is a non-drug treatment method that has anti-inflammatory effects, reduces edema, increases neovascularization, increases the synthesis of collagen fibers, and accelerates the wound healing process. This study aims to evaluate the results of treating patients with diabetic foot ulcers with HBO.*

Material and methods: *A randomized controlled study was conducted. A total of 94 patients was diagnosed with diabetic foot ulcers, and treated at the Institute of Maritime Medicine from January 2021 to December 2023. Study subjects were divided into 2 groups: the study group included 43 patients treated with HBO combined with intravenous antibiotics, wound care, and control of underlying disease; the reference group included 51 patients who were not treated with HBO, but were treated with intravenous antibiotics, wound care, and control of underlying disease.*

Results: *The infection status and level of granulation tissue growth of the study group were better than the reference group ($p < 0.001$); the depth and diameter of the ulcer in the study group decreased compared to the reference group ($p < 0.05$). Treatment time and amputation rate in the study group were reduced in comparison with the reference group: 10.1 ± 4.6 days, 15.1 ± 7.8 days and 4.6%, 11.7%.*

Conclusions: *Hyperbaric oxygens a good method for treating diabetic foot ulcers, helps with anti-inflammation, stimulates the growth of granulation tissue, quickly heals ulcers, reduces treatment time, and reduces amputation rates.*

(Int Marit Health 2025; 76, 4: 259–267)

Keywords: diabetic foot ulcer (DFU), hyperbaric oxygen therapy (HBOT), hyperbaric oxygen (HBO)

INTRODUCTION

The 21st century is the century of non-communicable diseases and mental behavioral disorders. Diabetes mellitus is one of the most common non-communicable endocrine diseases globally today. This disease has a rapid growth rate and is one of the three most prevalent diseases causing disability and death in the world (cancer, cardiovascular disease, and diabetes) [1, 2]. Currently, there are about 537 million adults living with diabetes, which is expected to increase to 783 million by 2045 [3]. Diabetes is mainly concentrated in low and middle — income countries and is the main cause of death for about 1.5 million people globally each year [2].

Diabetic foot complications are mainly related to peripheral neuropathy and lower extremity arterial disease. Peripheral neuropathy is the most important risk factor for leg ulcers [4]. Patients who are slow to notice ulcers and whose feet are not protected when there is decreased or lost sensation in the feet, foot deformities, increased pressure on the feet are risk factors for foot ulcers combined

Tam Nguyen Van, Hai Phong University of Medicine and Pharmacy, Vietnam, 72A Nguyen Binh Khiem, Dang Giang, Ngo Quyen, 18000 Hai Phong, Vietnam, e-mail: nvtam@hpmu.edu.vn

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with malnourished legs due to lower limb arterial disease making ulcers very difficult to heal, especially when the ulcers become infected, which increases the rate of amputation [4, 5].

The rate of foot disease in people with diabetes varies greatly depending on the economic and social conditions of each country and region. It is estimated that about 15% to 25% of people having diabetes will get ulcers on their inner feet [6–8]. These wounds are often difficult to treat and heal. Therefore, the rate of people with diabetes requiring lower limb amputation is 20 times higher than people without diabetes [9]. Diabetic foot ulcer (DFU) affects quality of life, increases the risk of amputation, and increases mortality for patients [10, 11]. Current treatment of DFU mainly uses wound care methods combined with antibiotics; treatment time is often long, treatment costs and amputation rate are high [12, 13].

HBO is a treatment method in which the patient breathes 100% pure oxygen in a device capable of withstanding high pressure called a hyperbaric chamber under pressure conditions greater than atmospheric pressure (greater than 1 atmosphere) [14].

The mechanism of HBO in the treatment of DFU has been proven to have anti-inflammatory effects, reduce edema, increase collagen production, increase neovascularization, thereby helping the wound healing process faster, shorten the treatment process, and reduce the risk of amputation [15–17].

Rakesh Sharma et al. [18] analyzed 14 controlled clinical trials, data taken from PubMed, EMBASE, Clinical key, Ovid Discovery, ERMED (768 study subjects with diabetic foot ulcers participated), the results showed that hyperbaric oxygen therapy (HBOT) was significantly effective in completely healing diabetic foot ulcers (OR = 0.29, 95% CI: 0.14–0.61) and reduced risk of amputation (OR = 0.60, 95% CI: 0.39–0.92) [18]. Another study pooled 20 randomized clinical trials to evaluate the effectiveness of HBO in the treatment of diabetic foot ulcers. Research results showed that HBOT increased the healing rate of diabetic foot ulcers (OR = 1.9, 95% CI: 1.48–2.43, $p < 0.001$), shortened wound healing time, and reduced the rate of major amputation (OR = 0.51; 95% CI: 0.32–0.83, $p < 0.01$) [19].

Currently, in Vietnam, the Institute of Maritime Medicine is the leading unit in applying high-pressure oxygen to treat DFU and other difficult-to-heal ulcers, initially showing very positive results. On that basis, this study aimed to evaluate the results of treating diabetic foot ulcers with hyperbaric oxygen.

MATERIAL AND METHODS

STUDY PARTICIPANTS

A total of 94 patients with diabetic foot ulcers was treated at the Institute of Maritime Medicine, Vietnam, during the period from January 2021 to December 2023; study subjects were divided into 2 groups:

- Study group: 43 patients were treated with high-pressure oxygen combined with intravenous Betalactam antibiotics, blood sugar control with insulin, wound care, and underlying disease control.
- Reference group: 51 patients were treated with intravenous Betalactam antibiotics, blood sugar control with insulin, wound care, and underlying disease control.

Criteria for selecting participants: Patients with diabetes with damage to the skin structure and subcutaneous tissue of the foot due to spontaneous or external trauma, including cellulitis, skin and subcutaneous tissue ruptured, creating an open wound with manifestations ranging from oozing inflammation to necrosis [20]. The patients agreed to participate in the study and had no contraindications to hyperbaric oxygen treatment.

Exclusion criteria: The patient did not agree to participate in the study and had contraindications to hyperbaric oxygen treatment.

Study design: This was a randomized controlled study.

Sample size: 94 patients diagnosed with diabetic foot ulcers (43 patients in the study group and 51 patients in the reference group). Purposively selected all patients diagnosed with diabetic foot ulcers during the study period.

DATA COLLECTION

Face-to-face interview study subjects: gender, age, duration of diabetes, circumstances of ulcer appearance (natural, post-traumatic), and time of ulcer appearance until admission to hospital for treatment.

Clinical examination: location of the ulcer (toes, soles, instep, or heel); assess the infection status of the ulcer, ulcer depth, and ulcer area.

Blood test: blood formula – red blood cell count (T/L), Hemoglobin (g/100mL), Hematocrit (%), White blood cell count (G/L); blood sedimentation rate (mm/1h); quantification of fasting blood sugar (mmol/L), HbA1C (%). Fasting venous blood was taken in the morning (at least 8 hours from meals) and was analyzed at the Biochemistry Laboratory of the Institute of Marine Medicine using the Beckman Coulter AU 480 automatic biochemical analyzer based on the Electrochemical principle of luminescence.

X-ray of the foot: All participants with diabetic foot ulcers underwent foot x-rays to detect bone damage.

TREATMENTS

Study group: treatment with HBO according to VINIMAM 2 protocol [21], combined with intravenous Betalactam antibiotics, blood sugar control with insulin, wound care, and underlying disease control if any.

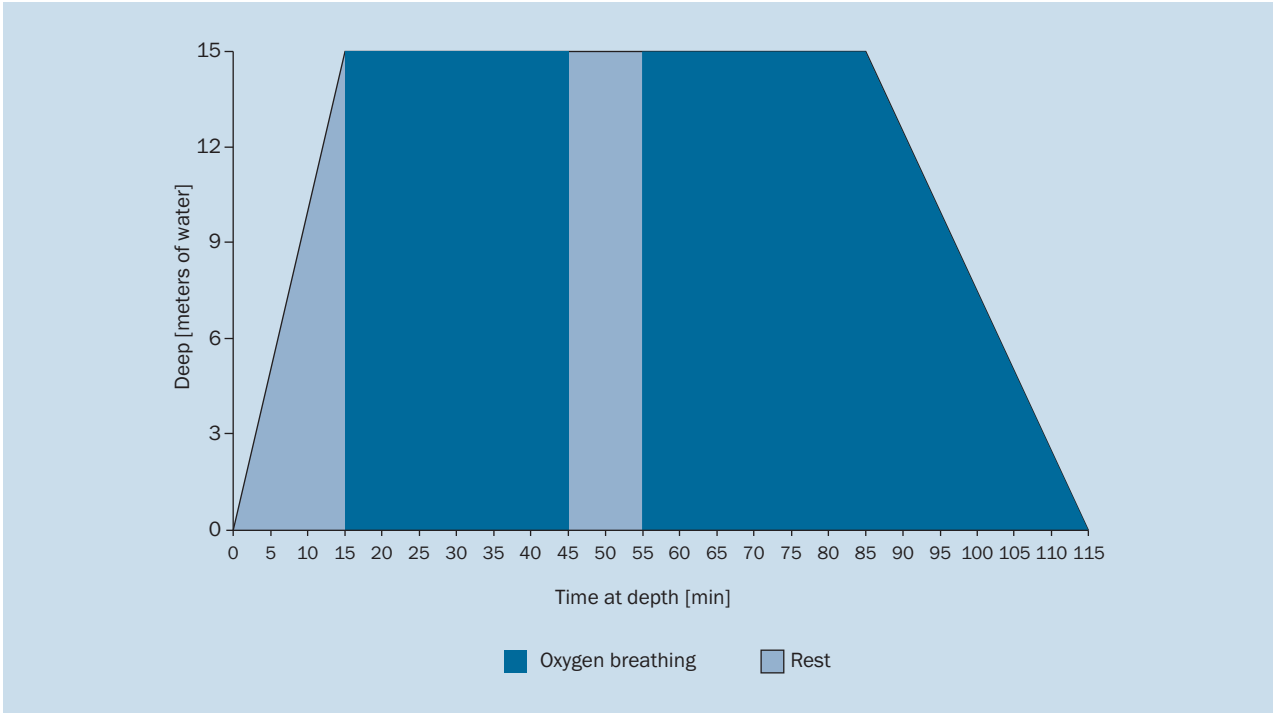

Figure 1. VINIMAM regimen 2. Treating pressure: 2.5 absolute atmospheric pressure; total treatment time: 115 minutes; total oxygen breathing time: 90 minutes; between 2 oxygen breaths, rest 10 minutes (breathe oxygen interrupt); breathing flow: free (breathe oxygen free through a mask)

Reference group: treatment with intravenous Betalactam antibiotics, blood sugar control with insulin, wound care, and underlying disease control if any (Fig. 1).

Evaluate treatment results

Assessed ulcer infection status, granulation tissue growth, ulcer depth, and ulcer area at the following times: day 1, day 7, after 14 days, or discharge from the hospital.

Treatment results: good when the ulcer heals; medium: when the ulcer develops good granulation tissue but has not yet healed; poor: amputation.

SOME DEFINITIONS:

- Diagnosed with diabetes according to ADA 2022 standards or have been diagnosed with diabetes and are using diabetes medication [22].
- Assess ulcer depth according to the Wagner classification of 6 grades [23]:
  - Grade 0: no ulcers, but the foot is at risk of ulceration (calluses, bone protrusion, foot deformity, loss of feeling...);
  - Grade 1: superficial ulcer (ulcer in part or all of the skin);
  - Grade 2: deep ulcer spreads to tendons, bones, and joint capsules;
  - Grade 3: localized infection (deep abscesses, inflammation of bones, ligaments, joints);
  - Grade 4: necrosis of the front part of the foot;
  - Grade 5: widespread necrosis of the foot.
- Assess the width of the ulcer: Treece et al. [24] classified the area of diabetic foot ulcers into 3 levels: < 1 cm^2, 1–3 cm^2, and > 3 cm^2.
- Assess ulcer infection: according to the Infectious Diseases Society of America (IDSA) and the International Working Group on Diabetic Foot (IWGDF) [25].

DATA ANALYSIS

The research data were processed using biostatistical methods, based on Statistics Package for Social Science (SPSS) for Windows 22.0 software. Frequency distributions and percentages were used to describe categorical variables. The chi^2 test was used to compare two ratios. Mean values were used to describe quantitative variables. The t-test was utilized to compare mean values.

ETHICAL CONSIDERATIONS

The research topic was approved by the Ethics Council in biomedical research of the Institute of Maritime Medicine according to decision 03/2021/QD-YHB. Subjects participating in the study were completely voluntary and signed a consent form to participate in the study.

RESULTS

A study on 43 patients with DFU treated with HBO combined with intravenous Betalactam antibiotics, blood sugar control with insulin, wound care, and underlying disease control in comparison with 51 patients with DFU receiving treatment with intravenous Betalactam antibiotics, blood sugar control with insulin, wound care, and underlying disease control, the following result was obtained:

The results (Tab. 1) showed that some characteristics of the study subjects, such as gender, age, duration of diabetes, circumstances in which the ulcer appeared, location of the ulcer, and time of ulcer appearance, had no statistically significant difference between the study group and the reference group.

Research results (Tab. 2) showed that clinical characteristics of diabetic foot ulcers, such as infection status and ulcer depth, did not differ between the study group and the reference group. Characteristics of blood sugar, HbA1C, and foot bone damage on X-ray also had no difference between the 2 groups.

Progression of diabetic foot ulcers in the study group and reference group, the study results (Tab. 3) showed: The infection in the study group improved well after 7 days of treatment (p = 0.003). However, in the reference group, the infection only improved after 14 days of treatment (p = 0.038). The level of granulation tissue growth in the study group improved well after 7 days of treatment (p = 0.005), and in the reference group, the level of granulation tissue

Table 1. Characteristics of study subjects

Variable		Study group (n = 43)		Reference group (n = 51)		p
		No	[%]	No	[%]	
Gender	Male	25	58.1	29	56.9	1.000
	Female	18	41.9	22	43.1	
Age [years]	< 60	2	4.7	3	5.9	0.981
	60–69	12	27.9	15	29.4	
	70–79	14	32.6	17	33.3	
	≥ 80	15	34.9	16	31.4	
	Mean (SD)	74.7 (9.6)		74.3 (9.1)		0.836
Duration of diabetes	< 5 years	12	27.9	14	27.4	0.930
	5–10 years	19	44.2	21	41.2	
	> 10 years	12	27.9	16	31.4	
Circumstances where ulcers appear	Nature	32	74.4	40	78.4	0.807
	Injury	11	25.6	11	21.6	
Location of the ulcers	Toe	15	34.9	18	35.3	0.995
	Instep	10	23.2	11	21.6	
	Stoles	6	14.0	6	11.8	
	Heel	3	7.0	4	7.8	
	Multiple locations	9	20.9	12	23.5	
Time of ulcer appearance	< 1 month	5	11.6	7	13.7	0.930
	1 to 3 months	31	72.1	35	68.6	
	> 3 months	7	16.3	9	17.7	

Table 2. Clinical and paraclinical characteristics of diabetic foot ulcers

Variable		Study group (n = 43)		Reference group (n = 51)		p
		No	[%]	No	[%]	
Infectious condition	Grade 1	0	00	0	00	
	Grade 2	21	48.8	25	49.0	0.986
	Grade 3	22	51.2	26	51.0	
Ulcer depth	Grade 1	15	34.9	18	35.3	1.000
	Grade 2	10	23.3	12	23.5	
	Grade 3	7	16.3	8	15.7	
	Grade 4	11	25.5	13	25.5	
HbA1c [%]	> 7.0%	40	93.0	46	90.2	0.723
	≤ 7.0%	3	7.0	5	9.8	
	Mean (SD), (Min–Max)	9.82 (2.05), (4.20–12.31)		9.79 (2.11), (4.43–11.95)		0.945
Glucose [mmol/L]	> 7.0 mmol/L	39	90.7	45	88.2	0.750
	≤ 7.0 mmol/L	4	9.3	6	11.8	
	Mean (SD), (Min–Max)	15.09 (6.53), (5.10–29.95)		14.69 (6.12), (5.05– 28.10)		0.760
Foot X-ray	Bone damage	7	16.3	10	19.6	0.790
	Without bone damage	36	83.7	41	80.4	

Table 3. Progression of diabetic foot ulcers in the study group and reference group

Variable		Treatment timeline						p	
		Day 1 (1)		Day 7 (2)		Day 14 (3)			
		No	[%]	No	[%]	No	[%]	p 1–2	p 1–3
Infectious condition									
Study group	Grade 1	0	0	9	23.7	6	54.6	0.003	< 0.001
	Grade 2	21	48.8	15	39.5	5	45.4		
	Grade 3	22	51.2	14	36.8	0	0		
Reference group	Grade 1	0	0	1	2.3	3	10.3	0.676	0.038
	Grade 2	25	49.0	20	45.4	9	24.2		
	Grade 3	26	51.0	23	52.3	17	65.5		
p		0.986		0.012		0.001			
Granulation tissue									
Study group (n = 43)	Good	1	2.3	9	23.7	6	54.5	0.005	< 0.001
	Poor	42	97.7	29	76.3	5	45.5		

→

Table 3 cont. Progression of diabetic foot ulcers in the study group and reference group

Variable		Treatment timeline						p	
		Day 1 (1)		Day 7 (2)		Day 14 (3)			
		No	[%]	No	[%]	No	[%]	p 1–2	p 1–3
Reference group (n = 51)	Good	1	2.0	3	6.8	5	17.2	0.333	0.022
	Poor	50	98.0	41	93.2	24	82.8		
p		1.00		0.057		0.042			
Ulcer depth									
Study group (n = 43)	Grade 1, 2	25	58.1	25	65.8	10	90.9	0.480	0.042
	Grade 3, 4	18	41.9	13	34.2	1	9.1		
Reference group (n = 51)	Grade 1, 2	30	58.8	25	56.8	21	51.7	1.000	0.333
	Grade 3, 4	21	41.2	19	43.2	8	48.2		
p		1.000		0.498		0.030			
Diameter of ulcer (cm^2)									
Study group (n = 43)	< 1	2	4.7	5	13.1	5	45.4	0.364	0.002
	1–3	28	65.1	24	63.2	4	36.4		
	> 3	13	30.2	9	23.7	2	18.2		
Reference group (n = 51)	< 1	3	5.9	4	9.1	3	10.3	0.830	0.766
	1–3	33	64.7	28	63.6	18	62.1		
	> 3	15	29.4	12	27.3	8	27.6		
p		0.964		0.814		0.046			

growth improved well after 14 days of treatment (p = 0.022). The depth of the ulcer in the study group decreased significantly after 7 days and 14 days of treatment (p = 0.042); however, after 14 days of treatment, the depth of the ulcer had a significant difference compared to the reference group (p = 0.03). The diameter of the ulcer in the study group decreased significantly after 7 and 14 days of treatment (p = 0.002); after 7 days of treatment, the ulcer diameter in the study group and the reference group did not have a significant difference (p = 0.814). However, after 14 days of treatment, the ulcer diameter in the study group and the reference group had a significant difference (p = = 0.046).

The results of treatment of patients with diabetic foot ulcers (Tab. 4) showed that the study group had good results of 79.1%, the reference group had good results of 47.1%; medium treatment result in the study group were 16.3%, in the reference group were 41.2%; Poor treatment results in the study group were 4.6%, in the reference group were 11.7%, the difference was statistically significant with p = 0.006. The number of treatment days in the study group was shorter than in the reference group: 10.1 ± 4.6 days and 15.1 ± 7.8 days, p < 0.001.

DISCUSSION

Diabetic foot ulcers (DFU) are a common and severe disease with vascular and/or neurological complications that, if not diagnosed and treated promptly, can rapidly worsen. DFU is a major health concern for both physical and mental health for patients. Currently, treatment of diabetic foot ulcers in Vietnam mainly involves using antibiotics and wound care, so the treatment time is long and the amputation rate is high [13, 26]. Study of 43 patients with DFU treated with HBO combined with intravenous antibiotics, blood sugar control with insulin, wound care, and underlying disease control. The study

Table 4. Results of treatment of patients with diabetic foot ulcers

Variable		Study group (n = 43)		Reference group (n = 51)		p
		No	[%]	No	[%]	
Treatment results	Good	34	79.1	24	47.1	0.006
	Medium	7	16.3	21	41.2	
	Poor (amputation)	2	4.6	6	11.7	
Number of days of treatment		10.1 ± 4.6		15.1 ± 7.8		< 0.001
Mean ± SD, Min–Max		5–23		9–31		

results showed that the group of patients with DFU treated with HBO had good infection and granuloma growth after 7 days of treatment ($p < 0.001$). In the group not treated with HBO, infection and granule growth improved well after 14 days of treatment ($p = 0.038$ and $p = 0.022$). The ulcer depth and ulcer diameter in the group treated with HBO also progressed better than in the group not treated with HBO.

Explaining this, studies suggested that HBO had a mechanism of action that helped increase oxygen supply to tissues, had anti-inflammatory effects, reduced wound edema, increased fibroblast synthesis, and increased collagen synthesis to help heal wounds quickly [18, 27, 28]. On the other hand, hyperbaric oxygen acted as a natural antibiotic, helping to eliminate bacteria and their growth by promoting the killing ability of white blood cells. HBO acted as a bactericidal/bacteriostatic agent against anaerobic bacteria by increasing the formation of free oxygen radicals. It could serve as an adjunct to antibiotic therapy because it has bactericidal properties [14, 29].

Flegg et al. [30] suggested that HBO affected the synthesis of collagen fibers, a factor that strengthened wounds, thereby increasing the speed of wound healing. Therefore, the wound healing speed would slow down when there was a lack of oxygen. Tissue hypoxia significantly reduced the wound healing process, and, on the contrary, ischemic injuries would be clinically improved significantly when blood oxygen was increased. This increase in blood oxygen sped up wound healing and reduced wound edema. Because when the ischemic damaged area was supplied with plenty of oxygen, neoangiogenesis was promoted and the wound healing process was quickly completed. Experiments on dog skin grafts had shown that hypoxia and poor circulation increased the risk of infection. The present study results were similar to studies by some authors on the role of hyperbaric oxygen in the treatment of wounds, difficult-to-heal ulcers, and diabetic foot ulcers [18, 19, 27, 28].

Perren et al. [27] studied patients with DFU treated with HBO, compared with medical treatment and wound care groups. Patients were monitored and evaluated weekly. Study results showed that the level of granular tissue growth, the depth, and area of ulcers in the group treated with HBO had a superior improvement compared to the group not treated with HBO ($p < 0.001$).

One study analyzed data from seven randomized controlled clinical trials, evaluating the effects of HBOT on diabetic foot ulcers. The results showed that HBOT significantly improved the rate of complete healing of diabetic ulcers (OR = 3.59, 95% CI: 1.56–8.29, $p < 0.001$), compared to the group that did not receive treatment with HBOT [31].

The results of diabetic foot ulcer treatment (Tab. 4) showed that the rate of the group treated with HBO had good results was higher than the group not treated with HBO (ulcers were healed), at 79.1% and 47.1% respectively ($p < 0.001$). The amputation rate in the group treated with HBO was 4.6%, whereas the amputation rate in the group not treated with HBO was 11.7%. The treatment time of the group treated with HBO was shorter than the group not treated with HBO ($p < 0.001$). The results of the present study were consistent with the study of Sharma et al. [18] and Zhang et al. [19], HBO was significantly effective in completely healing DFU, shortening the wound healing process, and reducing the amputation rate. Research by Huynh et al. [13] on patients with DFU treated at Tro Ray hospital, Vietnam, patients treated with antibiotics, wound care, blood sugar control (not treated with hyperbaric oxygen), results showed that the rate of amputation was 46.5%, and the average treatment time was 22.5 days. Thus, HBO played an important role in the treatment of DFU, helping heal wounds quickly, shorten treatment time, reduce treatment costs, and reduce amputation rates. HBO is an essential treatment and the main indication for diabetic foot ulcers [17].

CONCLUSIONS

Study of 43 patients with diabetic foot ulcers treated with HBO combined with antibiotics and wound care, compared with 51 patients with diabetic foot ulcers receiving only antibiotics and wound care: the infection status and the degree of granulation tissue growth in the study group were better than the reference group; the depth and diameter of ulcers in the study group were reduced compared to the reference group. Treatment time and the amputation rate in the study group were reduced compared to the reference group: 10.1 ± 4.6 days, 15.1 ± 7.8 days and 4.6%, 11.7%. HBO should be used in combination to treat diabetic foot ulcers and other difficult-to-heal ulcers because it has anti-inflammatory effects, stimulates the growth of granulation tissue, quickly heals ulcers, reduces treatment time, and reduces amputation rates.

ARTICLE INFORMATION AND DECLARATIONS

Data availability statement: All the data has been collected and presented objectively, honestly and is highly reliable. The data used in this study can be shared with qualified medical professionals or research institutions upon reasonable request. All datasets have been anonymized, and there are no legal or institutional restrictions that prevent us from providing them.

Ethics statement: The research topic was approved by the Ethics Council in biomedical research of the Institute of Maritime Medicine according to decision 03/2021/QD-YHB. Subjects participating in the study were completely voluntary and signed a consent form to participate in the study.

Author contributions: Nam Bao Nguyen: manuscript writing and revision, literature review, and interpretation of results.
Tam Nguyen Van: conceptualization, methodology, and data analysis; manuscript writing and revision.
Ha Nguyen Thi Hai: application of statistical, mathematical, computational, or other formal techniques to analyze or synthesize study data.
Son Nguyen Truong: literature review and background research; data acquisition.

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Disabling diseases and disabilities in professional divers from the region of Murcia (Spain)

Laura Balanza Cañete, Laura Martínez-Alarcón, Francisca Sánchez-Ayllón

University of Murcia, Cartagena, Spain

ABSTRACT

Background: *Professional diving is an activity that is carried out more and more frequently, due to the great professional opportunities it offers. It is a job with high responsibility and a lot of risk, involving low temperatures, adverse weather conditions, and high pressures, which requires the diver to be in optimal conditions. The general objective of this research work is to analyze disabling diseases and disabilities in professional divers in the Region of Murcia.*

Material and methods: *A descriptive and cross-sectional observational study, type of case series, has been carried out to analyze the causes and factors of the disabilities that occurred in 169 professional divers in the region of Murcia (Spain) from 2014 to 2020.*

Results: *The accumulated incidence of disability in seven years, with 39 cases, is 230.7 subjects per 1,000 divers, much higher than that of the rest of the maritime workers, which turns out to be 130.1/1000 in the same period of time. The average age is 33.7 ± 7.2 years, and the professional experience is 9.6 ± 6.1 years. Occupational diseases and work accidents were responsible for 15 (38.55%) cases. Otorhinolaryngologic (33.3%), musculoskeletal (25.6%), and psychiatric (10.2%) pathologies are the three most common causes.*

Conclusions: *Perfect physical condition, health and, especially, age in professional diving are a limitation, the latter being a risk indicator, so it is essential that the professional is in optimal physical condition and is aware of the limitations to carry out said professional activity, due to the great adversity it entails in being able to carry out it throughout one's entire active working life.*

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Keywords: diving, accidents, barotrauma, disabilities, contraindications

INTRODUCTION

Professional diving is an activity that is carried out more and more frequently, due to the great professional opportunities it offers and the relative ease with which one can obtain the training that accredits it.

The work carried out under the sea, including the change in pressures to which the diver is subjected during daily work multiplied over months and years, can lead to multiple consequences, many of them disabling for the development of their profession. In addition to the repercussions for health, it entails a significant economic deterioration that negatively affects the socioeconomic well-being of the family, forcing them to readjust to a change in professional activity.

However, most accidents are derived from non-compliance with regulations. "Professional divers in 2014 presented between 83.3 and 291.7 times more risk of having a fatal work accident than the average of the Spanish workforce" [1].

Cabo et al. [2] state that "The pathology associated with diving appears in more than 80% at the head and neck level. The most common injuries in diving accidents are disorders

Laura Balanza Cañete, University of Murcia, Plaza del Cronista Isidoro Valverde, Edif. La Milagrosa, 30202 Cartagena, Murcia, Spain, e-mail: laurabalanza@hotmail.com

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of the middle ear (46%), followed by disorders of the inner ear (18%), nose and paranasal sinuses (17%), external ear (8%), and decompression illness (8%)".

Invasion by humans into the aquatic environment can be seen as a threat by marine species, which can have fatal consequences for the diver who enters the depths of the sea without any protection other than their suit.

For Ortiz [3], the most frequent are bites, trauma from the sting of species that inoculate poison, and electric shocks from fish.

Díaz [4] states that sinus and tympanic barotraumas are frequent in diving due to the complexity that these cavities present when it comes to the adaptability to the hyperbaric environment due to the presence of air inside "With an intact eardrum, the only route to balance pressures that the middle ear has is the Eustachian tube through the nasopharyngeal ostium. These ostia are normally closed and opened by the action of the tensor or elevator palate muscles, which occurs when swallowing".

Because the opening of this cavity does not occur spontaneously and it is necessary to perform different maneuvers to force it — such as the well-known Valsalva maneuver — persistent blockages of the tubal ostium, congestion, edema, hemorrhage, and so on, may occur. "The pressure imbalance between the tympanic cavity and the nasopharyngeal cavity can lead to rupture of the tympanic membrane".

For Carazo [1], decompression illness occurs to a lesser extent in experienced divers, and it is stated that only in 27% of cases do serious neurological symptoms appear, being more frequent in dives that require extra effort, in repeated dives, or deep dives in very low temperatures [1].

Regarding contraindications in diving, Barosa et al. [5] states that the pathologies that are not compatible with the practice of diving are those that pose a serious risk to diving, such as underlying pathologies that can worsen with diving, in addition to the basic motor alterations that are required to practice this practice.

When ear barotraumas are recurrent over time, which denotes the existence of poor tubal functionality, it must be considered that the diver has lost the ability to adapt to the hyperbaric environment and must be proposed for an evaluation to be declared incapable of practicing their profession [6].

In the case of an accident that has caused a decompressive illness, the cause of which is a gas embolism, serious or mild, depending on whether there has been neurologic involvement or simply limited to superficial dermatologic lesions or joint pain, and which has required specialized treatment in a hyperbaric chamber, it is very important to analyze the cause of the same, and it is often not identified once the diver's non-compliance with the safety standards established in diving has been ruled out. As for divers who have suffered from decompression illnesses of unknown and unforeseeable cause, considering the severity of their consequences, the permanent disability of the diver must be assessed [6].

GOALS

The general objective of this research work is to analyze disabling diseases and disabilities in professional divers in the Region of Murcia (Spain).

As specific objectives, the authors aim to determine the socio-occupational characteristics of divers who, due to presenting pathologies or physical defects, request or are proposed to be declared incapable of practicing their profession, and analyze the different pathologies causing the permanent disability process, and whether there is any known determining factor.

MATERIAL AND METHODS

STUDY DESIGN

An observational study has been carried out, with descriptive and transversal purposes — a type of case series, to analyze the causes and factors that exist around maritime workers who are dedicated to professional diving and who have resolved an administrative application process of disability for their profession, due to suffering from a common or professional illness, or the consequence of the consequences of having suffered an accident, work-related or due to other causes. Quantitative methodology has been used for the analysis of the variables that have been coded, and qualitative methodology has been used for the analysis of the texts of the documents analyzed.

The target population of the study was made up of maritime workers affiliated with the Spanish Special Social Security Regime for Sea Workers, in the Region of Murcia, managed by the state organization Instituto Social de la Marine (ISM).

The period of time studied is seven years, from 2014 to 2020. During this period, the population of active workers is quite uniform, taking as reference the number of affiliates at the end of November of each year analyzed, it ranges between 927 and 1,192 active workers, with an average of 1,114 workers in the period studied. The study population is made up of the 162 files resolved on permanent disability processes by the Provincial Directorate of the ISM of Cartagena, between 2014 and 2020, after the assessment of the resolution opinion of a medical court called the Disability Assessment Team (EVI, *Equipo de Valoración de la Incapacidad*) of the National Institute of Social Security, once the medical reports of the seafarers who initiated the administrative process in order to obtain a disability for the exercise of professional activity as seafarers have been analyzed and assessed.

The only inclusion criterion is that the resolved permanent disability file was for professional divers; thus, the sample studied was 39 documents during the aforementioned period. Documents belonging to the same subject, generated by a review or new assessment of the EVI, as a consequence of a claim or other administrative reasons, were excluded, thus ensuring a single file per subject.

In the document where the EVI presents its evaluation opinion of the disability process initiated, there is a free text section where it develops, in abbreviated form, the clinical picture responsible for the disability process and the organic and functional limitations of the worker, always considering the tasks typical of the diving profession, in the which they have relied on to make their proposed opinion. After reading the text, the authors have considered it of interest to code pathologies by groups or systems. Multiple causative pathologies are common; in these cases, the most relevant ones were chosen as the cause of the disability.

For the analysis of results, descriptive statistical techniques have been used, values of the frequencies of the categories of the qualitative variables and the values of the arithmetic mean, standard deviation, range of values, and values of the percentiles when the variable to be analyzed was quantitative. To test hypotheses, since these are very small samples, non-parametric statistics, the Mann-Whitney U, and the Kruskal-Wallis test have been used to analyze the distribution of a quantitative — qualitative variables. Statistical significance was accepted for a value of $p < 0.05$.

RESULTS

The total number of proposed reports of permanent disability from the EVI, of the National Social Security Institute, to maritime workers, in the Region of Murcia, is 162 cases, in the referred period, of which 39 belong to professional divers.

The group of active maritime workers in the Region of Murcia is made up of 1,114 subjects, which represents a cumulative incidence in the seven years reviewed of 145.4 cases of disability per 1,000 workers.

Analyzing separately the accumulated incidence of the group of active professional divers, made up of 169, and the 945 that make up the rest of the maritime workers, it was found that the incidence of proposed disability ruling in divers is 230.7 cases for each 1,000 divers in the seven years analyzed, an incidence much higher than that of the rest, which turns out to be 130.1 cases per 1,000 in the same period.

The overall average age obtained is 33.7 ± 7.2 years, with a range of values between 25 and 53 years. The median value is 36.0 years, with the 75th percentile corresponding to the value of 41 years and the 25th percentile corresponding to the value of 31 years.

Regarding the reference to the years of professional activity as divers, an average value of 9.6 ± 6.1 years was obtained. The percentile value of 50 is 8 years of work as a diver, 14 years is the 75th percentile, and 4 years is the 25th percentile. The range of values is between 1 and 24 years.

Pathologies and factors causing disability:

- Otorhinolaryngologic (ENT) — 13 (33.3%) cases, which is the most frequent group:
  - 10 cases of chronic rhinosinusitis, resulting in the most frequent pathology within the ENT group, 76.9%, and representing 25.6% of the total disability processes in the study,
  - 2 cases of chronic otitis media, as consequences of barotrauma, with involvement of the middle ear, requiring surgical intervention to repair the eardrum,
  - 1 case due to inner ear pathology, with vertiginous symptoms.
- Muscluloskeletal — 10 (25.6%) of the cases, occupying second place, of which 7 (70%) were due to a common illness or non-work accident and 3 (30%) were due to a work-related accident. The pathologies described:
  - 4 of the cases in this group were as a consequence of disc disease at the cervical and lumbar spine level,
  - 5 cases were related to consequences of trauma, caused by a work or traffic accident, 3 cases in the lower extremity, and 2 cases in the shoulder,
  - 1 refers to the Arnold Chiari malformation, diagnosed after the study of severe headaches and dizziness during diving, asymptomatic when not in a hyperbaric environment.
- Psychiatric — 4 (10.2%) cases, described as:
  - 2 anxious-depressive disorder, one associated with adverse life circumstances,
  - 1 somatoform disorder, presents various symptoms not explained by the existence of a conclusive organic lesion,
  - 1 adjustment disorder, stressful situation with significant problems at work.
- Neurologic — 3 (7.7%) cases, described:
  - the 3 cases are recorded as an epileptic disease, one as a temporary irritative outbreak, the second as clonus in the right hemibody associated with language disorders, and a third as a tonic-clonic seizure due to frontal cortical dysplasia.
- Decompression illness — 3 (7.7%), all of them presented accidentally as type 2 decompression illness, with neurological involvement:
  - 1 case that leaves as a sequel a right vestibular dysfunction that produces vertiginous symptoms,

— 1 case, which produces important neurological alterations and evolves without leaving sequelae, but which is recurrent, two cases in a short period,
— 1 case, which left a facial sensory alteration as a sequel.
• Cardiovascular disease — 2 (5.1%) cases:
— 1 patent foramen ovale, diagnosed after a study for syncope during a dive,
— 1 case of congenital malformation of the left internal carotid artery, causing a transient ischemic attack.
• Dermatologic — 1 (2.6%) case:
— 1 for chronic histiocytic folliculitis due to the pressure of the neoprene suit.
• Endocrine — 1 (2.6%) case:
— 1 Diabetes 1, in a 32-year-old, asymptomatic diver, diagnosed in a professional fitness medical examination.
• Urological — 1 (2.6%) case:
— 1 neurogenic bladder with hypotonia, the diver needs to continually perform self-catheterization to empty the bladder.
• Pulmonologic — 1 (2.6%) case:
— 1 extrinsic bronchial asthma.

Occupational diseases and work accidents are responsible for 15 (38.55%) cases.

Of the cases of disability, 8 (20.5%) are as a result of the previous existence of allergic processes, such as the case grouped in pulmonology, 1 (2.6%) diagnosed as extrinsic bronchial asthma. There is also an allergic cause in 1 (2.6%) case classified as a dermatologic process, due to an allergy to a certain chemical compound in the neoprene with which diving suits are made. As a consequence of various allergic processes, there are 6 cases of rhinosinusitis, which represent 15.4% of the total sample studied, 60% of the rhinosinusitis described, and 46.2% of the total ENT cases.

Table 1 shows the analysis of age and professional experience, with the differences not being statistically significant in any case found, depending on the independent variables analyzed. However, it can be highlighted that the 3 cases of professional divers in hydraulic works are much older, 44.3 ± 10.2 years, than the fish farm divers, 36.1 ± 6.7 years, p = 0.140.

In Table 2, the age and professional experience in relation to the group of pathologies analyzed and involved in the permanent disability process is described. It can be highlighted that the average ages of the grouped pathologies all exceed 30 years, but none of them reach 40 years, except for the only case belonging to urology, with 45 years. If one analyzes the minimum and maximum age ranges, it can be observed that in all groups, there are divers for whom a disability file has been initiated at very young ages, 30 years or less.

If one analyzes the experience of the worker as a professional diver (Tab. 2), in all pathology groups, except musculoskeletal diseases, and isolated cases of urology and endocrinology, the average professional experience is below 10 years, highlighting how the value of the minimum experience range in all cases is less than or equal to 3 years, with the maximum value of 24 years of experience corresponding to the group of musculoskeletal pathologies in most of the pathological groups, the maximum professional experience of divers with a disability record does not reach 20 years (Tab. 2).

DISCUSSION

The disability for professional diving is very considerable, with a cumulative incidence of 230.7/1000 cases in seven years, almost double that of the rest of the group of maritime

Table 1. Age and seniority and their relationship with activity, contingency, and disability

	Age		Antiquity	
	M ± SD	Average range	M ± SD	Average range
Activity				
Fish husbandry	36.1 ± 6.7	19.1	9.3 ± 6.1	19.5
Underwater construction	44.3 ± 10.2	29.6	12.6 ± 6.5	25.8
	p = 0.140		p = 0.374	
Contingency				
Common disease	37.1 ± 6.7	20.8	10.2 ± 6.5	20.9
Professional illness	35.2 ± 9.0	16.7	7.8 ± 3.4	17.3
Work accident	36.6 ± 8.2	19.5	9.0 ± 6.3	19.0
	p = 0.749		p = 0.765	
Disability proposal				
Yes	37.4 ± 8.2	20.7	9.7 ± 6.8	19.9
No	35.3 ± 4.6	18.4	9.3 ± 4.4	20.0
	p = 0.549		p = 0.988	

M — mean, p — statistical significance, SD — standard deviation

Table 2. Age and seniority and their relationship with the pathologies of the opinion

Pathologies	Age		Seniority	
	M ± SD	Range min–max	M ± SD	Range min–max
ENT (n = 13)	36.6 ± 6.6	28–47	9.0 ± 4.3	
Osteomuscular (n = 11)	38.4 ± 7.4	28–53	11.6 ± 6.9	3–18
Psychiatry (n = 4)	34.5 ± 4.2	29–39	8.5 ± 5.0	2–24
Neurology (n = 3)	33.3 ± 7.6	30–51	3.3 ± 2.5	
Cardiology (n = 2)	32.5 ± 10.6	25–40	8.5 ± 10.6	2–13
Decompression disease (n = 3)	37.3 ± 11.8	30–51	9.3 ± 8.0	1–17
Allergies (n = 8)	38.6 ± 6.3		9.6 ± 6.0	1–16
Pulmonology (n = 1)	30	30–47	3	1–16
Urology (n = 1)	45		20	
Endocrinology (n = 1)	33		13	3–18

ENT — otorhinolaryngological, M — mean, SD — standard deviation

workers in the same period of time, 130.1/1000 cases. If one considers incidence a measure of risk, one can interpret that this high risk of suffering disability is a consequence of the hardness of the work and, on the other hand, the requirement that divers have a perfect state of health to guarantee their activity safely [7].

Ciudad-Valls [8] stated that the Autonomous Community of Murcia is the second community with the highest accident rate in Spain for divers.

The age difference in the present study is striking, an average of 33.7 years, compared to the age of the study carried out by Balanza [9], whose average age was 50.6 years in the disabled maritime workers in the study, where there was no population of professional divers; they were all merchant sailors and fishermen.

The ISM [6] considers age as an aspect of special consideration in the Protocol for assessing fitness and health monitoring in professional diving due to the hardness of the physical work and the unfavorable conditions that this practice entails. Furthermore, it is interesting to highlight the short professional experience of divers in the professional activity, with only 9.6 years on average. Age and professional experience are associated with the disability processes of this group of workers; for health reasons, they are disabled at a very young age and with little experience.

Age seems to be one of the most important risks for the development of pathologies associated with diving, with type 2 Decompression Illness being more common after the age of 35 [8]. The subject of the present study, who suffered from decompression illness of unknown cause, was over 50 years of age, granting him a permanent disability as a preventive measure, as it was a recurring accident with no known cause, considering the extreme severity of the consequences or even a result of death to which he was exposed.

Diseases caused by otorhinolaryngologial (ENT) pathologies are the most numerous, representing 33.3% of work disability. Cabo et al. [2] already stated that middle ear pathology was the most common, however, in the present results rhinosinusitis appears as the main cause, but it must be considered that all divers with chronic rhinosinusitis suffer from tubal dysfunction that In turn, they cause middle ear pathology, and less frequently the inner ear, the last link in a chain that leads to the inability to practice diving. The diver is not disabled by suffering from chronic rhinitis but by its consequences. The physiological changes in the ear of divers after immersion have been described in the literature by Boyle Mariotte's Law on the variation of pressure in the middle ear, being a cavity with gas, therefore, it is common to find a thickening of the eardrum, this being matte, dull and without shine [10] which although they are not disabling alterations, they are a reflection of the consequences that changes in pressure to those to which divers are exposed and which harmfully affects the structures of the ear and mucous membranes of the upper airways [10].

In second place, musculoskeletal diseases occupy 25.6%, a frequency somewhat lower than that of studies taken as a reference in the maritime fishing sector. Musculoskeletal processes occupy first place, 31.8% in the study by Balanza [9] and 29.1% in that of Benéitez and Táuriz [11].

The cause of the mechanisms that produce the accumulation of nitrogen bubbles in the diaphysis of long bones, such as the femur, tibia, and humerus, and in the joint areas of these bones, causing aseptic necrotic areas, is unknown. The symptoms they present can be confused with arthritis or trauma, and in their early stages, they are asymptomatic, but they can become disabling injuries, even leading to the need for orthopedic prostheses. In the seven years reviewed of the disability process in divers, the authors have not found any case of necrotic bone pathology.

CONCLUSIONS

The incidence of disabilities due to pathologies derived from diving activity is increasing, and it is alarming to see their appearance in increasingly younger subjects with little professional experience. It is necessary to guarantee, through updated laws, the safety conditions of the professional divers with more precise indications regarding health surveillance and medical examinations, with the unification of criteria at the national level.

The disrepair of physical health and — especially — age in professional diving are limitating factory, the latter being an indicator of risk. It is essential that the professional is in optimal physical condition and is aware of the limitations in carrying out professional activities, due to the great adversities they may face if they are to carry them out throughout their entire active working life.

ARTICLE INFORMATION AND DECLARATIONS

Data availability statement: Authors declare under their responsibility that the data has been collected and is stored in a secure place. The data is available on reasonable request.

Ethics statement: Authors declare under their responsibility that the data collected has been treated with total confidentiality and under the appropriate ethical code.

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VIA MEDICA

The need for antimicrobial stewardship in maritime settings

Yusuff Adebayo Adebisi

College of Social Sciences, University of Glasgow, Glasgow, United Kingdom

The global challenge of antimicrobial resistance (AMR) has far-reaching implications, including in maritime settings, which represent a unique yet critically underexplored frontier for intervention. Maritime environments, including ships, ports, and offshore platforms, are particularly vulnerable to the spread of resistant pathogens due to confined living and working spaces, limited medical resources, and the constant movement of individuals and goods across international borders [1]. These characteristics create the perfect conditions for infections to proliferate and for antimicrobial misuse to exacerbate resistance. Recent evidence has highlighted an increasing prevalence of AMR in maritime environments [2], which is further compounded by the frequent and often inappropriate use of broad-spectrum antibiotics in the absence of diagnostic tools [3].

Antimicrobial stewardship (AMS) is an evidence-based strategy that offers a promising solution to mitigate the growing AMR threat in maritime settings [3]. AMS programs can be tailored to address the unique challenges of healthcare delivery aboard ships and in maritime environments, starting with equipping medical personnel with training to recognize and respond to AMR risks. This training should emphasize judicious antibiotic use, adherence to treatment guidelines, and infection prevention practices. Furthermore, the establishment of robust surveillance systems onboard ships is critical to monitor infection trends, track resistance patterns, and assess the effectiveness of AMS interventions over time. Surveillance data should be integrated with broader global health networks to inform coordinated responses.

Response to AMR needs global coordination [4]. Collaborative efforts between maritime authorities, healthcare providers, and global organizations such as the International Maritime Organization and the World Health Organization are essential to the success of AMS initiatives in this sector. These partnerships can help establish standardized protocols for antibiotic prescribing, infection control, and health screening at ports of entry and departure. Such measures would promote consistency in practices across maritime operations, enhancing their effectiveness. Additionally, fostering data-sharing initiatives between ships and shore-based health systems could provide critical insights into AMR dynamics within maritime settings and facilitate timely interventions.

It is important to recognize that maritime settings are not isolated from global health systems [5]. Rather, they serve as conduits for the transmission of resistant pathogens between countries, implementing AMS in this sector a global health priority. Ships transport millions of passengers and goods annually and serve as workplaces for large, diverse crews. As such, they are not only at risk of outbreaks but also act as amplifiers for the spread of resistance, especially when robust infection control measures are lacking. Failure to address AMR in maritime contexts risks undermining international efforts to combat resistance.

Given the interconnectedness of maritime activities with global health, the adoption of AMS programs in these settings is a necessity. By addressing AMR at sea, we can strengthen health security onshore, safeguarding the well-being of seafarers, passengers, and global populations alike.

Yusuff Adebayo Adebisi, College of Social Sciences, University of Glasgow, Glasgow, United Kingdom, e-mail: adebisiyusuff23@yahoo.com

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ERRATUM

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In the article: **"Initial results of treating thermal burns by hyperbaric oxygen therapy at the Vietnam National Institute of Maritime Medicine"** (LH Pham, TH Duong, LH Ngo et al. Int Marit Health 2025; 76(3): 224–228) on page 224:

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Ly Huu Pham, Thanh Hoang Duong, Long Hoang Ngo, Kha Ai To Tran

Faculty of Medicine, Can Tho University of Medicine and Pharmacy, Can Tho, Vietnam

should be:

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[1]Can Tho University of Medicine and Pharmacy, Can Tho, Viet Nam

[2]Vietnam National Institute of Maritime Medicine, Hai Phong, Vietnam

[3]Hai Phong University of Medicine and Pharmacy, Hai Phong, Vietnam

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The authors confirm contribution to the paper as follows: Huu Ly Pham: conceptualization, methodology, formal analysis, investigation, writing — original draft; Thanh Hoang Duong: formal analysis, visualization, data curation; Long Hoang Ngo: formal analysis, visualization, software; Kha Ai To Tran: writing — original draft.

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MAGAZINE
Table of contents

Int Marit Health 2025; 76, 4: 277–287

Editorial

by James A. Denham

Dear Readers,
Welcome to this new issue of International Maritime Health Magazine. The field of maritime health has always advanced in a dynamic intersection between progress and reflection, where new challenges meet time-tested lessons. As the maritime industry evolves — technologically, demographically, and operationally — it becomes essential for us to maintain a sharp focus on groundbreaking innovations while embracing the enduring lessons carried in our wake.
In these pages, we invite you to look ahead to the emerging winds that are shaping the future of seafaring, while also reflecting on the echoes of earlier tides. Without giving away what follows, I can say that history has a remarkable way to resurface just when we need its guidance most. We hope the contributions in this issue inform, challenge, and inspire as we continue charting a course through a sector undergoing constant transformation.

Warm regards,
James A. Denham, MD
Editor, IMH Magazine

OLD WAVES, NEW WINDS: LESSONS MARITIME MEDICINE CAN'T AFFORD TO FORGET

by James A. Denham

Every generation stands on the shore of lessons learned and lessons forgotten, watching the next wave take shape.

Maritime medicine has historically advanced in uneven tides. Some centuries pushed us forward with bold reforms; others left us drifting between outdated laws, limited science, and the harsh realities faced by people who worked at sea. Looking back at that history is not nostalgia, but an opportunity to make a diagnosis.

The good is instantly recognizable. When political will and scientific insight aligned, the seas became safer: the near eradication of scurvy through nutritional reform, the birth of modern quarantine, the creation of international labour standards, and the gradual recognition that seafarers' health is a matter of global public interest.
The bad is equally persistent: progress arrived sporadically, often in the wake of crises, like wars, epidemics, mass casualties, or the economic pressure of keeping ships at sail. Safety systems were reactive, evidence was often thin, and crew welfare was sometimes subordinate to commercial imperatives.
And then there is **the ugly**: well-documented patterns of exploitation, preventable deaths, indifference to mental health, and regulatory gaps that left generations of fishers and seafarers unprotected. Some of today's challenges, like fragmented oversight, unequal global standards, and health risks that fall heaviest on those with the least power, echo those earlier shortcomings.

"The past doesn't anchor maritime medicine; it teaches us how to navigate the next swell."

Yet the value of revisiting these old waves lies not in lamenting, but in using them as navigation aids. History teaches us that meaningful changes happen when three elements meet:
1. strong enough evidence to challenge a habit,
2. organizations that are willing to make changes, and
3. a community of medical professionals reluctant to accept preventable harm.

As the maritime sector undergoes its own transformation — automation, demographic shifts, new health technologies, and increasingly complex global risks — the lessons of the past have never been more relevant. And although we cannot predict every storm that lies ahead, we can refuse to repeat the ones we've already survived.
Maritime medicine has advanced only by learning from its own wake. The next chapter should be no different.

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**These sources were selected to illustrate enduring patterns in maritime health — its advances, its persistent challenges, and the historical lessons we continue to relearn.

News

contributed by Nebojša Nikolić

FROM WHO

NEW TOOLS SAVED A MILLION LIVES FROM MALARIA LAST YEAR BUT PROGRESS UNDER THREAT AS DRUG RESISTANCE RISES

The latest World Health Organization (WHO) World Malaria Report highlights significant progress made in the global fight against malaria, as well as emerging threats. The expanded use of dual-ingredient insecticide-treated nets, WHO-recommended vaccines, and seasonal malaria chemoprevention has helped prevent an estimated 170 million cases and one million deaths in 2024. Since the approval of the first malaria vaccines in 2021, 24 countries have incorporated them into their routine immunization schedules. Additionally, the use of seasonal chemoprevention has increased across 20 countries from 200,000 children in 2012 to 54 million today.

Despite the progress made in malaria control, the WHO warns that efforts to combat the disease face mounting challenges. WHO Director-General Dr. Tedros Adhanom Ghebreyesus emphasizes that the rise in cases, growing drug resistance, and funding cuts risk reversing two decades of progress. Artemisinin-partial resistance, which is concerning because artemisinin-based combinations are the global standard, has now been confirmed or suspected in at least 8 African countries. Additionally, there are signs that the efficacy of partner drugs is declining. Mutations like pfhrp2 deletions undermine the reliability of rapid diagnostic tests, while widespread pyrethroid resistance in 48 countries further reduces the effectiveness of insecticide-treated nets.

The threat of urban malaria caused by Anopheles stephensi, a mosquito species resistant to common insecticides, is on the rise and has now spread to nine African countries. Dr. Martin Fitchet, CEO of Medicines for Malaria Venture, highlights that increasing resistance demands the rapid development of new medicines with novel mechanisms of action. He points to Ganaplacide–Lumefantrine, the new non-artemisinin combination therapy, as a sign of scientific progress.

World Health Organization maintains that with strong leadership and targeted investment, a malaria-free future remains achievable.

FROM ILO

COVID-19 AND RECOVERY: THE ROLE OF TRADE UNIONS IN BUILDING FORWARD BETTER

A new ILO edition of the International Journal of Labour Research argues that trade unions played a decisive role in protecting workers during the COVID-19 pandemic and remain essential to a fair and inclusive recovery. The report titled *COVID-19 and Recovery: The Role of Trade Unions in Building Forward Better* notes that unions worked to safeguard jobs and worker protections despite membership losses, rights violations, and in some contexts a hostile political environment.

The publication stresses that post-pandemic recovery requires unions to adopt new strategies to address a widening agenda: job-rich growth, stronger occupational safety and health systems, universal social protection, gender equality, digitalization, and a just transition to sustainable economies. Instead of marginalizing organized labour, the pandemic illustrates the need to reinforce workers' organizations as central institutions in global labour policy.

Maria Helena André, Director of ILO ACTRAV, notes that the crisis reaffirmed the urgency of the ILO Centenary Declaration's vision. The adoption of the Global Call to Action for a Human-Centred COVID-19 Recovery signals wide recognition that social justice and decent work depend on strong institutions of social dialogue and worker representation.

FROM IMO

THE SAFE HORIZONS INITIATIVE

The International Maritime Organization (IMO) and the European Union (EU) have jointly launched Safe Horizons, a major initiative promoting zero tolerance for violence, harassment, sexual assault, and bullying across the maritime sector. Conceived as a seed project, Safe Horizons focuses on capacity-building rather than compliance mechanisms and aims to help maritime nations strengthen regulatory frameworks, training, and institutional culture.

Key objectives include:

— Promoting a zero-tolerance culture for all forms of violence and harassment.
— Supporting countries (upon request) in aligning national policies with international standards.

— Enhancing training and awareness through updated IMO materials, enabling seafarers and stakeholders to identify, prevent, and respond to incidents.

The initiative is designed to produce scalable models that can be adopted industry-wide, reinforcing both safety and inclusiveness in global maritime workplaces.

FROM THE SEAFARERS' CHARITY

SUPERYACHT ALLIANCE AND CHANGING TACK UNITE TO IMPROVE CREW WELFARE

The Seafarers' Charity, as part of the Changing Tack coalition, has announced a new partnership with the Superyacht Alliance (SYA) to elevate welfare standards for superyacht crew. Through a Memorandum of Understanding, Changing Tack will act as a crew-welfare think tank within the SYA, contributing expert insights and ensuring seafarer perspectives shape industry decision-making.

The expanded collaboration brings together major yachting associations — including SYBAss, MYBA, IAMI, ICOMIA, PYA, IYBA, and AIMEX — and aims to strengthen professionalism and drive collective action. Planned focus groups will provide a direct platform for crew voices, shaping projects aimed at concrete welfare improvements. A joint panel session at the upcoming Superyacht Forum in Amsterdam will launch this new phase of strategic cooperation.

Commenting on the initiative, ISWAN CEO Simon Grainge emphasizes that there are many people in the industry who care about crew welfare, but that progress depends on cohesive action. Tina Barnes, The Seafarers' Charity's Impact Director, notes this as a pivotal moment for driving meaningful change within the sector, and that the ITF convening power to bring stakeholders together will allow for the start of a real change.

FROM ITF

WORLD TOILET DAY: REAL ACTION NEEDED NOW TO TURN RIGHTS INTO REALITY

For World Toilet Day, the International Transport Workers' Federation (ITF) renewed its call for urgent action to guarantee safe and decent sanitation for transport workers — an issue especially severe for women. Across maritime, aviation, rail, and road transport, inadequate access to sanitation undermines health, safety, and dignity, and can become a barrier to employment. Women seafarers frequently report a lack of menstrual hygiene products, inadequate disposal options, and absent or inaccessible toilets on board. Lorena Pintor Silva, ITF Seafarers' Section Women's Representative, notes that such issues are too often minimized or ignored.

A significant step forward is the new Maritime Labour Convention amendment (Guideline B3.1.10), adopted in 2025 and entering into force in December 2027, which mandates appropriate menstrual hygiene products and disposal facilities on all ships.

However, legislative progress alone is insufficient. The ITF highlights systemic sanitation failures across maritime workplaces and emphasizes that respect for women's rights requires concrete implementation. To support unions and activists, ITF has released a comprehensive Sanitation Toolkit, offering research, bargaining guidance, and campaign materials to help secure sanitation rights globally.

Communication

NAVIGATING CHANGE: ICMA WORLD CONFERENCE 2025 IN BARCELONA

by Jason Zuidema
General Secretary, International Christian Maritime Association

The International Christian Maritime Association (ICMA) held its World Conference from October 6–9, 2025, in Barcelona, Spain, under the theme "Navigating Change." Hosted by Stella Maris Barcelona, the gathering brought together more than 250 delegates from over 40 countries representing maritime welfare organizations dedicated to serving seafarers, fishers, and their families.

The conference opened with an ecumenical service at the Sagrada Família Basilica led by Cardinal Juan José Omella, followed by visits to the Port of Barcelona and the Maritime Museum, where Catalan leaders welcomed participants.

In his keynote, the Rev'd Mark Nestlehutt, ICMA Chair, reflected on the association's ongoing mission of unity and service. "Navigating change," he said, "requires planning and openness to new opportunities — building relationships across boundaries to focus on what unites us."

Messages from Arsenio Domínguez, Secretary-General of the IMO, and Beatriz Vacotto of the ILO, highlighted ICMA's crucial role in ensuring that global maritime transformation keeps the human element at its heart. They commended ICMA's advocacy for welfare standards, rights, and dignity at sea. Local host Deacon Ricardo Rodríguez-Martos urged closer collaboration between welfare agencies, port authorities, and shipowners to sustain seafarers' wellbeing as a shared responsibility.

Over three days of sessions, delegates exchanged best practices on mental health, women in ministry, the Maritime Labour Convention, and fishers' welfare, while also sharing stories from ministries around the world.

In closing, Nestlehutt reminded participants that navigating change means "choosing collaboration over competition, hope over hesitation, and faith over fear." The ICMA community left Barcelona renewed in its mission to serve those who live and work at sea.

More information and session recordings are available at icma.as/icma-world-conference-2025

THE BRAZILIAN SOCIETY OF MARIT IME AND HYPERBARIC MEDICINE CELEBRATES ITS SECOND CONGRESS ON MARITIME MEDICINE

by Dr. Marcus Vinícius de Moraes
Incoming President, Brazilian Society of Maritime and Hyperbaric Medicine

In October 2025, the **Brazilian Society of Maritime and Hyperbaric Medicine** (**SBMH**) held the **10th Brazilian Congress of Hyperbaric Medicine** in conjunction with the **2nd Brazilian Congress of Maritime Medicine**, in the picturesque city of Canela, Rio Grande do Sul, Brazil.

Organized biennially, this congress stands as the largest and most representative event in its field in Brazil, bringing together leading national and international experts.

This edition was privileged to host distinguished figures in Hyperbaric, Diving, and Maritime Medicine, as well as Hyperbaric Safety, including Stephen R. Thom (USA), Neal Pollock (Canada), James Denham (Panama), and Tom Workman (USA).

Under the scientific direction of Dr. José da Mota and the presidency of Dr. Ivan Carlos Feltes, the congress featured a broad

range of timely and relevant topics that were enthusiastically presented and discussed, fostering a highly interactive exchange of knowledge and professional experience among participants.

This meeting holds particular significance, as it not only celebrates the ongoing development of Hyperbaric, Diving, and Maritime Medicine as a recognized medical discipline in Brazil but also marks the leadership transition of SBMH for the 2026–2027 term. The Society's leadership team includes Dr. Iriano da Silva Alves, current president, Dr. Marcus Vinícius de Moraes, vice-president, and Dr. José da Mota, scientific director.

The next edition of the congress will be held in 2027, in the coastal city of Natal, Rio Grande do Norte — a renowned destination in northeastern Brazil. The SBMH Board and the organizing committee extend their sincere appreciation to the international speakers for their presence and invaluable contributions, which will continue to inspire and advance clinical practice in Brazil.

INDIA MARITIME WEEK 2025

By Dr. James A Denham

Bringing together global maritime leaders, policymakers, and innovators, from 27–31 October 2025, India held **India Maritime Week 2025** in Mumbai, under the theme "*Uniting Oceans, One Maritime Vision*", showcasing its ambition to emerge a global maritime hub and a frontrunner in the Blue Economy.

The week-long event highlighted India's rapid strides in modernising its maritime ecosystem — from overhauling century-old colonial shipping laws to implementing progressive, technology-driven frameworks for the 21st century. Today, India's ports stand among the most efficient in the developing world, often outperforming their counterparts in developed economies.

With new policies recognising large ships as infrastructure assets, India is accelerating its shipbuilding and port-led development efforts. Amid global trade disruptions and shifting supply chains, the nation positions itself as a symbol of stability and strategic autonomy.

Addressing the Maritime Leaders' Conclave, Prime Minister Shri Narendra Modi reaffirmed India's role as a "steady lighthouse" in turbulent global seas, calling this "the right time to work and expand in India's shipping sector." His message underscored India's commitment to inclusive growth, innovation, and maritime sustainability.

As India sails confidently toward its vision of "One Maritime Future," India Maritime Week 2025 stood as both a reflection of progress and a call to collective global action to unite oceans under a shared vision of prosperity and peace.

Particulars

DOCKSIDE DIALOGUES: A CHAT WITH MARITIME HEALTH EXPERTS

An interview with Dr. Tim Carter

When it comes to the intersection of medicine, maritime policy, and occupational health, few have contributed as extensively — or as insightfully — as Dr. Tim Carter.
Dr. Carter's career spans public service, academia, international advisory roles, and hands-on occupational medicine, bringing a panoramic perspective to the evolving health landscape for seafarers. From his tenure as Chief Medical Adviser to the UK Maritime and Coastguard Agency to his final post as Professor at the Norwegian Centre for Maritime Medicine, he has championed practical reforms and pushed for better understanding of the unique health needs of maritime workers. He has worked as a special adviser to the ILO and IMO to revise seafarer medical guidelines, edited the second edition of the *Textbook of Maritime Health*, and recently authored *Merchant Seamen's Health* 1860–1960, a researched history that highlights how medicine, labour, and state interests have long shaped the fate of seafarers.

Professor, researcher, former Chief Medical Adviser to the UK MCA, and leading voice in international maritime health.

In this edition of Dockside Dialogues, Dr. Carter reflects on his journey from petrochemicals to policy making, how his early experiences as an occupational physician helped him systematize responses to risks in changing behaviours, sharing with us candid insights on the challenges facing maritime health, and looking ahead to the changes needed to keep seafarers healthy and safe in the decades to come.

1. **If you had to describe your career in maritime health using a maritime metaphor, what kind of vessel would it be — and where do you think it's sailing next?**
   It's a ship that is not always going full ahead — sometimes its leaky, in others it even goes in circles. Many of the skills needed aren't purely medical. If you want to improve health, you have to think about cargo toxicity, mental health, prevention, and you have to work across the whole system. The key is delivering change as part of a team, without compromising ethics.

2. **Your career has spanned many roles. How did you find your way into the field of Maritime Medicine?**
   I first began in occupational medicine, working first in the petrochemical industry and as Medical and then Field Director of the UK Health and Safety Executive, at one time with a staff of 2,000 employees and a £50 million budget. When the right opportunity came at age 52, I took retirement, did some consultancy, and then took a fascinating posting in the Caribbean, working on healthcare during a volcanic eruption. I later realised how much small-island health challenges resemble those on ships. Later I joined the MCA as part-time Chief Medical Adviser, drawing on my knowledge of regulation from government service and industry. Early in my career I became an approved doctor for seafarer medicals (his first published paper in 1975 examined illness patterns among British tanker crews).

3. **You've also been active in historical research, including your book Merchant Seamen's Health 1860–1960. What lessons from history are still relevant today?**
   It was possible to tell a national story from 1860–1960. However, any history after that period must be viewed from a global perspective because of the complexities of multinational crews. Interestingly, some of the best times for seafarer welfare was during wartime, when the state treated them as essential. While maritime technology evolves rapidly, the attitudes of seafarers and shipowners change much more slowly. Risk and profit remain unevenly shared. Protection and Indemnity (P&I) insurers who see their task as reducing employer costs for illness and injury, fail to empower seafarers in managing their own health. Another lesson is that the risks of infectious diseases have historically been high, and prevention strategies, such as vaccination, can frequently face challenges in implementation.

4. **During your fifteen years at the Maritime and Coastguard Agency, what were some of the most complex challenges you faced?**
   Handling of clinical cases where approved doctors (AD) had made dodgy decisions on fitness, introducing audit systems for ADs and managing those found wanting, gaining consensus for revised national fitness standards. One end of the spectrum was the disgruntled seafarer being told he was unfit to work; the other was the shipowner facing an expensive crew problem. We improved the quality of medical assessments and backed doctors who followed policy although it meant asking them to give up some of their freedom.

5. **You've worked extensively with ILO and IMO. How effective are international guidelines in practice?**
   Pace is glacial. It depends on the agency. ILO is tripartite — governments, employers, unions — and can revise standards proactively. IMO lacks policy development functions in its secretariat. Nations reneging on earlier agreements — notably US and Canada on colour vision testing. Lack of budget for improving evidence on risk and the effectiveness of intervention. WHO has backed off recently and has focused more on infectious diseases. Maritime health can sink down the gaps between different organizations, and collaboration is hard to sustain.

6. **You've noted a lack of research capacity in maritime health. What are your recommendations?**
   A few academic centres and individuals publish, but most maritime health work is delivered by commercial service providers who aren't incentivised to research. Data held by P&I Clubs could be often treated as commercially sensitive. We need good key performance indicators for maritime health, and ways to what I call 'weaponize knowledge' so it influences management practice.

7. **In your view, what are the most pressing needs in seafarer medical certification?**
   Standards must reflect new evidence, often from outside the maritime world. Prognosis for hip replacements is one example. We also need to address ethical issues with overly intrusive screening and focus more on prevention. For instance, tackling smoking habits may have more impact than adding another defibrillator.

8. **You've pointed out before that many health professionals have limited understanding of seafarers' unique needs. What steps can be taken to better prepare general practitioners to assess seafarers?**
   It's more difficult now that seafarers no longer live in port cities. In-service training is key. It was easier in fishing where most live close to work. There are successful projects in the UK with Seafarers Hospital Society, where I am a trustee. New MCA-approved doctors were reviewed after 40–50 medicals, with feedback and resources. Peer networks, where doctors can discuss unusual cases with more experienced colleagues, are invaluable. Understanding the unique health needs on board ship is essential.

9. **What practical measures could health systems adopt to improve care and follow-up, for seafarers?**
   Shorter port stays make access to care difficult. Priority treatment in port requires strong local networks, like Antwerp has, but that's rare. Private healthcare models sometimes handle this better than state systems, processing cases quickly during clinical emergencies. We also need specialist centres for seafarers, but many have disappeared.

10. **Could integrating digital records improve care?**
    In theory, yes, but first we'd need a recognised group of certified maritime physicians. There are also trust issues: seafarers may hide medical conditions for fear of losing their jobs. Secure systems, possibly using smart cards, could help, but safeguards against misuse are vital.

11. **You took part in all the editions of the Textbook in the Maritime Health. Have you noticed any gaps in current maritime health training, and where does training fit into the future of maritime health?**
    I think they're not gaps, but what we actually need are targeted, task-based courses for doctors, their superintendents and HR departments. In one part, few 'maritime' practitioners have a full oversight of the whole maritime health system; many just do medicals. In the other, a lot of seafarers don't really see looking after the health of other crewmen as their priority in training, until after experiencing a serious incident. There is a need for easy learning, some online, some face to face, which can enable people to learn about these. Non-maritime practitioners need easy access to information on

maritime health. Satellite communications now make real-time telemedical support possible, but standards for such services need improvement. All need to understand something of the whole system.

12. **What advice would you give to someone entering maritime health today?**
You're going to have to work with a team of people. You have skills, they have skills. If you respect their skills, they'll respect your skills. We need to work as part of a team. Respect others' skills, and they'll respect yours. Doctors are used to being the top dog, but in maritime and occupational health, you'll achieve more by collaborating.

Editor's Note:
Speaking with Dr. Carter felt like charting a voyage through the evolution of modern maritime medicine itself, guided by intellect, humility, and a steadfast concern for seafarers' welfare. Our conversation also emphasized how the future of maritime health will depend on collaboration across disciplines, the humility to learn from past experience, and the readiness to adapt to challenges still beyond the horizon, all in service of those whose lives and work are at sea.

Dr. James A. Denham
Editor, IMH Magazine

Report

IMHA

FUTURE-PROOFING SEAFARER HEALTH STANDARDS: IMHA WORKSHOP ON APPENDIX E

by Sue Stannard, Katherine Sinclaire and James A. Denham

"If the STCW Convention is under review, then surely our medical guidelines must also be," said IMHA President **Dr. Rob Verbist**, opening the February 2025 workshop on seafarer medical standards. His words set the tone for three days of debate, collaboration, and forward-thinking on one of the most important tools in maritime health: the **ILO/IMO Guidelines on the Medical Examination of Seafarers.**
These guidelines, which were first published in 2013, are used globally to assess the fitness to work of seafarers. However, Appendix E, the section that addresses fitness in relation to common medical conditions, has not been reviewed in over a decade. During this time, advancements in medical science, changes in the seafaring industry, and an increasingly diverse workforce have occurred. Recognizing the need for an update, the International Maritime Health Association (IMHA), with support from the ITF Seafarers' Trust, has taken an opportunity for a closer at these guidelines.

Why a Review Now?

Medicine has advanced rapidly, from **continuous glucose monitors** for diabetes and new medications for **HIV**, to the growing awareness of **neurodiversity**. However, challenges such as **obesity**, an **aging workforce**, and the inclusion of more **women in maritime professions** have revealed some gaps in the existing framework.
As Dr. Tim Carter, the original author of the 2013 Guidelines, reminded the group, "*What seemed adequate twelve years ago may no longer reflect today's medical practice or the realities of modern shipping.*"

How the Workshop Worked

IMHA began with a global survey, gathering input from 107 participants across 27 countries. Then, in February 2025, **18 experts**, including physicians, regulators, academics, and industry representatives, gathered at the UK Maritime and Coastguard Agency in Southampton.

Over the course of three days, participants debated various topics in groups, staged arguments on whether to support change or maintain the current status and compared practices from different nations. The atmosphere was lively, marked with candid discussions on challenging issues, while also fostering a strong spirit of collaboration.

What Emerged from the Discussions

Some topics generated particularly strong consensus:

- **Obesity:** There is a need for fair, evidence-based assessments that go beyond body mass index (BMI) to focus on physical capability and health risks.
- **Diabetes:** Continuous glucose monitoring may change the picture for insulin users, but more precise guidance is needed.
- **HIV:** With treatment, many individuals can live healthy lives; however, side effects, viral load, and the risk of transmission must be taken into consideration.
- **Neurodiversity:** Conditions such as ADHD and autism should emphasize functional capability, rather than blanket exclusions.
- **Medication use:** The introduction of new anticoagulants, immunosuppressants, and even medicinal cannabis presents new challenges.
- **Women's health:** The increasing number of female seafarers calls for more inclusive guidance, ranging from gynaecological health to fair screening standards.

Across all conditions, participants stressed the need for clearer definitions (e.g., what "stable" really means) and overarching guiding principles to help doctors make balanced, consistent judgments.

Looking Ahead

The purpose of the workshop was not to establish new rules but to reach a strong consensus that **Appendix E**, along with possibly other sections, **needs a review**. The next steps will involve forming structured working groups, engaging a wider range of stakeholders, and securing funding to support the process.

As one participant put it, "*We must strike a balance between protecting safety and avoiding unnecessary exclusion. Seafarer health standards need to be fair, evidence-based, and future-proof.*"

For now, the message is clear: the maritime medical community is prepared to take on this challenge. A detailed workshop report from the workshop will be available on the IMHA website. However, the spirit of the meeting can be summed up in one line: **The new guidelines must keep pace with medicine, shipping, and the people who go to sea.**

***A full workshop report will be published on the IMHA website.*

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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CONTENTS

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