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EPIDEMIOLOGICAL, MEDICAL AND SOCIAL ASPECTS OF OCCUPATIONAL AND WORK-RELATED MORBIDITY ON WATER TRANSPORT (REVIEW OF LITERATURE)

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Summary. Talalayev K. O., Ignatiev O. M., Vastyanov R. S., Golubyatnikov M. I., Panyuta O. I. **EPIDEMIOLOGICAL, MEDICAL AND SOCIAL ASPECTS OF OCCUPATIONAL AND WORK-RELATED MORBIDITY ON WATER TRANSPORT (REVIEW OF LITERATURE).** – *The Odessa National medical University; e-mail: ignatyev2009@rambler.ru*. Work on water transport remains a dangerous profession, and seafarers have a higher risk of developing occupational diseases and injuries than those in other industries. A comprehensive detailed analysis of occupational health indicators of water transport workers in the world and in Ukraine has practically not been conducted in recent years; available data on the modern structure and dynamics of occupational morbidity diseases are sporadic and unsystematized. The authors conducted a comprehensive retrospective study of available literature sources and analyzed data regarding the structure and cause-and-effect relationships between professional activities and morbidity among sailors. The relationship between social, medical and occupational risk factors and possible ways to eliminate them have also been studied. The study of seafarers' working conditions on the ships of major charterers and the investigation of cases of seafarers seeking medical aid for illnesses require detailed consideration, development of preventive measures and instructions for providing medical aid for seafarers' occupational diseases and injuries.

Key words: seafarer, occupational disease, maritime sector, medical aid.

Реферат. Талалаєв К. О., Ігнатьєв О. М., Вастьянов Р. С., Голубятников М. І., Панюта О. І. **ЕПІДЕМІОЛОГІЧНІ, МЕДИЧНІ ТА СОЦІАЛЬНІ АСПЕКТИ ПРОФЕСІЙНОЇ ТА ПРОФЕСІЙНОЇ ЗАХВОРЮВАНОСТІ НА ВОДНОМУ ТРАНСПОРТІ (ОГЛЯД ЛІТЕРАТУРИ).** - *Одеський національний медичний університет; e-mail: ignatyev2009@rambler.ru*. Робота на водному транспорті залишається небезпечною професією, а працівники мають ризик розвитку професійних захворювань і травматизму вищій, ніж у інших галузях. Комплексний детальний аналіз показників професійного здоров'я працівників водного транспорту у світі та Україні практично не проводився протягом останніх років; наявні дані про сучасну структуру і динаміку розвитку захворюваності на професійні захворювання є уривчатими і несистематизованими.

Автори провели комплексне ретроспективне дослідження доступних літературних джерел та проаналізували дані щодо структури та причинно-наслідкових зв'язків між професійною діяльністю та захворюваністю осіб плавскладу. Вивчено також взаємозв'язок між соціальними, медичними та виробничими факторами ризику та можливі способи їх усунення. Вивчення умов праці моряків на судах основних фрахтувальників та розслідування випадків звернення моряків за медичною допомогою при захворюваннях потребує детального врахування, розробки профілактичних заходів та інструкцій з надання медичної допомоги при професійних захворюваннях і травмах у моряків.

Ключові слова: особа плавскладу, професійне захворювання, морський сектор, медична допомога

Urgency of the problem. The main part of the world trade, about 80% of cargo by volume and about 70% by value, is carried out with the use of maritime transport. Under the flag of host countries with appropriate regulation, an average 20% of the total tonnage of merchant ships is kept. The main carrier companies ("Maersk", "Mediterranean shipping company", etc.) control more than 75% of the ships, their work is international in nature with the registration of ships under the "flag of convenience" of Panama, the Marshall Islands, Liberia and so on. Economic growth in 2017-2018 led to an increase in orders for new ships and a decrease in the number of decommissioned ships [1].

The total number of ships, sailors and water transport workers is increasing. Based on ICS/BIMCO reports, the number of active seafarers has increased from 1.67 million in 2015 to 1.89 million in 2021. They operate about 75.000 vessels [2, 3]. However, one should take into account the generalized nature of such data, since a total account is taken of all known certified sailors and all known ships in the world, which does not reflect the significant segmentation of the labor market in the areas of river navigation, fishing, etc., which are not subject to globalization processes [4].

The second method of counting seafarers is based on the study of the crew lists of ships that provide services from cooperating ports. It is used, for example, by SIRC, and shows between 10 and 17% of seafarers reported by ICS/BIMCO [5]. This method also has significant limitations associated with the "horizontal transfer of information": the readiness of ports to cooperate with researchers, language restrictions, restrictions on access to some information, the need for peer review of a significant amount of documentation, etc. [6]

Regardless of the method of calculation, it is noted that the labor market in the maritime industry is growing steadily. Despite the increase in the number of workers in water transport, a high level of automation leads to a decrease in the crew on a single vessel [7]. Some countries are considering further reductions in the crew, up to the implementation of the concept of an unmanned vessel (MASS) [8]

This circumstance contributes to the growth of requirements for each crew member, both from the side of preliminary training, and for health reasons, and for the motivated attitude of the seafarer to the safety of navigation, the prevention of injuries, occupational diseases and accidents on board [9].

On the other hand, the work of a seafarer on a ship is traditionally regarded as associated with a low quality of life, exposure to numerous harmful factors, and a high risk of developing occupational diseases and injuries [10, 11].

Purpose. Make a comprehensive retrospective study of the literature, systemize and analyze the recent data, visual structures, determinants and causal links between occupations and morbidity of seafarers with acute, chronic diseases and pathological conditions caused by work on board, in their connections with social, medical and occupational risk factors; on the basis of scientific and soil propositions about additional approaches, in the implementation of such similar approaches to the promotion of health care practitioners in the marine area of Ukraine to international standards.

Materials and Methods. Bibliosemantic, statistical, analytical and structural-logical. The biblical-semantic method was used for understanding the problems of occupational morbidity in the world and Ukraine through the analysis of available literary and electronic resources. Research, analysis and generalization of publications devoted to occupational and professionally caused

diseases in seafarers have been carried out. The works were selected on the basis of their predominantly medical focus - assessment of risk factors for acute, chronic diseases and pathological conditions; the prevalence of certain diseases depending on the ethnic, social or occupational characteristics of seafarers groups; leading causes of their mortality and disability.

The review also includes some works devoted mainly to the issues of training seafarers, hygienic and engineering support for ships, migration policy, if their content allows to better demonstrate the medical aspects of occupational pathology in seafarers.

The method of statistical caution is used with the aim to create an informational base on the beginning of statistical research based on the principles of scientific organization for the data collection.

The analytical method was used in order to understand the essence of the phenomenon of illness in water transport during cargo transportation on merchant and the port fleet ships.

The method of structural and logical analysis gave the possibility to determine, structure and identify the causal relationship between the obvious procedures for carrying out transport operations and the need to implement additional measures, oriented towards the proximity of Ukraine to the high standards in the protection of health and the reach of effective indicators of its protection on water transport.

National features of occupational morbidity and injuries in the merchant marine. Researchers have repeatedly demonstrated the difference in attitudes of seafarers to their own health in general and the development of diseases on board a ship in particular, depending on nationality and citizenship [12, 13].

Citizens of countries with high per capita income (Great Britain, Scandinavian countries, EU) are less interested in a career in the fleet. For those who become a seafarer, the overall motivation for work is obviously lower than for seafarers from other countries [14].

Seafarers from countries with poor populations are extremely motivated, since working in the marine sector according to international standards brings them significantly higher salaries and other social benefits than they could expect when working ashore in their own country [15].

The existing requirements of world trade for the fleet and the fleet for the level of training of seafarers do not allow shipping companies to form crews exclusively from citizens of the countries to which the ships belong. Moreover, over time, this problem will only intensify. For example, the earlier ICS/BIMCO 2021 report predicts a shortage of more than 25.000 fleet officers by 2026. Therefore, on the ships of the leading companies, regardless of the flag, an increasing share of the crews will be occupied by highly motivated seafarers from other countries. Thus, in one of the studies, it was demonstrated that foreign seafarers entering work in German shipping companies and, de facto, being labor migrants, de jure, are not regulated in any way, since the ships of German companies are registered under a “flag of convenience”, and sailors during the voyage are at sea, and not in Germany [16].

Recruitment of seafarers who have trained and gained experience in other countries is associated with a number of difficulties in assessing their compliance with the requirements. If the level of training and the pre-trip health of candidates for sailors can be assessed in advance, then the attitude to one's own health, safety and safety of navigation in general is the object of study [17].

Thus, it has been demonstrated that there are fundamental differences between seafarers who are EU citizens and seafarers from other countries when working together on ships under the flag of EU member state. Seafarers-citizens of the EU with lower motivation to work always openly discuss ship safety issues, note and discuss the incorrect behavior and / or condition of other crew members with these seafarers, the captain of the ship, company representatives, etc. Seafarers from other countries (for example, the Filipinos) are highly motivated and carefully monitor their own health and safety, but refuse to discuss safety violations / inappropriate behavior both on the part of other crew members and vessel safety issues in general [18, 19].

Such differences lead to a significantly higher risk of injury and accidents for seafarers from Western European countries [20].

The researchers also note the difference between the approaches to safety between seafarers from developed countries. For example, when comparing the frequency of injuries and accidents on ships under the flags of Greece and Denmark, there is a relatively higher frequency of injuries

and accidents among seafarers on ships from Denmark [21]. The researchers assume that this is a reflection of a different safety culture, the organization of safety control on the ship and a higher workload for seafarers.

Evacuation of seafarers from the ship. The evacuation of an injured person from a ship for medical reasons is an extreme form of struggle for the life and health of a seafarer. The reasons for evacuation can range from urgent assistance to one sick sailor to the need to evacuate the entire injured crew and passengers in a disaster leading to the death of the ship [22]. The most common reasons for the evacuation of seafarers are injuries and cardiovascular diseases in seafarers over 50 years of age [23]. The evacuation of seafarers also has differences depending on the nationality and citizenship of the sailor. It has been shown that the frequency of evacuation of seafarers from EU-flagged ships varies significantly by nationality. Seafarers who are citizens of other countries are 2 times more likely to be evacuated from ships for medical reasons than citizens of the EU countries, while seafarers over 50 years old are evacuated from a ship 2 times more often than seafarers under 30 years old [24, 25]. This is explained by the fact that seafarers over 50 years of age, many of whom are labor migrants, are more often subject to evacuation for medical reasons.

At the same time, the difference in the frequency of evacuations does not allow us to attribute such events solely to attempts to hide one's poor health during medical examinations before the voyage. According to the researchers, the reasons are also excessive workload on board the ship for ordinary crew members, high motivation of seafarers from other countries, readiness to carry out the instructions of the management regardless of their health [26].

Fatalities on board. The work of a seafarer is associated with a high risk of injury, accidents at work and occupational diseases. Some forms of maritime activity, such as fishing, have been claimed for years as the leaders in the risk of death among all professions both in the world and in individual countries. Thus, in the USA, the mortality rate among sailors is 18.5 per 100.000 persons, which is 6 times higher than in other professions [27, 28].

However, the current system of crew death records on a ship only partially reflects crew mortality and only for certain ships flying the flags of certain countries. So, starting from the 1970s, part of the fleet of British shipping companies changed the country of registration of ships from Great Britain to Hong Kong, Bermuda, etc. Further evaluation of accidents and deaths on ships showed that, within companies, the mortality rate on ships that changed their registration is higher than on those remaining under the flag of the kingdom. In subsequent years, in connection with the tightening of legislation, British companies transferred part of the ships under the "flags of convenience" of Belize. The researchers suggest that the mortality rate on these vessels may be even higher, but the data available under such conditions is insufficient [29].

Data on seafarer deaths on a voyage is difficult to assess, as they are irregular and partial. The analysis is carried out on the basis of information provided by the port medical services and telemedicine centers. As mentioned previously, the specificity of this approach does not allow to obtain at least approximate data on mortality. Neither the number of active seafarers in any given cohort nor the actual mortality in that cohort is known, as many port authorities and telemedicine centers do not provide information on their reported deaths [30, 31]. The main causes of death on board ship are cardiovascular disease and death from external influences (including criminal events, alcohol, drugs and suicide).

Almost any statistics on the mortality of sailors is not very informative from a medical point of view. Thus, in the annual reports of the European Maritime Safety Agency (EMSA), one can observe a more than threefold decrease in the number of deaths from 98 to 32 from 2014 to 2022. However, only the deaths of EU sailors with STCW certificates are taken into account. In this case, only deaths as a result of an accident are analyzed, which are unambiguously related to the work performed and are of a professional nature. Such an approach testifies to the legal side of the issue - how many deaths of EU-citizen seafarers on a voyage have been linked to work. It is of little value for the analysis and planning of the work of the medical service, since with this calculation methodology it is impossible to know how much the decrease in mortality is due to improved safety on board, and how much is due to the replacement of EU seafarers by migrants who are not taken into account in the statistics[32].

If we evaluate the effectiveness of pre-trip medical examinations as a prevention of mortality on ships, it turns out that the reasons for not issuing a certificate for medical reasons will

be mainly those diseases and pathological conditions that limit the ability to perform work or increase the risk of evacuation from the ship. At the same time, sailors with some of the diseases that lead to death on the water are practically not detected during medical examinations and are not suspended [33].

Crew fatigue. The average age of merchant mariners is about 40 years. More than half of seafarers change their profession or stop working by the age of 50 y.o. [34].

The main reason for changing jobs is psychological and medical conditions that are associated with chronic fatigue. Chronic fatigue in the post-voyage period is noted by about 50% of seafarers, and 15% indicate that the feeling of fatigue persists until the next voyage. [35].

The most common pathological conditions associated with chronic fatigue are arterial hypertension, obesity, gastrointestinal diseases (gastric and duodenal ulcers, irritable bowel syndrome) and sleep disorders. Among sailors, such phenomena are observed in 12.7%, 9.1%, 9.1%, 7.3%, respectively [36, 37].

These phenomena have similar etiology - shift work, change of time zones, stress and the impact of harmful factors of the sea-economic complex. And the pathogenesis - overstrain, violation of the rest regime and lack of sleep lead to the accumulation of fatigue, untimely, monotonous nutrition with an excess of easily digestible carbohydrates contribute to the development of obesity. [38, 39].

Excessive consumption of unbalanced food and the multifaceted effect of harmful factors of shift work contribute to the development of gastritis/ulcers and irritable bowel syndrome more than twice in similar sex and age groups who work at a day time and have the opportunity to eat well [40].

Chronic fatigue of a sailor and its clinical manifestations contribute to a decrease in working capacity, increase the risk of accidents [41].

The fight against chronic fatigue involves the use of targeted individual rehabilitation programs during the post- voyage period and preventive measures during the voyage. Correction of chronic fatigue can contribute to the preservation of working capacity and the prevention of accidents in the fleet [42].

Injuries of the crew. A serious injury is an injury received by a seafarer and caused work – ability loss if the seafarer cannot function normally for more than 72 days, beginning from 7 days after the information about the injury [43] appeared.

From 2014 to 2021 EMSA registered 5394 victims in 6155 episodes, 84.6% of the victims were crew members. The number of injuries has tended to decrease from 999 injuries in 2014 to 587 in 2020, and their up to 641 in 2021. It is impossible to assess whether there was an actual increase in injuries on ships or whether the ratio of recorded and not recorded cohorts of seafarers has changed [32] because of the peculiarities of EMSA statistics regarding seafarers from different countries.

The Telemedicine Centre (Italy) studied the epidemiological features of the occupational diseases and injuries prevalence among seafarers and showed that the overall injury rate was 6.31 per 1000 seafarer-years over the study period. It was also noted that ratings suffer more often than fleet officers, and deck – crew sailors more often than the engine room ones [44].

However, in a similar study of the causes of seafarers' disability based on telemedicine centers requests, the risk of injury was already 113 per 1000 seafarer- years, with a similar distribution of injuries between officers and ratings [45].

Such differences indicate, first of all, the absence of a unified methodological approach to research.

The causative factors leading to accidents were investigated by Erkan Çakır (2019) according to seven categories that were obtained from accident reports on commercial cargo ships [46]. Unsafe working methods and ignorance of rules and instructions (53.2%) were recognized as the most common cause of accidents (for example, working in the wrong place on board, not using personal protective equipment, unsafe work habits). Other common factors contributing to injury were inadequate risk assessment and hazard identification (19.8%), machine/equipment malfunction (11.2%), inadequate education, training experience, and unsafe work environment (e.g., bad weather, poor lighting , insufficient ventilation) lack of communication and teamwork

Seafarer injuries attract increased attention, including due to the occurrence of an insured

event. However, injuries account for 14 to 35% (average 20%) of the medical causes of a seafarer's incapacity for work on a voyage [47]. This, in general, corresponds to the average ratio of occupational diseases to industrial injuries - 4:1.

Intoxication with fumigants Cargo containers and holds for bulk cargo on ships are treated with various chemical pesticides. Those that are gaseous (usually used as "smoke") are combined under the name "fumigants" - they easily penetrate the cargo, but can also easily leave the cargo holds or containers if they are not properly sealed. These chemicals are toxic to humans and pose a potential health risk to the crew on board, pesticide residues may be present after the vessel arrives at its destination, posing a health hazard to ship's crew, dock workers during unloading, customs officers and warehouse workers, who receive and process fumigated cargo containers [48].

Phosphine became the most widespread as a fumigant. Phosphine is defined as relatively easy to use by trained personnel but this does not exclude accidents with fatal consequences [49].

According to L. M. Shafran (2020), 70.5% of those poisoned are crew members of bulkers and other ships that transported fumigated grain. This contingent accounts for 31.3% of deaths. In coastal conditions, the main exposed contingent are members of farmers' families, in whose farms fumigation was carried out and elementary violations of safety requirements took place [50].

Although adverse health effects following exposure to pesticides do occur, documentation of these incidents is often insufficient, with a lack of documented exposure data, adverse health effects, and clinical symptoms [51].

In two papers, Preisser et al. described 26 patients referred to German clinic with symptoms of pesticide intoxication after opening transport containers [52]. The authors were able to confirm the diagnosis based on typical symptoms and a thorough clinical examination. Additionally, laboratory analysis revealed dichloridethylene, methyl bromide, phosphine and methylene chloride. The predominant symptoms were headaches, problems with concentration and memory, dizziness and nausea, irritation of the skin and mucous membranes, and reduced physical tolerance. In addition to neurological and neuropsychological disorders, analyzes confirmed the development of reactive airway dysfunction syndrome in 14 of 26 patients with long-term symptoms resulting from contact with fumigants. They mainly affect the central and peripheral nervous system and the respiratory tract, but can also cause cancer. Phosphides can be absorbed through damaged skin [53].

Among the main causes of accidents and poisoning of sailors are also insufficient professional training and competence of ship officers, cargo fumigators and port supervision, poor professional supervision of the activities of "accidental" fumigation teams working in ports without the necessary IMO permit, as well as non-regulation of legislative, administrative and legal responsibility of managers at different levels [54].

For high-quality prevention of accidents, it is important to strictly comply with legislation, train crews, create models of effective communication between various participants (ship owner, captain, fumigator, crew, loaders) of transit treatment with insecticides, such as fumigation with phosphine [55].

Modern principles of the scientific organization of work indicate that, in the face of any disease, prevention should precede treatment [56]

Merchant mariners and COVID-19 pandemic. The start and subsequent spread of the COVID-19 pandemic in 2020 are inextricably linked to maritime transport. After the discovery of the first sick passenger on the *Diamond Princess* cruise ship, the Port Authority's restrictions on the crew and passengers of the *Diamond Princess* set a precedent. Subsequently, many seafarers have been subjected to unprecedented pressure and violation of rights by national regulators. Restrictions were related to the possibility of receiving medical care in case of illness, the right to go ashore, repatriation if necessary, etc. [57, 58].

The spread of COVID-19 among seafarers who were on shore, as well as the high incidence of other workers in the sea - economic complex (pilots, port workers, ship agents, etc.), led to two significant consequences:

- long stay of seafarers who remained healthy on the ship, which significantly exceeded the terms of the contracts, with the development of asthenia, depression, complications associated with prolonged exposure to harmful factors in the maritime industry [59];

– the spread among seafarers of mental disorders (fear, depression, etc.) associated with the threat of infection and death from COVID-19 when entering the port, from new crew members, passengers (on cruise liners) and other ship visitors [60].

The sailors' fears were not unfounded. The peculiarities of working on a ship lead to the fact that seafarers during the voyage, on average, get sick with community - acquired pneumonia more easily and face the need for hospitalization on the pneumonia line 1.4 times more often than on shore [61]. The problem of outbreaks of COVID-19 among seafarers locked on board with sick persons without the right to leave the ship was so acute at the height of the epidemic that it required the urgent development and implementation of WHO recommendations for the treatment of seafarers on board [62, 63].

The effectiveness of all measures taken remains unknown both from a medical and insurance point of view [64, 65], and the consequences of the COVID-19 pandemic on the health of seafarers continue to be studied [66, 67]

Conclusions

Estimating the prevalence of occupational diseases and injuries in the fleet depends on the type of information sources.

The results of formally similar studies may differ significantly depending on the chosen methodology for forming the study groups.

An increasing proportion of seafarers from other countries and FOC ships undermine the value and reliability of the aggregated statistics provided by European regulators.

The facts obtained about occupational pathology in water transport workers demonstrate the epidemiological, medical and social significance of the problem.

A comprehensive detailed analysis of occupational health indicators of water transport workers in the world and in Ukraine has practically not been conducted in recent years; available data on the modern structure and dynamics of occupational morbidity diseases are sporadic and unsystematized.

Work on water transport remains a dangerous profession, and workers have a higher risk of developing occupational diseases and injuries than in other industries.

The bulk of the observations on the causes of occupational diseases relate to chemicals. The number of injured sailors will increase in accordance with the spread of cargo fumigation, but the possibility of its adequate registration is doubtful.

The impact of the COVID-19 pandemic on the maritime industry has demonstrated the lack of scientifically sound recommendations for providing medical care on ships in extreme conditions, which confirms the urgency of comprehensive scientific research

Studying the working conditions of seafarers from other countries (including Ukraine) on the ships of major charterers and investigating cases of seafarers seeking medical help for illnesses requires detailed consideration, development of preventive measures and instructions for providing medical care for seafarers' occupational diseases and injuries.

A comprehensive detailed analysis of indicators of the professional health of water transport practitioners in the world and Ukraine was practically not carried out for the recent years; real data about the current structure and dynamics of the occupational diseases development urivchatymi and unsystematized.

Work on water transport is left with an unsafe profession, and practitioners may risk the development of professional illnesses and injuries to other people.

Pitoma vaga is a guardian of the causes of professional ailments of chemical speeches. The number of affected seafarers will increase in visibility to the expansion of fumigation vantages, and the possibility of adequate registration will call for sums.

Having injected the COVID-19 pandemic into the marine environment, demonstrating the lack of scientifically sound recommendations for the provision of medical assistance on board ships in extreme minds, which confirms the insolence of conducting complex scientific research

Training the minds of seafarers from other lands (including Ukraine) on the ships of the main charterers and investigating the training of seafarers for medical assistance in case of illness will require detailed medical care, prophylactic entry and instructions and s of medical assistance in case of occupational illnesses and injuries among seafarers.

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Conflicts of Interest

The authors declare no conflict of interest.

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