

Review

## Occupational Risks and Challenges of Seafaring

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**Abstract: Occupational Risks and Challenges of Seafaring: Marcus OLDENBURG, et al. Department of Maritime Medicine, Institute for Occupational and Maritime Medicine, Germany**—Seafarers are exposed to a high diversity of occupational health hazards onboard ships. **Objective:** The aim of this article is to present a survey of the current, most important hazards in seafaring including recommendations on measures how to deal with these problems. **Methods:** The review is based on maritime expert opinions as well a PubMed analysis related to the occupational risks of seafaring. **Results:** Despite recent advances in injury prevention, accidents due to harmful working and living conditions at sea and of non-observance of safety rules remain a main cause of injury and death. Mortality in seafaring from cardiovascular diseases (CVD) is mainly caused by increased risks and impaired treatment options of CVD at sea. Further, shipboard stress and high demand may lead to fatigue and isolation which have an impact on the health of onboard seafarers. Communicable diseases in seafaring remain an occupational problem. Exposures to hazardous substances and UV-light are important health risks onboard ships. Because of harsh working conditions onboard including environmental conditions, sufficient recreational activities are needed for the seafarers' compensation both onboard and ashore. However, in reality there is often a lack of leisure time possibilities. **Discussion:** Seafaring is still an occupation with specific work-related risks. Thus, a further reduction of occupational hazards aboard ships is needed and poses a challenge for maritime health specialists and stakeholders. Nowadays, maritime medicine encompasses a broad field of workplaces with different job-related challenges. (*J Occup Health 2010; 52: 249–256*)

**Key words:** Communicable diseases, Disaster, Occupational cancer, Occupational risks, Seafaring, Stress

### Occupational Risks in Seafaring

#### *Disasters and accident rates*

In the last few decades the disaster and accident rates in seafaring have fallen sharply<sup>1</sup>. According to a study on fatal work-related accidents onboard UK merchant shipping from 1919 to 2005, large reductions were found for mortality rates in fatal disasters and personnel accidents over the course of time<sup>2</sup>. This trend has been confirmed by other studies. Major causes of mortality in shipping disasters were vessels foundering in typhoons, storms and heavy gales, explosions in cargo holds and collisions due to poor visibility. Considering the types of ship the highest mortality rates, up to 400 per 100,000 seafarer-years, were found among fishermen<sup>3</sup>.

Rough weather, insufficient awareness of safety, lack of use of personal protective devices as well as inexperience are regarded as the main causes of fatal injuries related to work. Many of the fatal occupational accidents happen among deck ratings and deck officers and a recurrence of similar accident types is observed, such as falls into or inside cargo holds, falls overboard or being struck by heavy seas on deck. Fatal injuries during off-duty hours are often associated with alcohol consumption. International Maritime Organization (IMO) statistics reveal that 80% of accidents onboard cargo ships are caused by the human factor<sup>4</sup>.

The available mortality studies about English, Danish and Polish seafarers onboard merchant ships cover the 1980s and 1990s<sup>5–7</sup>. The non-natural causes were divided into accidents occurring during the off-duty hours, occupational accidents occurring as a direct consequence of work onboard and maritime disasters (death caused by shipwreck or capsizing) (Fig. 1). In total, the non-natural causes ranged between 40% and 50% of all deaths in these studies. Natural causes in terms of diseases were found in 36% to 42% of all deaths in the three studies.

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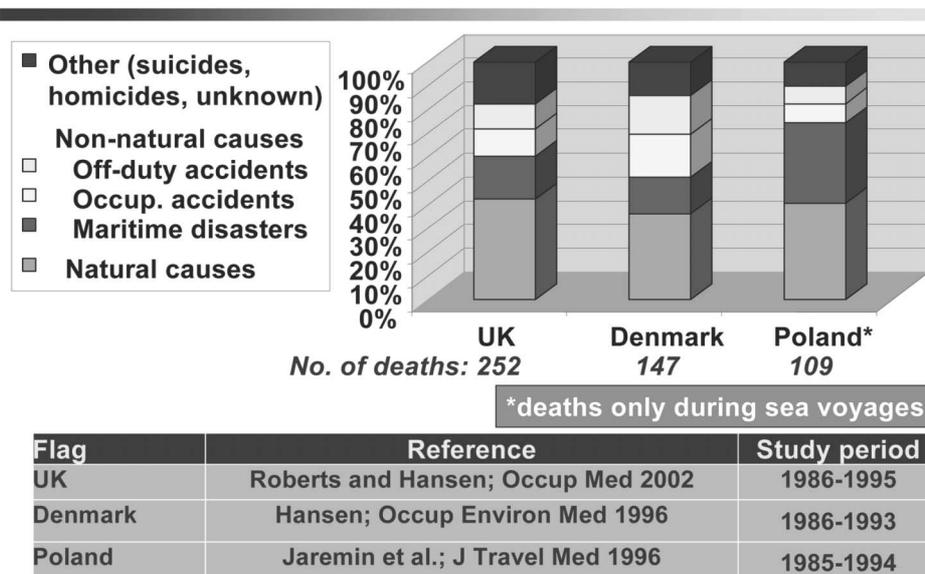


Fig. 1. Causes of deaths of seafarers employed on English, Danish, and Polish merchant ships.

According to a Danish mortality study, the incidence of accidents among seafarers was 11.5 times higher than among the Danish male workforce ashore<sup>6</sup>. An explanation offered by the authors is the risk of maritime disasters in which the workplace itself disappears or is severely damaged.

- Recommendations:* Occupational measures are required to diminish fatal accidents onboard. They should include:
- training and instruction of seafarers in safe behavior on board, for example during the medical refresher course
  - comprehensive information onboard to raise awareness on the use of personal protection devices, including onboard programs in terms of primary and secondary prevention
  - intensified education in the official language on board (usually English).

All these measures are of importance and a challenge for maritime health specialists and researchers.

*Piracy*

In recent years, the issue of piracy has gained international topicality. The International Maritime Organization has summarized all incidents of piracy and armed robbery against ships reported to the Organization since 1984<sup>8</sup>. The number of acts of piracy and armed robbery against ships reported to have occurred or to have been attempted from 1984 until December 2009 was 5,224. In 2009, 403 incidences were observed with a rising tendency since mid 1990s. Worldwide, the areas most affected by piracy are the South China Sea, the coasts of East and West Africa and the Indian Ocean. In 2008, 774 crew members were reportedly taken hostage/

kidnapped and about 38 crew members were still unaccounted for; 1 vessel was reportedly still unaccounted for, and 51 ships were reportedly hijacked.

*Recommendations:* The IMO is implementing an anti-piracy project, focusing on a number of regional seminars and workshops attended by Government representatives from countries in piracy-infested areas of the world. The ship operators, shipmasters and crew should comprehensively be advised on prevention and suppression of acts of piracy and armed robbery against ships.

*Impaired treatment options of cardiovascular diseases at sea*

Apart from accidents and work-related injuries acute CVD is the main cause of death—both at sea and on land in industrialized countries. In the 1980s and 1990s deaths due to CVD accounted for 55% to 70% of all natural causes of death among seamen on British and Danish merchant ships<sup>5, 6</sup>. Deaths due to other illnesses (gastrointestinal, infectious diseases or neoplasm) appears to have played minor roles.

In other mortality studies, the CVD mortality rate was found to be from 27 to 45 per 100,000 seafarer-years. This mortality does not significantly differ from that of the respective general population ashore, but a healthy worker effect has to be taken into account among seafarers who are subjected to pre-employment examinations and medical surveillance including medical-fitness tests for nautical service<sup>9</sup>.

An important difference in the treatment of seafarers at sea is that medical care onboard is applied by a medical health officer who is not a medical professional. The STCW Code (Seafarers’ Training Certification and

Watchkeeping, 1978) defines the standard of competence for such seafarers designated to provide medical first aid onboard ship<sup>10</sup>. These seafarers must be able to take immediately effective actions in the case of accidents or illness likely to occur on ships.

The treatment options for CVD occurring at sea are impaired owing to the nature of the rescue team onboard, the frequently delayed resuscitation actions, the limitations of treatment onboard as well as the problems of evacuation ashore. Jaremin and Kotulak (2003)<sup>11</sup> showed in their mortality study covering more than 11,000 Polish seafarers and deep sea fishermen that only one quarter of the persons with myocardial infarction at sea was still alive one year after the onset of the acute cardiac event. As this survival rate significantly differs from that of Polish employees ashore, it was assumed by the authors that the myocardial infarction prognosis at sea is worse.

*Recommendations:* Generally, it should be mentioned that the possibilities of modern treatment of cardiovascular diseases (such as acute percutaneous transluminal coronary angioplasty (PTCA), lysis or aortocoronary venous bypass (ACVB)) have fundamentally improved the survival of affected patients ashore. However, these treatment options necessitate profound medical/surgical experience; thus they are not available onboard ships.

During medical surveillance examinations, seafarers at high risk of cardiac events need to be identified in a reliable way in order to reduce morbidity and mortality. Nowadays, well established risk-scores exist allowing assessment of the likelihood of an initial episode of heart disease. Seamen with an observed high coronary risk should be advised and treated according to the recommendations of the International Task Force for the Prevention of Coronary Heart Disease<sup>12</sup>. Based on our results, the most important practical measures available to decrease CVD risks among seafarers are training cooks in low-fat diets, offering smoking cessation programs and treatment of elevated blood pressure<sup>9</sup>.

For medical treatment at sea the responsible officer should seek telemedical advice from a radiomedical physician ashore. It is strongly recommended that transmissions of telemedical ECG be made available to the telemedical assistant service to facilitate diagnoses of patients with unspecific chest pains, especially in cases of potentially arrhythmic heart diseases.

#### *High load of work-related stress in seafaring*

As early as 1998 Agterberg and Passchier described higher work-related stress in seamen than in the general population<sup>13</sup>. Seafaring is associated with special mental, psychosocial and physical stressors and cannot be compared with jobs ashore. The working and living conditions of seafaring are characterized by long-time separation from family and home for months, economic

pressure as well as considerable and sometimes extreme psychosocial problems.

In a standardized interview, 134 male seafarers sailing on German-flagged vessels were asked about their living and working conditions onboard<sup>14</sup>. The seamen rated the individual stress level of 23 different stressors aboard. This study revealed that separation from the family, time pressure/ hectic activities, long working hours per day, heat in workplaces, and insufficient qualifications of subordinate crew members were the most important stressors onboard. This study also showed considerable differences in the duration of shipboard stay between European and non-European seafarers. Some studies found an average contract duration from 3 to 6 mo for European seamen and from 6 to 9 mo for Non-European ones<sup>9, 15</sup>. Seafarers with a shipboard stay of more than 12 mo often feel confined onboard a ship. This extreme long stay is a serious occupational problem because seamen on such contracts normally have no possibilities to meet their families during this time period or to follow other leisure time activities.

*Recommendations:* On account of the extraordinary multiplicity of job-related stressors in seafaring, particular attention should be paid to preventive occupational and organizational measures. According to the above mentioned results, it is especially important to shorten the duration of shipboard stay in order to reduce long-time separation from family and to minimize extremely long working hours.

Further, the medical training courses for ship officers should include prevention messages. The high smoking consumption of seafarers needs to be paid more attention through anti-smoking campaigns<sup>9, 16, 17</sup>. Besides life-style factors, seafarers should learn how to prevent and how to manage stress, for instance by making use of relaxation techniques.

Current studies exploring the efficiency of stress-prevention strategies are needed.

#### 1) Fatigue

High stress load and isolation may cause psychosomatic disorders including burn-out syndrome and fatigue.

There are several reasons for fatigue among seafarers and fatigue is a major occupational problem aboard many modern ships. According to the Maritime Labour Convention (2006) all ships must have a sufficient number of seafarers employed onboard to ensure that ships are operated safely and efficiently<sup>18</sup>. In the last decade, however, the number of crew members onboard has decreased considerably. Reduction of Safe Manning Level leads to reduced shipboard safety and increases the risk of accidents with possible severe, life-threatening, environmental and economic consequences.

Further, high job demands and long working hours

which are often present in 2 watch systems can result in fatigue. Crews become more exhausted and tired due to long working days, especially when having frequent port turnarounds. Although the relationship between working hours and mental health problems has not been fully clarified yet, it is assumed that occupational stressors, such as long working hours, might impair workers' health both psychologically and physically<sup>19, 20</sup>.

The duration and the quality of sleep are also important. Sleep requirements and habits may individually vary considerably but everyone requires unbroken periods of rest. According to the Maritime Labour Convention (2006) the maximum hours of work should not exceed 14 h in any 24-hour period and 72 h in any 7-day period<sup>18</sup>. There is a strong association between the number of hours seamen work and sleep deprivation.

Environmental factors such as noise, vibration and adverse weather conditions also disturb sleep quality.

*Recommendations:* According to the UK Maritime and Coastguard Agency (2007) suitable measures to counteract acute fatigue are to take a break, to have a nap, to have a drink (water is best) and/ or to have something to eat (not too heavy). To cope with fatigue, seafarers should get enough recreational and rest time. Further, seafarers should ensure that the schedule of their duties is realistic and can be adhered to in all normal circumstances. Additionally, shipping companies need to check the manning levels onboard their ships.

## 2) Isolation

In recent years, a development in merchant seafaring has occurred in which reduced crew size owing to modern techniques has led to increased workload aboard. The shortening of turn-around times has resulted in decreased duration of ship's stay in port and it has consequently minimized crews' social contacts<sup>21</sup>. Further, the access for seafarers to areas next to ships has been prohibited for several years. As a preventive measure against security incidents affecting ships or port facilities used in international trade the International Ship and Port Facility Security (ISPS) Code came into force in 2004. It is a comprehensive set of measures to enhance the security of ships and port facilities and was developed in response to the perceived threats to ships and port facilities in the wake of the 9/11 attacks in the United States. The requirements for ships and for port facilities include the monitoring and controlling of access of people as well as cargo. In consequence, it is normally very cumbersome for seamen to leave the ship during a port stay and pass the port safety barriers. Thus, many seafarers don't make the effort to stay ashore in welfare facilities which unfortunately are often far away from the vessels' embarkation point.

Seafarers are among the most isolated demographic working groups in the world, a circumstance which also

refers to access to medical care, both in emergency situations and for primary health care. As the physical demands and health requirements of seafaring are rigorous and the job market appears competitive, many seafarers are reluctant to seek medical and psychological help. Some seamen compensate shipboard isolation with high alcohol consumption. Cheng *et al.* (2008) investigated the relationship of occupational stress and social support with health-related behaviours of smoking and alcohol consumption among Chinese offshore oil workers and concluded that work-related stress can affect health-related behaviours; e.g. alcohol consumption was positively related to perceived stress from "interface between job and family/social life"<sup>22</sup>. Further, it has also been observed that occupational stress is associated with digestive problems<sup>23</sup>. The results of another study suggested that stress due to management problems and relationships with others might promote work-related unintentional injuries<sup>24</sup>.

In the worst cases strong isolation can lead to despair, depression and finally to suicide. The largest cause of traumatic work-related fatalities among British seafaring sub-groups was suicide<sup>25</sup>. Couper (1996) cited a threefold increase in suicide among seafarers, as compared to the general population<sup>26</sup>. The main causes for seafarers' suicides other than isolation are trouble with problems at home, mental stress and strain onboard or motion sickness leading to a breakdown in personality and/or the will to live<sup>27</sup>.

*Recommendations:* Measures to diminish isolation in seafaring are improvements in to-shore telecommunications (at reasonable charge, guaranteed privacy of the messages, free access to all ranks) and promotion of social contacts onboard as well in the port (shipboard sport events, easily accessible welfare facilities, pastoral care and anonymous seafarer's health counselling). Further, much effort must be paid to facilitate the access of the seafarers to port welfare facilities.

In cases of strong isolation, which tends to increase the risk of suicide, psychological support must be available in seafarers' port welfare facilities.

## 3) Multinational crews

Shipboard stress may be a consequence of the specific psychosocial demands on ships. Besides a heavy workload and isolation, multinational crews have been recognized as a stressor. Approximately 65% of the world's merchant fleet is manned with multinational crews<sup>28</sup>. Crews consist not only of many different nationalities but also of members from different religious and cultural backgrounds. Reflecting this, different needs, values and expectations exist<sup>29</sup>.

Today, most seafarers originate from South East Asia, predominately from the Philippines. Generally, they

provide cheaper labour than seafarers from Western Europe, they are easier to recruit and to keep in business. Many Philippines seafarers are doing low skilled or unskilled work and they are subject to poor social security. Although their stays on board often last for a long time, they usually have only short duration contracts. That means that their contracts are restricted only to temporary voyages and afterwards they have to reapply for a subsequent contract at specific agencies. If they lose their job due to temporary unfitness, it is scarcely possible for them to find subsequent employment on a ship. Although multinational crews do not necessarily lead to isolation, the often observed communication problems onboard may cause isolation<sup>30</sup>.

Most of the available studies about occupational health and safety at sea concern populations from Europe. However, little is known about the large number of seafarers from South East Asia and other parts of the world. The known lower level of emotionally expressive behaviour of Asians may have an impact on seafarers' safety and is possibly caused by neural time course differences of the populations in the processing of emotional events<sup>31</sup>. Due to genetic variations in the South Asian population, differences in the individual genetic susceptibility or resistance to diseases of Asians are assumed<sup>32</sup>.

*Recommendations:* Kahveci *et al.* (2001) performed a study from 1999 to 2001 aboard 14 ships and interviewed more than 510 seafarers<sup>33</sup>. They found that multinational crews can operate extremely successfully under conditions which need to be introduced or developed onboard. These were: high levels of fluency in the working language of the ship among both officers and ratings; policies encouraging stable crewing; promotion of social activities onboard via masters and senior officers; minimize the circulation of materials reinforcing cultural and national stereotypes which can often be found onboard.

#### 4) Limited opportunities for recreation

The often observed lack of leisure time facilities, such as fitness-rooms or social events, often impairs seafarers' well-being onboard ship. Regular, vigorous exercise contributes to a general sense of physical, psychological and social well-being and stops unused muscles becoming flabby thereby reducing the risk of accident or injury. Sport not only improves health but, due to social interaction, it also encourages team-building. Well-being onboard is essential for seafarer's health promotion and also for ship security. The occurrence of psycho-emotional stress of seafarers is often associated with disturbed sexual life and with disturbed working and resting regimes due to time zone changes<sup>34</sup>.

*Recommendations:* Ship managers as well as the shipping company can organize social and sport events or provide well-equipped fitness-rooms onboard. Quality

of life onboard, especially leisure time as an important source of recreation, needs to be improved.

#### *Environmental stressors on board*

Not only during working time but also during leisure time seafarers are continuously exposed to ship-related environmental stress factors such as ship motion, noise and vibration. These factors are perceived as stressful (especially during sleeping times) and can distinctly impact the recreational value of leisure time. Further, depending on the weather, ship motion can be very stressful. Severe seasickness can distinctly impair a crew's well-being onboard and seafarers suffering from it are incapable of changing it if they do not respond to treatment or medication is not available on board.

*Recommendations:* Reduction of the exposure levels to noise in all accommodation, recreational and catering facilities is critical. Seafarers should be informed about the adverse effects of exposure to excessive noise on the hearing and instructed in the proper use of noise protection devices and equipment.

#### *Communicable diseases*

International travel and trade is associated with an increased risk of spreading communicable diseases across borders. Outbreak reports and systematic studies mainly rely on disease activity on cruise ships. A systematic review of the literature conducted by the WHO revealed that more than 100 disease outbreaks were associated with ships during the period from 1970 to 2000<sup>35</sup>.

Most publications of infectious disease risk onboard are based on data from pre-employment exams, reports of port clinics and case/outbreak examinations. In a study conducted by our institute the documented entries in 49 medical log books from seagoing cargo ships under the German flag between 2000 and 2008 were evaluated in order to assess the incidence rate of communicable diseases onboard. Nearly one fourth of the visits to the ships' infirmary were due to presumably communicable diseases with 75% of those being classified as acute respiratory diseases<sup>36</sup>.

Disease outbreaks due to Novovirus or influenza A and B infection on cruise or military ships have been repeatedly reported<sup>37,38</sup>. Recently, the novel influenza A H1N1 has attracted worldwide attention. Other communicable disease risks which have been documented in seafarers are vaccine-preventable diseases, such as rubella, chickenpox, measles, influenza and other respiratory diseases (tuberculosis)<sup>39,40</sup>.

Vector-borne diseases are a well known risk to seafarers. The occurrence of malaria has been documented as an occupational hazard. Other vector-borne diseases have not been described in seafarers yet, but occur frequently among travellers in regions at risk of these diseases, such as Dengue Fever and Chikungunya Fever; thus seafarers

can be assumed to be a population at risk<sup>41, 42</sup>).

Blood-born and sexually-transmitted diseases (Hep B, C, HIV) also pose a risk to seafarers who have to rely on local health systems in port. Also unsafe procedures, such as tattooing or unsafe sex, play a role. According to a survey among 158 seafarers visiting the International Seamen's Club in the port of Hamburg nearly 20% of seafarers stated having casual sexual contacts while away from home<sup>43</sup>).

A main cause for the spread of communicable diseases onboard is that crew members with different susceptibility to infection share living quarters, common food and water supplies as well as sanitation and air-conditioning systems<sup>44</sup>). At present, onboard food and water hygiene is highly variable and may be a source of disease, such as gastrointestinal or legionnaire's disease<sup>45, 46</sup>).

*Recommendations:* Preventive measures such as proper water and food sanitation, access to safe medical care in ports (with anonymous testing of sexual transmitted diseases and health counselling), vaccination of crew, allocation of seafarers to single cabins, early treatment and isolation of infectious/respiratory diseases may be useful tools for safeguarding ship operation.

#### Occupational cancer

Most of the available cancer studies of seafarers are from the Swedish Family-Cancer Database from 1961 to 1998. For example, according to Nilsson (1998), in Swedish engine officers and ratings age-standardized cumulative cancer incidence ratios (SIR) for lung cancer were more than twice as high as expected<sup>47</sup>) (SIR 2.1). Occupational exposure to benzene may have contributed to the increased risk of chronic myeloid leukaemia (SIR 3.15)<sup>48</sup>). Further, exposure to sunlight has been found to be associated with significantly elevated incidences of lip cancer among seafarers (SIR 2.74)<sup>49</sup>).

The causes of the elevated risk of some cancers among seamen are not clear, but life-style related factors such as alcohol, smoking and diet have been regarded as causative. Further, exposures to UV-light from the sun during voyages represent a risk for skin cancer (particularly near the equator where exposure is 2 to 4 times higher than in Northern-Europe).

Ships transport all kinds of goods including toxic cargoes. Particularly, crews on chemical and product tankers can have contact with them. Product tankers mainly carry petroleum products such as gasoline, whereas chemical tankers transport a wide range of chemicals including petroleum products. Especially during tank cleaning, loading and unloading of gasoline, high benzene concentrations up to some 100 ppm have been measured<sup>47</sup>). Transport containers frequently have high concentrations of fumigants and/or toxic industrial chemicals<sup>50</sup>). Although these containers are not usually opened during the voyage they are not tight and some

exposures take place.

Further, the engine room crew is exposed to a variety of exposures with possible harm to health, such as polycyclic aromatic hydrocarbons. Moen *et al.* (1996) found traces of degraded hydrocarbon products and other chemicals in the urine of ship engineers<sup>51</sup>). The clinical importance of these findings, however, is still unclear. In accommodation aboard tankers, toxic substances can also accumulate and affect the indoor climate in some cases. Asbestos was commonly used as an insulating material in ship building until the mid 1970s. In the last 30 yr, however, asbestos has only been used in shipbuilding to a very limited extent.

*Recommendations:* Ongoing training and safe handling of hazardous substances as well as in the proper use of personnel protection devices is needed. As heavy smoking and alcohol habits may also considerably contribute to the increased risk of some cancers, seafarers should be advised on abandoning unhealthy lifestyles including excessive exposure to UV-light.

Seafarers handling toxic substances should be subjected to repeated bio-monitoring examinations during their medical fitness tests for nautical service in order to detect hazardous exposures at an early stage.

#### Conclusions

Seafaring is characterized by several occupational risks: accidents and maritime disasters, piracy, impaired treatment options for CVD, high shipboard stress levels including fatigue and isolation, communicable diseases and exposures to hazardous substances. Despite improvements in occupational safety standards onboard, seafaring is still a high risk occupation, not only during working hours but also during leisure time.

The most important measures for diminishing the occupational health risks of seafaring include primary and secondary prevention of work-related hazards arising from unsafe practices and toxic substances, psychological stress and lifestyle risks. Also, measures should be focused on improving the first-aid education of crews, and the optimization of medical care as well as the hygiene conditions on vessels. Additionally, long separation from families, long working hours and communication problems owing to different shipboard languages are all promoters of fatigue and isolation and should be minimized.

#### References

- 1) Hisamune S, Amagai K, Kimura N, Kishida K. A study of factors relating to work accidents among seamen. *Ind Health* 2006; 44: 144–9.
- 2) Roberts SE. Fatal work-related accidents in UK merchant shipping from 1919 to 2005. *Occup Med (Lond)* 2008; 58: 129–37.
- 3) Roberts SE. Occupational mortality in British commercial fishing, 1976–95. *Occup Environ Med*

- 2004; 61: 16–23.
- 4) International Maritime Organization (IMO, 2002) IMO'S 50th Anniversary—a record of success. [Online]. 2002 [cited 2010 Mar 6]; Available from: URL: [http://www.imo.org/About/mainframe.asp?topic\\_id=321](http://www.imo.org/About/mainframe.asp?topic_id=321)
  - 5) Roberts SE, Hansen HL. An analysis of the causes of mortality among seafarers in the British merchant fleet (1986–1995) and recommendations for their reduction. *Occup Med (Lond)* 2002; 52: 195–202.
  - 6) Hansen HL. Surveillance of deaths on board Danish merchant ships, 1986–93: implications for prevention. *Occup Environ Med* 1996; 53: 269–75.
  - 7) Jaremin B, Kotulak E, Starnawska M, Tomaszunas S. Causes and circumstances of deaths of Polish seafarers during sea voyages. *J Travel Med* 1996; 3: 91–5.
  - 8) International Maritime Organization (IMO, 2010). MSC.4 (Reports on Piracy and armed robbery against ships). [Online]. 2010 [cited 2010 Mar 6]; Available from: URL: [http://www.imo.org/includes/blastDataOnly.asp/data\\_id%3D27321/147.pdf](http://www.imo.org/includes/blastDataOnly.asp/data_id%3D27321/147.pdf)
  - 9) Oldenburg M, Jensen H-J, Latza U, Baur X. Coronary risks among seafarers aboard German-flagged ships. *Int Arch Occup Environ Health* 2008; 81: 735–41.
  - 10) STCW. International convention of standards of training, certification and watchkeeping for seafarers. Seafarers' training certification and watchkeeping code 1978. [Online]. 1978 [cited 2010 Mar 6]; Available from: URL: [http://www.imo.org/Conventions/contents.asp?doc\\_id=651&topic\\_id=257](http://www.imo.org/Conventions/contents.asp?doc_id=651&topic_id=257)
  - 11) Jaremin B, Kotulak E. Myocardial infarction (MI) at the work-site among Polish seafarers. The risk and the impact of occupational factors. *Int Marit Health* 2003; 54: 26–39.
  - 12) Assmann G, Carmena R, Cullen P, et al. Coronary heart disease: reducing the risk: a worldwide view. International task force for the prevention of coronary heart disease. *Circulation* 1999; 100: 1930–8.
  - 13) Agterberg G, Passchier J. Stress among seamen. *Psychol Rep* 1998; 83: 708–10.
  - 14) Oldenburg M, Jensen H-J, Latza U, Baur X. Seafaring stressors aboard merchant and passenger ships. *Int J Public Health* 2009; 54: 1–10.
  - 15) Jensen OC, Sørensen JF, Thomas M, Canals ML, Nikolic N, Hu Y. Working conditions in international seafaring. *Occup Med (Lond)* 2006; 56: 393–7.
  - 16) Kirkutis A, Norkiene S, Griociene P, Griocius J, Yang S, Gintautas J. Prevalence of hypertension in Lithuanian mariners. *Proc West Pharmacol Soc* 2004; 47: 71–5.
  - 17) Hansen HL, Jensen J. Female seafarers adopt the high risk lifestyle of male seafarers. *Occup Environ Med* 1998; 55: 49–51.
  - 18) Maritime Labour Convention 2006. [Online]. 2006 [cited 2010 Mar 6]; Available from: URL: [http://www.ilo.org/wcmsp5/groups/public/—ed\\_norm/—normes/documents/normativeinstrument/wcms\\_090250.pdf](http://www.ilo.org/wcmsp5/groups/public/—ed_norm/—normes/documents/normativeinstrument/wcms_090250.pdf)
  - 19) Chen WQ, Wong TW, Yu TS. Influence of occupational stress on mental health among Chinese off-shore oil workers. *Scand J Public Health* 2009; 37: 766–73.
  - 20) Fujino Y, Horie S, Hoshuyama T, Tsutsui T, Tanaka Y. A systematic review of working hours and mental health burden. *San Ei Shi* 2006; 48: 87–97.
  - 21) Kaheveci E. Fast turnaround ships and their impact on crews. *Seafarers Int Res Centre (SIRC)* 1999.
  - 22) Chen WQ, Wong TW, Yu IT. Association of occupational stress and social support with health-related behaviors among chinese offshore oil workers. *J Occup Health* 2008; 50: 262–9.
  - 23) Chen WQ, Wong TW, Yu TS. Direct and interactive effects of occupational stress and coping on ulcer-like symptoms among Chinese male off-shore oil workers. *Am J Ind Med* 2009; 52: 500–8.
  - 24) Chen W, Huang Z, Yu D, Lin Y, Ling Z, Tang J. An exploratory study on occupational stress and work-related unintentional injury in off-shore oil production. *Zhonghua Liu Xing Bing Xue Za Zhi* 2002; 23: 441–4.
  - 25) Mayhew C. Work-related traumatic deaths of British and Australian seafarers: what are the causes and how can they be prevented? *Seafarers International Research Centre; Cardiff University: Cardiff*, 1999. [Online]. 1999 [cited 2010 Mar 6]; Available from: URL: <http://www.sirc.cf.ac.uk/pdf/Work%20related%20traumatic%20deaths.pdf>
  - 26) Couper A. Discussion comments in: proceedings of a research workshop on fatigue in the maritime industry. Cardiff: Seafarers international research centre, university of Wales, April 23–25, and May 7–9, 1996.
  - 27) Low A. Seafarers and passengers who disappear without a trace from aboard ships. *Int Marit Health* 2006; 57: 219–29.
  - 28) Lane AD, Obando-Rojas B, Wu B, Tasiran A. Crewing the international merchant fleet. London: Lloyd's Register - Fairplay Ltd; 2002.
  - 29) Knudsen F. "If you are a good leader, I am a good follower". Working and leisure relationships between Danish and Filipino seafarers on board Danish ships. Research Unit of Maritime Medicine. ISBN 87-90866-09-6; 2004.
  - 30) Sampson H, Thomas M. The social isolation of seafarers: causes, effects, and remedies. *Int Marit Health* 2003; 54: 58–67.
  - 31) Hot P, Saito Y, Mandai O, Kobayashi T, Sequeira H. An ERP investigation of emotional processing in European and Japanese individuals. *Brain Res* 2006; 29: 171–8.
  - 32) Ayub Q, Tyler-Smith C. Genetic variation in South Asia: assessing the influences of geography, language and ethnicity for understanding history and disease risk. *Brief Funct Genomic Proteomic* 2009; 8: 395–404.
  - 33) Kahveci E, Lane T, Sampson H. Transnational seafarer communities. *Seafarers Int Res Centre Cardiff (SIRC)*; 2001.
  - 34) Salyga J, Juozulynas A. Association between environment and psycho-emotional stress experienced at sea by Lithuanian and Latvian seamen. *Medicina (Kaunas)* 2006; 42: 759–69.
  - 35) World Health Organization. Sustainable development and healthy environments. Sanitation on ships. Compendium of outbreaks of foodborne and

- waterborne disease and legionair's disease associated with ships, 1970–2000, WHO/SDE/WSH/01.4; 2001. [Online]. 2001 [cited 2010 Mar 6]; Available from: URL: <http://www.who.int/mediacentre/factsheets/fs269/en/>
- 36) Schlaich CC, Oldenburg M, Lamshöft M. Estimating the risk of communicable diseases aboard cargo ships. *J Travel Med* 2009; 16: 402–6.
  - 37) Brotherton JML, Delpech VC, Gilbert GL, Hatzi S, Paraskevopoulos PD, Mcanulty JM. A large outbreak of influenza A and B on a cruise ship causing widespread morbidity. *Epidemiol Infect* 2003; 130: 263–71.
  - 38) Centers for Disease Control and Prevention. Influenza B virus outbreak on a cruise ship—northern Europe 2000. *MMWR Morb Mortal Wkly Rep* 2001; 50: 137–40.
  - 39) Buff AM, Deshpande SJ, Harrington TA, et al. Investigation of mycobacterium tuberculosis transmission aboard U.S.S. Ronald Reagan 2006. *Mil Med* 2008; 173: 588–93.
  - 40) Centers for Disease Control and Prevention. Rubella among crew members of commercial cruise ships—Florida 1997. *MMWR Morb Mortal Wkly Rep* 1998; 46: 1247–50.
  - 41) Nikolic N, Poljak I, Troselj-Vukic B. Malaria, a travel health problem in the maritime community. *J Travel Med* 2000; 7: 309–13.
  - 42) Tomaszunas S. Malaria in seafarers. 1. The magnitude of the problem and the strategy of its control. 2. The status of malaria in large ports of the world. Protective measures against malaria in crews of ships. *Bull Inst Marit Trop Med Gdynia* 1998; 49: 53–61, 63–71.
  - 43) Schlaich C, Reinke A, Rosin I, et al. Seafarers health counselling in the port of Hamburg—revisiting the Brussels agreement 1924. In: *Quality maritime health & seafarers welfare—a global perspective*. 10th International symposium on maritime health, Goa–India 23–26.9.2009. Book of abstracts. Goa (India): International Maritime Health Association.
  - 44) Kak V. Infections in confined spaces: cruise ships, military barracks, and college dormitories. *Infect Dis Clin North Am* 2007; 21: 773–84.
  - 45) Cayla JA, Maldonado R, Gonzalez J, et al. Legionellosis study group. A small outbreak of Legionnaires disease in a cargo ship under repair. *Eur Respir J* 2001: 1322–7.
  - 46) Lamshöft MM, Schlaich C. Estimating the risk of communicable diseases aboard cargo ships. In: *European Centre for Disease Prevention and Control, ed. European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE) 2008*. Abstract book. Berlin: ECDC; 2008. p.26.
  - 47) Nilsson R. *Cancer in seamen with special reference to chemical health hazards*. Department of InternalMedicine, Section of Occupational Medicine, Göteborg University. ISBN 91-7876-999-X; 1998.
  - 48) Jianguang J, Hemminki K. Occurrences of leukemia subtypes by socioeconomic and occupational groups in Sweden. *J Occup Environ Med* 2005; 47: 1131–40.
  - 49) Jianguang J, Hemminki K. Occupation and upper aerodigestive tract cancers: a follow-up study in Sweden. *J Occup Environ Med* 2005; 47: 785–95.
  - 50) Baur X, Yu F, Poschadel B, Veldman W, Vos TK. Health risks by bromomethane and other toxic gases in import cargo ship containers. *Int Marit Health* 2006; 57: 46–55.
  - 51) Moen BE, Nilsson R, Nordlinder R, et al. Assessment of exposure to polycyclic aromatic hydrocarbons in engine rooms by measurement of urinary 1-hydroxypyrene. *Occup Environ Med* 1996; 53: 692–6.