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Cardiovascular diseases in the modern maritime industry

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ABSTRACT

Acute cardiovascular diseases (CVD) are the main natural causes of death in industrialized countries — both at sea and on land. Seafarers face very specific job-related cardiac risk factors, such as time pressure, long working hours, or high stress factors onboard [1, 2]. Taking into consideration the healthy worker effect of seafarers, cardiac risk factors are shown to occur slightly more frequently in seafarers than in the general population. Owing to the lack of health professionals onboard and the limited treatment options of events at sea, effective cardiopulmonary resuscitation is often delayed and the outcome of cardiac events may be worse compared to that in other occupations ashore.

Seafarers' medical surveillance examinations should be used more intensively as an opportunity for education of crews in CVD risks and the possibilities to reduce them. Further, enhancement of treatment options (e.g. by implementation of advanced therapy and diagnostics such as telemedicine or AED onboard) may contribute to improved CVD prognosis at sea.

INTRODUCTION

CVD is the cause of 45% of all deaths in industrialized countries and 25% of all deaths in developing countries [3]. In modern maritime industry, CVD also presents the most common cause of non-traumatic sudden incapacity and death at sea. Some studies focused on the mortality of seafarers aboard merchant ships in the 80s and 90s. The proportion of seamen deaths from British and Danish merchant ships caused by CVD ranged between 55% and 71% of all natural causes of seafarer mortality (Figure 1) [4, 5]. A high proportion (75%) of CVD mortality was also found in Polish shipping from 1985–1994 [6] and in Swedish shipping from 1984–1988 (54%) [7].

By comparison, infectious and gastrointestinal diseases were a minor cause of mortality among seamen in these studies (Figure 1).

At sea a medical layman usually holds the responsibility for medical care, often far away from professional medical support, so diagnosis and treatment at sea depend mainly on the experience of officers trained in medical care and telemedical advice. Often, advanced therapy of severe cardiovascular diseases occurring at sea will only be available after several hours or days when a ship reaches a port or the patient is evacuated. The Maritime Labour Convention 2006 recommends conducting medical refresher courses every 5 years for the medically responsible officers in order to update and intensify their knowledge and skills in the treatment of sick and injured patients [8].

In recent decades, the prevalence of CVD ashore has increased due to demographic changes and due to increasing relevance of lifestyle-related cardiac risk factors (more smoking, stress, high fat diet, and less physical activity). All these factors contribute to an overall higher cardiac risk for the general population and surely also for seafarers who face these factors

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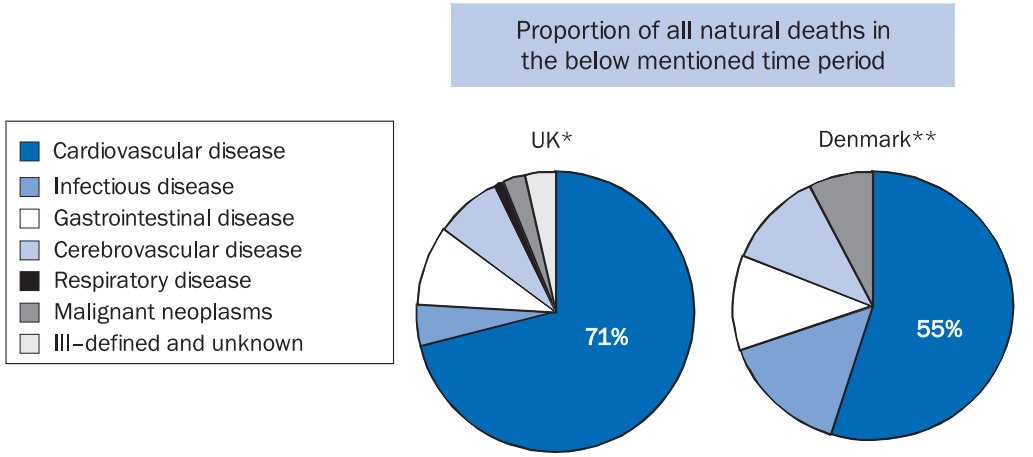

Period of time	1976–1995	1986–1993
Number of seafarers (years)	983,119	104,000
Mortality rates due to CVD (per 100,000 seafarer years)	43.4	27.9

*Roberts; Int Marit Health 2002, **Hansen; Occup Environ Med 1996

Figure 1. Causes of natural deaths of seafarers on English and Danish merchant ships

to at a least similar extent. Furthermore, the expected advancing average age of seafarers will raise the CVD risk considerably. Whenever a shortage of skilled maritime employees occurs — as is the case in Europe — the recent trend to hire older seamen will further increase the likelihood of the occurrence of CVD on ships.

CARDIOLOGICAL PROBLEMS IN SEAFARING

CVD RISK FACTORS

The risk of CVD depends on many factors [9], which can be categorized in the groups 'non modifiable' (genetic factors, family history, sex, age), 'modifiable but not directly related to conditions onboard' (arterial hypertension, diabetes mellitus, smoking), and 'modifiable and probably related to conditions aboard' (stress, lack of exercise, high-fat diet). Particular attention should be paid to the latter. The diet may be unbalanced and contain a high proportion of fat leading to high cholesterol, high triglycerides, and obesity [10].

The quality of food is influenced by the cook's style of cooking, the opportunity to purchase high quality and fresh food in ports, and the budget committed to the nutrition of the seafarers.

The cooks responsible for the order of food should consider the logistical problems in advance. As healthy and tasty food is always an important topic during a sea voyage, the shipping company should be aware that job satisfaction onboard and subsequently the performance of the crew can be increased by improvement of food. Considering the different tastes of the multinational crews, it is not possible to satisfy everybody onboard.

The seafarers often have limited opportunities to change the diet onboard or to supplement the diet by individual purchases. The common practice of seafarers to use vitamin supplements probably is of limited value concerning CVD risk reduction. Limited leisure time facilities onboard often lead to a lack of exercise, which also favours overweight.

Owing to the unity of workplace and living with limited leisure areas onboard — which may last for months — seafarers are exposed to stress at a high level [11]. Kivimäki et al. (2006) observed in their broad meta-analysis of prospective cohort studies that stress at work increased the risk of CVD by 50% on average [12].

To determine the likelihood of stress factors for coronary heart diseases, a German cross-sectional study was recently conducted to assess the frequency of coronary risk factors among seamen sailing un-

der German flag [13]. In total, 161 exclusively male seafarers were interviewed and medically examined. In this study the cardiac risk factors high blood pressure (49.7%), high triglycerides (41.6%), advanced age (39.8%), and smoking (37.3%) predominated. As seafarers are subject to periodic medical-fitness tests for nautical service, a healthy worker effect should be expected in this occupation.

In addition, other studies have confirmed a high number of work-related cardiac risk factors among seafarers [14–16]. Jaremin and Kotulak (2003) state that about 20% of myocardial infarction patients are attributable to additional work-related factors, such as strain and excessive physical effort [16]. These factors may also aggravate and influence the CVD risk.

Concerning life-style risk factors, studies from Germany, Lithuania, and Denmark revealed the seafarers' cigarette consumption to be higher than in the respective general population [13, 15, 17]. These studies suggest that seafarers are not targeted or reached by work-related or population-based health promotion programs which aim to modify the risk of CVD in the workforce.

CVD PROGNOSIS

Prognosis after a cardiac event was assessed in the mortality study of Jaremin and Kotulak (2003) based on a population of 11,325 Polish seafarers and deep sea fishermen in the time period from 1985 to 1994 [16]. They showed that 106 out of the 149 documented fatalities at sea were caused by myocardial infarction. The mortality rate of myocardial infarction in Polish seafarers was lower than that in the general male Polish population in the same decade, probably due to the expected healthy worker effect among seamen. Nevertheless, the survival after a coronary event at sea was shown to be lower than that ashore since the early (first day) pre-hospital mortality of seafarers after a myocardial infarction at sea was 48% compared to 20–35% in the general population [16]. Thus, it was concluded by the authors that the prognosis after a myocardial infarction at sea is worse than that ashore.

There are several reasons for the latter hypothesis. The most important reasons probably are that the team of rescuers onboard is often inexperienced, the means of treatment are limited, the rescue/resuscitation action is frequently delayed, and the evacuation ashore is often difficult or even impossible.

MEASURES TO DIMINISH CVD RISKS IN SEAFARING

A. Surveillance examination and education about CVD diseases

Compared with other occupations onshore, Tüchsen et al. (1996) assess seafaring as a high-risk occupation for ischaemic heart diseases [18]. To cope with the problem of CVD in seafaring, the 'medical surveillance examination' could be used more intensively as an opportunity for risk reduction. The minimal scope of examination for maritime fitness is generally defined in the ILO/WHO guidelines 1997 [19] and in national guidelines.

It was written that the performed medical surveillance examinations were often insufficient to detect seafarers with high cardiac risk [16]. A Polish study showed that 58% of seafarers with myocardial infarction at sea did not have preceding symptoms before their cardiac event [16]. Furthermore, it was assumed that some seafarers did not accurately state their CVD symptoms during their fitness examination, being afraid of medical unfitness declaration. Thus, the possibilities of identifying seafarers with a higher CVD risk are still limited.

After an acute cardiac incident, the risk of recurrence of that particular event is increased. Subjects with a history of a severe myocardial infarction, those with unstable ischaemic heart disease, and those with hypertension of stage II–III are normally unfit to work at sea [20].

However, if the preconditions in medical fitness for work at sea are very high, many qualified seafarers are at risk of losing their job and thus they may have considerably personal, social, and economic consequences for themselves and their families. In order to estimate the future risk of seafarers with prior cardiac events, several clinical test methods are established, e.g. specific blood analysis of triglycerides and cholesterol, ECG stress tests, and echocardiographic examination. Seamen with an observed higher coronary risk should be advised and treated according to the recommendations of the International Task Force for the Prevention of Coronary Heart Disease [21].

The Maritime Labour Convention 2006 demands measures of a preventive character, such as health education programs [8]. An opportunity to communicate health promotion messages to seafarers are 'medical (refresher) courses' for seafarers. The teaching content of the medical refresher courses are

determined in national schedules mainly focusing on the diagnosis and treatment of ill or injured seafarers at sea. However, the prevention of diseases, especially of CVD, is scarcely considered in the schedules of these courses.

The effect of educational measures is difficult to quantify. Due to the instability of the seafarer population, clinical outcome variables cannot be used (e.g. morbidity or mortality). However, some studies exist that measured behavioural changes. For example, a Polish study focused on the training of leaders in maritime health promotion. Maritime students had to take a 30-hour training program dealing with medical and psychological issues. In this study, the effect of the training was measured by questionnaires, individual interviews, and feedback programs [22]. The Finnish project "TrimMare" also aimed to promote safe behaviour on Finnish ships [23]. Some seafarers were trained as coaches to support health activation onboard. The activities encompassed distribution of information material on health promotion (put out on information panels and in mess rooms), cookery courses for stewards (focusing on appetizing, low-calorie, and low-salt meals), and training for shipping companies in health promotion. By means of interviews and questionnaires it was shown that these measures were successful (e.g. the food on board became lower in salt and calories, more vegetables were available, and seafarers began or continued various physical activities).

Recommendations:

- The medical surveillance examination should help to not only identify persons with overt CVD but also inform seafarers on personal risk and strategies for risk reduction.
- Advanced clinical tests (e.g. specific blood analysis, ECG stress tests, and echocardiographic examination) should be implemented in medical surveillance examinations of those seafarers who have already experienced a cardiac event. Advanced examinations during the nautical fitness test demand additional time for the physicians issuing health certificates, and generate costs. To reduce the workload for these physicians some duties can be assigned to the seafarers' general practitioner. He is, as the individual physician of the seaman, in charge, e.g. to treat high blood pressure or elevated blood glucose values and to document the treatment process.
- The pre-employment examination should rely on strong fitness criteria to reduce the risk of seafarers with incipient health disorders from becoming unfit for nautical service in the course of time. In Germany, for example, the finding of glucose urine during the pre-employment examination results in incapability for nautical service because of the higher likelihood of developing insulin-dependent diabetes and CVD. This would lead to nautical unfitness in older age when an occupational redeployment is scarcely possible.
- Depending on a single case assessment, patients with a history of a myocardial infarction and an only slightly increased CVD risk in the course of time must be restricted to accompanied working or watch keeping and only to operations in near coastal waters.
- During the medical refresher courses or during other maritime courses more effort should be made to train the officers in the treatment of CVD, to raise the seafarers' awareness about their individual risk of CVD, and to advise them on prevention. Recommendations should be made about lifestyle modifications of the seafarers as important risk factors of CVD, such as smoking cessation, dietary control, and exercise to reduce cardiac risk. Further studies are needed to measure the effects of education measures among seafarers.

In conclusion, it is a challenge for maritime health experts to increase the compliance of seafarers in the abandonment of a lifestyle that can be detrimental to health. To reduce the CVD risk and to improve the survival after cardiac events at sea, joint action is necessary by the shipping company (e.g. by provision of suitable technical devices, telemedicine or ECG, by a satisfactory offer of shipboard exercise possibilities, a more balanced diet, and health information campaigns), the ship masters (e.g. by active motivation of the crew to use these offers), and the seafarers themselves (e.g. by self-observation of health and eating habits, and by taking responsibility for their health promotion).

B. Implementation of telemedicine onboard

In cases of unspecific thoracic symptoms, the medical causes should be identified first. Due to the often unclear genesis of symptoms (mainly cardiac, pulmonary, or orthopaedic), a medical evaluation considering all differential causes is required. In this situation, seamen increasingly use telemedical advice by physicians at a telemedical centre ashore. To improve reliability of diagnosis a telemedical ECG transmission is a central piece of information, espe-

cially in cases of potentially arrhythmic heart diseases. The ECG is more likely to provide a correct diagnosis via a telemedical doctor in patients with unspecific thoracic symptoms as well as cardiac disorders. As the ECG may be normal in the first hours after myocardial infarction, continuous ECG monitoring (via AED) of patients with angina pectoris at sea is required. Thus, the telemedical doctor is aware of the ECG in the course of time until advanced medical care is available onboard.

Nowadays, even most merchant vessels are equipped with the basic equipment for the treatment of myocardial infarction such as nitroglycerin, oxygen, morphine, and aspirin. The appropriateness of supplying worldwide operating vessels with advanced treatment facilities, such as thrombolytics and automatic external defibrillator (AED), requires further consideration and evaluation.

The implementation of AEDs onboard passenger liners with many passengers of older age (a higher-risk population for CVD) is currently medical standard. In the maritime medical community it is controversially discussed whether these devices should also be recommended on merchant ships with a relatively low likelihood that an acute cardiac event occurs among the crew [16]. While some maritime medical specialists evaluate the AEDs on merchant ships as economically unjustified, others regard them as useful for this type of ship, especially due to their telemedical function (e.g. for diagnosis of heart rhythm disorders) [24]. This discussion mainly regards the cost-benefit analysis of AEDs as well as ethical aspects in merchant shipping. A cost-benefit analysis, however, is scarcely possible since AEDs on merchant ships have different purposes (resuscitation, analysis of heart rhythm, determination of death), and the incidence of all these events at sea cannot be reliably assessed on the basis of available mortality/morbidity studies in seafaring.

CONCLUSIONS

CVD is a common cause of sudden incapacity and death at sea. Seafaring is associated with factors resulting in an increased risk of CVD and with impaired outcome of events occurring at sea. Due to several seafaring-related features, survival rates after an acute cardiac event at sea are reduced compared to survival ashore. Therefore, the prevention of CVD at sea is very important. In seafaring, however, preventive measures are complex and difficult to implement.

Several shipboard stress factors, which are assumed to contribute to a higher CVD risk, can only be reduced slightly (e.g. shift work, noise and vibration, occasional exposure to high temperature during physical effort). Thus, ships can be regarded as a high-risk worksite for seafarers with CVD. It is important to detect high-risk subjects during their medical fitness test and to continuously adapt and improve strategies of prevention, diagnostics, and pre-hospital medical care. Useful strategies might include:

- avoidance of risk situations onboard by improving the working and living conditions (e.g. to ensure sufficient sleeping and resting time for the whole crew, to reduce extreme overtime hours, and to offer a balanced diet);
- implementation of advanced diagnostics (e.g. ECG, troponin test) as well as advanced drug treatment for pre-hospital use onboard of ships (the benefit of these measures at sea needs to be proven in trials);
- using opportunities for educative efforts for primary prevention of CVD during medical courses for seafarers and medical fitness examinations more intensively;
- intensified telemedical interaction with telemedical centres;
- advanced diagnostic and preventive measures after a first event of CVD.

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