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EDITORIAL

COVID-19 in the maritime setting: the challenges, regulations and the international response

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INTRODUCTION

The maritime industry is responsible for the transport of about 90% of the world's trade [1]. Throughout the current pandemic, the industry has striven to maintain supply chains and the delivery of essential cargoes, including food and medical supplies, whilst ensuring the continued health and welfare of the 1.6 million seafarers serving on board ships. It has faced many challenges and these have been met by an unprecedented level of international, cross industry collaboration. All of the United Nations (UN) Agencies, the International Chamber of Shipping (ICS), the International Transport Workers Federation (ITF), the International Maritime Health Association (IMHA), the International Seafarer's Welfare Association (ISWAN) and many more organisations and governments, at an international and national level, have worked tirelessly in an attempt to manage these issues.

CHALLENGES FACING THE MARITIME INDUSTRY

The key areas that have challenged the industry include but are not limited to:
- the management of an active case on board;
- the need to establish physical distancing and other measures to reduce the spread of the disease on a ship;
- access to pre-employment medical examination;
- interaction with shore staff in ports;
- crew changes;
- access to medical, dental and welfare services in port;
- reduced possibilities for shore leave;
- contract extension;
- increase in mental health issues in seafarers on board.

The International Maritime Organisation (IMO) and the International Labour Organisation (ILO) recognised many of these issues back in February and the IMO issued Circular Letter 4204/1 [2] on February 19th. This identified the international instruments in place that may be relevant to the management of a pandemic and clearly stated the responsibility of all nations to adhere to these and to the Maritime Labour Convention (MLC) 2006 [3].

WHAT, WHEN, HOW MANY?

First reported in Wuhan, China in the last months of 2019, the current outbreak of COVID-19, caused by the SARS-CoV-2, virus was declared a pandemic by the Director-General of the World Health Organization (WHO) on March 11th 2020. At the time of writing, over 9 million cases have been reported, with over 470,000 deaths [4] and the numbers continue to increase. The illness spreads by direct or indirect contact with droplets from an infected person and in order to slow the spread of the disease, and reduce the pressure on health services, many countries introduced 'lockdown' measures. These measures remain in place in many countries, to a greater or lesser degree, and have a major impact on the maritime industry.

No figures are currently available for the actual number of cases identified amongst crew serving on board a ship. Outbreaks on cruise ships such as the Diamond Princess and the Holland America ship, Zaandam, were widely reported in the press and in scientific journals [5]. However, reports in the press or journals of cases or outbreaks on non-passenger ships including fishing vessels, are few, suggesting that the number of cases on board these ships are limited. However, we know that there are cases on board ships as far afield as Brazil, Mozambique, Antwerp and China and some of these have unfortunately led to the death of seafarers [6].

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MANAGEMENT OF COVID-19 ON BOARD

In accordance with the International Ship Management (ISM) Code [7] or other applicable regulatory instruments, shipping companies are required to assess all identified risks to their ships and personnel and establish appropriate safeguards, normally documented in their Safety Management Systems (SMS). Therefore, shipping companies should develop plans and procedures to address the risks to the health of seafarers and the safety of their ship operations posed by the current pandemic, including a case or a number of cases on board.

If a crewmember develops signs and symptoms suggestive of possible COVID-19, he/she should report these to the medical officer immediately. The crewmember should be isolated in the sick bay or his/her own cabin, preferably with access to a bathroom that is not used by others, and assessed further. Isolation of a crewmember may be very challenging depending on the size and design of the ship. Meals should be delivered to the cabin and a full cleaning protocol instigated.

Assistance with making a diagnosis is available at COVID-19 at sea [8], designed by the Norwegian Centre of Maritime and Diving Medicine to assist in diagnosis and supportive care. The ICS publication, “COVID-19 — Guidance for Ship Operators for the Protection of the Health of Seafarers” [9] gives further advice for the management of the case and possible contacts.

The early recognition and close monitoring of a case is key to its successful management and that is one advantage of a shipboard environment. The sick seafarer should be monitored in person or by telephone, two to three times a day and a record kept of his/her symptoms and vital signs. Any deterioration should be a trigger for referral to a Telemedical Assistance Service (TMAS) or other shore side medical support. Early access to oxygen and to more advanced medical care, if required, is essential and this has proven to be a potential issue for seafarers.

The ship must report all suspect cases to the relevant health authorities at the next port of call as per the International Health Regulations (2005) [10]. For ships on an international voyage and calling at a foreign port, the Maritime Declaration of Health must be completed.

MANAGEMENT OF CLOSE CONTACTS ON BOARD

In a shipboard environment the sick crewmember is likely to have been in contact with many/most of the other seafarers, depending upon the size of the ship, number of crew on board and of course the position of that seafarer. The WHO publication “Operational considerations for managing COVID-19 cases or outbreaks on board ships: interim guidance” [11] published in March 2020, defines a close contact as anyone who has ‘had physical contact (face to face contact within 1 metre for more than 15 min) or were in a closed environment with a suspected or confirmed COVID-19 case’. In addition, close contacts are those who have shared a cabin and those that have provided medical care to a suspect case. The ICS guidance advises that close contacts, and therefore crewmembers at high risk of transmission of the virus specifically include those that have:
- had close contact within 1 metre or were in a closed environment with a suspect/confirmed COVID-19 case (for example tank work, shared watch in an engine control room, eaten a meal with);
- participated in the same immediate travelling group without quarantine before boarding the ship;
- been a cabin steward who cleaned the cabin of a suspect/confirmed case of COVID-19.

If the number of high risk close contacts is relatively small they should be asked to quarantine, if to do so would not endanger the safety of the ship, those on board or the ship’s operation.

On a small ship, if one seafarer develops possible COVID-19, all crewmembers will be close contacts and should therefore quarantine for up to 14 days depending on local advice. Obviously, this is impractical on such a vessel as operations would be severely impaired and the ship unable to function. In these circumstances, all crewmembers should self-monitor for symptoms and report anything suggestive of COVID-19 immediately. Daily temperature screening may also be appropriate, as may the wearing of a face covering.

THE USE OF PERSONAL PROTECTIVE EQUIPMENT ON BOARD

The MLC 2006 states that each member shall ensure that all seafarers on ships that fly its flag are covered by adequate measures for the protection of their health. The use and availability of personal protective equipment (PPE) should be included in the risk assessment completed as above. Guidelines for the use of PPE on board a ship have been published by the European Healthy Gateways in its document ‘Who, Where, How’ [12], released in May 2020. In order to comply with these recommendations, ship owners must ensure that there are adequate amounts of the required PPE on board. Recommendations differ for well crewmembers and in the scenario of a suspect case on board. All crewmembers who encounter a suspect case should wear a medical mask and gloves whilst those providing medical care are advised to use a medical mask or FFP2 respirator (prioritised for aerosol generating procedures), gloves, a gown and visor/goggles. Crew will need information on how to safely use this equipment as this is not currently covered in the STCW Medical Care course, although maybe this is a consideration for the future. Such advice on the safe use of PPE is available from the WHO and the ICS in their publications.

SETTING: ON BOARD SHIP			
WHO	**WHEN**	**WHAT**	
Crew members who are not ill or showing symptoms	**Interaction only among crew members** The following is advice to be considered. Further information can be found here: • EU HEALTHY GATEWAYS: https://www.healthygateways.eu/Portals/0/plcdocs/EUHG_PPE_Travellers_17_04_2020_F.pdf?ver=2020-04-23-140238-597 • ECDC Technical Report: https://www.ecdc.europa.eu/sites/default/files/documents/COVID-19-use-face-masks-community.pdf	**Medical face mask** At all times when physical distancing of 1.5-2 metres is not possible to maintain. Mask should be replaced regularly at intervals not exceeding 4 hours. Proper disposal of disposable face masks must be applied in accordance with ECDC. More information on how to properly manage (don, doff and dispose of) face masks can be found here: https://www.ecdc.europa.eu/sites/default/files/documents/Home-care-of-COVID-19-patients-2020-03-31.pdf	 ©ECDC
		If medical face mask unavailable, non-medical "community" face mask can be used and replaced when the mask becomes wet.	
		Perform frequent hand hygiene	

Recommended personal protective equipment for crew members not ill or showing symptoms. From: European Healthy Gateways: https://www.healthygateways.eu/Portals/0/plcdocs/EUHG_PPE_Overview_24_04_2020_F.pdf?ver=2020-05-20-201841-010 (page 26) (Accessed June 25th 2020)

INTERACTION WITH SHORE BASED STAFF

Early advice from the IMO gave the recommendation to limit the number of interactions with shipboard personnel to 'only those critical and essential for the continued operation and supply of the ship' and also to ensure that those working in ports 'are provided with appropriate personal protective equipment... prior to contact with seafarers'. Whilst this may give the impression of being in place to protect port workers from seafarers, the risk may well be greater the other way around. Initial studies, yet unpublished, suggest that the incidence of COVID-19 in crew joining a ship and in port staff is equivalent to that in the general population. On the other hand, a ship's crew that has been at sea with no contact from the 'outside world' for 14 days may be considered 'free' of COVID-19. Taking into the account the potential risk for transmission in either direction the IMO published Circular Letter 4204/Add.16 [13] in May 2020 outlining a risk management plan for ship: shore interaction. Additional information is also found in the ICS Guidance document. It must also be noted that the requirements for workers and the general public to wear PPE, and in particular face coverings, vary between countries and good communication is essential to ensure that shipboard and local requirements are met.

CREW CHANGE

The issues surrounding crew change are many and include but are not limited to:

— The availability or not of travel from the seafarer's home to the port. This may involve travel by road, sea and air and may involve crossing country borders. Whilst air travel is slowly increasing again after many months of very limited availability, not all routes are open and schedules are liable to change at short notice leaving crew stranded.
— Entry restrictions and quarantine requirements in the country where the seafarer should join the ship or the seafarer's home country. Some of these can be lifted or eased if countries identify seafarers as key workers. However, a few countries remain closed to all, including their own citizens trying to return home, and there may be significant restrictions to travel within a country. Many seafarers remain on cruise ships in Manila Bay awaiting permission to go ashore and get home having been brought to the Philippines on board ships [14].
— Quarantine and testing requirements developed by the shipping company designed to protect crew on board by reducing the risk of new crew introducing the virus when they board.

The difficulties of changing crew became apparent very early in the pandemic and many organisations have highlighted this as an increasing cause for concern. The MLC 2006 clearly states that seafarers have the right to be repatriated at no cost to themselves, and states a default period of a maximum service of 11 months. Under the claim of 'force majeure', companies have extended crew contracts beyond this and seafarers are spending an ever increasing period at sea. Maritime Bergen hosted a webinar concerning this subject in March and other organisations outside of the UN agencies and social partners have highlighted the issue in various publications [15]. Simultaneously the UN agencies, the ICS, ITF and others approached various governments in order to ensure that countries recognise seafarers as key workers and are therefore exempt from quarantine and travel restrictions that they impose on the public. Examples of action include:

- an open letter [16] to UN agencies from the ICS and ITF on March 19th 2020;
- a statement of the officers of the Special Tripartite Committee of the MLC 2006 [17] on March 31st 2020;
- an information note on maritime labour issues and COVID-19 [18] produced by the ILO on April 7th 2020;
- a 12 step plan [19] produced by the IMO and published on May 6th to assist governments to put in place co-ordinated procedures to allow the safe movement of seafarers to and from ports;
- a joint statement [20] from the IMO, ILO and International Civil Aviation Organisation (ICEO) on May 28th calling on governments to designate seafarers as key workers and facilitate crew changes;
- a call from the UN [21] on June 12th to ensure that seafarers are recognised as key workers.

At the time of writing, this has not been resolved satisfactorily and there are estimated to be around 200,000 seafarers who remain on board after the end of their contract because it remains impossible to make crew changes at many ports around the world.

TESTING

Testing for COVID-19 and in particular, the role of tests in crew change is a matter of much discussion. Testing policies and therefore the availability of tests, varies hugely around the world, as do the requirements of different countries and different shipping companies. Whilst 14 days of quarantine at the point of embarkation is the ideal way to try to ensure that new joiners do not carry on board COVID-19, this is often very difficult to arrange. Countries and ship owners have developed different strategies to try to reduce the risk of introducing the virus on board, including quarantine in the home country pre-travel to the ship and, in some cases, the use of testing.

The polymerase chain reaction test is the most accurate to detect the presence of the virus but it is not widely available out of a health care setting and still has up to a 30% false negative rate, often related to how the swab was taken. These tests can certainly not be used on board. Rapid diagnostic tests to detect either the virus antigen or antibodies produced because of prior infection are not yet accurate enough for use outside of a research or health care setting [22].

Any test only provides a snapshot of the moment it was taken. It cannot predict whether a seafarer will develop COVID-19 in the coming days. Whilst a positive test at any point will ensure a seafarer with the virus does not travel or board the ship, a negative test should be interpreted with care and in the context of any clinical findings. At present, testing can only form a small part of the overall risk assessment and cannot be used to exclude all risk. As an example, as part of the agreed local policy, one clinic has tested 650 crew prior to joining a ship. Seven (1%) have tested positive although only half of those displayed symptoms at the time of testing. However, on one ship following the same policy there is currently one seafarer hospitalised and four seafarers with confirmed COVID-19. No system is ideal.

ACCESS TO MEDICAL CARE OVERSEAS

The International Health Regulations (2005) clearly state that ships should not be prevented from entering port and embarking or disembarking persons on board for public health reasons. Equally, MLC 2006 makes it clear that all states shall ensure that seafarers in its territory in need of immediate medical care are given access to medical facilities with the 'right to visit a qualified medical doctor or dentist without delays in ports of call, where practicable'.

Health care provision and policies regarding occupational health protection vary widely across the world. In the current pandemic situation, health care systems are often stretched and in many countries, governments have placed restrictions on the opening, availability and ways of working for health care providers. This means that some services or treatments are not available to the local population and therefore not available to seafarers arriving in these ports. However if the service is available ashore it is clearly stated in the MLC that it should also be available to seafarers. In many instances, in many ports, this is the case. However, there are some examples, in some places, of ships refused entry to port and seafarers refused the right to disembark to seek urgent medical care. Examples range from the assessment of possible COVID-19 cases to the assessment and treatment of appendicitis and assessment of chest pain likely due to ischaemic heart disease. There was also the widely publicised case of a seafarer who suffered a cerebrovascular event and the nearest port refused permission for the ship to enter and medivac the seafarer for further assessment. Only after intervention by the UN agencies did this seafarer receive appropriate care [23]. There can be no defence of such actions by individual countries. On the other hand, Radio Medico Norway have had cases where the seafarer, captain and ship owner/manager have made it clear that they do not want to enter port and disembark a sick seafarer but would rather treat the seafarer on board. TMAS doctors provided medical advice in these situations, far and above 'normal'. Equally we know that there are port health facilities open and willing to see and treat seafarers but seafarers are not keen to leave the 'safety' of the ship and visit facilities ashore.

As more and more health care providers use telephone or video consultations for their usual patients, the availability of a remote consultation for a seafarer should be better than ever before. This requires good communication between the ship, the port agent and the medical facility, but is possible. Particularly whilst a ship is in port, the crew have the right to obtain medical care as required and they should do so. If not, there is a risk that a ship leaves the safe haven of a port with a sick crewmember on board.

Remote consultations are also very useful to obtain repeat prescriptions for long-term medication. There are an increasing number of requests for prescriptions as seafarers extend their contracts on board because of the issues in changing crew. The problem here may not be so much in speaking to or seeing the relevant professionals shore side, but more in identifying the medication required and ensuring it is available in a different country to the seafarer's home. Again, with good and timely communication this can usually be resolved.

MENTAL HEALTH ISSUES

The mental health of seafarers has been of concern for some time and the current pandemic has highlighted it further.

Natalie Shaw, Director of Employment Affairs at the ICS, suggests some of the reasons for the current increase in mental health issues include:

- extended periods at sea beyond the normal contract length;
- conflicting information from different sources;
- pressures to get home from family members;
- caring responsibilities back home;
- concern around family member's health in vulnerable cities and locations;
- concern about longer term financial stability;
- difficulty in getting shore leave and access to ship visitors and port welfare centres;
- increased isolation resulting from the requirement to remain on board;
- inaccurate media and fake messaging;
- limited medical facilities and equipment;
- inaccurate media and fake media messaging;
- potential to be infected with COVID-19 when travelling from home to ship, ship to home or visiting port facilities;
- limited medical facilities and equipment on board cargo ships;
- less access to general medical care ashore because of local health care restrictions;
- limited training for those administering medical care on board cargo vessels and limited ability to handle an outbreak of COVID-19 on board;
- difficulties in procuring supplies to restock in certain ports.

Organisations such as ISWAN have provided assistance to seafarers though their helpline and with online advice as seafarer's centres and welfare facilities remain closed in many ports. Other organisations have done their best to highlight the issue in an attempt to raise the profile of these seafarers 'trapped on board' by COVID-19 [24]. Despite best efforts, unfortunately there have been a number of reported suicides on board ships [25].

SUMMARY

Since the beginning of the COVID-19 pandemic the maritime industry has faced many and varied challenges which are affecting the health and welfare of seafarers and may threaten the global supply chain of essential goods. The industry, UN agencies and other, influential organisations have come together in previously unseen levels of cooperation and understanding. I personally have taken part in three webinars aimed at highlighting the issues described here and whilst admittedly progress is slow, much has been done. Application of the various regulatory instruments, cooperation with governments and good communication amongst all parties will ensure that we meet the seafarer's medical and welfare needs whilst the industry continues to fulfil its essential role.

To quote the IMO Secretary General, Kitack Lim, in his document promoting the Day of the Seafarer 2020 on June 25th: **'Seafarers continue to deliver for all of us. Now, let's ensure that we deliver for them!'**

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ORIGINAL ARTICLE

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Irukandji-like syndrome caused by single-tentacle box jellyfish found in Thailand, 2007–2019

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ABSTRACT

Background: *Irukandji syndrome definition is still widely misunderstood. Irukandji-like syndrome is more unclear than Irukandji syndrome. This study aimed to describe Irukandji-like syndrome in cases involving stinging by single-tentacle box jellyfish species in Thailand.*

Materials and methods: *Surveillance system and networks of toxic jellyfish incidents were established to enable case detection. In the period 2007 to 2019, all cases of stinging by single-tentacle box jellyfish resulting in collapse, hospital attendance or death were investigated.*

Results: *The majority of the 19 Irukandji-like syndrome cases were male (68.2%), median age 35.0 years (range 6.0–60.0), and Thai nationality (52.3%). Clinical manifestations of Irukandji-like syndrome were categorised as severe wound pain with immediate systemic reaction (66.7%), moderate wound pain with gradual systemic reaction (16.7%), and moderate wound pain with the immediate systemic reaction after a physical/chemical trigger (16.7%). The pain occurring when being stung differed from the pain occurring during the systemic reaction. The five most common symptoms were pain (100.0%), high blood pressure (100.0%), palpitations (86.7%), respiratory distress (52.6%), and near collapse/collapse (31.6%). The pain occurs when being stung was excruciating or burning pain at the wounds, felt like an electric shock, and rapidly expanded to heart pain. While the pain occurring during the systemic reaction was back pain, muscle pain, joint pain, abdominal pain, and body aches. The marks from the tentacles appeared similar in appearance to the caterpillar tracks of tanks. In 6 cases the species could be identified and all of them involving the Morbakka spp.*

Conclusions: *This was the largest study of Irukandji-like syndrome cases involving stings by single-tentacle box jellyfish in Thailand and the different clinical manifestations might be caused by different species of single-tentacle box jellyfish.*

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Key words: Irukandji-like syndrome, box jellyfish, envenomation, sign, symptom, definition

INTRODUCTION

The occurrence of box jellyfish envenomation was initially denied in Thailand. In 2008 a medical epidemiologist from the Ministry of Public Health and one from the Faculty of Medicine, Chiang Mai University (author) started to investigate this issue and provided evidence to show the existence of lethal box jellyfish envenomation in Thailand [1–3]. Dangerous envenomation incidents concerning box jellyfish in Thailand have involved both multiple-tentacle and single-tentacle box jellyfish. Multiple-tentacle box jellyfish, *Chironex* spp. have caused fatal and near-fatal cases [4–10]. Single-tentacle box jellyfish stings are known to cause Irukandji syndrome and Irukandji-like syndrome. Small carybdeid jellyfish, specifically *Carukia barnesi* are considered to be the main cause of Irukandji syndrome [11]. Other Australian carybdeid jellyfish are *Morbakka* spp. and *Morbakka* fenneri [12, 13]. There are at least three unnamed species of single-tentacle box jellyfish known to cause injuries in Thailand. However, it is possible that other species can cause Irukandji-like syndrome with different clinical manifestations [9, 10, 12, 14].

A case definition of Irukandji syndrome has been described as a severe local and systemic reaction occurring after a *Carukia barnesi* box jellyfish sting involving exposed

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skin [11]. The symptoms and signs developed between 5 and 40 minutes after being stung. These were predominantly pain and autonomic disturbances, such as severe muscle pain, muscle cramps, vomiting, sweating, agitation, hypertension, and heart failure [15–17]. However, Irukandji syndrome definition is still widely misunderstood, including species causing the syndrome, toxins, and geographic distribution. There had been reports of box jellyfish envenomation presenting as Irukandji syndrome but with other different symptoms and signs [16, 18]. Irukandji-like syndrome is more unclear than Irukandji syndrome. The Irukandji-like syndrome case report that occurred in Victoria was in 1998 [19]. Irukandji-like syndrome was described as: "Other jellyfish species (Not *Carukia barnesi*) cause a similar but not necessarily identical symptom complex referred to as Irukandji-like syndrome" [16]. The first case report of Irukandji syndrome in Thailand was published in 2001, which should have been described as Irukandji-like syndrome [20]. Physicians rarely diagnosed Irukandji-like syndrome in Thailand due to limited knowledge and inadequate laboratory facilities [8]. There is little known about the clinical manifestations of Irukandji-like syndrome caused by single-tentacle box jellyfish found in Thailand. The findings will be useful for diagnosis, health care, surveillance, and prevention and control measures. This study aimed to describe Irukandji-like syndrome associated with cases of stinging by single-tentacle box jellyfish found in Thailand.

MATERIALS AND METHODS

A medical epidemiologist from the Ministry of Public Health (MOPH) and one from the Faculty of Medicine of Chiang Mai University (author) started to investigate whether lethal jellyfish existed in Thailand as long ago as 2007. They established ad hoc toxic jellyfish surveillance in 2009, which later became the National surveillance system. They formed a steering team and invited officers from the Ministry of Natural Resources and Environment to join. This steering team established three toxic jellyfish networks, specifically task forces, experts, and communities. The initial members included Divers Alert Network, experts and health personnel in Thailand and a journalist and experts from universities in Australia. The membership expanded to stakeholders such as resort/hotel managers/owners, divers, speed boat/long-tail boat groups and biologists in order to detect the cases, build knowledge and collaborate regarding strategy. In the period from 2007 to 2019, all cases of stinging by single-tentacle box jellyfish resulting in collapse, hospital attendance or death were investigated. The investigations were conducted under the government service policy of emergency public health problems. These cases were included in this study. Data included details of the incident, physical examination, photographs of the wound, description of the box jellyfish, and a sample (if available) of the tentacle of the box jellyfish using Vacuum Sticky Tape for Identification of Toxic Jellyfish Class [5, 10]. The same technique was used for the collection and transfer of the tentacle of the single-tentacle box jellyfish from the incident place and for nematocyst identification to determine the class of box jellyfish [5, 10].

Descriptive analyses included proportion, mean ± standard deviation (SD), or median (minimum, maximum) depending on data distribution. Data management and analyses were performed using Epi Info for Windows version 7 (Centres for Disease Control and Prevention, Atlanta, GA).

RESULTS

INCIDENT BY PERSON, TIME AND PLACE

During the period from 2007 to 2019, 19 cases of stinging by single-tentacle box jellyfish were detected and investigated by the surveillance system. No fatalities were reported. The majority of cases were male (68.2%), with a median age of 35.0 years (range 6.0–60.0 years), tourists (52.3%), and Thai nationality (52.3%). The places where the incidents occurred were located along both coasts of Thailand. The three provinces with the highest reported incidence were Surat Thani (52.6%), Krabi (15.8%), and Trang (10.5%). The median number of incidences was 3 cases per year and the highest incidence was in 2016 (26.3%). About 31.6% of cases were received appropriate first aid (Vinegar poured on the wounds immediately for at least 30 s; Table 1). Among 19 cases, 6 of them could identify species group of single-tentacle box jellyfish. All of them were *Morbakka* spp. (31.6%). All cases had severe wound pain with immediate systemic reaction.

CLINICAL MANIFESTATIONS

Clinical manifestations of Irukandji-like syndrome were categorised into three groups. These were severe wound pain with immediate systemic reaction (66.7%), moderate wound pain with gradually systemic reaction (16.7%), and moderate wound pain with immediate systemic reaction after physical or chemical trigger (16.7%), such as rubbing with sand, taking a bath in freshwater, and rubbing with soap. The duration between the time of sting and pain development varied from a few seconds to a few minutes. The description of pain occurring when being stung included excruciating, burning, electric shock, and heart pain. The pain experienced during the systemic reaction included: headache, back pain, muscle pain, joint pain, abdominal pain, and body aches similar to being stabbed by knives (sharp jabbing pain). The pain was not constant but came in looping waves that increased for a few hours and lasted for 1 to 2 days.

The top five common symptoms and signs were pain (100.0%), high blood pressure (100.0%), palpitations

Table 1. Incident by the person, time, place in 19 Irukandji-like syndrome cases

Characteristics	Frequency	Per cent
Occupation		
Tourist	10	52.3
Fisherman	4	21.1
Jet ski rider	1	5.3
Divemaster	1	5.3
Civil servant	1	5.3
Volunteer	1	5.3
Employee	1	5.3
Nationality		
Thai	10	52.3
British	3	15.8
American	2	10.5
Finnish	1	5.5
French	1	5.5
Dutch	1	5.5
Burmese	1	5.5
First aid		
Appropriate vinegar pouring	6	31.6
No first aid	6	31.6
Inappropriate first aid	6	31.6
Late vinegar pouring	1	5.2
Year of occurrence		
2007	2	10.5
2008	2	10.5
2014	3	15.8
2015	1	5.5
2016	5	26.3
2017	3	15.8
2019	3	15.8
Province		
Surat Thani	10	52.6
Krabi	3	15.8
Trang	2	10.5
Phuket	1	5.3
Petchburi	1	5.3
Stun	1	5.3
Chonburi	1	5.3

(86.7%), respiratory distress (52.6%), and near collapse/collapse (31.6%) (Table 2).

The systemic reaction presented in waves of mild to severe symptoms and signs, including burning pain, headache, body aches, back pain, muscle pain, joint pain, abdominal cramps, nausea, vomiting, fatigue, paralysed limbs, respiratory distress, palpitation, high blood pressure, sweating, anxiety, and agitation.

Table 2. Symptoms and signs in nineteen Irukandji-like syndrome cases

Symptoms and signs	Frequency	Per cent
Pain	19	100.0
High blood pressure*	14	100.0
Palpitations**	13	86.7
Respiratory distress	10	52.6
Near collapse/collapse	6	31.6
Fatigue	5	26.3
Nausea or vomiting	5	26.3
Anxiety/agitation	4	21.0
Abdominal cramp	4	21.0
Sweating	2	10.5

*Excluded 5 cases with no record; **Excluded 4 cases with no record

WOUND CHARACTERISTICS

All cases had tentacle marks. In all cases, except four with healing wounds when undergoing a physical examination, the marks from the tentacles appeared similar in appearance to the caterpillar tracks of tanks which have articulated steel bands passing around the wheels with repeated interspersion by normal tissue (Fig. 1). The width of the brown erythematous tentacle marks varied (Fig. 1A, B).

Three cases had blisters within 1 day after being stung. One case had sweat on the right hand which had been in contact with box jellyfish tentacles 18.5 hours after being stung and lasted for 2 days (Fig. 2).

DISCUSSION

The actual incidence of cases of Irukandji-like syndrome might be higher than that recorded in this paper. Two of the reasons for this are that health personnel might give a misdiagnosis and cases with mild symptoms might not go to a doctor [7, 14]. However, this study emphasized moderate to severe cases in order to reduce false positive case. Although the majority of the cases are tourists, fishermen are another vulnerable population that needs consideration and they are active all year round. Many Thais believe that Caucasian people have a hypersensitivity to jellyfish not Thai people [7, 14]. This study found that more than half of the cases were Thai nationals and had clinical manifestation that indicated a non-allergic response to the toxin [2, 7, 14, 21]. The highest number of cases was in the Surat Thani Province in the Gulf of Thailand. Although fatal cases stung by multiple-tentacle box jellyfish were found in this province,

Figure 1. The width of the tentacle marks varied; **A**. Erythematous brownish colour on the second day after being stung by *Morbakka* spp.; **B**. Erythematous colour on the second day after being stung by other species on the left ring finger (image source: Cases)

Figure 2. Sweat appeared on the right hand which had been in contact with box jellyfish tentacles 18.5 hours after being stung (image source: Case)

there was no report of a fatal case stung by single-tentacle box jellyfish [4, 7, 8, 14].

Appropriate first aid for stings by box jellyfish found in Thailand is pouring vinegar (4–6% acetic acid) for at least 30 seconds continuously on the wound immediately after contact with the tentacle (except for stings in the eye) [6–8, 22–24]. In more recent years, stings were treated with vinegar as the intervention measures had been launched. Based on the author's experiences, severe cases of being stung by box jellyfish who had late vinegar poured on the wounds (as long as 10 to 15 min) after the events survived. Thus, vinegar pouring is recommended for first aid [7, 8, 22–25]. The steering team contributed the results from researches, surveillance, and outbreak investigations to policymakers, which led to prevention and control measures, including vinegar stations and educational warning signs being installed at the beaches [3, 5, 7].

This study showed that the majority of cases experienced severe wound pain with an immediate systemic reaction, while Irukandji syndrome sufferers usually had mild to moderate wound pain with a gradual systemic reaction about 5 to 60 minutes after being stung [16, 26]. Some cases had moderate wound pain with an immediate systemic reaction after physical or chemical triggers (such as rubbing sand or soap into the wound, taking a bath with freshwater). The possible explanation of the immediate systemic reaction might be due to more toxin entering the system due to physical or chemical triggers. It is worth noting that the pain occurring when being stung differed from the pain occurring during the systemic reaction. The pain occurs when being stung was excruciating or burning pain at the wounds, felt like an electric shock, and rapidly expanded to heart pain. While the pain occurring during the systemic reaction was back pain, muscle pain, joint pain, abdominal pain, and body aches. These pains were not constant but came in waves which increased in a few hours and lasted for 1 to 2 days. Therefore, a clear case definition can help in diagnosis, health care, and advice patients. The clinical manifestations of multiple-tentacle box jellyfish sting found in Thailand usually present with immediate severe wound pain following the stings and do not have waves of increasing pain and loops of systemic reaction [7, 8, 14, 27].

The tentacle marks found in this study appeared as caterpillar tracks of the tank that have articulated steel bands passing around the wheels, which is similar to that of multiple-tentacle box jellyfish [7, 8, 14, 24, 27]. According to the context of Thailand, Thaikruea et al. [7, 24] used caterpillar track appearance in defining Thai language term as "Teen-ta-kab" for risk communication because it is more understandable than other professional's terms (i.e. "Frost-ladder-like", "Step ladder-like", or "Ladder-like transverse band"). The tentacle marks caused by single-tentacle box jellyfish stings often cover a smaller area of skin than those caused by multiple-tentacle box jellyfish stings. However, it is difficult to distinguish between a few tentacle marks caused by multiple-tentacle box jellyfish stings and tentacle marks caused by single-tentacle box jellyfish stings. Thus, a history of exposure and clinical manifestation is important information for diagnosis [27]. Another interesting wound characteristic was blistering. Blisters were reported among severe cases stung by multiple-tentacle box jellyfish found in Thailand [14, 27]. The blisters in these cases developed within 24 to 48 hours among cases with massive stings or incorrect first aid. In some cases, blisters developed on the 4th or 5th day after being stung [14, 27]. In this study, 3 cases had blisters within 24 hours. Possible explanations were probably high doses of toxin due to massive stings (1 case) and incorrect first aid which increased nematocyst firing (2 cases). This finding is useful because blister has been reported only in severe wound complications among cases involving stings by multiple-tentacle box jellyfish [6]. However, only 1 case had deep dermal necrosis and needed wound debridement for about 2 months in this study. Another study reported a delayed development of dermal necrosis in a girl with one of these stings [28]. One case had sweating localised on the skin area which had been in contact with the tentacle of a single-tentacle box jellyfish. Interestingly this sign has not been reported in any cases involving stings by both single and multiple-tentacle box jellyfish found in Thailand.

This study found that the systemic reactions presented in waves of mild to severe symptoms and signs. These symptoms and signs were similar to those of Irukandji syndrome [16, 26, 29]. However, no cases report any feelings of impending doom. They were more likely to experience anxiety or agitation. The common symptoms and signs can be used for determination and diagnosis. In this study, the top five most common symptoms and signs were pain, high blood pressure, palpitation, near collapse/collapse, and fatigue. Although less common, nausea and vomiting were found in cases involving stings by multiple-tentacle box jellyfish found in Thailand [7, 8, 14, 27]. Based on the author's experiences, this nausea and vomiting symptoms without taking a history of jellyfish contact and no/unnoticed tentacle mark may lead to misdiagnosis of other possible illnesses such as food poisoning and appendicitis among children.

According to the findings of symptoms and signs related to cardiovascular and respiratory systems, monitoring of vital signs is recommended for treatment assessment and progression. It is worth noting that all cases involving stings by *Morbakka* spp. had severe wound pain with immediate systemic reaction. Fenner et al. [13] reported the first case involving a sting by *Morbakka* spp. which had similar symptoms and signs to the findings in this study. Based on toxic jellyfish networks in the surveillance system, *Morbakka* spp. were found in diving spots in the deeper areas of the sea. In recent years, they have also been found in shallow water near the beach. An outbreak investigation team from MOPH reported *Morbakka* spp. in August 2003 [8]. A new species *Morbakka fenneri* was discovered and identified as a species of Irukandji jellyfish [12]. However, the actual species of *Morbakka* spp. found in Thailand have not yet been identified. To date, they are named as *Morbakka* spp.A, *Morbakka* spp.B, and *Morbakka* spp.C [9]. Different clinical manifestations support the possibility that more than one species of single-tentacle box jellyfish found in Thailand can cause Irukandji-like syndrome. Further studies should be conducted to prove this observation. The location and species of single-tentacle box jellyfish are useful in distinguishing between Irukandji syndrome and Irukandji-like syndrome.

There were some limitations to this study, the species of single-tentacle box jellyfish could not be identified in some cases due to the practical difficulty in catching the jellyfish. Also, the setting up of laboratory facilities for research has only occurred recently. The numbers of cases might be somewhat underestimated due to misdiagnosis or undetected by surveillance in earlier years when there was a lack of Irukandji-like syndrome knowledge. However, the number might have little effect on the findings of this study because the toxic jellyfish networks of the surveillance system cover both coasts of Thailand and communities and stakeholders engaged in the surveillance and interventions [2, 3, 5, 7, 10].

CONCLUSIONS

This is the largest study of Irukandji-like syndrome cases involving stings by single-tentacle box jellyfish in Thailand and the clinical manifestations differ from those of multiple-tentacle box jellyfish stings. The different clinical manifestations in these cases might be caused by different species of single-tentacle box jellyfish. Clear clinical manifestation is particularly important in this context that communities play a major role in early warning and rapid response. The practical definition will be useful for medical care, surveillance system, and prevention and control measures.

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VIA MEDICA

REVIEW ARTICLE

Past, present, and future perspectives of telemedical assistance at sea: a systematic review

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ABSTRACT

Background: *Telemedicine is an effective technology for evaluating, diagnosing, treating, and providing health care services for remote populations, including seafarers, in case of diseases or accidents on board. Delivery of telemedicine in a maritime environment is not an easy task and, in general, differs from what can be done onshore. The aim of this review is to provides an overview of Telemedical Maritime Assistance Services (TMAS) in Europe by describing the previous and current status in terms of communication technologies as well as the nature of services rendered at sea. Secondly, to discuss the areas needing improvement and future directions to improve the quality of offshore telemedicine services.*

Materials and methods: *Different databases, including PubMed (Medline), Google Scholar, Scopus, and journal of International Maritime Health, were searched between August 1 and September 15, 2019. Articles only published from 1969 to 2019 were considered. Relevant articles were selected by reviewing keywords, titles, and abstracts initially based on our inclusion and exclusion criteria. We critically reviewed the full-text articles included in this review. Information on the means of communication, telemedicine services, years of publication, and the name of the first author was extracted from selected studies. The quality of the selected studies was assessed using the criteria of the Newcastle-Ottawa scale.*

Results: *Initially, 135 articles were identified through searching various databases by using keywords, abstracts, and titles. After removing the duplicates, 121 articles remained. Then we performed an independent article assessment and selection based on the selection criteria, which removed an additional 61 studies, leaving 60 papers. Finally, 27 full-text papers left, and we critically reviewed it. In 27 accepted articles, email and telephone were used most often and accounted for 30% (17/57) and 28% (16/57) of all communication links, respectively. Teleconsultation was the most used telemedicine service on board and represented 58.6% (17/29) of accepted papers.*

Conclusions: *Email and telephone were the principal means of TMAS doctors to provide medical advice as well as assistance for patients at sea. Despite the potential offered by technological progress, there are still many limitations to the provision of adequate medical care at sea. The modernisation of telemedicine services will help decrease the gap in healthcare delivery at sea.*

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Key words: telemedicine, telemedical maritime assistance service, medical advice, seafarers, teleconsultation, telemonitoring, telemedicine services

INTRODUCTION

Shipping is one of the most widespread transportation systems, and more than 80% of the world's trade utilises it [1, 2]. Approximately 65,000 deep-sea merchant ships operate worldwide, carrying nearly 1.6 million sailing seafarers [3, 4]. In general, the workforce's on board ships are grouped into three main categories, deck, engine, and galley/support personnel. Deck and engine groups include officers and ratings [5]. Globally, the number of seafarers actively employed on board ships in 2015 included 774,000 officers and 873,500 ratings [3].

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In Europe, the maritime industry plays a significant role by connecting more than 70% of the European market with its external trade partners as well as 36% of intra-European union trade exchange [6]. Nearly 32% of the world's total merchant fleet with more than 300 main seaports along its coastline managed by European Union (EU) [6]. Besides, approximately 400 million passengers are traveling per year at EU seaports. Regarding maritime health, given their particularly hazardous work environment [2], marked by physical and psychological strain, sudden climate change, and unexpected electromagnetic, vibration, and sound radiation [7], workers at sea, have higher rates of mortality, injuries, and illnesses compared with workers ashore, with a probability of one in eleven of being injured on the job [7].

For most of maritime history, except for rare exceptions when a doctor was on board, healthcare on board merchant ships was in the hands of the captain, whose training may have included rudimental notions of hygiene and medicine. Following the development of radio in the 1920s, doctors had the means to evaluate, diagnose, treat, and provide medical advice for sick or wounded seafarers as well as passengers. Different EU countries [8, 9] set up a radio medical centre 80 years ago to prove medical advice at sea. However, there are still various limitations to providing appropriate medical care on board due to incomplete medical data, poor still images, absence of trained paramedics, and poor radio communication coverage [10, 11]. This should highlight the need to update maritime telemedicine in terms of communication links/networks, medical diagnose, treat, and provide medical advice for sick or wounded seafarers as well as passengers.

Telemedicine in the maritime environment differs from the onshore provision of telehealth services. In general, in case of sudden diseases or injuries on board ships, the chance of receiving proper and effective treatment is not the same for seafarers as for workers on the land, given the inadequate medical skills of ship officers with duties for medical care on board, the limited range of medical equipment and the limited supply of medical products aboard [12, 13].

In general, there are several reviews published on telemedicine services regarding the onshore [14–18]. However, reviews of telemedicine services in the context offshore are scarce [19]. The purpose of this review aimed to provide an overview of Telemedical Maritime Assistance Services (TMAS) in Europe by describing the previous and current status in terms of communication technology as well as the nature of services at sea. Besides, areas needing improvement and future directions to improve the quality of maritime telemedicine services will be discussed.

Table 1. Detail search strings used for the PubMed database

1.	"Medical aid" [Title/Abstract] AND "on board" [Title/Abstract]
2.	"Offshore" [Title/Abstract] AND "telemedicine" [Title/Abstract]
3.	"Medical" [Title/Abstract] AND "assistance" [Title/Abstract]) AND "at sea" [Title/Abstract]
4.	"Radio medical" [Title/Abstract]
5.	"Maritime" [Title/Abstract] AND "Telemedicine" [Title/Abstract]
6.	"Telemedicine" [Title/Abstract] AND "at sea" [Title/Abstract]
7.	"Telemedical" [Title/Abstract] AND "assistance" [Title/Abstract]) AND "onboard" [Title/Abstract]
8.	"Radio medical" [Title/Abstract] AND "advice" [Title/Abstract]
9.	"Maritime" [Title/Abstract] AND "Medicine" [Title/Abstract]

MATERIALS AND METHODS

SEARCHING STRATEGY

The different electronic databases, including PubMed (Medline), Google Scholar, Scopus, and the journal of International Maritime Health, were searched to identify the relevant studies. Besides, additional articles were also extracted from the references list of selected papers to get a complete overview of the telemedical maritime assistance services in EU countries. The literature searches were carried out between August 1 and 15 September 2019. We used following key terms for searching in this review: "maritime telemedicine", "Radio Medical advice", "telemedical assistance on board", "telemedicine at sea", "offshore", "maritime medicine", "medical assistance at sea", "maritime health", "medical aid on board". Boolean operators and quotes have been used in the search process to acquire variations in the lexicon and for a better search strategy (Table 1) [20]. A manual search of Google Scholar, Scopus, and the journal of International Maritime Health was performed in web-based resources. Initially, keywords, abstract, and titles were used. Finally, we identified the relevant articles by reviewing full texts for articles independently.

INCLUSION AND EXCLUSION CRITERIA

Studies expected to describe the means of communication and offshore telemedicine services to be considered in the review. Furthermore, studies eligible for selection included published in peer-reviewed journals between 1969 and 2019, conducted within the EU countries, and published in English. Whereas: 1) review studies, 2) unpublished documents, 3) studies published only as an abstract, 4) expert opinions were excluded from the review.

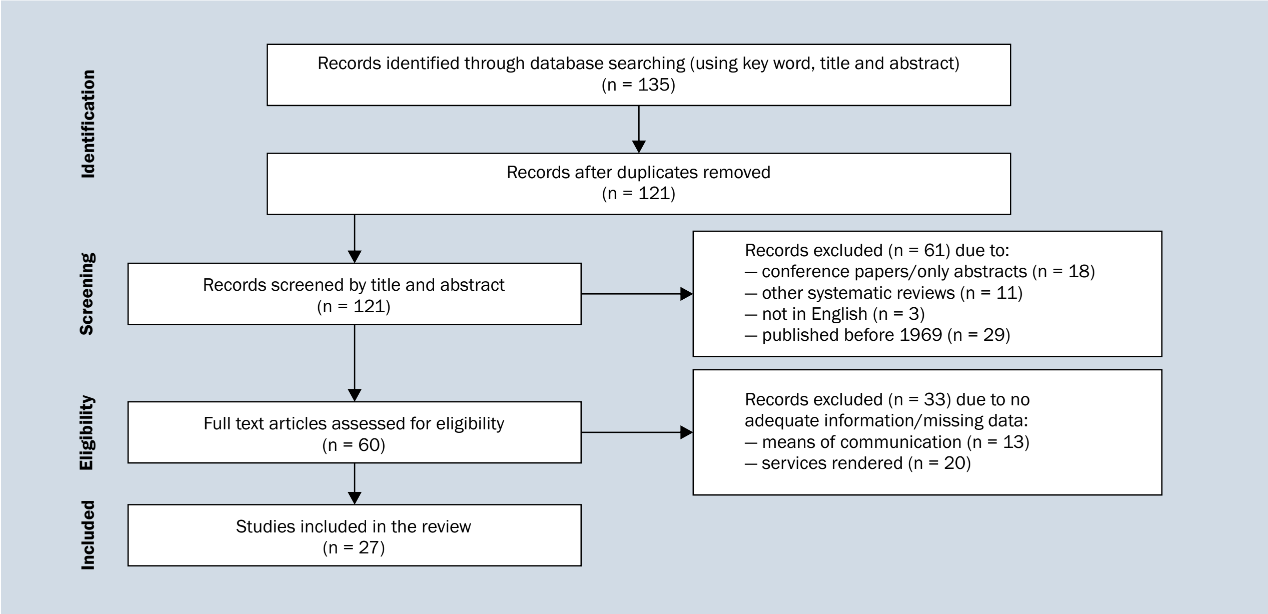

Figure 1. Literature search flow chart with inclusion and exclusion criteria

DATA EXTRACTION AND MANAGEMENT

The information extracted from the selected literature based on the following defined variables: 1) Means of communication, defined as the means used to facilitate the practice of telemedicine in terms of receiving and transmitting the information. 2) Maritime telemedicine services; this category defines the types of telemedical services provided during the study period, and the other information extracted from the selected articles were: 3) the name of the first author, 4) publication year. These variables have been taken into account based on previous studies and literature reviews to assess, analyse, and evaluate the previous and current status of maritime telemedicine services. Data extraction conducted using a Microsoft Excel form that lists all the information mentioned above. The first author G.G.S. has extracted the required information from accepted articles. The second author F.A. has reviewed the completed form and made corrections when necessary.

QUALITY ASSESSMENT

We used the Newcastle-Ottawa-Scale [21] to evaluate the quality of the selected articles. We assessed each selected study on 8 items and assigned up to a maximum of 9 points in 3 areas, including selection, comparability, and outcomes of interest with detailed analysis. As a result, we evaluated the quality of the selected studies based on agreed category scores ranging from 0 to 9: low quality (0–4), moderate quality (5–6), and high quality (7–9). The assessment of the title and abstracts was performed by two (G.G.S. and F.A.) reviewers independently. If any disagreement about inclusion and exclusion criteria, the full article was assessed. Besides, the disagreement on paper selection was resolved by the discussion between authors. The full paper was retrieved after the approval of reviewers based on the selection criteria, and the entire article assessed again separately.

RESULTS

RELEVANT ARTICLES

We identified a total of 135 articles through searching databases by using keywords and titles. The articles were filtered using the publication years from 1969 to 2019 and the inclusion and exclusion criteria. After removing duplicates, 121 papers remained. The authors did an independent assessment of the articles based on inclusion and exclusion criteria. Then after screening titles and abstracts, 61 papers rejected. Besides, full-text papers were assessed, and after evaluation, we excluded 33 full-text length articles. Finally, 27 full-text papers left, and we critically reviewed it (Fig. 1).

MEANS OF COMMUNICATION

As shown in Table 2, in general, six various means of communication were identified through different literature review during the study period. These include email, telephone, radio, and others (telefax, fax). Accordingly, email was the most used means of communication represented by 30% (17/57). Telephone and radio were the second and third most used means of communication for the transmission of medical information. They accounted for (28%, 16/57) and (21%, 12/57) of all communication tools, respectively. Videoconference (7%, 4/57) was the least used means of communication to transmit and receive medical data during the study period. The other means of communication, such as fax and telefax (14%, 8/57), were used as a means of communication for telemedicine services. Table 3 describes all selected studies along with reported means of communication as well as the type of telemedicine services rendered at sea [22–48].

Table 2. Means of communication reported in selected articles from 1969 to 2019

Means of communication	Frequency (%)
Email	17 (30%)
Telephone	16 (28%)
Radio	12 (21%)
Videoconference	4 (7%)
Others (fax, telefax)	8 (14%)

MARITIME TELEMEDICINE SERVICES

In general, 8 types of maritime telemedical services were identified in accepted articles. These included teleconsultation, telepathology, data sharing, telemonitoring, teledentistry, teledermatology, teletraining, and radio medical advice (Table 4). Of these, teleconsultation is the most used and accounted for 58.6% (17/29) of accepted articles. Data sharing was the second most used telemedicine services on board and accounted for 10.4% (3/29). Tele pathology, telemonitoring, and radio medical advice were third often provided services on board and accounted for nearly 7%

Table 3. Summary of selected articles with the name of the first author, publication year, means of communication, and nature of services

Name of the first author	Year	Means of communication	Telemedicine service	Quality score
F. Amenta [22]	1969	Telephone, telefax, radio	Teleconsultation	5
N. Rizzo [23]	1997	Radio, telefax, telephone, fax	Teleconsultation	5
G. Anogianakis [24]	1998	Videoconference	Teleconsultation	6
G. Anogianakis [25]	2000	Videoconference	Tele education/training	5
J. Norum [26]	2002	Radio, fax, telephone, email	Data sharing	8
K. Aujla [27]	2003	Radio	Radio medical advice	6
O.C. Jensen [28]	2005	Telephone, email, telefax	Teleconsultation	6
F. Mair [29]	2008	Videoconference	Telemonitoring, teleconsultation	4
K. Webster [30]	2008	Email, telephone	Telemonitoring	7
K. Westlund [31]	2011	Email, fax	Teleconsultation	8
E. Dehours [32]	2012	Email, telephone	Data sharing, teleconsultation	9
L. Grappasonni [33]	2012	Telephone, email	Teleconsultation	7
F. Amenta [34]	2013	Email, telephone, telefax, radio	Teleconsultation	4
E. Dahl [35]	2014	Email	Teledermatology	4
M. Kurlapski [36]	2014	Radio	Teleconsultation	7
E. Dehours [37]	2016	Telephone, email	Telepathology	6
S. S. Mahdi [38]	2016	Email	Data sharing	9
S. S. Mahdi [39]	2016	Email, telephone, radio	Teleconsultation	7
K. Westlund [40]	2016	Telephone, fax, email, radio	Teleconsultation	8
E. Dehours [41]	2017	Telephone, email	Telepathology	6
C. Marimoutou [42]	2017	Telephone, email	Teleconsultation	9
T.-E. Holt [43]	2017	Telephone	Teleconsultation	7
C. Montocchio-Buadès [44]	2018	Radio	Teleconsultation	7
K. Herttua [45]	2019	Radio	Teleconsultation	9
J. Szafran-Dobrowolska [46]	2019	Email, telephone	Teleconsultation	6
R. Mulić [47]	2019	Email, telephone, video, radio	Radio medical advice	6
P. Binaisse [48]	2019	Radio, email	Tele dentistry	8

Table 4. Maritime telemedicine services reported in selected articles from 1969 to 2019

Telemedicine services	Frequency (%)
Teleconsultation	17 (58.6%)
Data sharing	3 (10.4%)
Telepathology	2 (6.7%)
Radio medical advice	2 (6.7%)
Telemonitoring	2 (6.7%)
Teledermatology	1 (3.5%)
Teledentistry	1 (3.5%)
Tele-education/training	1 (3.5%)

in the equal rank of accepted studies. Teledermatology, teledentistry, and teletraining were used almost 4% of accepted articles, respectively. Telemedicine services are used most of the time in the context of accidents or emergencies on board.

DISCUSSION

This study provides an overview of telemedical assistance at sea, focusing on means of communication and the nature of the medical services offered on board from 1969 to 2019. Therefore, in order to provide important answers to questions about the growth of telemedicine at sea, considering communication technologies and the nature of on board services are vital aspects. Access to telemedicine services at sea is limited compared to onshore telemedicine. Offshore operating locations are challenging for delivering emergency medical care to personnel due to inadequate coverage of communication networks, bad weather conditions, absence of health professionals, or trained paramedics on board. However, regardless of these limitations, for the last 50 years, telemedicine by use of various means of communication such as telephone [22, 23, 26, 28, 30, 32–34, 37, 39–43, 46, 47], radio [22, 23, 26, 27, 34, 36, 39, 40, 44, 45, 47, 48], videoconference [24, 25, 29, 47], email [26, 28, 30–35, 37–42, 46–48], and telefax [22, 23, 28, 34] has been offered different emergency medical services at sea successfully. As a result, telemedicine in the maritime industry has made it possible to reduce number of unnecessary evacuations (nearly by 20% per year), reduce treatment delay, improve the perception of safety, and increase patient satisfaction [29, 32, 49, 50].

In this review, the email and telephone were used to be the principal means for onshore physicians to provide medical advice as well as to share medical data for patients at sea. The early form of telemedicine involved communication over radio and telephone [51, 52], but the telephone remains a major communication tool between onshore and offshore for medical advice. Historically, in the 19th century, most merchant ships had no medical personnel aboard, lacked areas dedicated to medical or nursing service, and had inadequate levels of hygiene. As it was impossible to communicate with doctors onshore, responsibility for treating diseases or injuries fell to the captain. After the Italian inventor, Guglielmo Marconi, developed radiotelegraphy in 1897 [53], coastal radio centres were established. From the 1920s onwards, radiotelephony was used to provide medical advice for patients on merchant ships [54]. Over the years, there were improvements in the range of radiotelephony services. After World War II, it became widespread and further improved ship to shore communications [55]. The first license for a radio medical service was issued on November 18, 1920, to the Seamen's Church Institute of New York. Then, many EU countries have got a radio medical license. As a result, Sweden in 1922, the Netherlands in 1930, Germany in 1931, Italy in 1935, Yugoslavia in 1938, Norway in 1949, Spain in 1964, France in 1983, Greece in 1985, Denmark in 1992 [34, 55, 56]. Now that such medical assistance is also provided through satellite-based telecommunication systems, perhaps it would be more precise to adopt the term telemedicine, which in the strict sense indicates the provision of health care services, clinical information, and education over a distance using telecommunication technologies. However, both systems are telecommunication technologies, and therefore we cannot object if the approach with which we assist patients' on board ships today is the same as that used 100 years ago.

Currently, all TMAS centres in Europe use various means of communication such as telephone, telefax, radio, email via satellite (INMARSAT) or other connection links to provide telemedicine services in case of need aboard merchant ships [34, 57–59]. However, direct electronic communication (videoconferencing) between patient and doctor is scarce. To modernise the telecommunication part and to minimise treatment delay and misdiagnosis, as well as to counter the psychological distress caused by the sense of isolation far out at sea, real-time videoconference consultation should also be considered. The outlays needed to purchase advanced telemedicine devices for ships will be more than offset by the increased health and productivity of maritime workers, and of course, the importance of saving lives on board. Furthermore, the use of TMAS offers significant savings to the industry or shipowners (approximately €150 million per year) [50]. Today, satellite technology has made medical services available at sea with high accuracy. In keeping with this change, radio medical centres are now called Telemedical Maritime Assistance Service (TMAS) centres. According to the International Labour Organisation (ILO) Convention 2006 and the International Maritime Organisation (IMO) 2006, all maritime nations must have a centre that provides medical services for seafarers 24 hours a day [60]. These nations have complied, but with different approaches: Italy and Spain have organisations specifically dedicated to providing telemedicine services, and other countries like Denmark, France, Germany, Norway, and Sweden designate doctors employed in hospital units to provide this service.

This review found that teleconsultation was the most used telemedicine services on board. Most of TMAS centres in Europe staffed seven days a week, 24 hours a day, and 365/366 days a year in which doctors experienced in managing teleconsultations in the context of accidents or emergencies are available for medical advice to on board ships. In addition to providing advice, the doctors may recommend medical evacuation (MEDEVAC) or that the ship changes direction so the patient can be brought to shore [53]. However, improvements in on-board medical and communications equipment and the medical training of crew should be encouraged for advanced teleconsultation service at sea.

The presented study revealed that telemonitoring was one of the least used services on board. It is to be argued that ships will begin to carry telemedical devices capable of transmitting the biomedical data of patients to a TMAS. For example, a telemonitoring device such as blood pressure measuring devices, spirometers, blood glucose level testing kits, Electrocardiogram (ECG) machines or digital thermometers equipped with cables or Wi-Fi connections so that the information can be downloaded to a phone or computer, and from there sent to the doctor. Such systems could even be supported by advanced artificial intelligence. This would make it possible for an inexpert ship crewmember to incorporate objective and accurate biomedical data into his description of the patient's symptoms to the TMAS doctor. Also, early detection of patients with chronic diseases can be of real help in optimising the patient management process and possible prognosis, primarily by preventing an emergency. Because some chronic diseases, particularly cardiovascular diseases, are the leading cause of mortality and morbidity among seafarers [33, 59, 61–63]. It would be useful to have onboard automated external defibrillators in addition to ECG machines.

Similarly, monitoring patients with chronic diseases is key to optimising patient outcomes, and that is certainly not possible without telemonitoring devices on board. Of course, crew members will need training on how to provide necessary life-saving measures in a medical emergency and how to operate the equipment such as ECG, ultrasound, and X-ray and how to transmit the records to TMAS doctors onshore for interpretation. Doctors ashore should also be informed about the new scenario of ships provided with telemedicine equipment because many are specialists in their fields and unfamiliar, even uncomfortable, in managing situations beyond their competence.

In 2006, the ILO had adopted the Maritime Labour Convention (MLC) 2006 [64], and was entered in to force on August 20, 2013. The EU has also paid attention to guarantee the effectiveness of the MLC 2006 to strengthen international regulations within ever more effective community code [65]. Furthermore, EU member states have been encouraged to ratify the Consolidated MLC 2006 [66]. In Chapter 4 (Title 4), the Convention 2006 addresses health protection and medical care on board ship aspects such as training of personnel, the necessity of medicines, equipment, medical data sharing, and means of communication, availability of doctors [60]. Furthermore, the Convention mentions that all seafarers must be covered by adequate measures for the protection of their health and must have access to prompt and appropriate medical care when working on board [60]. Accordingly, today's regulates more than 90% of the world's gross tonnage fleet [64]. However, it has not yet been fully applied related to health protection and medical care [65, 67, 68]. There are limitations related to patient monitoring, medical data sharing, decision making, and personnel training [67]. This could be explained by the fact that most communication technologies were limited to voice (telephone and radio) and text (email) rather than videoconferencing. Thus, quality of communication, doctor's direct contact with a patient, real-time video calls may be questionable. Consequently, improvement of telemedicine practices through MLC 2006 in terms of improving access to medical data, to have direct contact of TMAS doctors with the patient, development of real-time teleconsultation by satellite or other digital technology connection could improve the quality of services. Also, it would increase to alleviate the concerns of patients and doctors.

CONCLUSIONS

This review considered only published articles, and there may be many other unpublished projects that have not been reported in this study. The email was the most used means of communication. Teleconsultation has frequently used telemedicine services on board. On the other side, teledermatology, teletraining, telemonitoring, and teledentistry were the least used services on board. Delayed treatment, misdiagnosis, poor patient satisfaction, incomplete patient records, poor image quality undoubtedly limits the quality of medical care at sea. In this regard, the use of real video calls, the installation of telemonitoring devices, and the training of crew members in the applications of telemonitoring devices could help to improve the quality of offshore telemedicine services. In this study, we have demonstrated an overview of various means of communication and telemedicine services at sea. These may benefit decision-makers anticipating the improvement of telemedicine practice on board ships. Also, we recommend further research on the overview of the communication technologies and medical applications to confirm these results forming a base for improvement telemedicine services at sea.

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CASE REPORT

Decompression illness type II with stroke: challenging situation in acute neurorehabilitation

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ABSTRACT

A professional 55-year-old female experienced diver, who surfaced after the second dive, had a lucid interval before dropping Glasgow Coma Scale (GCS) to 3/15. She was admitted to intensive care unit and commenced on hyperbaric oxygen therapy. Her initial computed tomography of the head was normal but her magnetic resonance imaging of the brain at 48 hours showed extensive bilateral cortical watershed territory infarcts. She developed acute respiratory distress syndrome which resolved within a few days. Her GCS gradually improved from 3/15 to 6/15, was repatriated to United Kingdom after about 2 weeks of the insult and admitted to a tertiary care hospital where she had myoclonic seizures and was started on anti-epileptics. Then she was transferred to the Rehabilitation Medicine Ward of Leicester General Hospital, with GCS 14/15 with poor sitting balance, for her management and rehabilitation. She had weakness of right upper and lower limbs, dysarthria, neuropathic bilateral shoulder pains, pressure ulcer of left heel, bladder and bowel incontinence and cognitive issues. She improved to have significant neurological recovery within next 3 months, became ambulant independently and bladder and bowel continent. Her Barthel index (from 4 to 17), Montreal Cognitive Assessment Test, Adembrook Cognitive Examination and Berg Balance scale (from 33/56 to 44/56) improved significantly. Early diagnosis, treatment and rehabilitation can have a significant impact on the recovery of decompression illness.

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Key words: decompression sickness, scuba diving, the bends, hyperbaric oxygen therapy, hyperbaric chamber

INTRODUCTION

Decompression illness (DCI) is a clinical manifestation of Henry's Law which states that while ascending up after a dive, reduction in pressure can cause release of dissolved nitrogen into blood and tissues leading to intravascular and extravascular bubble formation [1]. The clinical manifestations can range from mild pains to complete vascular obstruction, respiratory and circulatory disturbances. Management involves securing and maintaining airway, breathing and circulation as well as hyperbaric oxygen therapy which should be instituted as early as possible followed by intensive inpatient rehabilitation.

This report describes a 55-year-old experienced diving instructor who has had more than 1000 successful dives in the past. She met with this fate in spite of the fact that she followed all prescribed procedures required during ascent. This report intends to understand the rare clinical presentation of decompression illness with stroke and to appreciate the importance of early inpatient rehabilitation programme.

CASE REPORT

A 55-year-old female professional diving instructor, who was a trained and certified diver, left handed, ex-smoker (left 12 years ago), occasional drinker, with no past medical history, delivered two dives while scuba diving in Cyprus. She had been diving for the past 24 years and had a history of more than 1000 successful dives in the past. First dive was 31 m in depth having duration of about 1 h using Nitrox 32% (oxygen enriched air having oxygen percentage as 32% and nitrogen percentage as 68%). She undertook decompression stop for 2 min duration at 9 m of depth and

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for 5 min duration at 6 m depth. This was followed by the second dive which was 30 m in depth, 43 min of duration using Nitrox 34% (having oxygen percentage as 34% and nitrogen percentage as 66%). During this dive the decompression stop was at 6 m depth, for 8 min. She followed all prescribed procedures for a safe ascent while ascending up, and during both dives, she undertook the decompression stops according to the standard guidelines. The surface interval in between the dives was 1 h and 59 min, during which she kept herself well hydrated. She surfaced after the second dive. She was well hydrated before, in between and after both the dives. She had no significant past medical history. There were no technical problems and emergency ascent was excluded. She had a lucid interval of around half an hour before dropping Glasgow Coma Scale (GCS) to 3/15, that is she had no eye opening, no verbal and no motor response. She was rushed to the local tertiary hospital in Cyprus, was intubated and commenced on hyperbaric oxygen therapy (100% oxygen in high pressure chamber). Her initial computed tomography (CT) of the head was normal, while CT head after 48 h showed large left frontal infarct with diffuse cerebral oedema with pressure effects on ventricular system. Her magnetic resonance imaging of the brain showed extensive bilateral cortical watershed territory infarcts, more extensive on left than right, particularly involving pre-motor and primary motor cortex. There was involvement of dorsolateral prefrontal cortex bilaterally. Period of hypotension and presence of recent cerebral oedema could have resulted in further ischaemic injury/watershed infarcts which were not visible on CT head. Extensive bilateral cortical watershed territory infarction was consistent with a moderate hypoperfusion injury and the low GCS. Electroencephalography showed moderate encephalopathy. She developed acute respiratory distress syndrome during the first week of her stay in Cyprus, which resolved within a few days. She was tracheostomised after a week. Her GCS gradually improved from 3/15 to 6/15 wherein she started opening eyes to pain and showed extensor motor response. Her verbal response was incomprehensible sounds or speech. After around 2 weeks of the insult, she was repatriated to United Kingdom, by air ambulance and admitted to neurology department in a tertiary care hospital, initially in intensive therapy unit and after a couple of days was transferred to neurology ward. She underwent around 7 sessions of hyperbaric oxygen therapy (HBOT) according to the established standard protocols. HBOT was initiated with at a depth of around 18 metre sea water (msw). Total duration of the session being around 4 h. Subsequent sessions were of around 100 min duration each at a depth of 14 msw. During the course of her stay in hospital, she also had myoclonic seizures and was started on anti-epileptic drugs in the form of Phenytoin and Levetiracetam. Phenytoin was subsequently tapered off while she was continued on maintenance dose of Levetiracetam 1 g twice a day. She even had episodes of hypotension, requiring fluid resuscitation. She was suffering from hypoxic ischaemic encephalopathy secondary to cerebral decompression sickness causing extensive bilateral watershed territory ischaemic infarcts (left > right) which were likely air embolic. Clinical presentation of the patient at the time of admission to rehabilitation medicine ward comprised of weakness of right upper and lower limbs, poor sitting and trunk balance, dysarthria, moderate to severe expressive and receptive dysphasia with semantic difficulties, neuropathic bilateral shoulder pains plus restriction of range of motion of bilateral shoulders, subluxated right shoulder, mild to moderate dysphagia. Initially she required moderate assistance with bed mobility, transfers, feeding, grooming and upper body dressing, and maximal assistance with lower body dressing and ambulation. In the rehabilitation medicine ward, she underwent a comprehensive rehabilitation programme comprising of active and passive range of motion exercises, stretching and strengthening exercises, retraining of sitting balance, activities of daily living and gait training. On completion of a 4-week course of inpatient rehabilitation, the patient improved to modified independence with all activities of daily living and transfer and required no assistance for ambulation. Her motor strength normalised in the lower extremities and her dysmetria improved. She became continent of both bowel and bladder, and urodynamic study demonstrated normal bladder function. For management of her neuropathic pain in bilateral shoulders, she was prescribed Gabapentin 300 mg up to 3 times a day (gradual escalation of dose). She was even given ultrasound guided steroid injection around the bicipital tendon for her bicipital tendonitis. Apart from regular rehabilitation techniques, she underwent hydrotherapy, dynamic balance training, functional electrical stimulation for right shoulder subluxation, dynamic splinting for improving hand functions, transfer training comprising of hoist transfer, followed by rotunda transfer followed by step transfer, activities of daily living training comprising of large handle cutlery. Outcome measures included were 10 m walk test, Berg Balance Scale, JFK Coma Recovery Scale, 9 hole peg test, Barthel Score. She continued to gradually improve over the next few weeks, became independent in all her activities of daily living and was able to ambulate independently. She became continent in bladder and bowel.

DISCUSSION

Decompression illness was first reported in 1841, also called Caisson disease. It is common in under water, high altitude events and recreational activities. In spite of a drastic increase in number of recreational dives as well as the growing popularity of the same, the incidence rate of DCI remains only 0.02% to 0.03% per dive [2]. According to Vann et al. [2], the risk of DCI increases with age and body mass index. Two main mechanisms are thought to be responsible for pathomechanism of DCI. The first one being, acute increase in pressure in the lungs, leading to stretching and rupturing of alveolar capillaries (pulmonary barotrauma), which causes alveolar gas to enter arterial circulation (air gas embolism) [2]. On the other hand, an excess amount of inert gas which is released from the saturated tissues can form bubbles in venous blood. This may cause pulmonary and arterial embolisms due to right to left shunting. Main causes for DCI have been documented to be very rapid ascent and lack of decompression stops [3]. Decompression stops can prevent decompression illness as these delay ascent to the surface and allow inert gases to be eliminated in dissolved form rather than as bubbles [4, 5].

Decompression illness can be classified into two types on the basis of severity and type of symptoms. Type I, the minor type is the 'pain only' DCI, which requires lesser magnitude of recompression therapy. It occurs in 70–85% and is self-resolving. Type II is the DCI which is characterised by neurological symptoms and can even present as shock. Spinal cord lesions are the most common presenting as back pain, paraesthesias, motor weakness, loss of sphincter control. DCI II has worse prognosis and requires greater magnitude of recompression therapy [6]. Air gas embolism on the other hand, occurs immediately after resurfacing and occurs more commonly in brain than spinal cord. This can also cause embolism of coronary vessels leading to arrhythmia and infarction. DCI has several risk factors.

The diving risk factors include, the depth and the duration of the dive, the breathing gas used, the ascent rate and if the dive was conducted at altitude higher than sea level or flying after diving. Among individual risk factors are the quantum of exercise during the dive, older age, higher body fat content, and presence of a patent foramen ovale (PFO) [2]. To be precise, age more than 42 years, depth of dive more than 39 m, having bladder dysfunction, having clinical symptoms before recompression therapy are the factors associated with worse outcome [7].

Patent foramen ovale is associated with severe neurological decompression sickness, inner ear decompression sickness and cutis marmorata. A workshop at the South Pacific Underwater Medicine Society (SPUMS) Annual Scientific Meeting 2014 with representatives of the United Kingdom Sports Diving Medical Committee (UKSDMC) present and subsequent discussions including the entire UKSDMC resulted in a consensus statement according to which right-to-left shunt across a persistent or PFO is a risk factor for some types of DCI. It was agreed that divers with a history of cerebral, spinal, inner-ear or cutaneous DCI, migraine with aura, a family history of PFO or atrial septal defect and those with other forms of congenital heart disease should undergo routine screening for PFO. Screening should be undertaken by bubble contrast transthoracic echocardiography with provocative manoeuvres, including Valsalva release and sniffing. In case of presence of shunt, experienced diving physician should take a decision based on the clinical context and size of the shunt. Transcatheter device closure of PFO may be considered in order to return to normal diving [8].

In the present case report, the patient had hypoxic ischaemic encephalopathy secondary to cerebral decompression sickness type II, causing extensive bilateral watershed territory ischaemic infarcts (left > right) which were likely air embolic. Out of the risk factors, she had older age, higher body fat content and bladder symptoms. As stated by Jüttner et al. [9], treatment of DCI, should comprise of initial normal pressure 100% oxygen inhalation. The two purposes solved by pure oxygen are to improve tissue oxygenation and increase the partial pressure gradient leading to passage of nitrogen out of the bubbles formed during decompression [1].

Furthermore, whether ventilation occurs via invasive or noninvasive means, re-expansion barotrauma may be a contributory factor in DCI, thus peak pressures should be minimized to any extent possible. Additionally, adequate fluid resuscitation should be ensured by emergency department providers to ensure no compounding effects of dehydration or shock physiology [10].

However the mainstay of treatment of DCI remains rapid hyperbaric oxygenation in pressure chamber. This helps to reduce the size of existing bubbles, increase inert gas clearance from tissues and blood [9]. This should be initiated as soon as possible. Recompression therapy should be initiated without waiting for the conclusion of investigations [2]. The fastest available method of transportation is often by helicopter air ambulance. However, the manifestations of DCI may be exacerbated by decreases in atmospheric pressure [11]. In spite of the limited studies available on establishing safe altitudes for patients with DCI, current recommendations include ensuring that the cabin altitude does not exceed 500 feet (152 m) above the departure location [12].

Mechanism of action of hyperbaric oxygen comprises of recompressing bubbles and forcing gas back into solution for a more controlled ascent. Inert nitrogen is replaced by rapidly-metabolised oxygen, and bubbles move either to the lungs where they are excreted, or to smaller vessels where obstruction is less important, and surface tension forces eventually collapse the bubbles. Hyperbaric oxygen also counteracts platelet and leukocyte activation and endothelial interactions [13].

CONCLUSIONS

Decompression illness is rare with the rate of occurrence estimated to be around 0.03% in recreational divers [2]. Adherence to standard diving guidelines is essential. Regardless of the fact that all diving guidelines being followed, and even if the diver is an experienced one, the medical team should be ready for any emergencies. Early recognition of DCI and its prompt management incorporating early treatment with hyperbaric oxygen and comprehensive rehabilitation is the key to recovery of DCI. First aid treatment comprises of 100% oxygen and definitive treatment is recompression therapy that is HBOT according to established standard protocols. Recompression therapy should be initiated without waiting for the conclusion of investigations.

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CASE REPORT

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Fatal accident involving a welder employed by a shipping container company, associated with the use of tramadol and antidepressant agents

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ABSTRACT

The widespread use of opioids for the treatment of moderate or severe acute and chronic pain has become a public health problem due to the physical and psychological dependence and tolerance they produce. The increasingly higher doses that patients require may reach toxic levels or lead to accidents, including fatalities.

We present the case of a welder who, while working for a shipping container company, fell from height without a safety harness and subsequently died as a result of a traumatic brain injury. Post-mortem examination revealed a cardiac blood tramadol concentration of 2.83 mg/L, which is 3–4 times higher than the maximum therapeutic dose. The combined use of synthetic opioids and antidepressants may heighten the adverse neurological and psychiatric effects.

A review of the literature, identified studies, including previous reports of fatalities, supported our causal hypothesis of a serotonin syndrome. This syndrome can lead to a loss of cognitive and sensory capacity, interfere with decision-making ability, and produce mental confusion and dizziness, among other symptoms. In order to prevent harm to themselves and others, all persons who are currently taking these kinds of drugs should avoid dangerous tasks at work and must be advised by a physician regarding the type of activities that are safe for them to perform.

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Key words: fatal outcomes, occupational accidents, poisoning, opioid abuse, antidepressant agents, drug-related side effects, adverse reactions

INTRODUCTION

The widespread use of opioids, especially for the treatment of moderate or severe acute and chronic pain, has become a public health problem in many countries. Notably, in the United States, there are increasing reports of fatalities among people prescribed these drugs, which produce both physical and psychological dependence [1]. In February 2017, the Spanish Medicines Agency AEMPS published a report on opioid use in our country during the period 2008–2015 [2], and data for 2010–2018 [3] are available on the Agency's website. The most widely used active substance in this class is tramadol (either alone or in combination with analgesics and anti-inflammatory drugs), accounting for 63.2% of prescribed analgesic opioids in 2018 [3].

A report published in January 2015 [4] by the Spanish Medicines Agency documented a 200% increase in the use of antidepressants in Spain during the period 2000–2013. The data showed that the most widely used drugs of this class were selective serotonin reuptake inhibitors (SSRIs), followed by those classified as "other antidepressants", which accounted, respectively, for 70.4% and 29.7% of total antidepressant use in 2013. Although only certain antidepressants may interfere with a person's ability to drive and/or carry out potentially dangerous tasks at work, many

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Table 1. Results for the main active substances found in blood samples from the deceased*

Active substance	Concentration in blood [mg/L]	Therapeutic concentration [mg/L]
Tramadol	**2.83**	**0.1–0.8**
Venlafaxine	0.05	0.01–0.2
Midazolam**	0.14	0.08–0.25

*A very low blood concentration of diazepam was also detected, 0.01 mg/L (therapeutic value is 0.02–4 mg/L)

**It was subsequently clarified that the paramedics had administered midazolam

patients have prescribed them in combination with other psychotropic drugs, which increases the associated hazards.

There are only some recommendations by the "Driving Under the Influence of Drugs, Alcohol and Medicines" project (DRUID) in 2011 [5], on the effects of some medicines and driving. That is why, we have produced a guide that includes, in addition to driving, the main dangerous work activities for the worker himself and for other people [1]. In this case report we want to highlight the danger of tramadol.

Just to summarise this case report article. We describe the case of a fatal accident involving an employee of a shipping container company in the Port of Barcelona, in which the post-mortem examination showed a high blood concentration of tramadol and a concentration within the therapeutic range of venlafaxine.

CASE REPORT

DESCRIPTION OF THE OCCUPATIONAL ACCIDENT

The 41-year-old man had been working for the past 11 years for a shipping container company in the Port of Barcelona. At the time of the occupational accident (8 a.m.) he was working in the maintenance terminal of a freight shipping company, where his task was to raise the height of the upper gangway allowing access to the straddle carriers. The accident occurred while he was preparing the necessary material waiting for his work colleague arrival to start the task. The steel walkway unexpectedly gave way and, as he had not attached a safety harness, he fell from a height of 12.20 m to the floor of the maintenance terminal.

The emergency paramedics arrived 12 minutes after the accident and observed an open fracture of the left forearm, left otorrhagia and a traumatic brain injury. Standard resuscitation and treatment procedures were performed *in situ* to stabilise the patient's vital signs (cervical collar, cardio-pulmonary resuscitation manoeuvres and administration of 15 mg of Midazolam). Later he was transferred by ambulance to the emergency department of a hospital in Barcelona (admitted at 9:40 a.m.).

The patient arrives at the Hospital in Coma (grade 3 of the Glasgow Coma Scale), hypotension, bradycardia, bilateral mydriasis, non-palpable pulses, intraoral blood, bilateral otorrhagia. Three litres of Ringer's serum and 4 vials of Beriplex (combination of type II, VII, IX, XI coagulation factors) are administered. In a period of 40 minutes, the patient progresses to severe bradycardia and asystole, which is attempted to be reversed with a defibrillator, but it is not successful and the patient dies.

The main autopsy findings are a fracture of the skull base, a bilateral pulmonary contusion, and an open fracture of the left elbow.

Adams and Hirsch in 1993 published the 5 degrees of certainty according to the autopsy findings. Group 1 being the most certain and group 5 the least. This case is classified in group 1 (the cause of death is identified with the autopsy findings with absolute certainty and the mechanism of death is structurally demonstrable), these Adams and Hirsch grades are well commented by Teijeira et al., 2006 [6].

Biological fluid samples were sent to the toxicology laboratory in order to rule out the presence of recreational drugs and/or prescribed medicines. The main results of this analysis are shown in Table 1.

PERSONAL HISTORY

The man's medical records, to which access was granted by a court order, revealed the following information of interest. He had suffered from musculoskeletal problems for the past 5 years and the initial diagnosis was cervicalgia. A year later a diagnosis of cervical osteoarthritis was made, and a year prior to the accident he was diagnosed with spondylosis (chronic dorsalis). Treatment involved anti-inflammatories, muscle relaxants, antidepressants and synthetic opioids. Five years prior to the accident he had been prescribed a synthetic opioid (tramadol 37.5 mg/paracetamol 325 mg), which he took only sporadically for the first 3 years, but during the past 2 years he had taken between 6 and 12 tablets/day. Six months prior to the accident he had been prescribed venlafaxine 150 mg/day for reactive depression triggered by his chronic pain. He occasionally took diazepam 2 mg at night.

The blood tramadol concentration that was detected post-mortem is 3–4 higher than the maximum therapeutic dose. The analysis was performed using cardiac blood as the purpose was to screen for recreational drugs and prescribed medicines, although in the specific case of tramadol, testing is best performed using femoral blood as the cardiac-to-femoral blood ratio is 1.4 [7], which in the case of this man would imply a femoral blood concentration of tramadol of 2.1 mg/L.

DISCUSSION

Mainly, in this case, we will refer to the toxicity of tramadol, because high concentrations in blood have been identified. The rest of the psychotropic drugs concentrations were found within the therapeutic values and they can only increase the effects of tramadol.

Tramadol is a synthetic opioid receptor agonist that is used as an analgesic in cases of moderate or intense pain. It is converted in the liver to O-desmethyltramadol and several inactive metabolites. The O-desmethyl metabolite, also known as M1, is 2–4 times more potent than tramadol itself and is primarily responsible for the analgesic effect. Peak plasma concentration is reached within 1–2 hours of oral administration, and therapeutic blood concentrations are in the range 0.1–0.8 mg/L [8]. Tramadol crosses the blood-brain barrier and has an elimination half-life of 5–6 hours, while that of its active metabolite is 7–8 hours. Excretion is primarily via the kidneys.

The analgesic effect of tramadol is mainly due to its action as an inhibitor of serotonin-norepinephrine reuptake in the spinal cord [1, 2]. Accordingly, the most common adverse reactions to tramadol are nausea and dizziness, which occur in 10% of patients. Among neurological side effects, headache and drowsiness are the most frequent, although patients may exceptionally experience loss of appetite, paraesthesia, tremor, respiratory depression, seizures, involuntary muscle spasms, problems with coordination or syncope. Respiratory depression can occur when the dose given is much higher than recommended and when the drug is administered simultaneously with other central nervous system (CNS) depressants [9]. The most common psychiatric symptoms associated with the use of tramadol are hallucinations, confusion, sleep disorders (including nightmares) and anxiety. The intensity and nature of adverse psychological effects varies from one individual to another (depending on personality and the duration of drug treatment). Impairment of cognitive and sensory abilities (e.g. decision making, altered perception) may also be observed. Importantly, tramadol can produce dependence.

The use of tramadol in conjunction with other serotoninergic agents, such as SSRIs, or with monoamine oxidase inhibitors may result in a severe serotonin syndrome, which in some cases can be fatal. Notably, the patient in the present case report was taking tramadol in conjunction with venlafaxine (a SSRI). Clarot et al., 2003 [10] examined the combined use of tramadol and 21 other drugs and concluded that benzodiazepines posed a particular risk. Several studies have also documented the neurological effects produced by tramadol overdose.

A study of 190 patients, Marquardt et al., 2005 [11], found that 27.4% experienced CNS depression, 5.8% dizziness, 3.7% confusion, 3.2% headache and 1.6% entered a coma. Shadnia et al., 2008 [12] examined 114 cases of intentional tramadol intoxication and found that 71 (62.3%) patients presented vertigo, 40 (35%) had seizures, 31 (27%) anxiety and 26 (23.4%) lost consciousness. Finally, a study by Spiller et al., 1997 [13] of 87 patients found that the symptoms reported with tramadol overdose were lethargy in 26 (30%) cases and coma in 4 (5%) patients.

Several studies have also examined fatal intoxications involving tramadol. Tjäderborn et al., 2007 [14] analysed 17 cases of unintentional intoxication and found that blood tramadol concentrations at autopsy ranged from 1.1 to 12 mg/kg. De Decker et al., 2008 [15] described 8 cases of fatal intoxication in which tramadol but no other toxic substances were detected in blood. Tramadol concentrations ranged between 1.6 and 15.1 mg/L. Simonsen et al., 2015 [16] conducted an epidemiological study of fatal poisoning in drug addicts over a period of three decades in five Nordic countries. In Finland during the period 2002–2012, deaths due to tramadol accounted for 9–11% of the total number of cases.

The blood tramadol concentration that was detected in our patient at autopsy is like that reported in several previous cases. It should be noted that tramadol concentrations in cadaveric blood may vary due to post-mortem redistribution, and in this respect, determinations in femoral blood are more reliable [3].

Venlafaxine is an antidepressant that increases neurotransmitter activity in the CNS. Both venlafaxine and its main metabolite O-desmethylvenlafaxine are potent inhibitors of serotonin-norepinephrine reuptake. Therapeutic doses of venlafaxine range between 75 and 375 mg/day, and peak plasma concentration is reached within 2–3 hours of oral administration. The elimination half-life of venlafaxine is 4–5 hours, while for O-desmethylvenlafaxine it is 11 hours.

Adverse neurological effects associated with venlafaxine administration include dizziness, headache, paraesthesia, sedation and tremor. It may also cause psychiatric symptoms such as insomnia, drowsiness, agitation and sleep disturbance in the form of nightmares. The concomitant use of venlafaxine and tramadol may result in a serotonin syndrome involving both central and peripheral neurological changes, and fatalities have been reported [17, 18].

It is relevant to notice that medication use is an important matter to be evaluated from the first and the periodical Medical Fitness Examination, especially if the worker has to perform dangerous activities. As an example, it is clearly included in the Appendix D of the ILO/IMO Guidelines on Medical Examination of Seafarers [19], it says “ensure that seafarers are not taking any medication that has side effects that will impair judgement, balance, or any other requirements for effective and safe performance of routine and emergency duties on board” (STCW Code, Section A-I/9, Paragraph 2.5). The examining doctor will need to assess the known adverse effects of each medication used and the individual’s reaction to it. This is particularly important for those medications that are controlled drugs or which may be abused. In the first group, we have medications that can impair routine and emergency duties like CNS depressants (e.g. sleeping tablets, antipsychotics, some analgesics, some anti-anxiety and anti-depression treatments and some antihistamines). They may need surveillance requirements and restrictions to certain type of work, more frequently that full duration of the fitness certificate. A follow up of the Occupational Health Department and Risk Prevention Services should be taken into account.

This fatal occupational accident showed a disconnection between the National Health System that controls diseases of non-occupational origin and the occupational health practitioner in charge of monitoring his health surveillance. Normally, only the worker himself, voluntarily, reports his health status to his occupational health service. Without this knowledge, the occupational doctor cannot adequately follow, complete or modify the treatment and propose modifications or changes in his or her job. The company carries out information and training campaigns for its workers, regarding specific occupational risks and health promotion. But it is needed a better communication system. It is a must to show how dangerous, medicines can be, when driving or carrying out dangerous work.

CONCLUSIONS

Medication can play an important part in enabling the persons to continue to work. And the Occupational Health System and the Risk Prevention Department has to be aware about, to be able to restrict dangerous work from the worker.

In the case reported here, the drugs identified at autopsy may have been interfering with the man’s capabilities at the time of the accident. Specifically, the concentrations ingested and detected in the toxicological analysis could have impaired his cognitive and sensory capacity, including his decision-making ability and perception of the environment, and they may have produced symptoms such as confusion and dizziness.

In order to prevent harm to themselves and others, all persons who are prescribed medication that may impair their ability to drive or perform potentially dangerous tasks at work must be properly advised by a physician with regard to the activities that it is safe for them to carry out.

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Medical evacuations among offshore oil and gas industries in the Gulf of Thailand

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ABSTRACT

Background: *Medical evacuation in the offshore oil and gas industry is costly and risky. Previous studies have found that the main cause of medical evacuation due to illness is increasing. In Thailand, there have been no studies on the causes and costs of medical evacuation in the offshore oil and gas industry. This study aims to study on the causes and costs of medical evacuation among offshore oil and gas industry in the Gulf of Thailand.*

Materials and methods: *A retrospective review of data of medical evacuation among the offshore oil and gas industry in the Gulf of Thailand from 2016 to 2019 for a period of 36 months.*

Results: *During the research period, a total of 416 cases were evacuated. The majority of the causes of Medevac (84.13%) were illness. We found that 60.1% of all Medevacs were unpreventable or difficult to prevent, and only 39.9% were preventable. The cost of Medevac ranged from 10,000 to 880,000 THB per case. The cost of Medevac occurring from preventable causes was 17,160,000 THB for this period of 36 months.*

Conclusions: *Reducing the cost of Medevac can be done by: 1) vaccination to prevent vaccine-preventable diseases, 2) screening to prevent people at risk of getting complications from pre-existing diseases to work offshore, and 3) increasing treatment capability of offshore facilities. Offshore oil and gas industry may consider cost-benefit of these approaches compared to status quo.*

(Int Marit Health 2020; 71, 2: 114–122)

Key words: medical evacuation, Medevacs, oil and gas industry, offshore

INTRODUCTION

Operations in the offshore oil and gas industry are operations in special areas. Workers often work under environments different from general establishments. They usually work offshore for 14 consecutive days with shifts, alternate with staying onshore for 28 days (may vary depending on the agency and job position). They have a risk of personal health problems and work safety with the condition of the job at risk both from variable weather and accidents that may occur from working with machines [1]. Including unpreventable illnesses such as acute appendicitis or acute myocardial infarction.

In general, offshore rigs and platforms have medical personnel who can provide initial treatment to workers when the illness occurs. However, only some treatment can be provided due to remoteness and lack of sophisticated medical equipment. Some may seek medical consultation through a remote medical system (telemedicine) [2, 3].

In each offshore facility, there are medics on board for 24 × 7 services but there may not be a doctor at all times. The doctor is usually on a large platform and also takes care of other small platforms nearby. The facility clinic can handle illnesses/injuries of the medical treatment scope. Beyond this scope, the decision of referral is made by the on-duty doctor. The facility clinic has some life-saving medicines, isolation units, full personal protective equipment and protocol for infectious cases handling, can cast/external immobilisation for closed fracture, can do wound suturing/cleaning, but does not have general anaesthesia, operating room, nor negative pressure room.

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If a serious illness or accident occurs and exceeds the offshore medical treatment capability, that victim requires to be moved to an appropriate, usually onshore, hospital. This is done via an aircraft or a boat and often beyond regular schedule, thus increases the cost and the risk, especially in bad weather. Therefore, such medical evacuation is seriously considered regarding its severity and emergency [2].

In Thailand, there have been no studies on the causes and costs of medical evacuation in the offshore oil and gas industry. This study aims to investigate the causes and costs of medical evacuation among the offshore oil and gas industry in the Gulf of Thailand.

MATERIALS AND METHODS

This study was a retrospective descriptive study. The study was conducted using a previous medical record of medical evacuation among the offshore oil and gas industry in the Gulf of Thailand, which is a secondary data obtained from companies that consent to disclose information excluding names of companies and victims due to non-disclosure agreement. Such data were usually kept for 36 months then deleted. For this study, we obtained data of April 2016 to March 2019.

The data collection included demographic data (age, gender, nationality, type of employment, underlying disease) and diagnosis before and after Medevac (initial and final diagnosis). Then, we classified as injury or illness, and preventable or unpreventable/difficult to prevent. We calculated and compared the costs caused by preventable or unpreventable/difficult to prevent, and suggested methods for prevention. The estimated cost of evacuation was presented as a lump sum price per time and the detail was distributed as cost per flight time, doctor and nurse fee and other expenses.

STATISTICAL ANALYSIS

Data analysis was performed using STATA version 14.0 (StataCorp. 2015. Stata Statistical Software: Release 14.1. College Station, TX: StataCorp LLC). Variables with normal distribution were presented as mean (standard deviation [SD]) and those with non-normal distribution were presented as median (interquartile range [IQR]). Qualitative variables were presented with counts and percentages.

After obtaining approval from the Ethics Committee of the Faculty of Medicine, Chulalongkorn University, and obtaining companies' consent to disclose information, the study was conducted in the second week of June 2019.

RESULTS

From April 2016 to March 2019, there were a total of 416 evacuated cases, 410 (98.56%) males and 6 (1.44%) females; the median age was 37 years. Forty-seven per cent of the patients were between the ages of 30 to 39. The majority of the evacuees were 376 Thais (90.38%), followed by American 7 (1.6%) cases. The type of employment showed that evacuees were 216 (51.92%) subcontractors, 196 (47.12%) direct employees and 4 (0.96%) others (fishermen). No underlying disease data were obtained because such data were not recorded. The demographic data of the evacuees are presented in Table 1.

Other additional information received includes: types of evacuation, reasons for disembarkation, final diagnoses, outcome of treatment and work-relatedness, which is demonstrated in Table 2. Company doctor, doctor at assistance centre or offshore/rig manager decided on the need and type of medical evacuation as follows: emergency disembarking was immediate evacuation or within 24 hours

Table 1. Medevacs' demographic data

Demographic characteristics	Number and per cent of Medevacs	
Gender		
Male	410	98.56%
Female	6	1.44%
Age group [year]		
< 30	50	12.02%
30–39	196	47.12%
40–49	121	29.09%
50–59	44	10.58%
> 59	5	1.2%
Age [year]		
Minimum	22	
Median (IQR)	37	13%
Maximum	66	
Nationality		
Thai	376	90.38%
American	7	1.68%
Malaysian	6	1.44%
Indonesian	5	1.20%
Australian	5	1.20%
Canadian	4	0.96%
Filipino	3	0.72%
Myanmaese	2	0.48%
Irish	2	0.48%
Dutch	1	0.24%
Indian	1	0.24%
Laotian	1	0.24%
New Zealander	1	0.24%
Portuguese	1	0.24%
Croatian	1	0.24%
Type of employment		
Subcontractor	216	51.92%
Direct employee	196	47.12%
Other	4	0.96%

Table 2. Additional information

Additional information	Number and per cent of Medevacs	
Type of evacuation		
Emergency disembarking	39	9.38%
Non-emergency disembarking	328	78.85%
Medical referral	49	11.78%
Reasons for disembarkation		
Treatment	279	67.07%
Isolation	122	29.33%
Investigation	10	2.40%
Repatriation	5	1.20%
Final diagnosis		
No final diagnosis	274	65.87%
Known final diagnosis	142	34.13%
Outcome of treatment		
Unknown or no follow up	338	81.25%
Recovery and ready to return to work	64	15.38%
Unfit to work offshore	12	2.88%
Death	2	0.48%
Work-related diseases		
Yes	44	10.58%
No	372	89.42%

such as acute myocardial infarction. Non-emergency disembarking was evacuation within 24–72 hours such as urolithiasis or dental caries. Medical referral was evacuation for ongoing treatment, or treatment could be done offshore but the patient cannot work or can work but not fully, such as sprain and strain of ankle. Only 38 (9.13%) of the evacuees were emergency disembarking, while most evacuees (79.08%) were non-emergency disembarking. Regarding reasons for disembarkation, 279 evacuees (67.07%) were evacuated for treatment. Most evacuees (65.87%) had no final diagnoses. About 89.42% of Medevacs were not work-related diseases. Regarding outcome of treatment, 81.25% of cases were unknown outcomes or no follow-up.

REASONS FOR MEDEVACS IN THE GULF OF THAILAND

Reasons for Medevacs in the Gulf of Thailand were grouped by ICD-10 version 2016 [4] and shown in Table 3. During the research period, the majority of the causes of Medevac (diagnosis before Medevac) were diseases of the respiratory system 95 (22.84%) cases, the majority of this group was influenza 84 cases, followed by group of Injury, poisoning and certain other consequences of external causes 64 (15.38%) cases, the majority of this group was injury and wound 31 cases, certain infectious and parasitic diseases 51 (12.26%) cases, the majority of this

Table 3. Reasons for Medevacs (Initial diagnosis ICD-10 group) by incident year

Initial diagnosis ICD-10 group	Incident year			
	1st	2nd	3rd	Total
Certain infectious and parasitic diseases	15	8	28	51
Endocrine, nutritional and metabolic diseases	0	0	1	1
Mental and behavioural disorders	0	1	2	3
Diseases of the nervous system	2	6	4	12
Diseases of the eye and adnexa	3	9	3	15
Diseases of the ear and mastoid process	1	3	2	6
Diseases of the circulatory system	3	4	3	10
Diseases of the respiratory system	12	55	28	95
Diseases of the digestive system	17	19	13	49
Diseases of the skin and subcutaneous tissue	2	9	11	22
Diseases of the musculoskeletal system and connective tissue	3	14	7	24
Diseases of the genitourinary system	4	10	10	24
Pregnancy, childbirth and the puerperium	1	1	0	2
Congenital malformations, deformations and chromosomal abnormalities	0	0	0	0
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	8	17	12	37
Injury, poisoning and certain other consequences of external causes	20	25	19	64
External causes of morbidity and mortality	0	0	1	1
Total	91	181	144	416

1st April 2016 – March 2017, 2nd April 2017 – March 2018, 3rd April 2018 – March 2019 group was chickenpox 23 cases, diseases of the digestive system 49 (11.78%) cases. The majority of diseases of the digestive system were dental caries (23 cases). Symptoms, signs and abnormal clinical and laboratory findings not elsewhere classified 37 (8.89%) cases, of which the majority was fever, unspecified 12 cases. By diagnoses after Medevac, we found that diseases of the digestive system increased by 2 cases, diseases of the respiratory system increased by 1 case, diseases of the circulatory system increased by 1 case, diseases of the genitourinary system increased by 1 case, injury, poisoning and certain other consequences of external causes increased by 1 case, congenital malformations, deformations, and chromosomal abnormalities increased by 1 case, diseases of the musculoskeletal system and connective tissue decreased by 1 case and increased by 1 case, symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified decreased by 5 cases, diseases of the nervous system decreased by 1 case, and diseases of the eye and adnexa decreased by 1 case. There were no diving injuries during this 36-months period.

Table 4. Reasons for Medevacs (illness or injury and preventable or unpreventable)

Reasons for Medevacs	Number	Per cent
Illness or injury		
Illness	350	84.1%
Injury	66	15.87%
Preventable or unpreventable		
Unpreventable	250	60.10%
Preventable	166	39.90%

Next, we classified reasons for Medevacs as injury or illness, and preventable or unpreventable or difficult to prevent, and showed in Table 4. We found that most of the reasons were illness in 350 (84.13%) cases. Then, we analysed it together with age group and found that in every age group, illness was more common than injury. The highest proportion of illnesses was found in over 59-year-old group (100%), followed by 50 to 59 years (86.36%), 30 to 39 years (85.2%), 40 to 49 years (82.64%), and less than 30 years (80%), respectively. Older workers were evacuated due to illness more than younger workers and younger workers were evacuated due to injury more than older workers, as noted in Figure 1. Regarding the preventability, the majority of the causes of Medevac were unpreventable/difficult to prevent (250 cases, 60.1%) and the minority were preventable (192 cases, 39.9%). Then, we analysed it together with the estimated cost of evacuation and found that the cost of those preventable were 17,160,000 THB, and the cost of those unpreventable/difficult to prevent were 19,755,000 THB.

COSTS FOR MEDEVACS IN THE GULF OF THAILAND

In this study, costs of Medevacs depended on the mode of evacuation, flight time, dedicated chopper and medical escort, and are shown in Table 5. The majority of the mode of movement was helicopter (361 cases, 86.78%) and boat (55 cases, 13.22%). Regarding flight time, 356 (85.58%) cases were day flight. About 79% of Medevacs were not dedicated chopper, and 89.42% were unescorted.

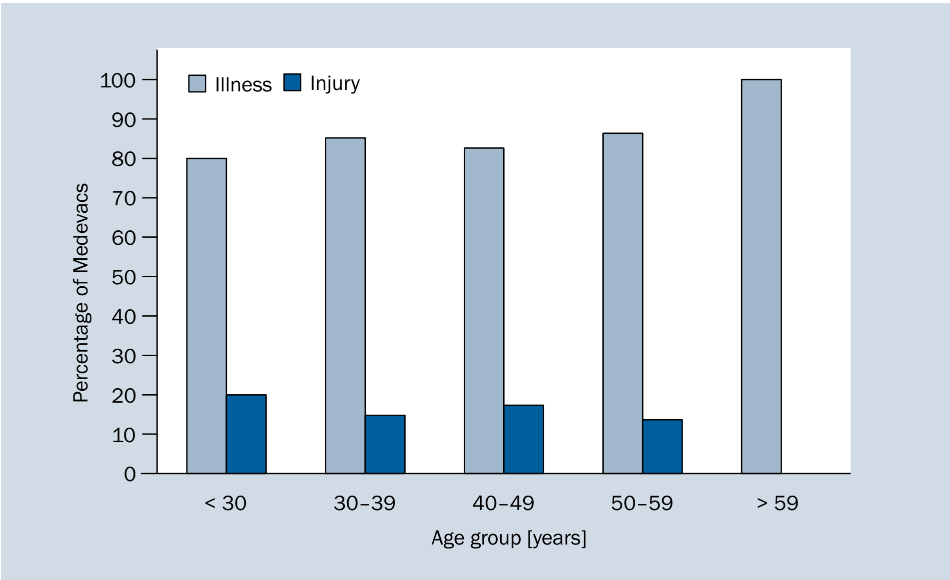

Figure 1. Medevacs by age group and type (illness or injury)

Table 5. Cost of Medevacs details

Cost of Medevacs details	Number and per cent of Medevacs	
Mode of movement		
Helicopter	361	86.78%
Boat	55	13.22%
Flight time		
Day flight	356	85.58%
Night flight	5	1.20%
Not applicable	55	13.22%
Dedicated chopper		
Yes	32	7.69%
No	329	79.09%
Not applicable	55	13.22%
Medical escort		
Unescorted	372	89.42%
1 nurse	32	7.69%
2 nurses	7	1.68%
1 doctor, 1 nurse	3	0.72%
1 doctor, 2 nurses	2	0.48%

Tables 6 and 7 show cost estimates for medical evacuation from the Gulf of Thailand, which were between 10,000 and 880,000 THB. 76.20% of all Medevacs costed 50,000 THB each. If evacuation by boat, the cost per seat is 10,000 THB. But if evacuated by helicopter, the cost will

Table 6. Cost estimates of Medevacs from the Gulf of Thailand details

Mode of movement	Flight time	
	Day flight (Thai Baht)	Night flight (Thai Baht)
Crew boat (one seat)	10,000	10,000
Helicopter (one seat) for passenger	50,000	NA
Helicopter (one seat) for escort nurse	50,000	NA
Helicopter (dedicated flight)	500,000	800,000
1 escort nurse and equipment	30,000	50,000
2 escort nurses with equipment	50,000	80,000
1 escort doctor and 1 escort nurse with equipment	65,000	85,000
1 escort doctor and 2 escort nurses with equipment	75,000	95,000

NA — not available

Table 7. Cost estimates for Medevacs from the Gulf of Thailand

Mode of movement		Total cost rate (Thai Baht)		Number of Medevacs by medical escort					Total
				Unescorted	1 nurse	2 nurses	1 doctor and 1 nurse	1 doctor and 2 nurses	
		Time of movement	Day time Night-time	0 0	30,000 50,000	50,000 80,000	65,000 85,000	75,000 95,000	
Boat		10,000		55	–	–	–	–	55
		50,000		317	–	–	–	–	317
Helicopter		130,000 (50,000+50,000+30,000)		–	12	–	–	–	12
Dedicated chopper		530,000 (500,000+30,000)		–	17	–	–	–	17
Dedicated chopper		550,000 (500,000+50,000)		–	–	5	–	–	5
Dedicated chopper		565,000 (500,000+65,000)		–	–	–	3	–	3
Dedicated chopper		575,000 (500,000+75,000)		–	–	–	–	2	2
Dedicated chopper	Night flight	850,000 (800,000+50,000)		–	3	–	–	–	3
Dedicated chopper	Night flight	880,000 (800,000+80,000)		–	–	2	–	–	2
Total				372	32	7	3	2	416

start at 50,000 THB per seat. Also, dedicated flight started at 500,000 THB for day flights and 800,000 THB for night flights. As for the medical escort team, if one nurse is needed in evacuation by a helicopter, it will normally cost an additional 50,000 THB for the nurse's seat. If it is a dedicated flight, there will be an additional cost for 1 nurse with equipment equal to 30,000 THB for day flights and 50,000 THB for night flights. The cost for 2 nurses with equipment is 50,000 THB for day flights and 80,000 THB for night flights. The cost for 1 doctor and 1 nurse with equipment is 65,000 THB for day flights and 85,000 THB for night flights. The cost for 1 doctor and 2 nurses with equipment is 75,000 THB for day flights and 95,000 THB for night flights.

EMERGENCY MEDEVACS IN THE GULF OF THAILAND

During the study period, 38 patients were emergency disembarking and 7 patients were high cost due to dedicated flight, a total of 45 cases. All evacuees were male, between the ages of 22 to 60 years, the mean age being 40.33 years. Most of them (37 patients, 82.22%) were Thai. Regarding type of employment, 22 (48.89%) evacuees were direct employee. Regarding injury or illness, 28 (62.22%) evacuees were illnesses. The top 4 causes of emergency Medevacs in the Gulf of Thailand were group of Injury, poisoning and certain other consequences of external causes (17 cases, 37.78%) with 7 cases of lower limb injuries (77.78% of injury groups). Nine (20.00%) cases were diseases of the digestive system. About 78% of diseases of the digestive system were acute appendicitis (7 cases, 15.56% of all Medevacs). Five cases were diseases of the circulatory system (11.11%). Four of the diseases of the circulatory system were acute coronary syndrome, accounting for 8.89% of all Medevacs. Four (8.89%) cases were diseases of the nervous system. Two cases were epilepsy and 2 cases were acute stroke, respectively, as shown in Table 8.

DISCUSSION

The purpose of this study was to explore the causes and costs of medical evacuation among offshore oil and gas industry worker in the Gulf of Thailand. We reviewed the previous medical record during April 2016 and March 2019 (36 months) which obtained from companies that consent to disclose information.

The majority (84.13%) of the causes of Medevac were illness, in line with previous studies in the North Sea from 1976 to 1984 with 2,162 Medevacs. They found that after the 1980s, the proportion of illness increased in contrast to the decrease of injuries [5]. Later, Health and Safety Executive conducted a study in the North Sea from 1987 to 1992, and found that there were 3,979 Medevacs, of which 55% were illnesses and 45% were injuries. Of note is that in the last year of the study, illness increased to 65% of all Medevacs. This was a result of increased safety management and the transition from exploration and construction to operation and maintenance [6]. Thibodaux et al. [7] reported that 77% of all Medevacs were due to medical reasons, and 23% due to occupational reasons [7]. Toner et al. [8] found that 80% of Medevacs were caused by illness and 20% by injury.

The top 8 causes of Medevacs in the Gulf of Thailand were influenza 20.19%, injury and wound 7.45%, chickenpox 5.53%, fracture, dislocation, sprain, and strain 4.09%, urolithiasis 3.85%, dental caries 3.13%, acute appendicitis 2.88%, and low back pain 2.88%, respectively. While previous studies on Medevacs in the offshore oil and gas industry revealed that the most common causes of Medevacs were gastrointestinal diseases, especially dental problems and abdominal pain, cardiovascular disease, especially myocardial infarction, diseases of the nervous system including seizures, diseases of the musculoskeletal system and injuries, respectively [3, 5, 7–10].

Regarding age of evacuees, we found that older workers were evacuated due to illness more than younger workers and younger workers were evacuated due to injury more than the older workers. This is consistent with most studies in foreign countries, such as the Norman et al. [5] study found that the age increase in the proportion of causes due to injury decreased but the illness increased. In December 2012, United Kingdom report on oil stations injuries in the North Sea indicated that 60.9% of these injuries are in those aged 25 to 49 years and those between the age of 30 and 34 years have the highest incidence rate at 15.8% [11]. Greuters et al. [10] studied the medical records of 115 patients who were repatriated by plane between 1998 and 2002. Those patients were divided into two groups: younger than 50 years (n = 38) and 50 years and older (n = 77). In the younger group, 32% were repatriated due to traumatic fractures. While 52% of the older group were repatriated due to cardiopulmonary disease [10]. Thibodaux et al. [7] found that younger workers were Medevacs due to occupational injuries more than older workers and medical conditions were the main cause of Medevacs among older workers [7].

In terms of work-relatedness, our study found that 89% of Medevacs were not work-related. This is in consistent with Thibodaux et al. [7] that 77% of all Medevacs were caused by non-occupational medical injury or illness.

There were 2 death cases in this 3-year study period, one cardiac arrest and one intracerebral haemorrhage.

We define "preventable" as prevention of Medevacs and/or reduction of emergency Medevacs are possible. This can be achieved by:

— Vaccination for vaccine-preventable diseases;

Table 8. Reasons and costs of emergency Medevacs from the Gulf of Thailand

Mode of movement	Total cost rate (THB)	Reasons for Medevacs	Age [years]	Nationality	Type of employment	Incident month	Incident year
ED	880,000	NSTEMI	42	Thai	Direct employee	January	2018
ED	880,000	Unspecified injury of thorax	32	Thai	Direct employee	July	2016
ED	850,000	ACS	53	Indonesian	Direct employee	September	2016
ED	850,000	Unspecified acute appendicitis.	38	Indonesian	Subcontractor	October	2017
ED	575,000	NSTEMI	42	Thai	Subcontractor	August	2018
ED	575,000	Dislocation of right shoulder joint	40	Thai	Subcontractor	December	2018
ED	565,000	Cerebellar stroke syndrome	33	Thai	Subcontractor	May	2018
ED	565,000	ACS	41	Thai	Subcontractor	December	2018
ED	565,000	Local infection of the skin and subcutaneous tissue, unspecified	46	Thai	Direct employee	December	2018
ED	560,000	Unspecified injury to unspecified level of lumbar spinal cord	27	Thai	Others	April	2017
ED	560,000	Epilepsy	41	Thai	Direct employee	May	2016
ED	550,000	Unspecified injury of head	42	Thai	Subcontractor	October	2017
ED	530,000	Unspecified fracture of right foot, initial encounter for closed fracture	46	Thai	Direct employee	January	2019
ED	530,000	Cerebellar stroke syndrome	50	Thai	Direct employee	February	2019
ED	530,000	Unspecified acute appendicitis	31	Thai	Direct employee	March	2017
ED	530,000	Other intestinal obstruction unspecified as to partial versus complete obstruction	42	Canadian	Direct employee	March	2018
ED	530,000	Traumatic pneumothorax	22	Myanmaese	Others	May	2018
ED	530,000	Low back pain	40	Thai	Direct employee	June	2017
ED	530,000	Chest pain, unspecified	47	Thai	Subcontractor	June	2018
ED	530,000	Pain localised to other parts of lower abdomen	59	Malaysian	Subcontractor	June	2018
ED	530,000	Unspecified acute appendicitis	38	Thai	Subcontractor	July	2017
ED	530,000	Pneumonia, unspecified organism	47	Thai	Direct employee	July	2017
ED	530,000	Gastritis, unspecified, with bleeding	40	Thai	Direct employee	September	2018
ED	530,000	Traumatic pneumothorax	42	Laotian	Others	September	2018
ED	530,000	Unspecified acute appendicitis	32	Thai	Subcontractor	November	2017
ED	130,000	Atrioventricular block, second degree	42	Thai	Direct employee	March	2017
ED	130,000	Unspecified acute appendicitis	54	Australian	Direct employee	March	2017
ED	130,000	Epilepsy	41	Thai	Subcontractor	April	2018
ED	130,000	Schizophrenia, unspecified	39	Thai	Direct employee	April	2018
ED	130,000	Fracture of lower end of femur	31	Thai	Direct employee	June	2017
ED	130,000	Unspecified acute appendicitis	29	Thai	Direct employee	November	2016
ED	50,000	Other peripheral vertigo, unspecified ear	60	Thai	Subcontractor	February	2017
ED	50,000	Burn of cornea and conjunctival sac, left eye, sequela	37	Thai	Direct employee	March	2017

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Table 8 cont. Reasons and costs of emergency Medevacs from the Gulf of Thailand

Mode of movement	Total cost rate (THB)	Reasons for Medevacs	Age [years]	Nationality	Type of employment	Incident month	Incident year
ED	50,000	Displaced fracture of distal phalanx of right middle finger, initial encounter for open fracture	41	Thai	Direct employee	May	2016
ED	50,000	Unspecified acute appendicitis	34	Thai	Subcontractor	June	2018
ED	50,000	Crushing injury of right ring finger	27	Malaysian	Subcontractor	August	2017
ED	50,000	Crushing injury of right foot, initial encounter	35	Thai	Direct employee	September	2016
ED	10,000	Unspecified asthma with (acute) exacerbation	56	Thai	Subcontractor	December	2016
NED	850,000	Unspecified fracture of right lower leg, initial encounter for closed fracture	45	Thai	Subcontractor	March	2017
NED	560,000	Unspecified fracture of right lower leg, initial encounter for closed fracture	29	Thai	Direct employee	September	2016
NED	560,000	Anxiety disorder, unspecified	24	Thai	Subcontractor	September	2017
NED	530,000	Unspecified injury of left foot, initial encounter	47	Thai	Subcontractor	May	2017
NED	530,000	Cellulitis of right lower limb	58	Thai	Subcontractor	June	2018
NED	530,000	Displaced fracture of lateral malleolus of left fibula, initial encounter for closed fracture	42	Thai	Direct employee	November	2017
Medical referral	530,000	Strain of muscle, fascia and tendon of lower back, subsequent encounter	31	Thai	Subcontractor	April	2017

ACS — acute coronary syndrome; ED — emergency disembarking, NED — non-emergency disembarking; NSTEMI — non-ST segment elevation myocardial infarction

— Screening to prevent people at risk of complications of underlying diseases from going to work offshore; or keeping their underlying diseases in good control while they are offshore. Examples of this approach are appropriate dental examination and treatment, appropriate fitness for work examination (such as non-communicable diseases) before allowing the workers go offshore, more than adequate individual medication (in case of longer offshore stay/work), etc.;

— Increasing the treatment capability of offshore facility, such as more sophisticated medical equipment and medications, more competent medical personnel, and more consultation via telemedicine. This approach may reduce Medevacs or postpone the time to evacuate from emergency to normal. However, this may be costly and not cost-effective.

We also define “unpreventable” as non-vaccine-preventable diseases, and those with no effective screening, such as fracture or severe injury.

And we define “difficult to prevent” as prevention of Medevacs is possible but costly, such as acute appendicitis or severe injury which are beyond usual offshore treatment capability. Establishing an offshore surgery is possible but will cost more than referring patients to a more-equipped onshore facility.

When dividing the preventable causes into three groups mentioned above, we found that 126 patients were in group 1: influenza, chickenpox, zoster, and mumps. Group 2 included 58 patients: acute coronary syndrome, urolithiasis, acute stroke, dental problems, hypertension, type 2 diabetes mellitus, gout, hernia, psychiatric disorders, asthma with acute exacerbation and gallstone. Group 3 included 66 patients: pain in extremities (any part), myalgia, skin infection, low back pain, acute conjunctivitis, acute gastroenteritis, acute upper respiratory infection, dermatitis, allergic reaction, dengue fever, chikungunya virus disease, dizziness, urticaria, urinary tract infection, impacted cerumen, folliculitis, functional dyspepsia, gastritis, and gastro-oesophageal reflux disease.

Over the 3-year study period, the preventable cause was established in 192 (39.9%) cases and costs of Medevacs for these preventable causes were 17,160,000 THB. About 50% of the preventable causes were in group 1, which can be prevented by vaccination, including influenza. Eighty-four cases of influenza were 41 direct employees and 43 subcontractors. The company may vaccinate direct employees, but the subcontractors may not be vaccinated, causing the spread of the disease. The costs of influenza-caused Medevacs were 3,450,000 THB. If each influenza vaccination cost 500 THB, we will be able to vaccinate up to 6,900 people with this amount of money.

In Thailand, companies have medical screening for health based on the United Kingdom Oil and Gas Industry Association Limited, trading as OGUK, standard and company standard which aligned with International Association of Oil and Gas Producers. There is not a code of practice; evacuation guideline is developed by each company. They have tried to develop a national guideline but no agreement among companies since they are also competitors.

They have employee wellness programmes. Non-occupational health risk is identified individually. Those with high risk and/or high consequence are focused and monitored continuously. Those with identified risk will be enrolled to appropriate health program accordingly, such as smoke cessation, exercise, weight reduction, diet control/restriction, lifestyle modification, etc.

Pre-placement examination and periodic examination, including health promotion and disease prevention programmes can reduce the severity of the disease and prevent the emergency Medevacs. Non-communicable diseases, such as diabetes mellitus, hypertension, cardiovascular and cerebrovascular diseases, caused high cost of Medevacs. For instance, there were only 4 patients evacuated with acute coronary syndrome, but the costs of Medevacs were up to 2,870,000 THB. Only 2 acute stroke patients costed up to 1,095,000 THB. Hypertension and diabetes mellitus costed 380,000 THB. Dental problems costed 720,000 THB. With appropriate dental examination and treatment, this cost could be reduced or avoided.

In group 3, pain in extremities (any part), myalgia, and low back pain costed up to 1,380,000 THB. Skin infection costed 725,000 THB. Acute conjunctivitis costed 450,000 THB. Functional dyspepsia, gastritis, and gastro-oesophageal reflux disease costed 360,000 THB. If these diseases can be treated offshore, the cost of Medevacs could be avoided.

LIMITATIONS OF THIS STUDY

This study is a retrospective descriptive study; therefore, only recorded data can be retrieved. We could not get some useful information such as patients' underlying diseases and job type data, so we did not have them. It is the limitation of this kind of secondary data. Moreover, some of the information received is incomplete, such as the final diagnosis. We did not know the majority of the final diagnoses because the company did not follow up nor record.

We obtained secondary data only from companies that have agreed to disclose information. Some companies do not consent to disclose this information, causing us not to obtain data from every company in the oil and gas industry in the Gulf of Thailand.

CONCLUSIONS

Medical evacuations among oil and gas industry workers in the Gulf of Thailand are very costly. The major causes of medical evacuations are illnesses. Reducing the cost of Medevac can be done by: 1) giving vaccines to prevent vaccine-preventable diseases, 2) screening to prevent people at risk of getting complications from pre-existing diseases to work offshore, and 3) increasing treatment capability of offshore facilities. Offshore oil and gas industry may consider cost-benefit of these approaches compared to status quo.

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Supplying ships with safe drinking-water

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ABSTRACT

Background: *Ships are supplied with water from various sources: directly from the public utility system at the port, from water supply vessels or barges, bottled water, ice or, if water production on board is possible, through processes such as desalination and reverse osmosis. All elements of a ship's water supply chain are exposed to the influence of different factors that may have a negative impact on water safety on board or on human health. Potable water standards are the same for vessels and for land-based facilities. In recognition of the importance of drinking water and the impact it can have on human health, stringent quality standards have been laid down in national and global regulations. The aim of the study was to describe the water supply system on ships and its weak points, as well as the health risks that the use of polluted drinking water can entail.*

Materials and methods: *The Medline Database has been searched using the following key words: ship, water supply, waterborne infections. Other available literature has also been used, as well as national and international regulations on drinking-water safety.*

Results and Conclusions: *Drinking water on ships is managed in line with the hygienic and health standards applied along the entire supply chain, from the source to the point of consumption. Regardless of the sanitary control system used by the authorised institutions on the ground, ship officers must oversee the entire water supply and distribution system on board, as well the water production systems if these exist. That means that they must be well aware of all of the fundamental facts of the supervision system, as well as the weaknesses of the water supply system. Maritime studies students, future deck officers and engine officers, must all receive training on the weak points of the system and on water contamination prevention.*

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Key words: potable water, ship water supply, waterborne infections, safe drinking-water

INTRODUCTION

All human beings need water; it is a prerequisite for their survival and for the normal functioning of their organisms. The Drinking Water Directive of the European Union points to the fact that the ecosystem, the society and the economy all need sufficient quantities of fresh water to grow and develop. Drinking water is the only staple that is used by all people on Earth, regardless of their religion, race, socioeconomic status or location [1–3].

On ships, the functioning of the water supply system is the responsibility of the engine officer, while the second mate or the captain are responsible for monitoring the quantity of water in the tanks and water safety. On the ground, health-care departments are tasked with analysing water samples and assessing water safety. The World Health Organization (WHO) warns of water-related problems, especially in developing countries. A variety of infections intestinal diseases are transmitted through the use of unsafe drinking water [2]. To suppress outbreaks of such diseases, improved sanitary conditions, safe drinking water and proper sanitary infrastructure must be put in place. On the other hand, poor water management can lead to the transmission of infectious diseases or to chemical poisoning. Research has shown that more than 100 outbreaks are ship-related, one fifth of which was attributed to water [4–7]. The number of infections on board passenger ships is rising and poses a significant public health problem considering the number of people who could be infected

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as well as the financial costs this would entail for the companies [5]. Most waterborne epidemics on board ships involve drinking water contaminated with pathogens from human or animal excretions. Diseases related to chemical water pollution are also on the rise [4–6, 8]. Outbreaks transmitted via contaminated water are most often linked to poor quality of water at the time of loading onto the ship. In order to prevent water-related diseases, vessels must be supplied with water that is safe for consumption in line with the 2017 WHO Guidelines for Drinking-Water Quality or relevant national standards, depending on whose criteria is more stringent. Even if water in the port is safe, due to the risk points at which it can become contaminated, there is no guarantee that it will remain safe during transfer and storage on board. In case of drinking-water production from seawater, on ships, the process must be monitored and the resulting water disinfected if necessary [2–9].

The objective of this paper was to describe the drinking-water supply system for vessels and its weak points, as well as the health risks posed by using contaminated drinking-water.

MATERIALS AND METHODS

In this paper, we used data from available literature. The Medline Database was searched for key words: ship, water supply, waterborne infections. Other available literature was also used, as well as national and international regulations on drinking-water safety.

DRINKING-WATER SUPPLY SYSTEM ON SHIPS

The drinking-water supply and transport system for ships consists of: the source of drinking water coming to the port, the transfer and delivery system and the ship's water system. The transfer and delivery system involves hydrants, water pipes, hoses, water supply and reception vessels, and provides ample opportunities for drinking-water contamination. A ship's water system includes water storage, distribution and production on board [9]. In each of these elements of the supply and distribution chain, water can be contaminated and will thus become unsafe.

Ports get drinking water for ships from public or private supply systems and are usually equipped with special systems to manage the water once it enters the port. After going through the port water system, water is transferred to ships via water tanker vessels and barges. The water that comes to the ship from the port water system, including the water from water tankers and barges, can only come from water sources and storage facilities that have safe drinking water of a quality that is in line with WHO standards or national regulations. The water supplied in ports must be adequate for distribution and consumption without any further processing, unless water quality needs to be maintained in the distribution system (e.g. additional disinfection or addition of anti-corrosion chemicals) [6–9]. In addition to the physical and chemical characteristics, special attention should be paid to the microbiological quality of water. European Union Member States have been aligning their water safety parameters with the European Union Drinking Water Directive, ensuring that water for human consumption is wholesome and clean [6, 7]. The equipment used for water transfer and distribution, be it new or repaired, must be disinfected prior to being put into use. In case water used for supplying ships with drinking-water is contaminated at the port, the port must take the necessary corrective measures and inform the person responsible for water storage, in order to prevent contaminated water from being transported onto the ship. Preventive measures aimed at preserving water safety and quality include making sure that the pressure in the pipelines is positive at all times so that the flow of water is not reversed. In addition to that, there must be no link between the drinking water system and other pipelines. All components, meters and other gear must be handled in a sanitarily acceptable manner [6–11].

Water tanker ships are specially designed and equipped to receive and supply water whenever direct delivery from the shore is not possible. These ships have water tanks, water pipes and an independent supply pipeline taking drinking water into the ship's systems. In order to avoid the contamination of water in the ship's water system, the reception, handling, storage and delivery of water must all be done in controlled, sanitary conditions. All pipes, fittings and tools must be kept in closed and clean compartments. Operators must be well trained on proper, hygienic and sanitary handling of water. All pipes and connections must be cleaned and disinfected on a regular basis. Water tankers must have the approval of the competent port health-care body or other competent health-care authority, confirming that they dispose of the necessary equipment for supplying vessels with water in line with the sanitary rules and regulations [7, 9, 11, 12].

In addition to being transported to vessels in liquefied form, water can also be shipped in bottles or as ice. The ice used to supply ships from ashore or that has been produced on board and is used for drinks and cooling is classified as food, and regulations on the safety of ice used on ships are applicable for both packaged water and ice for human consumption. According to WHO Guidelines, ice coming into contact with food or drinks must be produced from safe potable water. Sources ashore must be checked by local health care institutions, and ice delivery from shore to ship must be done in a sanitarily acceptable manner. The person in charge of transporting ice must wear clean clothes, gloves and boots. Ice should be kept in a clean storage facility, lifted from the surface by means of deck boards or other devices allowing drainage and free flow of air. All ice produced on ships must be treated and stored in a sanitarily acceptable manner. Water on board ships is stored in tanks. Many ships use the desalination process to produce their own drinking water [11, 12].

DRINKING-WATER SYSTEM ON SHIPS

Whenever possible, it is useful to set up only one system to supply potable water for drinking, cooking, dishwashing, laundering and personal hygiene purposes, although sometimes two or three water systems are put in place, e.g. the potable (drinking), the sanitary and the wash water system. A wash water system can be used to supply water to the sink, the laundry room, for cleaning, for heated dishwashing water and other special purposes. All taps that do not have potable water need to be properly labelled, e.g. “unfit for drinking” [13]. Pipelines on board ships consist of a number of tubes used for the distribution of freshwater, seawater, sewage and fuel, located in a confined space. These are usually rather comprehensive and complex, making their inspection, repair and maintenance difficult. When laying new pipes or repairing existing ones, precautionary hygienic measures must be taken, for which the crew must be adequately trained. When designing pipelines, it is very important to minimise the points where water could collect and become warm (> 25°C). For example, temperature-control valves that prevent overheating should be installed as close to the point of use as possible in order to reduce the formation of warm water pockets. The number of distribution system dead ends should also be minimised [7]. If hot-water and cold-water piping are laid side by side, they must be thermally insulated to prevent the pipes from heating up or cooling and to prevent bacterial growth. All piping components must be resistant to water temperatures over 90ºC for thermal disinfection purposes [7].

DRINKING-WATER TANKS

Drinking-water tanks must not have drainage lines or any pipes carrying wash water, salt water or other liquids going through them. If that is not possible, then pipes going through potable water tanks must be placed in a watertight tunnel that is self-draining. Waste waters sewages, wash-water tank manholes or anything of the like that could contaminate potable water should not go over the potable water tanks. It is also best if toilets and bathroom spaces do not extend over any part of a deck that forms the top of a potable water tank [13, 14]. All appliances for measuring potable water tank levels should be performed so as to prevent the entry of contaminated matters or liquids into the potable water tank. A graduated steel tape with a weight (probing tape) is used for measuring water tank levels. The measurements are performed in the probing tube (probe) which extends from the bottom of the tank to the deck. WHO recommends performing regular inspections of empty tanks, e.g. once a year. In cases when people enter tanks, they should wear clean protective clothing, a disposable face mask, disposable rubber gloves and light-coloured rubber boots, very clean, and used only in potable water tanks. Boots and all tools used in the tank must be disinfected prior to entering the tank. Persons with acute illnesses (e.g. diarrhoea) are banned from entering the potable water tank [7].

DRINKING-WATER PRODUCTION ON SHIPS

Ships can produce their own water using various processes, such as reverse osmosis or sea water evaporation. On large passenger ships, freshwater generators can produce up to 500 tonnes of water per day, while cargo ships can produce around 30 tonnes per day. The daily demand for water on passenger ships is around 200 litres of water per passenger and around 60 litres per crew member on cargo ships [12]. According to International Organization for Standardisation (ISO) standards, water that has been produced from sea water at temperatures below 80°C must be disinfected before it can be defined as potable [6]. Sea water sources can contain hazards that are not present in freshwater systems and these include various algae and cyanobacteria, certain free-living bacteria (including *Vibrio* species such as *V. parahaemolyticus* and *V. cholerae*) and some chemicals, such as boron and bromide, which are abundant in seawater. Due to contamination risks, sea water cannot be used for desalination if taken from up to 12 nautical miles from the shore [12]. In Croatia, the quality and safety of water samples is tested by county health-care institutes and in other countries by the competent health-care institutions.

LEGAL PROVISIONS CONCERNING DRINKING-WATER SAFETY

The first directive on the quality of drinking water was adopted at the level of the European Union in 1975 (Council Directive 75/440/EEC of 16 June 1975, followed by the first common drinking water directive adopted in 1980 and amended in 1998). It aimed at protecting public health from the hazardous effects of all forms of pollution. In 2018 amendments to the Directive on the quality of water intended for human consumption were proposed with the aim of improving consumer information as well as the quality of and access to drinking water. The standards for drinking-water quality are the same for land-based and floating structures. The Directive on the quality of water intended for human consumption established European Union’s drinking-water quality standards that are binding for all Member States and entail monitoring and control obligations. Parameters have been divided into three groups:

- microbiological parameters: related to the presence of *Escherichia coli* and enterococci;
- chemical parameters: the share of particular substances such as metals and organic compounds as well as generic substances such as pesticides and by-products of disinfection;
- indicator parameters enabling insight into the purification process and the organoleptic and aesthetic quality of drinking water which includes microbiological, chemical and radiological parameters.

Water intended for human consumption is all water, either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes, regardless of its origin and whether it is supplied from a public distribution network, from a tanker, or in bottles or containers. It is also all water used in undertakings for the manufacture, processing, preservation or marketing of products or substances intended for human consumption [2, 6, 7, 9, 15]. Pursuant to the Directive and the Act on Water for Human Consumption, water intended for human consumption shall be considered safe, or wholesome and clean, if it:

- is free from any micro-organisms and parasites and from any substances which, in numbers or concentrations, constitute a potential danger to human health;
- is free from harmful substances in such concentrations that they alone or in combination with other substances pose a threat to human health;
- does not exceed the values of water wholesomeness and cleanliness parameters prescribed in the ordinances in line with the legal provisions [1, 15].

The main problem on ships is the microbial risk and the risk related to toxic chemicals. In the Guidelines on Drinking-Water Quality, a wide spectrum of contaminants has been identified, including microorganisms, inorganic and synthetic organic chemicals, disinfection by-products and radionuclides, which can reach dangerous concentrations in drinking water supply chains. Safe drinking-water, as defined by the Guidelines, does not pose a significant health risk during a life-time of consumption, including various sensitivities that may occur between life stages [9, 10]. Convention C133 of the International Labour Organisation (ILO) — Accommodation of Crews defines the minimum standards for drinking water supply. All ships must provide sufficient quantities of water for drinking, food preparation, cooking, dishwashing, etc. (drinking-water) and water for sanitary purposes, e.g. washing up, bathing and showering (fresh water), taking into consideration the area of navigation, duration of the voyage and number of persons on board. The quality of water must meet all recognised sanitary norms for drinking-water and fresh water [14]. The Maritime Labour Convention (2006) contains minimum international standards on working conditions for seafarers on ships [16], which embodies more than 65 up-to-date standards of existing international maritime labour adopted over the past 80 years. Regulation 3.2 of the Maritime Labour Convention ensures that seafarers have access to good quality drinking water. Every Member to the Convention shall ensure that ships that fly its flag carry on board and serve drinking water of appropriate quality provided under regulated hygienic conditions [16, 17]. The Life-Saving Appliance Code (LSA) (International Maritime Organisation [IMO], 2010) contains additional information on the need for drinking-water in rescue boats [18]. In addition to the abovementioned, there are seven international standards that are issued by the ISO concerning the design and construction of ship water supply systems and the assessment of drinking-water quality. International Health Regulations (IHR, 2005) contain provisions obliging WHO States Parties to develop basic port infrastructure, including drinking-water supply [19]. In line with Articles 22(b), 22(e) and 24(c) of the IHR, States Parties shall take all measures to ensure that international transporters (conveyance operators) keep their conveyances away from the sources of contamination and infection, while the competent authorities shall be responsible for keeping facilities in international ports in a sanitarily acceptable condition and for the supervision of the removal and safe disposal of any contaminated water or food from a conveyance. All conveyance operators are responsible for setting up measures to control and eliminate the sources of infection or contamination, including the water supply system [9, 12, 13, 20, 21].

POSSIBLE CONSEQUENCES OF UNSAFE WATER ON HUMAN HEALTH

Unsafe water on ships is a potential source of viral, bacterial and parasite infections, as well as chemicals poisoning, and is mostly associated with swallowing water contaminated by human or animal dejecta. The evidence from the literature suggests that water availability has an important influence on health and diarrhoea incidence in particular [22, 23]. On cruise ships, gastroenteritis affects one to six passengers in 1,000 cruise trips [24]. In recent years, passenger ships have increased in number and size, which is a risk factor for diseases transmitted via food, water or contact. Research into Enterotoxigenic *E.coli* (ETEC)-caused gastroenteritis outbreaks has shown a link to the consumption of ice-cooled drinks on board ships and of tap water. However, a connection has also been established between contaminated water and food and the transmission of ETEC infections ashore. On cruise ships, Norovirus infections pose a major problem [4, 6–10, 19–21, 24–27]. Roney and associates described waterborne epidemics on ships between 1970 and 2003 based on data published in articles quoted in MEDLINE, Em base and Cab Health [4]. According to that research, more than 6,400 people were affected in the 21 reported outbreaks of waterborne diseases associated with ships between January 1, 1970 and June 30, 2003. Causes of outbreaks are linked to contaminated port water, inadequate treatment, improper loading techniques, cross connections between potable and non-potable water, poorly designed and installed drinking-water tanks and inadequate disinfection [4]. Enterotoxigenic *E. coli* was a proven pathogen in seven outbreaks (33.3%), noroviruses in three (14.3%), and *Salmonella typhi, Salmonella enteritidis*, *Shigella flexneri*, *Cryptosporidium spp* in one outbreak each (4.8%). One outbreak was due to a chemical (hydroquinone), and in five outbreaks no pathogen was determined [4, 6, 13, 20, 28]. In addition to gastrointestinal infections, respiratory tract infections can also be transmitted via water (aerosol). Poorly kept air-conditioning systems or unwanted/inadequate water heating can contribute to the reproduction of numerous pathogens including *Legionella spp.* Breathing-in contaminated aerosols can lead to an outbreak in legionellosis, a severe and sometimes life-threatening illness. Most susceptible are elderly persons with multimorbidity and immunocompromised persons [7, 27–29]. Inadequate water temperature, poorly designed or installed drinking-water systems, inadequate disinfection after overhaul, scaling and corrosion in the system all positively impact the growth of *Legionella spp.* bacteria in a ship's drinking-water system [7, 29]. WHO states that almost 200 cases of Legionnaires disease between 1970 and 2000 were associated with ships. Most incidents involved one or two individuals on passenger ships. There is very little information available on the prevalence of Legionnaires disease on merchant ships. Serological tests of seafarers suggest that one third of them have *Legionella pneumophila* antibodies. Drinking-water and air-conditioning systems on general cargo ships of are contaminated with *Legionella pneumophila* bacteria. Potential sources of legionellas on ships are humidifiers, parts of the piping where water stagnates or collects, air-conditioning systems, rooms on ships with higher room temperatures and the ship's water storage and distribution system [2, 27–29].

All employees working on the drinking-water system must be properly trained. The port authority is responsible for ensuring that safe, wholesome and clean, drinking water is loaded into the ship. If in doubt regarding the origin of water and concerns that it might come from an unsafe water source, the ship captain shall decide on additional water treatment to be applied (hyperchlorination or filtration). Great caution is required when dealing with sources from countries with inadequate hygienic-epidemiological standards. In the event of water treatment, the treatment to be applied must be the one that is most pertinent to the needs and that is most manageable for the ship's crew and officers [2, 6, 9, 12].

CONCLUSIONS

The system and organisation of water supply to and on the ship differs largely from the water supply system on the land; however, the same safety standards apply for drinking water on land and on board ships. The complicated water supply system on ships contains many risk points involving possible exposure to contamination. Pursuant to all international regulations, passengers and crew members have the right to sufficient quantities of drinking-water, and it is the ship operator's duty to provide it. Crews of merchant and passenger marines and tourists travelling on cruise ships are all exposed to the risk of waterborne infections. There are many points of risk and ways of drinking-water contamination on ships, but contamination can also arise from the port water source or during water loading, storage or distribution on ships. Outbreaks of waterborne diseases on ships can be prevented or at least their incidence reduced. Factors contributing to the occurrence and spread of outbreaks highlight that ships need to be managed in line with the hygienic and health-care standards along the entire water supply chain, from the source to the point of consumption. Engine and deck officers must all be trained on supervision procedures and on how to maintain high hygienic standards, as well as on the risk points during drinking-water supply on board ships.

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REVIEW ARTICLE

Post-travel screening of symptomatic and asymptomatic travelers

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ABSTRACT

Until last year, terrorism, economic instability, poverty and natural disasters were considered the major threats to humans globally. Infectious diseases were seen as a minor problem. This, however, changed in 2020 when the global COVID-19 pandemic broke out and a new danger emerged. The latest events generated a lot of discussion on health hazards associated with international tourism and uncontrolled spread of pathogens across the borders. The major health problems of travelers to developing countries with harsh environmental conditions and endemic infectious diseases include gastrointestinal disorders, dermatoses, respiratory infections and fevers of unknown origin. A medical interview by an experienced physician is the foundation of the post-travel screening process both in symptomatic and asymptomatic travelers; the interview should focus on identifying exposure to risk factors (endemic infectious diseases, failure to adopt disease prevention measures, consumption of food or water from unsafe sources, insect bites, animal bites, travelling in large groups, unsafe sex with casual partners). While physical examination (identification of abnormalities) and diagnostic tests (identification of pathogens) can be useful for detecting illnesses and asymptomatic infections as well as assessing the general health condition of a patient, including his immune system. The aim of the article is to provide information on the post-travel screening process in symptomatic and asymptomatic travelers who have returned from areas with harsh climate conditions and low sanitation standards.

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Key words: travelers, risk factors, diseases, diagnostics

INTRODUCTION

According to the World Tourism Organization (UNWTO), there were 1.5 billion international tourist arrivals worldwide in 2019. The gradually increasing number of international tourist arrivals seen in recent years (+6% in 2017, +6% in 2018, +4% in 2019) was predicted to reach a spectacular level of 1.8 billion in 2030. All regions saw a rise in tourism in 2019 compared to the previous year (Asia and the Pacific +5%, Europe and Africa both +4%, the Americas +2%). According to the estimates, a growth of 3–4% was predicted for 2020 [1]. However, the COVID-19 pandemic has brought the tourist industry to a halt, and the earlier forecasts had to be revised. Most experts believe that the domestic demand for travelling and travel services is likely to rise faster than international tourism; whereas the international demand is predicted to grow faster in Africa and the Middle East, where the number of active SARS-CoV-2 cases and COVID-19 deaths is much smaller compared to the European countries or North America [1]. The restrictions imposed on international air transport, travel agencies, hotels and restaurants will certainly have a significant impact on the economies of many countries, especially those in which tourism accounts for a significant proportion of Gross Domestic Product. According to the UNWTO estimates, the number of international tourist arrivals may drop by 60–80% in 2020 (compared to 2019; a loss of 850 million to 1.1 billion) [2]. The most visited countries by tourists in the world have reported both a very

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Table 1. The most visited countries by tourists versus number of detected SARS-CoV-2 infections and COVID-19 deaths, 29 May 2020

Country	Tourist arrivals in millions in 2018 [3]	SARS-CoV-2 infections [4]	COVID-19 deaths [4]
France	89	186,835	28,714
Spain	83	285,644	27,121
USA	80	1,793,530	104,542
China	63	82,995*	4,634*
Italy	62	232,248	33,229

*According to Chinese sources; USA — United States of America

large number of SARS-CoV-2 cases and COVID-19 deaths (Table 1) [3, 4].

The countries whose economies almost entirely rely on tourism, e.g. the Caribbean or the Pacific Islands, are likely to be affected by a serious economic crisis. But the global downturn may also affect the European Union countries, where the tourism industry offers employment to 12% of the economically active people and generates an income of 400 billion euro per year. Some countries, e.g. Greece or Croatia have been considering the introduction of the so-called 'tourist corridors' linking the popular resorts with countries least affected by the pandemic or those where the SARS-CoV-2 epidemic has been successfully contained, without a mandatory 14-day quarantine upon arrival. It is also planned to introduce COVID safety certificates for the re-opening hotels, restaurants and other tourist facilities to ensure that re-opening those businesses will not increase the risk of spreading COVID-19. Some countries are also discussing the introduction of 'immunity passports', a digital or paper document that will certify that an individual has been infected with SARS-CoV-2 and is immune to COVID-19 [5]. Turkey is planning to re-open its borders only for foreign tourists with a negative SARS-CoV-2 test result; visitors will be required to present the test result upon arrival. The Canary Islands in collaboration with the Department of Innovation and Digital Transformation (UNWTO) are working on a new project aimed at the introduction of digital health passports (a mobile phone application developed by Hi+ Card) for all tourists visiting the islands this summer. The application will contain the visitors' medical data certifying they are free of COVID-19 and will allow the authorities real-time tracking of travelers (for which the travelers grant their consent when installing the application). All these measures are meant to rebuild the tourism industry, which is a major branch of the global economy, as fast as possible.

Until 2019, it seemed that the major travel-associated threats to humans were terrorism (the Middle East, North Africa), socio-economic instability (Venezuela) and natural disasters (earthquakes and floods). Infectious diseases were further down the list, next to petty crimes or traffic accidents. In 2018, the World Health Organization (WHO) published a list of priority diseases which are a top threat to public health globally because of their pandemic potential, the first on the list were viral hemorrhagic fevers (Ebola, Marburg, Lassa, Crimean-Congo), coronavirus infections (MERS, SARS) and Disease X (a placeholder name for currently unknown disease, possibly a viral zoonosis) [6]. In January 2020, Disease X turned out to be COVID-19, an infection which originated in the Chinese province of Hubei and its capital, Wuhan and caused a global pandemic. Two years ago, the WHO stressed how important it is to improve the quality of healthcare systems around the world to be able to control the possible future outbreak and prevent the spread of diseases. Will the ongoing COVID-19 pandemic raise public awareness of the importance of post-travel health assessment, especially in those travelers who are returning from countries where infectious diseases are endemic? Now seems to be the right time to initiate discussion on travel-related health risk factors and uncontrolled spread of pathogens across the borders. The aim of the article is to provide information on the post-travel screening process in symptomatic and asymptomatic travelers returned from areas with harsh climate conditions and low sanitation standards.

INFECTIOUS DISEASES IMPORTED BY POLISH TRAVELERS

The Polish National Institute of Public Health – National Institute of Hygiene, the Department of Epidemiology and Surveillance of Infectious Diseases publishes a report on cases of infectious diseases and poisonings in Poland every 2 weeks. The report includes both domestic and imported cases. Influenza and influenza-like illness are at the top of the list: a total of 4,789,827 cases were reported in 2019 (5,239,293 in 2018) [7]. Unfortunately, most of these diagnoses are not confirmed by a laboratory test and therefore a large proportion of illnesses manifesting with similar clinical signs (fever, osteoarticular and muscle pain, general weakness) may be mistakenly reported as influenza or parainfluenza. These may include imported tropical diseases such as malaria or arboviral infections (dengue, chikungunya, zika). According to the reports, there were 25 confirmed cases of imported malaria, 55 cases of dengue, 2 cases of chikungunya and zero cases of zika in 2019 (in 2018, the number of confirmed cases was reported to be 28,30,0,1 infections, respectively) [7]. The actual number of other tropical infections (e.g. schistosomiasis, filariases, leishmaniases) or cosmopolitan diseases which are endemic in developing countries (ascariasis, trichuriasis, hookworm) in returned travelers is not known. There are two major reasons for this — the first is the lack of testing, and the second the lack of obligation to report the diseases to competent authorities. As was mentioned before, Polish patients are rarely screened for tropical diseases (even if a patient who has returned from a tropical country reports fever of unknown origin, post-travel screening is hardly ever recommended since Polish laboratories do not offer test panels for the detection of tropical diseases). Therefore, it is likely that some imported tropical infections may be misdiagnosed as cosmopolitan diseases. In such cases patients will only receive symptomatic treatment, and the real etiological factor will never be discovered. Asymptomatic carriers are especially problematic from a public health perspective because they can transmit the infection to other people without knowing it. Previous studies by the author, which involved groups of Polish soldiers deployed on military missions to Central Asia and the Middle East, demonstrated significant numbers of asymptomatic infections caused by intestinal parasites [8] and hepatitis E virus (HEV) [9].

COMMON HEALTH PROBLEMS OF INTERNATIONAL TRAVELERS

It has been estimated that as many as 43–79% of travelers from European or North American countries are likely to experience a travel-related health problem during or after travel to a developing country [10]. Most of these travelers will have mild symptoms, while 1–5% will seek medical care from a health care provider. A majority of travel-related conditions have a short incubation time with symptoms manifesting during or shortly after travel; there are some diseases, however, which have much longer incubation periods and whose symptoms tend to manifest weeks or even months after returning home. Travelers who have recently returned from a country where infectious diseases are endemic should inform their health care provider of this fact. A post-travel medical interview should primarily focus on the following questions: vaccinations received before travel; compliance with antimalarial chemoprophylaxis before, during and after travel; the use of insect repellents during travel; disease symptoms which occurred during travel and medications taken to treat the symptoms; countries visited, the length of stay, the type of accommodation; travel to large population centers; consumption of the local food; insect bites (mosquitoes, sand flies, ticks); animal bites; unsafe sex with casual partners (local people or other travelers); surgical procedures, blood transfusions, injections, tattooing [11–14]. The most common health conditions in travelers to destinations with harsh environmental conditions and endemic infectious diseases include gastrointestinal disorders, dermatoses, respiratory illnesses and fevers of unknown origin [15].

GASTROINTESTINAL DISORDERS

The most common gastrointestinal conditions in travelers include acute diarrheas (defined as a minimum of three loose stools within 24 h or an increase in stool weight > 200 g/day associated with increased stool liquidity, lasting for no longer than 14 days; mainly of bacterial [*Escherichia coli*, *Salmonella*, *Shigella*, *Campylobacter*] or less often of viral etiology [*Norwalk*, adenoviruses and rotaviruses]). These are commonly referred to as travelers' diarrhea (symptoms usually resolve spontaneously after a few days). Some returned travelers, however, may experience persistent diarrheas (lasting longer than 14 days), which are usually of parasitic etiology (*Giardia intestinalis*, *Cryptosporidium parvum, Entamoeba histolytica*). The diagnosis of suspected bacterial diarrheas is based on conventional microbiological methods (stool culture). The test is recommended if blood or pus is present in the stool, also in febrile or immunodeficient patients and patients with chronic conditions. The diagnosis of viral diarrheas relies on molecular methods (polymerase chain reaction [PCR]), while the gold standard for the diagnosis of parasitic diarrhea is the multiple fecal tests, i.e. examining of stool (at least three samples) by light microscopy, preferably using concentration techniques (sedimentation for the detection of protozoa and flotation for the detection of helminths). Persistent diarrheas should be differentiated from non-infectious or post-infectious conditions, such as the malabsorption syndrome or the irritable bowel syndrome. The malabsorption syndrome caused by impaired absorption of food nutrients in the gastrointestinal tract is often associated with celiac disease (gluten-sensitive enteropathy), cystic fibrosis, chronic pancreatitis or pancreatic cancer, status post gastrectomy, enzymatic deficiencies (lactase deficiency causing lactose intolerance, sucrase-isomaltase deficiency — sucrose intolerance aldolase deficiency — fructose intolerance). Irritable bowel syndrome, on the other hand, is an idiopathic gastrointestinal disorder of unknown etiology characterized by abdominal pain, flatulence and defecation disorders (diarrhea or constipation) [11, 14, 16].

DERMATOSES

The most common skin problems found in returned travelers include allergic reactions to insect bites (scratching the lesions may cause a secondary pyoderma, erosions or ulcerative lesions), allergic rash, superficial skin lesions (epidermal abrasion, animal bites or scratches, sunburns, exposure to marine animals, e.g. jellyfish stings), pyodermas (folliculitis, furuncles, abscess), fungal infections. Tropical dermatoses, such as an arboviral infection presenting with a skin rash (dengue, chikungunya, zika), cutaneous larva migrans or myiasis are rarely seen in travelers. The diagnosis of skin lesions is based on identifying the type of lesion (maculopapular or papular rash, nodules, vesicular/bullous rash, pustules, erosions/ulcers), its location (hairless or hairy skin, armpits, groins, joints), etiological factor (insect bites, exposure to sun, exposure to pathogens — viruses, bacteria, parasites, fungi) and associated symptoms (pruritus, pain, burning sensation, fever) [17].

RESPIRATORY INFECTIONS

The most common respiratory illnesses diagnosed in returned travelers include upper respiratory tract infections (a cold, pharyngitis, tonsillitis, sinusitis). Lower respiratory tract infections (e.g. pneumonia) are less common but present with more pronounced signs and symptoms (fever, chest pain, cough, dyspnea) and therefore may require in-hospital treatment. Respiratory illnesses are most often caused by viruses (influenza viruses, adenoviruses, rhinoviruses, coronaviruses) and bacteria (*Streptococcus pneumoniae, Mycoplasma pneumoniae, Haemophilus influenzae, Chlamydophila pneumoniae, Legionella pneumophila*). Tropical pathogens are rarely responsible for respiratory infections in travelers. Mass infections may occur during organized tours, in hotels, on cruise ships or passenger aircrafts (droplet or airborne transmission). The diagnosis of a respiratory illness is based on the identification of the etiological factor either by molecular methods (viruses) or standard microbiological techniques, e.g. culture (bacteria). The biological material used for testing is usually a sputum or nasopharyngeal swab sample, a bronchoscopy sample or tracheal aspirate samples; the standard imaging method for the diagnosis of respiratory illnesses include a sinus or a chest X-ray [18].

FEVERS OF UNKNOWN ORIGIN

Malaria is a common cause of fever in travelers returning from tropical or subtropical destinations (infection with *Plasmodium* parasite through a bite of an infected mosquito). Other common travel-related febrile illnesses include dengue, chikungunya, zika (arboviral infections transmitted by mosquitoes), viral hepatitis A, typhoid fever (transmitted through the fecal-oral route) and rickettsioses (transmitted by lice, fleas, ticks, mites). Febrile illnesses may be of non-tropical origin as well and be a sign of a respiratory or a urinary tract infection; fever may also be an accompanying symptom of many dermatoses, e.g. burns. A febrile patient is likely to have other symptoms as well (headache, general weakness, muscle and joint pain, gastrointestinal disorders, shin rash, conjunctivitis) which may be important for the differential diagnosis; most febrile illnesses have a short incubation period and tend to manifest within 4 weeks after traveler's return. Some conditions, however, have longer incubation periods and can manifest themselves many weeks after return; these include *Plasmodium vivax* malaria, tuberculosis or viral hepatitis. The onset of fever may be gradual and eventually reach a very high level and be associated with bradycardia (as in typhoid), or abrupt as in dengue. Malaria is typically characterized by a sudden onset of fever which is then recurring in cycles. In *Plasmodium vivax* and *P. ovale* infections, fever paroxysms occur periodically every 48 hours, in *P. malariae* infection — every 72 hours. Fever paroxysms in *P. falciparum* malaria are irregular and elevated body temperature of varying degree can persist all throughout the duration of the symptomatic disease. When diagnosing a febrile patient who has returned from a tropical destination, malaria should be ruled out first (the thick and thin blood smears) before proceeding with further tests. It is then recommended to perform serological tests to rule out arboviral infections (dengue, chikungunya, zika), tests to detect infections which are endemic in the visited part of the world (HAV, HEV), blood count with differential, liver enzymes levels, urinalysis, C-reactive protein (CRP), a chest X-ray, stool microscopy (detection of parasites) and, in justified cases, blood, urine and stool culture [19].

Most travel-related illnesses tend to manifest within a few weeks after traveler's return (Tables 2, 3). Some conditions, however, have longer incubation periods and their symptoms may manifest 6 or more weeks after coming back home. For this reason a medical interview forms the basis of post-travel assessment. A febrile illness occurring more than 3 weeks after return almost certainly rule out dengue or rickettsioses. A late onset of symptoms may be suggestive of visceral, cutaneous or mucocutaneous leishmaniasis, chronic Chagas disease, chronic brucellosis, malaria or schistosomiasis. The accuracy of a clinical diagnosis and the effectiveness of treatment will much depend on a patient himself. In order to establish an accurate diagnosis, a physician needs to know of all the risk factors a patient might have been exposed to during travel (Table 4). If patients conceal or omit any significant information from their health care provider, it will be more difficult for a physician to make an accurate diagnosis and implement effective treatment [11, 20, 21].

TYPES OF EXAMINED TRAVELERS

Post-travel assessment is primarily recommended to:

— symptomatic travelers who experience symptoms of an infection on their return or within three months after return, especially if they experience fever, persistent

Table 2. Incubation period and disease symptoms [20]

Incubation period	Symptoms	Disease
< 2 weeks	Fever + non-specific symptoms	Malaria, dengue, chikungunya, zika, campylobacteriosis, salmonellosis, shigellosis, African trypanosomiasis, leptospirosis, typhoid fever
< 2 weeks	Fever + coagulation disorders	Invasive meningococcal disease, leptospirosis, malaria, viral hemorrhagic fevers
< 2 weeks	Fever + neurological symptoms	Malaria, typhoid fever, rickettsioses, invasive meningococcal disease, rabies, African trypanosomiasis, poliomyelitis, encephalitis and/or meningitis
< 2 weeks	Fever + respiratory symptoms	Influenza, COVID-19, common cold, streptococcal pharyngitis/pneumonia, legionellosis, Q fever
< 2 weeks	Fever + skin lesions	Rubella, varicella, measles, herpes simplex, dengue, chikungunya, zika, rickettsioses, typhoid fever, HIV infection
2–6 weeks	A variety of symptoms: fever + neurological or respiratory symptoms or skin lesions	Malaria, tuberculosis, hepatitis A, hepatitis B, acute hepatitis C, hepatitis E, leishmaniasis, acute schistosomiasis (Katayama syndrome), amebic liver abscess, leptospirosis, African trypanosomiasis, Chagas disease, viral hemorrhagic fevers, Q fever, measles, typhoid fever
> 6 weeks	A variety of symptoms: fever + neurological or respiratory symptoms or skin lesions	Malaria, tuberculosis, hepatitis B, acute hepatitis C, hepatitis E, leishmaniasis, wuchereriasis, onchocerciasis, schistosomiasis, amebic liver abscess, African trypanosomiasis

Table 3. Incubation period and geographic regions [12, 21]

Incubation period	Geographic regions	Disease
6–30 days (98% onset within 3 months of travel)	Especially in Sub-Saharan Africa (> 90%), also in Central and South America, India and South-East Asia	Malaria, *Plasmodium falciparum*
8 days to 12 months (50% have onset > 30 days after completion of travel)	Especially in Central and South America, India and South-East Asia, also in Sub-Saharan Africa	Malaria, *Plasmodium vivax*
4–8 days (range 3–14 days)	South-East Asia, Central and South America, Africa, Pacific islands	Dengue
2–4 days (range 1–14 days)	South-East Asia, Central and South America, Africa	Chikungunya
3–14 days	South-East Asia, Central and South America, Africa, Pacific islands	Zika
< 21 days	Democratic Republic of the Congo (Ebola), Nigeria (Lassa); the Middle East, the Balkans, Central Asia, Africa (Crimean-Congo)	Viral hemorrhagic fevers
2–14 days	Arabian Peninsula	MERS-CoV
2–14 days	Cosmopolitan	COVID-19
1–3 days	Cosmopolitan	Influenza
5–6 days (range 2–10 days)	Cosmopolitan	Legionellosis
3–8 days	Sub-Saharan Africa, South America	Yellow fever
3–6 days (range 1–20 days)	Africa, Asia, Europe	West Nile fever
3–14 days (range 1–20 days)	South and South-East Asia (from India to Japan)	Japanese encephalitis
28–30 days (range 15–50 days)	Cosmopolitan	Hepatitis A
26–42 days (range 2–9 weeks)	Cosmopolitan	Hepatitis E
6–30 days (range 3–60 days)	Cosmopolitan (especially in Indian subcontinent)	Typhoid fever
7–14 days	Cosmopolitan, epidemics	Epidemic typhus
7–12 days (range 2–26 days)	Cosmopolitan (especially in Asia)	Leptospirosis
4–8 weeks	Sub-Saharan Africa, South-East Asia, South America	Acute schistosomiasis (Katayama syndrome)
2–6 months (range 10 days to years)	Mediterranean, Africa, Asia, Central and South America	Leishmaniasis (cutaneous, visceral, mucocutaneous)

Table 4. Risk factors (exposures and activities) [21]

Risk factors	Disease
Contact with fresh water	Schistosomiasis, leptospirosis
Contact with soil (walking barefoot)	Cutaneous larva migrans (hookworm, strongyloidiasis), tungiasis
Contact with animals	Rabies, tularemia, Q fever, anthrax, viral hemorrhagic fevers, plaque, brucellosis
Dairy consumption	Brucellosis, tuberculosis, shigellosis
Non-potable water consumption	Hepatitis A and E, typhoid fever, amebiasis, giardiasis, cryptosporidiasis, shigellosis, cyclosporiasis
Consumption of raw and undercooked food	Hepatitis A, bacterial enteric infections, trichinosis, amebiasis, toxoplasmosis, cestodiasis
High-risk sexual contact	AIDS, hepatitis B and C, herpes, gonorrhea, syphilis
Cave exploration	Rabies, histoplasmosis
Contact with ill/infected patients	Tuberculosis, invasive meningococcal disease, influenza, MERS-CoV, COVID-19, viral hemorrhagic fevers
Exposure to mosquitoes	Malaria, dengue, chikungunya, zika, yellow fever, other arboviruses, filariasis
Exposure to tics	Rickettsioses, borreliosis, Q fever, tularemia, Crimean-Congo hemorrhagic fever
Exposure to flies	African trypanosomiasis, leshmaniasis, onchocerciasis, bartonellosis
Exposure to fleas	Murine typhus, plague
Exposure to lice	Exanthematic typhus, relapsing fever
Exposure to mites	Scrub typhus

diarrhea, nausea, vomiting, respiratory symptoms, urinary or genital disorders, dermatoses including jaundice, weight loss;
- asymptomatic travelers who have a chronic illness, which may increase their risk of complications of travel-related infection;
- asymptomatic travelers who are immunocompromised (an immunological disorder, or medically induced immunosuppression);
- asymptomatic travelers who have spent more than 3 months in a country with harsh climate and poor standards of sanitation;
- asymptomatic travelers who might have been exposed to risk factors (non-compliance with disease prevention measures or antimalarial chemoprophylaxis, extreme sports, unsafe sex contacts, consumption of food or water from unsafe sources, etc.) [22, 23].

SYMPTOMATIC TRAVELERS

This group of travelers frequently consults a travel medicine specialist to seek or to confirm a diagnosis established elsewhere or on their own. Another incentive to consult a physician is the fear of spreading the infection to other people (family, friends, co-workers). This is particularly important in case of airborne transmission (coronavirus infection, influenza), fecal-oral transmission (intestinal parasites, salmonellosis, shigellosis), direct contact transmission (scabies) and sexually transmitted diseases.

ASYMPTOMATIC SHORT-TERM TRAVELERS

Routine post-travel screening can be restricted to patients who report exposure to risk factors during their travel, as well as patients who are immunocompromised or have chronic conditions. For those travelling on business, a post-travel screening procedure might be required by their employer (a compulsory periodic medical evaluation in occupational medicine).

ASYMPTOMATIC LONG-TERM TRAVELERS

This group of patients will greatly benefit from a thorough medical interview to assess potential risk factors they might have been exposed to while staying in a developing country. The major risk factors will include: exposure to mosquitoes, sand flies, ticks (vector-borne diseases), exposure to contaminated freshwater (schistosomiasis, leptospirosis) or contaminated soil (tetanus, intestinal helminthiases), consumption of food or water from unsafe sources (water- and food-borne diseases), unprotected sexual contacts with casual partners (sexually transmitted diseases [STDs]), animal bites (rabies). If a specific exposure is identified, with a significant risk of infection, screening laboratory tests may be indicated.

ASYMPTOMATIC EXTREME/ADVENTUROUS TRAVELERS

When visiting countries with harsh environmental conditions adventurous travelers frequently adopt lifestyles similar to those of the local people, and therefore run a higher risk of developing unusual infections. Infectious diseases which have a short incubation period are likely to become symptomatic during travel. When adventurous/extreme travelers are asymptomatic, the following infections or illnesses may be suspected: schistosomiasis (bathing or swimming in contaminated freshwater lakes, ponds or rivers), histoplasmosis (exploring bat-infested caves), cutaneous larva migrans (walking barefoot in feces-contaminated soil), filariasis (mosquito bites), leishmaniasis (sand flies bites), AIDS (unprotected sex with new partners) [23].

POST-TRAVEL SCREENING

The risk of developing a travel-related health problem will depend on a variety of factors. The common risk factors usually include: the level of endemicity in the countries visited, the general health condition of a traveler (proper functioning of the immune and the thermoregulatory systems, chronic diseases), adoption of prophylactic measures, duration of travel, type of activities (a leisure holiday vs. extreme sports). In general, the risk of acquiring a travel-related disease is higher in tropical and subtropical destinations, which is associated with a higher risk of exposure to vector-borne, food and water-borne, airborne or sexually transmitted pathogens. The groups of travelers who run the highest risk of developing a travel-related illness include the elderly, young children, pregnant women, people with disabilities, patients with cancer, patients with circulatory system disorders or renal disorders, diabetic patients, patients with thyroid disease, epilepsy or psychiatric disorders. Because of the rapidly increasing numbers of international tourist arrivals and the growing number of global health risk factors, post-travel screening has become a necessity. The introduction of screening test panels targeted at specific groups of travelers (depending on the type of clinical manifestations, risk exposure, countries visited) seem to be a good solution to the problem of travel-related health assessment. The pre-travel test panel is generally recommended for tourists with a history of chronic diseases (Table 5) [24].

A detailed medical interview is the basis of the post-travel screening process. In order to establish an accurate diagnosis and implement effective treatment a health care provider will need the information on the patient's past medical history, the symptoms which have occurred during or after travel, possible risk exposures and the list of countries the patient has visited. During a post-travel follow-up a doctor may inform the patient of the common routes of transmission (especially of the infectious and parasitic diseases) as it may help the patient identify potentially risky exposures (Table 4). It is important to remember that a considerable proportion of travel-related infections might be asymptomatic (numerous parasitic diseases) and that it would be impossible to detect certain infections during the window period, i.e. the period from infection to when the body products enough antibodies to be detected by laboratory tests (the window period for human immunodeficiency virus (HIV) may be up to 12 weeks). A popular method used for screening returned travelers is to perform qualitative rapid diagnostic tests, however, when it is important to assess the intensity of the invasion (as in schistosomiasis, some filarial infections) quantitative and semi-quantitative tests will be more useful. If an asymptomatic patient seeks medical help shortly after returning from a country where infectious diseases are endemic or where there has been an outbreak of an infectious disease, or if a patient had significant risk exposure during travel, a health care provider should inform him of the necessity to report for a follow-up screening 3 months after the initial tests (to confirm or rule out infections which have longer incubation and latent periods (tuberculosis, benign tertian malaria, amebic liver abscess, acute schistosomiasis, acute HIV seroconversion) [23].

The diagnostic procedures for common tropical and cosmopolitan infections in asymptomatic travelers who have returned from tropical or subtropical destinations are presented in Table 6.

BASIC LABORATORY TESTS

A basic set of laboratory tests includes a total blood count with differential, liver enzymes levels (ALT, AST, ALP, BR, GTP), creatinine, and CRP. These tests provide general information on potential infections and systemic inflammation and are useful in detecting any changes in the blood count (leukocytosis, leukopenia, anemia, thrombocytopenia, eosinophilia) as well as any dysfunction of liver or kidney. Urinalysis, including urine microscopy and testing for proteinuria, is essential when urinary tract infection is suspected, but generally fails to provide useful information on other diseases in asymptomatic patients [12, 23].

BLOOD EOSINOPHIL COUNT

Absolute eosinophil count (i.e. calculating the number of eosinophils in peripheral blood sample) may be used to detect parasitic infections, but also some allergic or respiratory infections. Eosinophilia is defined as an increased blood eosinophil count > 4% and is usually associated with parasitic diseases, such as schistosomiasis, strongyloidosis, ascariasis, hookworm infection, trichinosis, lymphatic filarioses (wuchereriosis), cutaneous and subcutaneous filarioses (loiasis, onchocerciasis), fasciolosis. Eosinophilia is usually more pronounced when parasites migrate through the blood or tissues, as in infections caused by the migratory intestinal helminths. However, in most patients with an asymptomatic parasitic infection, the eosinophil count is normal. Eosinophilia may also be associated with some infectious diseases, e.g. HIV infections, coccidioidomycosis, aspergillosis, tuberculosis and syphilis [11, 12, 25, 26].

Table 5. Screening test panels recommended for travelers [24]

No.	Screening test panel	Laboratory tests included
1	Pre-travel assessment panel	ESR, blood count with differential; urinalysis; urea, creatinine; liver enzymes (ALT, AST, ALP, BR, GGTP); routine tests for chronic diseases a traveler may have
2	Post-travel assessment panel (asymptomatic patients)	ESR, blood count with differential; urinalysis, creatinine; liver enzymes (ALT, AST, ALP, BR, GGTP); CRP, *quantitative*; multiple stool microscopy, three samples (intestinal parasites)
3	Post-travel assessment panel (gastrointestinal symptoms)	ESR, blood count with differential; liver enzymes (ALT, AST, ALP, BR, GGTP); CRP, *quantitative*; HAV, HEV IgM/IgG; gastrointestinal panel including 25 pathogens (Norovirus, Adenovirus, Sapovirus, Rotavirus, Astrovirus, STEC, EPEC, ETEC, EAEC, *E. coli* O157, *Shigella* spp., *Salmonella* spp., *Aeromonas* spp., *Campylobacter* spp., *Clostridium difficile* toxin A, *Yersinia enterocolitica*, *Vibrio* spp., *Dientamoeba fragilis*, *Blastocystis* spp., *Cryptosporidium* spp., *Cyclospora cayetanensis*, *Giardia lamblia*, *Entamoeba histolytica*), real-time PCR; multiple stool microscopy, three samples (intestinal parasites)
4	Post-travel assessment panel (respiratory symptoms)	ESR, blood count with differential; CRP, *quantitative*; respiratory panel including 26 pathogens (Flu A, Flu B, RSV A, RSV B, Flu A-H1, Flu A-H1pdm09, Flu A-H3, Adenovirus, Enterovirus, Parainfluenza virus 1,2,3,4, Metapneumovirus, Bocavirus, Rhinovirus, Coronavirus NL63, 229E, OC43, *Mycoplasma pneumoniae*, *Chlamydophila pneumoniae*, *Legionella pneumophila*, *Haemophilus influenzae*, *Streptococcus pneumoniae*, *Bordetella pertussis*, *Bordetella parapertussis*), real-time PCR
5	Post-travel assessment panel (fever of unknown origin)	ESR, blood count with differential; urinalysis, urine culture (bacteriological test); CRP, *quantitative*; malaria (*Plasmodium* spp.), parasitemia, blood microscopy; HAV, HEV IgM/IgG; dengue IgM/IgG; chikungunya IgM/IgG; zika IgM/IgG; gastrointestinal pathogen panel including 25 pathogens (see section 3), real-time PCR
6	Post-travel assessment panel (exposure to risk factors: unsafe sex with casual partners, injections, tattooing, piercing)	HBs Ag; HCV; HIV; syphilis (*Treponema pallidum*) IgM/IgG; urogenital panel (*Chlamydia trachomatis*, *Neisseria gonorrhoeae*, *Mycoplasma genitalium*, *Mycoplasma hominis*, *Ureaplasma urealyticum*, *Trichomonas vaginalis*), real-time PCR
7	Post-travel assessment panel for travelers returning from Mediterranean countries (Europe, North Africa)	HAV, HEV IgM/IgG; gastrointestinal pathogen panel including 25 pathogens (see section 3), real-time PCR; dengue IgM/IgG; chikungunya IgM/IgG; zika IgM/IgG; urine culture (bacteriological test); multiple stool microscopy, three samples (intestinal parasites)
8	Post-travel assessment panel for travelers returning from Sub-Saharan Africa, South and South-East Asia	Malaria (*Plasmodium* spp.) parasitemia, blood microscopy; HAV, HEV IgM/IgG; gastrointestinal pathogens panel including 25 pathogens (see section 3), real-time PCR; dengue IgM/IgG; chikungunya IgM/IgG; zika IgM/IgG; urine culture (bacteriological test); multiple stool microscopy, three samples (intestinal parasites)
9	Post-travel assessment panel for travelers returning from Central America/the Caribbean or South America	Malaria (*Plasmodium* spp.) parasitemia, blood microscopy; HAV, HEV IgM/IgG; gastrointestinal pathogens panel including 25 pathogens (see section 3), real-time PCR; dengue IgM/IgG; chikungunya IgM/IgG; zika IgM/IgG; urine culture (bacteriological test); multiple stool microscopy, three samples (intestinal parasites)

ALP — alkaline phosphatase; ALT — alanine aminotransferase; AST — aspartate aminotransferase; BR — bilirubin; CRP — C-reactive protein; ESR — erythrocyte sedimentation rate; GGTP — gamma glutamyl transpeptidase; HAV — hepatitis A virus; HEV — hepatitis E virus; HCV — hepatitis C virus; HIV — human immunodeficiency virus; PCR — polymerase chain reaction

ABDOMINAL ULTRASOUND

The test may be considered as a secondary diagnostic procedure in asymptomatic travelers presenting with abnormal liver and/or renal function tests and/or abnormal urinalysis [23].

RESTING ELECTROCARDIOGRAM

The test may be useful in identifying patients with the ‘long QT’ syndrome, who are at a higher risk of malignant ventricular tachycardia when treated with antimalarial medications (quinine, quinidine). Electrocardiogram can also help detect atrioventricular conduction problems, which are a contraindication to the use of mefloquine [23].

INTESTINAL PARASITIC DISEASES

Travelers returning from developing countries where intestinal parasitoses are endemic should be screened for parasitic infections (travelers may transmit the infection to others, even if they are asymptomatic). To establish an accurate diagnosis, it is essential to select the most reliable diagnostic method; the ‘gold standard’ for the diagnosis of intestinal parasitic infections is multiple stool microscopy using different techniques (direct smear, flotation, sedimentation). To differentiate between similar parasitic species (e.g. the pathogenic *Entamoeba histolytica* from non-pathogenic *Entamoeba dispar*) molecular techniques are recommended (PCR) [11, 27, 28].

Table 6. Diagnostics of common travel-related infections in asymptomatic travelers [23]

Disease	Incubation period	Diagnostic procedure	Time lapse after which asymptomatic infection becomes very unlikely (given negative screen)
Amebiasis	Days – > 6 months	Stool microscopy (infection with *E. histolytica*/*E. dispar*) Stool PCR for *Entamoeba histolytica*, serum antibody test (infection *E. histolytica*, tissue invasion *E. histolytica*)	6 months (may be longer, even years)
Malaria (*P. falciparum*)	9–30 days	Thick film, malaria antigen test (parasitemia in semi-immune) HRP-2 antigen test (confirmation of recent infection/diseases) Serum antibody test (post-infection confirmation and chronic suppressed infection)	Non-immunes: 3 months Semi-immunes: 4 years
Malaria (*P. vivax, P. ovale, P. malariae*)	8 days – > 12 months	Thick film, malaria antigen test (active infection/disease) Serum antibody test *P. vivax*, *P. ovale* (post-infection confirmation; interspecies cross reactions can occur)	Benign *P. vivax*, *P. ovale*: 2–4 years *P. malariae*: > 10 years
Typhoid fever	7–18 days (range 3–60 days)	Stool culture (convalescent carrier state) Serum antibody test Widal (negative test excludes recent infection, poor specificity)	2 months
Tuberculosis	> 30 days	Tuberculin test (asymptomatic infection) IGRA (asymptomatic infection in BCG vaccinees)	2–4 months (asymptomatic infection — risk lifelong)
Schistosomiasis	14 – > 60 days	Serum antibody test (asymptomatic infection)	3–6 months (exceptionally longer)
Intestinal helminths	3 – > 60 days	Stool microscopy (active infection)	2 months
Filariasis (*Wuchereria bancrofti*)	? – > 12 months	Serum antibody test (exposure or active infection) Serum antigen test (active infection) Nocturnal microfilaremia (active infection)	Up to 2 years
Filariasis (*Onchocerca volvulus*)	3 – > 15 months	Serum antibody test (exposure; low sensitivity) Ocular microfilaria (active infection; requires ophthalmologic examination)	Up to 2 years
Filariasis (*Loa loa*)	? – > 12 months	Serum antibody test (exposure or active infection) Daytime microfilaremia (active infection)	Up to 2 years
Strongyloidiasis	7 – > 21 days	Serum antibody test (exposure, active infection; sensitive, non-specific) Stool microscopy (concentration technique) or stool PCR or antigen test (active infection)	1 month
HIV	14 – > 90 days	Serum antigen/antibody test HIV-ELISA/p-24 (active infection: screening)	6 weeks – 6 months
Syphilis	9 – > 90 days	VDRL (active infection) TPHA, FTA (confirmation, post-exposure, post-treatment)	3 months
Hepatitis B	90 days (range 2–6 months)	Serum antigen test HBsAg (active or latent infection/disease) Serum antibody test HBsAb, HBV DNA (immunity, classification of infection activity)	6 months
Hepatitis C	2 weeks – 6 months	Serum antibody test (active or latent infection/disease) HCV RNA (confirmation of active infection)	6 months
Chagas disease (*Trypanosoma cruzi*)	5–14 days	Serum antibody test (latent or active infection) PCR (active infection)	To be followed up serologically until 6 months after possible exposure

BCG — Bacillus Calmette-Guerin; CRP — C-reactive protein; FTA — fluorescent treponemal antibody absorption; HBV DNA — hepatitis B virus DNA; HCV RNA — hepatitis B virus RNA; HRP-2 — histidine-rich protein 2; GGTP — gamma glutamyl transpeptidase; HIV — human immunodeficiency virus; IGRA — interferon-gamma release assay; PCR — polymerase chain reaction; TPHA— treponema pallidum hemagglutination assay; VDRL — venereal disease research laboratory test

SEXUALLY TRANSMITTED DISEASES

Post-travel screening is recommended in travelers with a history of unprotected sexual contacts with casual partners (including commercial sex workers). It should involve detection of HIV, syphilis, gonorrhea, chlamydiasis, hepatitis B and C, genital herpes (HSV), condylomata acuminata (HPV), and tropical STDs (e.g. chancroid). In patients returning from endemic regions the medical interview will be the foundation of the post-travel screening process (a physician should consider the time of exposure, the incubation period and the window period, as in HIV infection) [29]. The PCR tests for gonorrhea or chlamydiasis may be performed on urine samples [30]. Travelers who received blood transfusions during their stay in developing countries, where blood screening procedures are often less complete, should be tested for AIDS, syphilis, hepatitis B and C [23].

CONCLUSIONS

A medical interview by an experienced physician forms the basis of the post-travel screening process both in symptomatic as well as asymptomatic travelers. The interview should primarily focus on identifying exposure to risk factors (endemic infectious diseases, failure to adopt disease prevention measures, consumption of food or water from unsafe sources, insect bites, animal bites, travelling in large groups, unsafe sex with casual partners). While physical examination (identification of abnormalities) and a well-chosen set of diagnostic tests (identification of pathogens) can be useful to detect illnesses and asymptomatic infections as well as assess the general health condition of a patient and his immune status.

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VIA MEDICA

REVIEW ARTICLE

Stress dynamics in long-term isolation at sea. A demographic variables model

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ABSTRACT

The current article describes a naturalistic research programme carried out among fishermen during a 6-month expedition to the southern Atlantic Ocean. Stress levels of 81 participants were measured 4 times during the expedition. Social-demographic variables (age, years of experience at sea, job satisfaction, education, current and childhood place of residence, relationship status) were also included in the analysis. Results show that these variables should be considered when analysing stress dynamics among people experiencing long-term work-related isolation.

(Int Marit Health 2020; 71, 2: 140–146)

Key words: sea isolation, demographic variables, stress, anxiety, longitudinal study

INTRODUCTION

Research on stress and its effects on individual well-being, health, and functioning has seen a substantial increase in the last two decades. Theoretical models and empirical analyses both point to significant connections between quality of life and prevalence of diseases/mortality caused by stress.

The nature of maritime work causes chronic separation between the sailor and their family. Thus, such families experience characteristic cycles of the sailor (parent, spouse) leaving and returning. The stress thus generated necessitates the use of various coping mechanisms. Practical observation suggests that, despite protests on this point, institutions employing fishermen do not seem to pay particular attention to the psychological and health costs they and their families incur. Short periods of rest at home can allow the fishermen to "regenerate" their psychological resources, but they can also inhibit or make virtually impossible the "reactivation" of basic marriage and family roles. Through the delegation of responsibility on their wives, lack of knowledge of common and specific problems of family life, and marginal input in family decision-making, sailor husbands can experience difficulties in self-acceptance in the family context. Consequently, they can cope by "escaping back to sea."

The second significant factor in the development and maintenance of stress among fishermen and their families are the conditions at sea. The ship creates a specific work environment characterised by a closed, paramilitary structure of leadership and spatial confinement. Significant stressors also include the ship's movements, noise and vibration, frequent crossing of climate zones [1], temperature and air pressure fluctuations, for example, during storms [2], living space constraints, lack of typical emotional [3], sexual, and psychological gratification, lack of intimacy, separation from family [4, 5], loneliness, exhaustion, work in a multicultural crew [6], limited opportunities for recreation, and lack of sleep [7, 8]. The constant character of these stressors causes constant emotional tension in the majority of the fishermen. In turn, this tension increases with the duration of the expedition. Long-term stress ultimately contributes to increased mortality due to accidents, cancer, cardiovascular diseases, and suicide [9, 10].

Thus, the question arises of the psychological costs incurred by fishermen. These can be considered in the short- and long-term (repeated periods of isolation) perspective. Importantly, existing research has considered these psychological costs only to a minimal extent, focusing instead on difficulties in adaptation and work performance.

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In other words, the question concerned the individual, social, or organisational factors facilitating this adaptation or performance, rather than the accompanying costs. It is possible that a sailor can perform their work role well (e.g., in their supervisor's judgement), but at the cost of significant stress (i.e., negative emotional experiences, which are not taken into consideration by the supervisor). Prior studies have seldom, if at all, explored this issue from the individual differences perspective.

A review of the literature on stress shows that it is a virtually universal, complex phenomenon, determined by a variety of factors. Its duration and intensity mainly depend on an interaction of such factors as life experience (an individual's developmental course), individual differences, or sociocultural environment. Emphasis is placed on the necessity of a holistic approach both in methodology and data interpretation. The individual's experience and their environment influence one another — one family member's stress (e.g., an illness or marital conflict) indirectly affects the other members, both within and outside their family roles.

Thus, it seems pertinent to adopt a general assumption that an individual possessing appropriate levels of personal and social competences (chiefly within the family context) will function relatively effectively (without major stress) both in everyday life situations and difficult work conditions. Health psychology research seems to confirm this assumption by studying the psychological and social factors in numerous illnesses (including cancer), understood as the distal effects of stress. These are exacerbated by proximal stressors, varying between individuals. Fishermen, in particular deep-sea fishermen, are exposed to work-related stress and isolation. The risk of death in naval transportation is 3 times higher than in bus transportation. Compared to planes and trains, the risk of death on board a ship is 10 times as high. The human factor is responsible for nearly 80% of these incidents [11]. Exhaustion of the watch officers, steering errors, task overload, or a misplaced sense of safety caused by an over-reliance on automated systems result in an increased number of accidents. Thus, ship navigators' psychological functioning is especially important in the context of the errors they are liable to.

The current study thus attempts to answer the following questions: What causes the experience of stress to intensify during periods at sea for some fishermen, but not for others? What psychological factors lie behind these differences?

Of interest here is also the hypothesis, put forward on the basis of qualitative data (e.g., diaries), that as the duration of isolation (often involuntary isolation as well) increases, so does the role of demographic factors in coping with stress.

In sum, the current study focuses on demographic factors (independent variable) determining the dynamics of stress experience (dependent variable) among fishermen in conditions of long-term isolation at sea. The research question is as follows: Are particular demographic variables (age, education, relationship status, work experience, social-economic status, place of residence in childhood [cities vs. small towns], crew position, level of work satisfaction) related to differences between fishermen in stress experience during isolation at sea?

METHODS

Thus, researching it in terms of its dynamics requires integrating a range of variables, especially more so in the case of people undergoing prolonged social and emotional isolation. In the current study, state anxiety was measured with the state subscale of the State-Trait Anxiety Inventory [12]. This allowed for measuring changes in an individual's anxiety state as a consequence of environmental influences. Demographic data on the study group was collected using a structured survey (age, education, relationship status, number of expeditions, childhood residence, crew position, job satisfaction).

Cluster analysis of multiple state anxiety measurements has allowed distinguishing groups of fishermen on the basis of their dynamics of anxiety experience in various stages of long-term isolation at sea.

SAMPLE

The participants were between 21 and 53 years of age. Those from working class families constituted the largest group (76.5%). The majority of the sample grew up in large (29.6%) cities. 12.3% of the sample was on a deep-sea expedition for the first time in their career. The largest group had a vocational education (34.1%). Only 11% of the crew was educated specifically as fishermen. The majority of the fishermen in the sample were married (87.7%). 40.8% of the fishermen' families had 2 children (Table 1).

PROCEDURE

Participation in the study was voluntary. The fishermen were informed about the presence of a psychologist on board only after having arrived in Montevideo. The psychologist was obliged to prove their credibility and attest to strictly scientific purposes behind their presence. The aim of the study was presented to the crew during a meeting at the beginning of the expedition. The pragmatic aspect of the study was highlighted, that is, the possibility to use the results to improve expedition planning and to argue for a greater consideration of the fishermen' psychological needs by the management. The crew was assured of the anonymous character of the study and of the nondisclosure of individual results to the management. However, absolute anonymity of the research (i.e., the inability to match individual results to individual fishermen) was impossible due

Table 1. Descriptive data for fishermen

Variable	N	%
Age [years]		
Under 30	20	25.6
31–40	30	38.5
Over 41	28	35.9
Total	78	100
Education		
Primary school	18	23.1
Vocational school	27	34.6
High school	26	33.3
College	7	9.0
Total	78	100
Relationship status		
Single	9	11.5
Married	69	88.5
Total	78	100
Number of expeditions		
1	9	11.6
2–5	17	21.8
6–15	27	34.6
16 and more	25	32.0
Total	78	100
Childhood residence		
Rural areas	20	25.6
Small towns	34	43.6
Large cities	24	30.8
Total	78	100
Crew position		
Officer	17	21.8
Regular crewmember	61	78.2
Total	78	100
Job satisfaction		
Satisfied	34	43.6
Not satisfied	44	56.4
Total	78	100

to the continuous presence of the psychologist on board. Additionally, most of the fishermen were participating in psychological research for the first time, and thus, showed understandable apprehension towards revealing details of their psychological makeup and personal issues. A part of the sample withdrew their participation after a time, which might suggest that doubts about the purpose of the study were present all throughout its duration. For this reason, the help and motivation offered by the ship's captain and the doctor are to be acknowledged. The fishermen were also informed about the possibility of receiving their own individual results after the study's conclusion.

Table 2. Fishermen' anxiety levels across and between expedition phases (n = 78)

Expedition phase	M	SD
I	37.75	7.59
II	38.78	8.22
III	42.88	8.67
IV	37.89	8.23
Compared phases	**T**	**P**
I–II	0.80	NS
I–III	3.91	0.01
I–IV	0.10	NS
II–III	3.02	0.01
II–IV	0.68	NS
III–IV	3.67	NS

NS — non significant; SD — standard deviation

The schedule of data collection was established by the psychologist after becoming acquainted with the organisation of life on board, especially in the fisheries area, where work was particularly intensive. Stress (i.e., state anxiety) levels and its dynamics were measured four times throughout the expedition, on the 10th, 60th, 100th, and 130th day. To respect the fishermen' time and freedom, they were personally given an envelope containing the questionnaires every 10–12 days. The psychologist explained the questionnaire instructions and answered any questions. The fishermen then had up to 2 days to complete the questionnaires. The psychologist only checked the questionnaires for full completion. Statistical analyses were carried out after the expedition.

RESULTS

STRESS DYNAMICS

Seventy-eight fishermen participated in four measures of state anxiety. The results are presented in Table 2 and in Figure 1. The highest levels of anxiety were exhibited during phase III (out of four) of the expedition, that is, after 100 days (M = 42.88). The lowest levels were recorded at the beginning (M = 37.75) and at the end (M = 37.88). The differences between phase III and phases I, II, and IV were statistically significant.

Experienced anxiety varied over time. It increased as a function of the length of isolation and began to decrease towards the initial levels once the 2/3 point of duration was passed. These results partially confirm the results of previous studies.

Results of a cluster analysis have confirmed the hypothesis. Two groups of fishermen were distinguished based on the differences in their reports of state anxiety throughout the subsequent phases of isolation. Figure 2 and Table 3 shows the profiles of these groups.

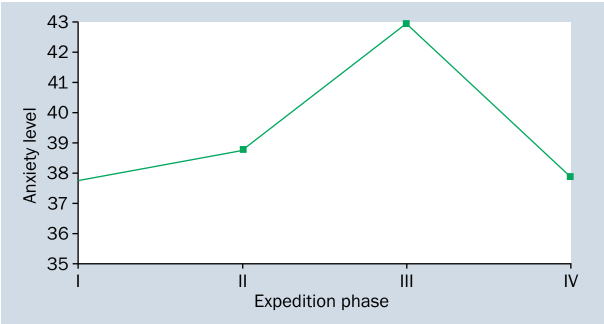

Figure 1. Dynamics of state anxiety in the sample of fishermen (n = 78)

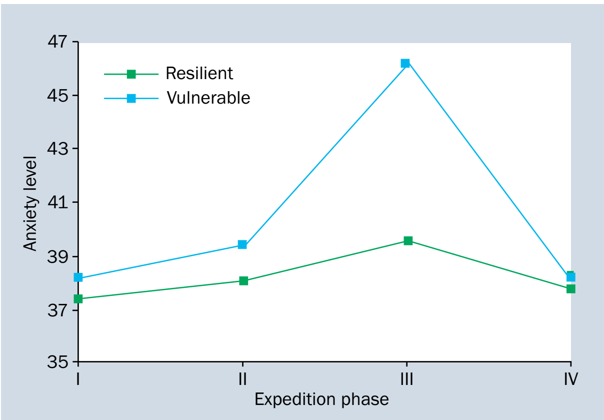

Figure 2. Patterns of anxiety levels among the resilient and vulnerable fishermen

The two distinguished groups differ both with respect to the magnitude of experienced anxiety as well as to the changes in its intensity throughout the expedition. Significant intergroup differences emerged in phase III ($p > 0.001$). The resilient group (n = 37) showed little variability in anxiety — differences between subsequent expedition phases were nonsignificant. In other words, these fishermen exhibited similar levels of anxiety throughout the expedition, neither increasing nor decreasing as isolation continued. On the other hand, the vulnerable group (n = 41) experienced a significant increase in anxiety between phases II and III, which nevertheless returned to baseline levels in phase IV, near the end of the expedition. Thus, these fishermen were more susceptible to the deleterious effects of isolation and they experienced increased emotional costs of functioning as it continued.

These two groups were analysed further in order to describe their differences in various demographic variables, such as age, relationship status, sailing experience, position in the crew, education, socioeconomic status of the family of origin, and upbringing in cities/rural areas, as these can contribute, at least partially, to stress resilience/vulnerability.

ANXIETY AND AGE

The chi-square test revealed significant differences in anxiety levels between three age groups — those below 30 years of age, those aged 31 to 40 years, and those above 41 years ($\chi^2 = 8.2$, $p < 0.2$).

Thus, a relationship between the fishermen' age and reported anxiety was revealed in the group aged over 41 years. Compared to younger fishermen, they experienced greater increases in anxiety in the middle phases of the expedition.

Table 3. Anxiety levels throughout the expedition in the two fishermen groups

	Resilient fishermen (n = 37)		Vulnerable fishermen (n = 41)	
Expedition phase	**M**	**SD**	**M**	**SD**
I	37.38	8.72	38.13	8.02
II	38.08	8.67	39.48	7.61
III	39.60	8.01	46.16	8.32
IV	37.73	8.83	38.04	8.43
Compared phases	**T**	**P**	**T**	**P**
I–II	0.34	NS	0.77	NS
I–III	0.78	NS	4.39	0.01
I–IV	1.14	NS	0.22	NS
II–III	0.17	NS	3.75	0.01
II–IV	0.15	NS	0.80	NS
III–IV	0.95	NS	4.34	0.01

NS — non significant; SD — standard deviation

ANXIETY AND EDUCATION

The results show that education, separated into four levels (primary school, vocational school, high school, college), is a significant predictor of anxiety vulnerability during long-term isolation ($\chi^2 = 14.64$, $p < 0.01$). This relationship mainly concerned individuals with primary school education. Among 18 such fishermen, 22.2% were in the resilient group, and 77.8% — in the vulnerable group. An opposite tendency was observed among the fishermen with high school and college-level education.

ANXIETY AND RELATIONSHIP STATUS

Results revealed that relationship status (single vs. married) did not influence the fishermen' resilience/vulnerability to stress. Similar numbers of single and married fishermen comprised each group.

ANXIETY AND JOB EXPERIENCE

This relationship did not reach statistical significance, however. Nevertheless, it points to a trend ($\chi^2 = 9.29$, $p < 0.06$). The vulnerable group comprised 66.7% of fishermen on their first deep-sea expedition, 70.6% of the fishermen with less than 5 years of experience, and only 29.7% of fishermen with medium amounts of experience (6–15 years).

ANXIETY AND CHILDHOOD PLACE OF RESIDENCE

Chi-square results for the current study's sample have confirmed such a relationship at a level of statistical trend ($\chi^2 = 4.9$, $p < 0.1$).

This relationship/tendency predominantly concerned fishermen raised in large cities. Most of them have been classified to the vulnerable group (70.8%). This suggests that individuals who have been raised in urban areas might experience greater difficulties in coping with long-term isolation. However, this topic requires additional analyses.

ANXIETY AND CREW POSITION

In the current sample, 76.5% of the officers were classified into the resilient group, compared to 39.3% officers in the vulnerable group. This difference is statistically significant ($\chi^2 = 7.23$, $p < 0.001$).

ANXIETY LEVELS AND JOB SATISFACTION

The results confirm the relationship between job satisfaction and levels of experienced anxiety during deep-sea expeditions. The majority (67.6%) of fishermen classified into the resilient group reported high job satisfaction ($\chi^2 = 9.84$, $p < 0.01$). Thus, it can be inferred that motivated individuals, who do not treat their work instrumentally (i.e., as a means to an end) are able to cope more effectively with its demands, as evident by no significant increases in their reported anxiety throughout the expedition.

SUMMARY AND DISCUSSION

Long-term exposure to stress can be viewed through the lens of personal costs. One of its basic measures is state anxiety. State anxiety is the subjective, consciously perceived feeling of worry and tension, with the accompanying activation of the autonomic nervous system [12, 13]. From a cognitive perspective, anxiety is the discrepancy between desired and de facto experienced internal states. The perception of this discrepancy can, in turn, be influenced by subjective and/or objective factors. Objective (situational) factors contribute to anxiety in individuals exhibiting state (behavioural) anxiety, comprised of blob: https://jsa.opi.org.pl/084716a8-0520-45dc-a7db-1ba6fd23022b subjectively felt tension and increased activity of the autonomic nervous system [13, 14]. The subjective factors in anxiety involve various emotional deficits stemming both from isolation itself as well as unrealistic expectations. Anxiety can be a reaction to sparse social and emotional relationships or a sense of danger, not necessarily caused by the presence of actual physical threats. Anxiety is an internal state that is difficult to describe in terms of singular and specific cognitive processes, emotions, or behaviours [15, 16].

In line with the interactional model of stress, it can be assumed that stress levels and its dynamics vary as a function of demographic and social factors. Differences in such "profiles" of stress reactions can be expected to depend on individual vulnerability or resistance to stress — some individuals will show a negative (increasing stress) dynamic, while others — a positive one (no increase or lowering stress). These dynamics will be compared between the experimental groups distinguished in the current study through cluster analysis, taking into account specific demographic variables

The results can be summarised as follows:

1. Measuring the fishermen' state anxiety in four phases of the expedition (10th, 60th, 100th, 130th day) showed a varied dynamic. Anxiety increased from the beginning, reaching its highest levels in phase III, after which it returned to the initial levels. This confirms the hypotheses put forward by other researchers about the existence of a specific isolation syndrome, emerging in the midpoint of the isolation period and involving lowered cognitive performance, increased interpersonal contacts, psychosomatic symptoms, irritability, and emotional dysregulation.
2. Cluster analysis has distinguished two groups of fishermen with respect to their psychological resilience. The resilient group showed near-constant, low levels of anxiety throughout the expedition. In contrast, the vulnerable group experienced a steady increase in anxiety up to phase III (the 100th day) of the expedition, after which it returned to its initial levels. Telerak [see 17] showed that the greatest psychological costs during a 14-month

polar expedition were incurred in the initial phase. Studies also suggest that the appraisal of isolation is related to emotion regulation abilities. The current study points to the necessity of adopting an individual differences perspective when studying such groups.

3. A relationship between the fishermen' age and their stress resilience/vulnerability was revealed. Fishermen over 40 years of age were more susceptible to stress than their younger colleagues. This can be related to a decreasing tolerance for environmental difficulties, which would facilitate quicker physical and mental exhaustion. In turn, separation from social support networks can be the most significant difficulty for the younger fishermen [4, 5]. Presumably, this is due to greater exposure to and a subsequent lower tolerance to the demands of isolation at sea. Greater susceptibility to anxiety can be related to quicker physical and mental exhaustion, which becomes the most evident during the most difficult expedition phase.
4. Fishermen with primary school-level education and fishermen who were on their first deep-sea expedition generally experienced greater anxiety. In contrast, officers and fishermen reporting high job satisfaction were more resilient to stress. Individuals with lower education levels likely have greater difficulties in adapting to ship conditions. They occupy lower positions in the crew, are assigned lower quality living quarters, and experience lower job satisfaction.
5. Education could also reflect career aspirations, and thus can be indirectly related to a low need for self-realisation. Fishermen with lower education levels report mainly being motivated by financial concerns. In the current study, these fishermen were also observed to abuse alcohol the most frequently, possibly as a maladaptive way of regulating the anxiety of long-term isolation. Fishermen with higher education, mostly holding officer ranks, exhibited a greater motivation and experienced lower anxiety during the most challenging phases of isolation. They presumably chose their position consciously and deliberately. Responsibility for expedition could also have mediated their stress resilience.
6. Fishermen with low job experience or participating in a deep-sea expedition for the first time also showed increased susceptibility to anxiety. The initial period of a career as a sailor thus seems to be related to increased emotional costs. These could be related to difficulties in anticipating challenging situations, the novelty of the experience, and difficulties in separating from the usual dynamics of life on land. Job experience as a fisherman denotes the acquired skill and task proficiency as well as the accumulation of specific physical and mental consequences of repeated long-term isolation in difficult conditions. Thus, it can be expected to influence stress vulnerability. These data might suggest that fishermen who have gathered appropriate experience and developed effective coping mechanisms, but have not yet begun experiencing burnout-like symptoms are the most resilient. In turn, risk factors of vulnerability might include difficulties in anticipating various challenges, novelty of the expedition conditions, and negative emotions related to separation from family and from land.
7. Those fishermen who grew up in large cities displayed lower resilience to stress on a level of statistical tendency. This effect requires further study, though it seems to suggest that growing up in urban environments facilitates a greater need for stimulation. Place of residence in childhood might influence the need for stimulation later in life. For example, it can be expected that people who spent their childhood/adolescence in rural areas might cope better with the monotony of a sailing expedition in contrast to people who were raised in urban areas which shape a greater need for stimulation.
8. Fishermen satisfied with their job and seeing it as valuable in itself are more resilient to anxiety. Work on a fishing vessel requires specific personal predispositions. Thus, it can be assumed that individuals who find difficult work in difficult conditions personally appealing will be more resilient to stress experienced during that work.

These results suggest that the dynamics of anxiety experience in conditions of long-term isolation has varied underlying causes and that psychological functioning in especially difficult environments is generally related to individual life experience, constructed and reconstructed in various developmental periods and social contexts. Such variables as age, education, and job experience determine the life experience of a sailor on a deep-sea expedition. However, a wide range of other individual and social factors must additionally be considered. Attempts at such research are presented in Plopa [17–19].

Coping with the stress of isolation during the initial phases of the expedition was similar for the entire studied sample, with differences emerging only in the subsequent phases. Some sailors experienced stable levels of anxiety, while others reported an increase. The results confirmed the hypothesis, suggested in earlier research, that the middle phase of the expedition is the most demanding psychologically.

The value of the current study thus lies in identifying areas of further research on factors determining stress resilience. Adaptive functioning in short-term situations, even of intense stress, most likely relies on other psychological resources (e.g., decision-making) than does functioning in prolonged conditions of stress where, for example, factors related to personality and social support networks come into greater prominence. For these reasons, the value of laboratory experiments for predicting individual functioning during long-term isolation is limited. On the other hand, the current research was carried out in highly difficult conditions of long-term deprivation and involved almost an entire crew of a fishing vessel. Prior research on natural isolation has usually involved much smaller samples, which limited the ability to consider individual differences. Also importantly, the current study addressed the personal psychological costs incurred by the sailors during the expedition rather than their job/task effectiveness, as was the case in much of the prior research.

The current study was based upon the transactional conception of stress, in which stress is the result of an interaction between an individual and their environment. This allowed for greater emphasis on the psychological underpinnings of this interaction as a whole. For example, an individual can subjectively perceive their objectively difficult conditions as relatively non-threatening, but can nevertheless experience stress on a physiological, psychological, or interpersonal level. The results of the current study have shown that an individual's perception of their current condition can be determined by their life experience (i.e., demographic variables). Thus, for some, this perception will be realistic and adaptive for some, and more biased and maladaptive for others. In conditions of long-term isolation, the influence of life experience, and, consequently, the experience of stress, will vary over time.

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VIA MEDICA

LETTER TO THE EDITOR

COVID-19 on cruise ships: preventive quarantine or abandonment of patients?

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The Diamond Princess, the Grand Princess, the A-Sara, we could continue the list of cruise ships with SARS-CoV-2 coronavirus patients on board. For several weeks, no country, despite having health care systems in place, agreed to receive them or to carry out a medical evacuation, to the point where a Frenchman declared: "*If no one comes to get us out of this impasse, we are facing something of a death sentence*" (https://www.francetvinfo.fr/sante/maladie/coronavirus/coronavirus-des-francais-bloques-sur-un-paquebot-au-large-du-panama_3889157.html). Quarantine is defined as "*a period of time during which a person that might have a disease is kept away from other people so that the disease cannot spread*" (https://dictionary.cambridge.org/fr/dictionnaire/anglais/quarantine). Keeping others away from people who might have a disease is certainly the most obvious way to contain an epidemic. But should it be done without treating patients?

The historical experience of our port shows that it should not. The city of Brest has been a port since Roman times. Of strategic importance, this military port grew in importance during the reign of Louis XIV. It became a naval construction arsenal and the centre of a large military fleet. It still is today. Since the great explorations, Europe and the world have experienced great epidemics. The port of Brest therefore set up a system of quarantine and care for crews returning from abroad. The island of Trébéron, a short distance from Brest, was reserved for quarantine [1]. If sailors fell ill during this period, they received appropriate care. If, alas, they died, they were buried on the neighbouring island, which came to be known as *the island of the dead*.

In England and the Mediterranean, quarantine did not mean an absence of care either. Faced notably with the risk of cholera in the 19th century, the English preventive system was set up, and in 1872 the Public Health Act was passed. The aim was then to identify the sick on the ships and to isolate them during boarding and disembarking [2]. The sick, who were identified and then isolated, could receive care. In the Mediterranean, a network of hospitals was set up. The spread of the epidemic was due to the lack of respect of quarantine measures in certain countries, and not to the care of the sick themselves [3].

The COVID-19 pandemic raises a number of ethical questions [4]. In this situation, quarantine or containment should not slow down care. In this day and time, we have medical evacuation technologies, protections to care for patients while reducing risks for caregivers, and also the protocols needed to avoid the spreading of micro-organisms. Can we really still think that leaving patients on board ships meets the definition of quarantine? A clear distinction must be made here between preventive quarantine, for the screening and referral of patients, and the segregation of patients due to the fear of a biological agent. In a global context such as the COVID-19 pandemic, perhaps doctors, who have taken the Hippocratic Oath to treat all patients, should have a say in how to avoid wasting time in the care of certain patients [5].

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LETTER TO THE EDITOR

The risk of the collapse of public health centres under the current system to prevent the spread of COVID-19

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COVID-19, which originated in the city of Wuhan, Hubei Province in China in December 2019, is spreading worldwide. Most of the recent media coverage in Japan has dealt with COVID-19. In its system to respond to COVID-19, Japan has criteria for determining suspected cases of COVID-19. If an individual might have COVID-19 based on those criteria, then government bodies in the form of public health centres or counselling centres (associated with public health centres) are contacted, and personnel at the public health centre or counselling centre "determine whether the individual needs to be seen by a COVID-19 centre" [1]. In addition, public health centres are responding to COVID-19 by "providing phone consultations to address COVID-19 concerns", "following up with patients with mild symptoms or individuals who might be infected", "investigating close contacts (which includes identifying clusters)", "investigating and examining routes of infection", "transporting specimens depending on the situation", and "looking for hospitals that will admit patients with COVID-19" [1, 2]. Public health personnel are performing routine tasks in addition to the aforementioned efforts to deal with COVID-19. Studies have reported that some of the workers performing over 80 hours of overtime a month (the "death from overwork limit") are in charge of the response to COVID-19 and that public health centre personnel are working throughout the crisis with almost no time off [2, 3].

Nationwide, there were 847 public health centres in Japan in 1994, but there are now 469 public health centres as a result of administrative reform, so the number of centres almost halved in about 30 years [2]. There are fewer public health centre physicians and public health nurses than in the past. Under Japan's current system to prevent the spread of COVID-19, public health centres are the frontline of the multifaceted response to the crisis, but the response by public health centres will falter due to the excessive workload and the dearth of personnel if nothing is done. Reports have described the "closure of emergency rooms" and "the potential risk of the medical system collapsing" [4, 5]. If such circumstances develop, then public health centres may be spending more time looking for hospitals that will see patients with COVID-19 in addition to their current tasks. Public health centres are "temporarily bringing retired public health nurses back in" and "extensively using ICT" [1], but these steps have not enhanced the ability of personnel to deal with the crisis nor have they reduced mental exhaustion suffered by personnel. Manpower needs to be increased, public health centre personnel need appropriate rest, and mental health care is urgently needed. Avoiding the potential collapse of public health centres will help correspondence during long-periods with COVID-19.

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LETTER TO THE EDITOR

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The current effects of the spread of COVID-19 in learning environments involving Japanese college students: what is the state of those environments elsewhere in the world?

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COVID-19 originated in the city of Wuhan, Hubei Province in China in December 2019. In 2020, COVID-19 has shaken the world, resulting in large numbers of infected and dead. Around the world, some countries have encouraged a lockdown or shelter-in-place restrictions due to the effects of the spread of COVID-19. Similarly, Japan has encouraged self-isolation, it has asked various types of businesses to close, and it has recommended that people work from home. Every day, Japan has been dealing with COVID-19 by following those steps. Schools are out, and a growing number of students are quickly taking classes online.

According to one report [1], an indicator of the situation is the fact that about 8% of college students and junior college students are considering dropping out. Due to the effects of the spread of COVID-19, their "family income has decreased or dropped to 0" or "there are fewer part-time jobs for students, and pay has been cut or is not available". Students are considering steps such as "consulting with the school to postpone tuition payment or to receive a scholarship from the school", or "applying to receive a student loan from the Japan Student Services Organisation" [2]. However, those steps alone cannot address the potential factors for dropping out due to the effects of the spread of COVID-19. Responses at the school level are obviously needed, but the country needs to clearly identify the potential factors for dropping out and specify various ways to address them. Based on national guidelines, prefectures can supplement those approaches or communities can devise their own; these efforts will build upon responses at the school level. The country, communities, and relevant bodies need to promptly work together to address these factors. The same or similar factors are becoming a societal problem in different countries around the world. The approaches adopted by those countries can serve as a reference.

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INFORMATION FOR AUTHORS

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

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

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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.

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Only English texts will be accepted.

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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.

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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.).

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