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Proceeding Paper

Advanced Telemedicine Solutions for High-Quality Medical Assistance at Sea †

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Abstract: The medical assistance to seafarers was not always improved in parallel with advances in medicine and telecommunications. Today technology offers systems including digital devices helping in collecting symptoms to be referred correctly to remote physicians. CIRM SERVIZI, the spin-off of Centro Internazionale Radio Medico (C.I.R.M.), and the Italian TMAS center, have developed an advanced system called CIRM PREMIUM. This aimed at offering extensive telemedicine solutions for the treatment of illnesses or injuries on-board ships. The objective of this paper is to present the results of offered service with CIRM PREMIUM and the standard basic TMAS service given by C.I.R.M. to ships not equipped with advanced technologies. We have considered 400 seafarers assisted on-board ships from 1 January 2020 to 31 December 2021 including 200 on-board ships equipped with CIRM PREMIUM (Test Group, TG) and 200 were on-board ships requiring the C.I.R.M. standard free telemedical assistance (Control Group, CG). The five most frequent different disorders assisted by C.I.R.M in the given period were considered. Diseases of the circulatory and respiratory systems were also considered to be the most frequent cause of medical emergencies on board. Data were analyzed comparatively by analysis of variance (ANOVA) and by the Chi-squared test. The average time for a patient's complete recovery was 115.1 ± 12.8 h (4 to 5 days) in the TG group and 132.8 ± 14.4 h (5 to 6 days) in the CG group. From a temporal point of view, PREMIUM patients showed an improvement in 12–24 h from the first request for medical advice, versus 36–48 h for those using the standard medical service. The patients who fully recovered on board were 48.8% for the TG group and 27.46% for the CG. Telemedical assistance resulted in avoiding diversions in 73.7% of cases in the PREMIUM service and in 43.7% in the standard service. The results of our analysis revealed that the CIRM PREMIUM services provide a better and quicker outcome for patient conditions and cause significantly less ship diversions for medical reasons. This indicates that technological progress can offer relevant advantages for treating diseases or accidents on-board ships. The presence of telemedical devices on board, their larger and constant use and a closer collaboration from the ship will offer seafarers adequate health protection and will reduce the present disadvantage of being ill while at sea.

Keywords: telemedicine; CIRM PREMIUM; seafarers health; onboard medical assistance

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1. Motivation

CIRM PREMIUM consists of two components, a Tele Medicine Vessel Software (TMV) and a Tele Medicine Corner (TMC). Figure 1 presents TMC medical components. TMV is an automated medical request system guiding the ship's medical officer to select the symptoms being reported and answer specific questions pertaining to those symptoms.

Figure 1. Medical devices contained in the Tele Medicine Corner (TMC).

In case of injuries or illnesses at sea, a medical officer is in charge of the patient. On land, dedicated medical centers called Telemedical Maritime Assistance Services (TMAS) are available to give advice [1]. In this situation, the doctor has never seen the patient, and probably never will, will rarely talk with the patient and has no previous medical history of the person they are treating. In this particular scenario, the doctor will need the best possible information about the state of the patient, whereas the medical responsibility remains with the captain.

Unfortunately, medical assistance to seafarers was not always improved in parallel with advances in medicine and telecommunications. Requests for medical assistance from ships to a specialized ashore center, in general, continue to follow the same procedure used probably 100 years ago. Today technology offers systems using digital devices that help in collecting symptoms to be referred correctly to the remote physicians. Moreover, digital devices can capture and transmit biomedical vitals, monitor progress, capture images of anatomical parts of the body, etc.

CIRM SERVIZI, the spin-off of Centro Internazionale Radio Medico (International Radio Medical Center, C.I.R.M.), the Italian TMAS, has developed an advanced system for offering expansive telemedicine solutions for the treatment of illnesses or injuries on-board ships [2]. This advanced system named CIRM PREMIUM has been adopted by some leading international shipping companies, which are using it as a standard of medical assistance on-board their ships. This paper has compared the results of the CIRM PREMIUM service with the standard basic TMAS service given by C.I.R.M. to ships not equipped with the advanced technologies offered by CIRM PREMIUM.

2. Approach

The effectiveness of the CIRM PREMIUM service was analyzed comparatively versus the standard free medical service offered by C.I.R.M. For this analysis, we have considered 400 cases of patients assisted on-board ships from 1 January 2020 to 31 December 2021. Two hundred patients were on-board ships equipped with CIRM PREMIUM facilities (Test Group, TG) and 200 were on ships receiving the C.I.R.M. standard free telemedical assistance (Control Group, CG). Patients of the CG were randomly selected from the 15,178 patients assisted by C.I.R.M. during the above elapse of time among subjects with the same diagnosis and triage code at the admission of those undergoing Premium service. The results of the two different services were compared in terms of (a) Patient outcome; (b) Days of treatment; (c) Diversions avoided; (d) Data missing.

Disorders considered for this study included the five top pathologies assisted by C.I.R.M in the 2 years considered, namely in the order Diseases of the digestive system; Certain infectious and parasitic diseases; Diseases of the musculoskeletal system and connective tissue; Injury, poisoning, and certain other consequences of external causes; Diseases of the skin and subcutaneous tissue. Diseases of the circulatory and respiratory systems were also considered to be the most frequent cause of medical emergencies on board.

Patients of the CG were randomly selected from the 15,178 patients assisted by C.I.R.M. during the above elapse of time among subjects with the same diagnosis and triage code

at the admission of those using the PREMIUM service. Parameters examined included (a) Patient outcome; (b) Days of treatment; (c) Diversions avoided; (d) Data missing. Data of days of treatment were analyzed comparatively by analysis of variance (ANOVA). The Chi-Squared test was used to determine the significance of differences in other parameters considered between TG and CG.

3. Testing Outcomes

Data of patient outcomes indicated in the TG group an improvement of 83% of cases, no changes of 16% of cases, and worsening of 1% of cases. In the CG, the improvement occurred in 49% of cases, the conditions of 41% of patients were unchanged, in 2% of cases patient's conditions worsened, whereas for 7% of cases the ships did not maintain contact and therefore we do not know the outcome of the assistance. The average time for a patient's complete recovery was 115.1 $\pm$ 12.8 h (4 to 5 days) in the TG group and 132.8 $\pm$ 14.4 h (5 to 6 days) in the CG. From a temporal point of view PREMIUM patients showed an improvement in 12–24 h from the first request for medical advice, versus 36–48 h for those using the standard medical service. Patients fully recovered on board were 48.8% for the TG group and the 27.46% for the CG group.

Based on the diagnosis, triage code and reported subjective symptomatology, the need of ship diversion for the patient's prompt hospitalization occurred in the 10.86% of cases for the TG and in the 11.63% of cases for the CG. Medical interventions from ashore resulted in avoiding diversions in 73.7% of cases in the PREMIUM service and in 43.7% in the standard service.

Data missed that can be relevant for the provision of medical advice were significantly less in the TG which in general uses a data exchange platform with fields to be filled-in compulsorily compared with the CG. This platform is compliant with the General Data Protection Regulation (GDPR). The name and the nationality of the patients were missing, respectively, in 30.2% and in 25.6% of CG cases. Patient's age was missed in 31% of cases, whereas the patient's rank, the knowledge of which is important to identify possible occupational diseases, was not mentioned in the 36% of CG requests for medical advice. Ship's position, port of departure, destination and nearest port which are information necessary for epidemiological reasons, in cases of emergencies such as a diversion required, a stop at a port, disembarkation, or hospitalization were not communicated in more than 40% of cases. The inventory of medicines available on board, based on which the TMAS doctor can give their prescriptions was missed in the 44.7% of cases.

4. Conclusions

The results of our analysis with a better outcome and a quicker improvement of the patient conditions as well as significantly fewer ship diversions for medical reasons indicate that technological progress can offer relevant advantages for treating diseases or accidents on board ships. Probably thanks to friendly technologies, the old consideration that because of the scarce possibilities of assistance, getting sick on board a ship at sea does not allow one to be properly cured must be debunked. The presence on board of telemedical devices, their larger and constant use, and a closer collaboration from the ship side will offer seafarers adequate health protection and will reduce the present disadvantage of being ill while at sea.

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References

1. Mahdi, S.S.; Amenta, F. Eighty years of CIRM. A journey of commitment and dedication in providing maritime medical assistance. *Int. Marit. Health* **2016**, *67*, 187–195. [CrossRef] [PubMed]
2. Sagaro, G.G.; Di Canio, M.; Battineni, G.; Samad, M.A.; Amenta, F. Incidence of occupational injuries and diseases among seafarers: A descriptive epidemiological study based on contacts from onboard ships to the Italian Telemedical Maritime Assistance Service in Rome, Italy. *BMJ Open* **2021**, *11*, e044633. [CrossRef] [PubMed]

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Abstract

Remote Monitoring of Ship Pharmacy: An Experience of Maritime Telepharmacy †

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Keywords: ship's pharmacy; ship medicine chest; inventory management; TelePharmaSEA; software

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1. Introduction

The ship is not only a workplace. It is a real living environment for a particular class of workers: the seafarers. Seafarers are particularly exposed to a high risk of accidents and diseases. Moreover, onboard commercial ships, there are no health personnel on board, and the health responsibility of the crew is in the Master's hands. That is why it is crucial to have available onboard medicine and medical instruments allowing for the performance of first aid interventions, and to counter any health hazards that may occur. The actual implementation of healthcare onboard ships depends on the "onboard pharmacy", also called "ship's medicine chest". On-board pharmacies currently present several problems: poor or no standardization (they are different for each country, according to different regulations), they usually have little (or not-effective) choice of medicines, and they often bear old medicines that can be replaced by more recent medications and last, but not least, often due to the lack of some specific drugs, an off-label use of medicines available becomes necessary. Another problem is that of expired medicines needing to be replaced. The above problems can be avoided or reduced by providing seagoing vessels with a system that uses computing technologies for handling the ship's pharmacy. A tele pharmacy service (TelePharmaSEA) is the system that we have developed to avoid these problems.

2. Material and Methods

The TelePharmaSEA software was developed for making the management of the on-board pharmacy easier and to have medicines and medical instruments required by the flag country's regulations always available. The application is based on a database containing information about medicines and medical devices required by different countries' regulations. To further improve the quality of the service, a questionnaire on "Customer Satisfaction" was developed, submitted to both ships subscribed to this service and TMAS providing regular medical advice to a given ship. This allowed us to assess the appreciation for the service offered. The questionnaire was sent to the 80 ships subscribed to the service and we received 65 filled-in forms (81% response rate). Data were analyzed statistically by Analysis of Variance (ANOVA).

3. Results

With the use of the TelePharmaSEA software, it was possible to standardize the inventory procedures, to quickly identify and to re-supply expiring medicines, and to facilitate the work of inspectors of maritime health authorities. Overall, thanks to TelePharmaSEA, a

ship's pharmacy maintenance is easier for the crew, not an expert in the field, due to the automatized procedures for medicine control and management. The use of the software, as well as the automation of different activities, in general, carried out manually, will help to handle the ship's pharmacy. The degree of satisfaction received for the service/software is quite high, with 90% of respondents highly satisfied ($p < 0.05$) and 10% satisfied ($p < 0.05$). The same is true for the resolution of technical problems, the correct and efficient management of the problems occurring in the ship's pharmacy, and IT assistance when necessary. Interestingly, the service has also guaranteed economic savings from shipping companies in terms of purchases and supplies for the onboard pharmacy.

4. Discussion and Conclusions

Advanced technologies can support inexperienced people responsible for handling/managing the ship's pharmacy to interact properly with TMAS and competent health authorities. This software represents a real opportunity to simplify the management of the ship's pharmacy and consequently, to improve the quality of medical assistance onboard seagoing vessels.

Author Contributions: G.N.: Concived and designed the study, analyzed the data and interpreted the results, drafted the abstract. A.A.: Contributed to collection of data and analyzed the data. F.A.: Supervised and approved the study. All authors have read and agreed to the published version of the manuscript.

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Abstract

Occupational Diseases and Injuries on Board Ships: A Preliminary Analysis for an Epidemiological Observatory of Seafarers †

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1. Introduction

Workers on board ships have a higher rate of mortality, injuries, and illnesses than their counterparts ashore due to their particularly risky working conditions. Occupational diseases including musculoskeletal disorders (MSD), cardiovascular diseases (CVD), diseases of respiratory systems, skin and subcutaneous disorders, and injuries are the most common causes of morbidity on board ships among seafarers. These health issues represent the main reasons for medical consultation, repatriation, and death of seafarers at sea. Different studies conducted on board ships have revealed a variety of problems in accessing data and health information of seafarers at sea, which can be used to recommend prevention strategies and provide evidence-based information to maritime health policymakers. To effectively address these challenges, we have been establishing an epidemiological observatory of occupational diseases and injuries for seafarers. This initiative has been realized in collaboration with the Italian Ministry of Health, the University of Camerino and the International Radiomedical Centre (C.I.R.M.), the Italian Telemedical Maritime Assistance Service (TMAS).

2. Materials and Methods

A descriptive epidemiological study approach was used, and the analysis was based on the telemedical assistance data of C.I.R.M. from 2010 to 2021. C.I.R.M. is the Italian TMAS that has provided medical assistance to seafarers and passengers on board ships since 1935. Each diagnosis was recorded in the C.I.R.M. database according to the 10th revised version of the International Classification of Diseases (ICD) of the World Health Organization (WHO). For this preliminary analysis, we focused on contacts of medical requests to C.I.R.M. related to occupational diseases and injuries of seafarers from Italian shipping companies. In this study, we considered occupational diseases, including diseases of the musculoskeletal system and connective tissue (ICD: M00 to M99), cardiovascular diseases (I00 to I99), diseases of the respiratory system (J00 to J99), disorders of the skin and subcutaneous tissues (L00 to L99), and injuries (S00 to S99 and T00 to T98). From the database, we retrieved diagnoses as well as parameters such as age, rank, gender, workplace, and other variables relevant to our analysis. A descriptive analysis was performed to evaluate the distribution of both diseases and injuries among occupational groups. Rank was stratified by officers (deck and engine officers) and non-officers (deck and engine

ratings, as well as galley staff). The age of the seafarer with medical cases was calculated by subtracting their date of birth from the date of medical advice provision and was grouped into five categories: under 25 years, between 26 and 35 years, between 36 and 45 years, between 46 and 55 years, and above 55 years. We excluded from the analysis seafarers whose date of birth was not available.

3. Results

It is estimated that 4298 seafarers aged 19 to 73 years (mean age: 39.74 $\pm$ 11.44) with 1843 (43%) officers and 2455 (57%) non-officers having requested medical advice from Italian flag ships during the study period. Most reported cases were injuries (16%), cardiovascular diseases (8%), dermatological disorders (7.9%), musculoskeletal disorders (6.9%), and respiratory disorders (5%). Out of 342 seafarers with CVD, 40% were officers [deck officers (18.7%) and engine officers (21.3%)], while 60% were non-officers [deck ratings (21%), engine ratings (25%), and galley staff (14%)]. The mean age of seafarers with CVD was 42.51 $\pm$ 12.39 years, and the mean age of seafarers with musculoskeletal disorders was 39.52 $\pm$ 11.18 years. Based on nationality, 36.5%, 35%, 21.1%, 3.4%, and 3.2% of seafarers who contacted for medical advice were Italian, Indian, Filipino, Chinese, and Romanian, respectively.

4. Discussion and Conclusions

Preliminary results indicate that injuries are the leading reason for medical advice requests from Italian shipping companies, followed by cardiovascular disease and dermatological disorders. In the present study, it was found that non-officers (engine and deck crew) were more frequently diagnosed with CVD and dermatological disorders than officers. The findings could help the industry, maritime doctors, and seafarers make informed decisions for the establishment of onboard prevention strategies.

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Role of teledermatology in the management of dermatological diseases among marine workers: A cross-sectional study comparing general practitioners and dermatological diagnoses

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Background: Diagnosis and treatment of skin disease in sea workers is an unmet need. The purpose of this study is to highlight how remote management of dermatological conditions appears inadequate in this scenario.

Objective: This study aimed to identify the best epidemiology for seafarers' diseases and analyze the adequacy of medical assistance in the diagnosis of dermatological maritime diseases.

Material and methods: A total of 420 cases of requests for dermatological diseases received by the Telemedical Maritime Assistance Service of the International Medical Radio Center (C.I.R.M.). in a referral year were included in this cross-sectional study. All pictures of cutaneous lesions had been submitted to both C.I.R.M. doctors and an expert dermatologist who provided their diagnosis.

Results: The most frequent diagnosis in both groups was infectious or inflammatory skin diseases. The main differences are represented by the amount of "unclassified dermatitis" or descriptive diagnosis, such as "cutaneous eruption" which were the most frequent diagnosis of C.I.R.M. doctors ($p < 0.05$ and $p > 0.0001$). In these cases, Cohen's K was < 0.5 consistent with low concordance between dermatologic diagnosis and C.I.R.M. diagnosis.

Conclusion and relevance: Our study emphasizes the magnitude of dermatological diseases in the maritime sector, although often underestimated, and highlights the difficulty in their diagnosis for doctors on call that need more training on specific dermatological issues.

KEYWORDS

maritime dermatology, teledermatology, seawork, occupational disease, diagnosis

Introduction

Dermatological diseases represent a primary cause of morbidity among fishermen and seafarers on board merchant ships (1, 2). Marine workers are exposed to conditions such as humidity, seawater contact, and chemicals, which are known risk factors for the development of hyperkeratosis, contact dermatitis, and injuries (3). Furthermore, UV exposure is 20% higher than that of land-based workers (4), increasing the risk of skin cancers (5). The most frequent professional skin diseases are contact dermatitis (6), mechanical injuries, infections, and stings from marine animals (3). However, the coverage of this topic in literature is limited with only a few small collections reported, mainly with small patient numbers and without dermatological evaluation (3, 7, 8).

The objective of this study is to identify the most frequent dermatological diseases encountered onboard, the epidemiology of sea workers affected, and the possible role and implications of teledermatology in dermatological diagnosis among marine workers.

Materials and methods

Dermatological diseases for which medical assistance was requested from the International Medical Radio Center (C.I.R.M.) in the years 2013–2017 were collected from the C.I.R.M. database and dermatological cases were identified. Cases from 1 January to 31 December 2017 were extracted and analyzed. They accounted for 5,095 assistance requests among which 512 were dermatological consultations. Photographic images or symptoms description were not available in 92 cases, which were excluded. C.I.R.M. Telemedicine platform accepts images with a resolution of at least 1,024 × 768 pixels, consistent with the American Telemedicine Association (ATA) guidelines; images with the lowest resolutions are automatically rejected. A total of 420 cases were included in the study; each patient received a diagnosis by a C.I.R.M. doctor who is not a dermatologist and one by an expert dermatologist (PQ) after pictures and case description had been sent to him through an email-telemedicine system.

The Pearson X2 test with Yates correction was performed to compare the frequency of diagnoses between the two groups. Cohen's kappa coefficient (κ) was used to measure the inter-rater reliability. Statistical analysis was conducted by using STATA 16 software.

Results

Between 2013 and 2017, the C.I.R.M. has assisted a mean of 4,363.4 ± 611.5 patients per year. Each year, the number of patients treated increases on average by 9.77%, while requests for medical care of dermatological interest increase on average by +17.99% every year. Dermatological consultations were on average 403.6 ± 108.1 per year, representing 10% of total cases.

The median age of patients with dermatological manifestations was 37 ± 10 years, the majority were part of the deck (35.4%) or engine crew (19.7%) and came from India or the Philippines.

Based on the diagnosis of the dermatologist, the most common diseases encountered on board were psoriasis (4.1%), herpes virus (3.52%), entomodermatosis (3.13%), pityriasis rosea (2.73%), cysts (2.40%), tinea (2.34%), pyodermitis (2.15%), and folliculitis (2.15%); while according to C.I.R.M. doctors, the most common were were dermatitis (36.91%), mycosis (5.27%), skin infections (3.13%), and pimples (3.32%). The highest level of concordance between dermatologists and C.I.R.M. doctors concerned the diagnosis of abscesses (11.33 and 7.81%, respectively, κ 0.79), whitlows (5.66 and 3.52%, respectively, κ 0.79), and eczema (3.52 and 8.4% cases, respectively, κ 0.52).

Table 1 summarizes the diagnoses made by C.I.R.M. doctors and dermatologists. The most relevant differences are represented by the amount of "unclassified dermatitis" which was the most frequent diagnosis of C.I.R.M. doctors (36.91%), while rarely made by the dermatologist (only 3 cases) (chi-square: 151.08 $p < 0.05$). Similarly, C.I.R.M. doctors reported a descriptive diagnosis ("dermatitis/cutaneous eruption," "erythema" or "wound") in 197 cases while this happened in only 10 cases by the dermatologist (chi-square: 2,209.48, $p > 0.0001$).

The dermatologist made a significantly more frequent diagnosis of psoriasis, perionyxis, entomodermatosis, granulomas, angiomas, lichen planus, and tinea. No significant differences between C.I.R.M. and dermatologist diagnoses were found for other diagnoses (warts, withlows, urticaria, abscess, herpes virus, and alopecia areata).

Cohen's Kappa test showed a moderate/high level of concordance (0.6 < K-coefficient < 1) between C.I.R.M. doctors and dermatologists regarding the diagnosis resulted in not statistically significant at previous tests and low/null level of concordance (K-coefficient < 0.5) for those statistically significant.

Discussion

Dermatological diseases represent common frequent pathologies aboard ships. According to the C.I.R.M. database, requests for dermatological medical assistance increased from 2.45% of total requests in 1994 to 8.3% in the years 2012–2014 (1), up to 10% in this report. In fact, in the last 5 years, requests for C.I.R.M. dermatological assistance have increased by 17.99% every year, against the average increase of 9.77% for medical assistance in general.

This case series of 420 cases represent, as far as we are concerned, the first cohort of sea workers analyzed by

TABLE 1 Comparison between C.I.R.M. doctors' and dermatologist's diagnoses, chi^2 test ($p > 0.05$) and Cohen's K-coefficient (<0.01: null; 0.01–0.2 low; 0.21–0.4 modest; 0.41–0.6 moderate; 0.61–0.8 good; 0.81–1 excellent).

Diagnosis	C.I.R.M. doctor		Dermatologist		chi^2 test		Cohen's kappa coefficient (κ)			
	Nr.	%	Nr.	%	chi^2	p-value	Both positive	Dermatologist positive and guard doctor negative	Dermatologist negative and guard doctor positive	Cohen's Kappa (Concordance)*
Intertrigo	2	0.39%	18	3.52%	13.19*	**0.0001**	2	16	1	0.180
Pityriasis	3	0.59%	14	2.73%	11.47*	**0.0007**	3	11	3	0.286
Mycosis	27	5.27%	7	1.37%	12.261*	**0.0004**	7	6	26	0.273
Unclassified dermatitis/skin eruption/skin rash	189	36.91%	3	0.59%	151.08*	**0.0001**	3	1	186	0.013
Wart	4	0.78%	7	1.37%	0.82	0.36	4	3	0	**0.724**
Pimple	17	3.32%	5	0.98%	6.72*	**0.009**	5	10	2	0.442
Urticaria	9	1.76%	19	3.71%	3.69	0.054	9	0	10	**0.632**
Abscess	58	11.33%	40	7.81%	3.74	0.0530	40	0	18	**0.793**
Perionyxis	2	0.39%	13	2.54%	8.19*	**0.0008**	2	11	0	0.261
Skin infection	16	3.13%	2	0.39%	11.08*	**0.0009**	2	1	14	0.201
Pyodermitis	1	0.20%	11	2.15%	8.43*	**0.0037**	1	10	0	0.163
Eczema	18	3.52%	43	8.40%	10.89*	**0.0010**	18	25	4	0.521
Entomodermatosis	5	0.59%	17	3.13%	6.72*	**0.009**	5	12	1	0.423
Granuloma	2	0.39%	10	1.95%	5.40*	**0.0202**	2	8	0	0.328
Detritive dermatitis	1	0.20%	8	1.56%	5.49*	**0.0191**	1	7	1	0.194
Seborrheic dermatitis	1	0.20%	8	1.56%	5.49*	**0.0191**	1	7	0	0.219
Psoriasis	5	0.98%	21	4.10%	10.01*	**0.0001**	5	16	2	0.341
Angioma	1	0.20%	8	1.56%	5.49*	**0.0191**	1	1	7	0.194
Erysipela	4	0.20%	14	1.56%	5.65*	**0.017**	4	10	1	0.411
Lichen planus	1	0.20%	8	1.56%	5.49*	**0.0191**	1	7	0	0.194
Actinic Keratosis	1	0.20%	8	1.17%	5.49*	**0.0191**	1	7	1	0.194
Whitlow	29	5.66%	18	3.52%	2.70	0.1005	18	9	0	**0.789**
Tinea	2	0.39%	12	2.34%	7.24*	**0.0071**	2	10	0	0.280
Folliculitis	6	1.17%	11	2.15%	1.5	0.2	6	5	1	**0.660**
Alopecia areata	4	0.78%	6	1.17%	0.4	0.5	4	2	0	**0.798**
Herpes virus infection	9	1.76%	18	3.52%	3	0.07	9	9	0	**0.657**
Cysts	4	0.79%	10	2.40%	2.6	0.1	4	6	0	0.566

*refers to the concordance (Cohen's Kappa).

comparing the diagnoses made by the doctor on call and an expert dermatologist.

The two main groups of dermatological diseases can be singled out: infectious dermatitis (abscesses 7.81%, herpes virus skin infections 3.52%, pyodermitis 2.15%, whitlows 3.52%, tinea 2.34%, warts 1.37%) and diseases related to environmental and working conditions (folliculitis 2.15%; intertrigo 3.52%, and detritive dermatitis 1.56%). Moreover, cases of eczema (8.4%) and urticaria (3.71%) could be attributed to contact with allergens or irritants due to working conditions.

A survey (3) involving 1,102 Moroccan fishermen based on legal medical consultation and not on requests for dermatological diseases, showed a high prevalence of palmoplantar hyperkeratosis (67%), skin infections (59.2%), and entomodermatosis (11.2%). Lucas et al. (8) reported dermatological diseases in 183 sea-workers through a telemedicine service without a dermatological review. Among

them, 68% had infections, 14% had inflammatory diseases, 7% had environmental conditions, and 11% had non-specific rashes. Another study reported data collection through self-completed questionnaires revealing that contact and allergic dermatitis followed by eczema were the most frequent diseases of seafarers' lower limbs (10).

In our series, psoriasis accounted for 4.1% of cases, a quite high figure as the majority of sea-workers came from India and the Philippines, where its prevalence is lower (1.49%) (9). On the other hand, diseases related to UV exposure (1.17% actinic keratosis) were not so common. This could be due to the young age of patients (median 37 years); moreover, effective UV exposure for these people was not available. Oldenburg et al. (7) reported higher percentages with actinic keratosis in 18.3% of patients and skin cancer suspected in 9.3% of patients. However, in this study, all the patients received a full body examination by a dermatologist, and not only through telemedicine, and the patient age was higher (median more than 50 years).

In contrast with the frequency of dermatological manifestations in sea workers and the increase in dermatological medical assistance, our study highlights the difficulty in their diagnosis for doctors on call, not supported by a dermatologist. Indeed, significant differences were found between the diagnoses made by the two doctors. The dermatologist made a disease diagnosis in a significant percentage of patients (97.6%) and thus supporting the cornerstone role of teledermatology in this field; the fact that a dermatologist was able to make a disease diagnosis in the large majority of cases argues in favor of the good quality of clinical pictures sent to the C.I.R.M. On the other hand, the diagnosis of the doctor on call was descriptive in nearly half of the cases (46.9%) and only some pathologies were identified correctly (abscesses, whitlows, warts, urticaria, and herpes virus) probably due to the signs and symptoms easily identifiable. Based on these data, doctors on call should be trained to acquire a more comprehensive knowledge of dermatological diseases or could be assisted by an expert dermatologist.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

PQ and FA planned the work. MD collected data. LB and SR make specialist diagnoses and statistical analysis. MD, LB, SR, FA, and PQ have discussed data. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

1. Mahdi SS, Amenta F. Eighty years of CIRM. A journey of commitment and dedication in providing maritime medical assistance. *Int Marit Health.* (2016) 67:187–95. doi: 10.5603/IMH.2016.0036

2. Tomaszunas S, Wecławik Z, Lewiński M. Morbidity, injuries and sick absence in fishermen and seafarers—a prospective study. *Bull Inst Marit Trop Med Gdynia.* (1988) 39:125–35.

3. Laraqui O, Manar N, Laraqui S, Ghailan T, Deschamps F, Hammouda R, et al. Prevalence of skin diseases amongst Moroccan fishermen. *Int Marit Health.* (2018) 69:22–7. doi: 10.5603/IMH.2018.0004

4. Caruso G. Do seafarers have sunshine? In: *8th International Symposium on Maritime Health (ISMH) Book of abstracts Rijeka-Croatia* (2005).

5. ICNIRP. ICNIRP statement—Protection of workers against ultraviolet radiation. *Health Phys.* (2010) 99:66–87. doi: 10.1097/HP.0b013e3181d85908

6. Clark SC, Zirwas MJ. Management of occupational dermatitis. *Dermatol Clin.* (2009) 27:365–83, vii–viii. doi: 10.1016/j.det.2009.05.002

7. Oldenburg M, Kuechmeister B, Ohnemus U, Baur X, Moll I. Actinic keratosis among seafarers. *Arch Dermatol Res.* (2013) 305:787–96. doi: 10.1007/s00403-013-1384-z

8. Lucas R, Boniface K, Hite M. Skin disorders at sea. *Int Marit Health.* (2010) 61:9–12.

9. Michalek IM, Loring B, John SM. A systematic review of worldwide epidemiology of psoriasis. *J Eur Acad Dermatol Venereol.* (2017) 31:205–12. doi: 10.1111/jdv.13854

10. Rego-Pena V, Bouza-Prego MÁ, Gómez-Muniz F, Veiga-Seijo R. Dermatological diseases in seamen's lower extremity: a prevalence study. *Int Marit Health.* (2021) 72:18–25. doi: 10.5603/IMH.2021.0003

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LASSO Regression Modeling on Prediction of Medical Terms among Seafarers' Health Documents Using Tidy Text Mining

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Abstract: Generally, seafarers face a higher risk of illnesses and accidents than land workers. In most cases, there are no medical professionals on board seagoing vessels, which makes disease diagnosis even more difficult. When this occurs, onshore doctors may be able to provide medical advice through telemedicine by receiving better symptomatic and clinical details in the health abstracts of seafarers. The adoption of text mining techniques can assist in extracting diagnostic information from clinical texts. We applied lexicon sentimental analysis to explore the automatic labeling of positive and negative healthcare terms to seafarers' text healthcare documents. This was due to the lack of experimental evaluations using computational techniques. In order to classify diseases and their associated symptoms, the LASSO regression algorithm is applied to analyze these text documents. A visualization of symptomatic data frequency for each disease can be achieved by analyzing TF-IDF values. The proposed approach allows for the classification of text documents with 93.8% accuracy by using a machine learning model called LASSO regression. It is possible to classify text documents effectively with tidy text mining libraries. In addition to delivering health assistance, this method can be used to classify diseases and establish health observatories. Knowledge developed in the present work will be applied to establish an Epidemiological Observatory of Seafarers' Pathologies and Injuries. This Observatory will be a collaborative initiative of the Italian Ministry of Health, University of Camerino, and International Radio Medical Centre (C.I.R.M.), the Italian TMAS.

Keywords: seafarers; text mining; lasso regression; disease mapping; correlations

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1. Introduction

Seafarers are regularly on the move and working at sea. As a result of long-term voyages, many international seafarers are away from their friends and families for at least six months per year [1]. The shipping industry is popular and used by 88% of world trade. However, it has a higher mortality rate, an injury rate, and a disease rate than land-based workers [2]. There are many risks associated with working at sea, including climate changes, seawater, humidity, and sun exposure [3,4]. Seafarers' health and living conditions are affected by their working environment. Medical issues onboard are explained via telephone or internet by the captain in consultation with Telemedical Maritime Assistance Services (TMAS) doctors onshore. Health services are provided based on the severity of the case. Later, patient data are stored as digital health documents, which are created as text records [5,6].

Data analysts including those from different fields are often tasked with analyzing text or other unstructured data [7]. From the seafarers' telemedicine data, we can extract pathology information, symptoms information, patient condition info, prescriptions from

doctors, etc. We can use these data to make better medical decisions. For doing, we need advanced computational tools and skills to analyze unstructured text [8]. One way to learn more is to use word frequency analysis. Sentiment analysis allows one to extract mapping words and emotions from symptomatic words. As a result, we can develop a basic understanding of Text Mining (TM) approaches, which are widely applied to retrieve symptomatic data [9]. Medical pattern recognition software that converts texts to natural language using medical directories, algorithms, and information knowledge [10,11]. The use of TM techniques has proven to be beneficial in detecting depression symptoms with comprehensive diagnostic accuracy, according to studies in mental health [12]. According to [13], the integration of TM knowledge with neurological data can be used to detect neurological diseases and syndromes based on annual data.

Natural language processing (NLP) and machine learning (ML) techniques are used in sentiment analysis (also known as opinion mining) [14]. Medical sentimental analysis is used for the evaluation of medical records and automated decision support systems [15,16], as well as for assessing a patient's emotions and sentiments based on medical history [17]. Likewise, a hybrid text model has been designed to help healthcare workers diagnose diseases such as diabetes and dementia [18,19]. Social media and the web can be analyzed with TM to identify knowledge about diabetes diagnosis and treatment. In this study, patterns in the web and social media text were analyzed to discover previously overlooked diagnoses or conditions of diabetes via comparison with those from standard diabetes treatment and diagnosis [19].

The literature on TM primarily focuses on sentiment analyses, such as emotion recognition, handwritten/typed text analysis, and data visualization. The authors of [20] provided a list of all methodologies and approaches for performing sentiment analysis based on three categories: machine learning, dictionaries, and ontologies. The study provides a brief introduction to opinion mining issues such as data sparsity, binary classification, and polarity shift problems in distinct domains. Various analytical algorithms are discussed to extract the text from mixed documents with the typed and handwritten text [21]. The study examines the sentimental analysis of medical treatment in detail and shows new challenges and possibilities in the medical field [22].

A previously published study [9] was extended in the present paper to highlight the importance of tidy TM in presenting symptomatic words of diseases common to seafarers. To represent the patient's emotions or feedback, we applied sentimental analysis to medical abstract documents with disease names and symptoms. Seafarers' medical documents are not aligned with the TM documentation. By mapping tidy TM symptom words to common diseases occurring onboard, we attempted to circumvent this limitation. The present study is the first comprehensive analysis of seafarers' diseases that has been conducted by researchers who have an understanding of maritime medicine.

We can understand a subject's emotions and behavior when studying such medical documents with text since emotions play an active role in human behavior. A domain-specific corpus from the digital health database contains clinical documents, which is critical for decision-making [15]. Text mining algorithms are applied to text containing seafarers' medical documents in the analysis of text containing TM of telemedical documents. The least absolute shrinkage and selection operator (LASSO) regression models were applied for text classification as well as for defining word relevance through this variable selection.

2. Materials and Methods

Methods used for the analysis included document collection, pre-processing, and sentiment analysis. The frequency of disease terms was determined by analyzing sentiment in the Bing lexicon. By using these techniques, we estimated the most commonly used words among seafarers.

2.1. Data Collection

Medical text data of seafarers were examined from 2006 to 2021 and data was analyzed among 41,292 seafarers who got telemedical assistance through the International Radio Medical Centre (C.I.R.M.). The Centre establishes digital medical files for each case after it makes contact with the ship and updates them and this study analysed these files.

Data for the last 15 years (2006–2021) were extracted from 41,292 text documents containing patient information, a seafarer sending a message (Tx), and a doctor receiving a message (Rx). Messages TX include ship name and radio call sign, position, destination port, estimated time of arrival, course, speed, patient's age, nationality, qualification, vital signs like breathing, pulse, temperature, and blood pressure, symptoms of localized pain, medical history, and medicines available on board. The message Rx contains a doctor's questions, treatment, diagnosis, and diet and prevention instructions, as well as all the patient's treatment information.

Documents include text data such as symptomatic information, doctor prescriptions, treatment information, medication details, etc. C.I.R.M. physicians classified diagnoses according to the International Classification of Diseases (ICD)-10 (WHO, 2007). Health management, epidemiology, and clinical analysis rely on this standard. Table 1 provides an example of medical abstracts for treatments. For a smooth experimental setup in the R framework, all text data were prepared as a CSV document.

Table 1. Sample of medical abstracts and treatment of given diagnosis.

Year	Case Number	Diagnosis	Medical Abstract	Suggested Treatment
2006	88	Abdominalgia	Mild pain in the lower part of the stomach and temperature.	Discontinue aspirin. Keep patient bed rest in the most comfortable position. Apply an ice bag wrapped in a cotton cloth on the painful area if it relieves pain.
2008	17	Acute Gastritis	The patient said he has stomach pain; he has a history of hyperacidity.	Keep patient rest in a sitting position. Give buscopan one tablet every six hrs. give antacid every six hrs. Give omeprazole one tablet every twelve hrs. Light boiled food diet with a large intake of mineral water. Give news in twelve hrs.
2009	151	Allergic Reaction	The rash on a body appears in various places namely round an eye, bridge of the nouse, behind an ear, on a breast and a back, on a neck and hands.	Keep resting cotton loose-fitting clothes. continue ciprofloxacin milligram. Cetrizine or chlophenaramine. Boiled food diet with abundant water. Avoid all contact with cargo.
2013	597	Fever	Stomach pain with loose motions, mainly at night. Burning sensation during urination especially during evenings when the fever sets in.	Keep bed rest far from air draughts and extremes of temp. Apply ice bag wrapped in a cotton cloth on the head when temperature rises above 39 °C Continue Paracetamol, Ciprofloxacin, continue also Buscopan.
2014	1042	Haemorrhage	Patient with profuse blooding from yesterday at the gingival level (maybe the presence of abscess) and of the urinary tract. He has lost knowledge several times yesterday and today, already underway in fluid therapy.	Continue fluid therapy with Ranitidine fl inside the flexo, Tranexamic acid is not available onboard. Give as antibiotic Amoxicillin 1 g CPR if not allergic. Urgent disembarkation should be organized with a faster vehicle.
2016	197	Anxious-Depressive Syndrome	Please note that for the last two days the patient had been complaining of improper sleep. He reported that he was feeling a little depressed. He also reported that he does not feel capable of keeping navigational watches during hours of darkness as it gives him a feeling of loneliness.	Keep at rest in the bed or armchair as he prefers but, in any case, under continuous control by a friendly person. Remove from his cabin dangerous objects (knives, forks, glasses, razor blades, belts, shoelaces, dangerous drugs, gas lighters, anything through which he can injure himself or other people).
2020	746	Foreign Body	One of the people in the crew has swollen right eye. He got some foreign dust particles inside his eye, he rubbed his eye with his dirty hands, the eye started swelling and itching. We gave him an eyewash and suggested washing the eye regularly. Looks like due to rubbing the eye, he developed an eye infection. Kindly advise treatment we can give.	Keep rest not necessary in bed in a semi-dark room. Wash accurately's the eye with sterile saline solution or e Optrex or other eye leashes. Then when dry apply eye antibiotic ointment and cover with a sterile or light bandage.
2021	54	Odontalgia	Complain regarding the patient's tooth on the lower left molar. It was found out that the filling was been detached which causes pain.	Keep at rest. Apply inside the tooth cavity a small ball of cotton wool soaked in clove oil. Administer Paracetamol one 500 mg tablet every 6 h and Co-amoxiclav one gram tablet every 12 h. A light diet with easily chewable foods and a large intake of liquids.

2.2. Corpus Pre-Processing

Data cleaning ensures that user data is consistent, reliable, and accurate, and the text should be organized logically, especially for in-text data. We come across questions regarding punctuation, abbreviations, and contractions after reading the corpus. The removal of stop words and stem words, as well as the treatment of lower- and uppercase letters, is also needed. In tidy TM, clean_corpus is a function within the tidytext package that helps process the corpus [23]. With some default tools, like strings (for text cleaning), this package can convert upper case letters into lower case.

2.3. Tidy Text Mining and Packages

We can manage text simply and easily by using tidy data standards. The tidy data structure has the variables as columns, observations as rows, and each observational unit type as a table [24]. Thus, a tidy text format appears as a table with one token per row. For text analysis, tokens are semantically meaningful words, and tokenization is the process of dividing text data into tokens.

With tidy TM, the token is stored in every row, which can be a single word, a sentence, an n-gram, or a paragraph. The 'tidytext' package provides the functionality of tokenization with commonly encountered text units. In this package, there is no requirement that the user maintains a clean text format at all times. Using dplyr and other tidy tools, the text is processed, filtered, and imported, and then data is converted into a document-term matrix (DTM) for use in ML applications, and ggplot2 can then be used to visualize and interpret these models [25]. Figure 1 shows the flowchart representation with help of tidy data principles.

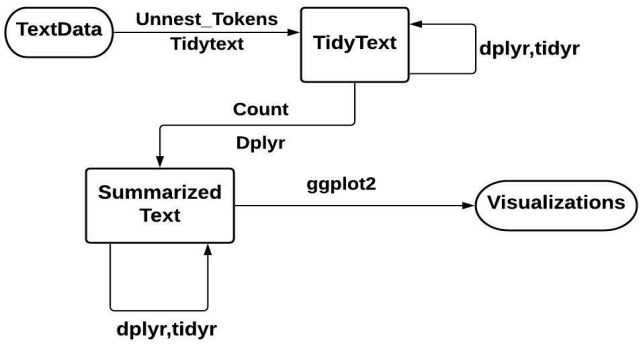


Figure 1. Flowchart representation of typical text analysis using principles of tidy data.

2.4. Sentimental Analysis

In order to make product sales more effective, a company manager might want to find out if the product reviews are positive or negative. It is possible to examine text sentiment using a word's combination and the sentimental content of the entire text by analyzing the sentiment of the singular words. With tidy TM, lexicon-based sentiment analysis is frequently used to calculate sentiment distributions based on lexicon alignments [26]. This semantic alignment can be negative, positive, or neutral. The lexicons dictionary can be formed either manually or automatically. Figure 2 illustrates the architecture of lexicon-based analysis.

A lexicon-based analysis determines the semantic orientation of the text by looking at adverbs and adjectives. This can be converted into a single score for the entire value in the final assessment. Three general lexicons can be found in tidy TM, namely AFINN, BING, and NRC. In the AFINN lexicon, sentimental scores range from -5 to 5, with negative scores for negative sentiment and positive scores for positive sentiment. As with the Bing lexicon, the NRC lexicon categorizes sentiments equally into yes/no categories as positive/negative.

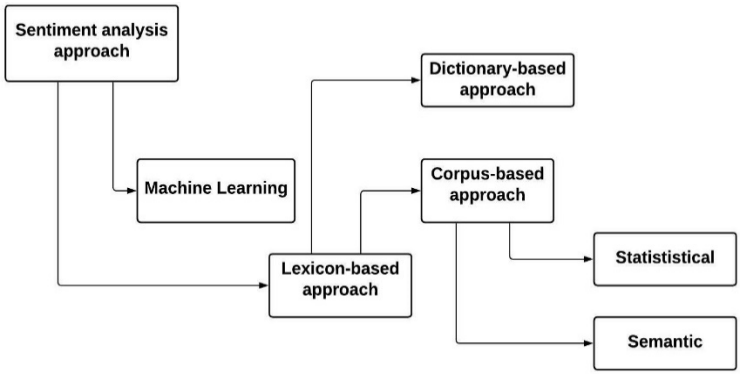


Figure 2. Lexicon-based sentimental analysis architecture for text documents.

2.5. Calculation of Word and Document Frequency (TF-IDF)

The term frequency-inverse document frequency (TF-IDF) indicates how relevant a medical term is to a particular telemedical document. A TF-IDF is a method for measuring the importance of a specific word in a document in comparison to the total number of documents. It is calculated as follows:

$$\mathrm{TF(t)} = \frac{\text{Number of times term t appears in a document}}{\text{Total number of terms in}} \quad (1)$$

where TF(t) presents how often a particular term appears in a document. Similarly, the inverse document frequency (IDF) is a metric value representing the information provided by a particular word. Mathematically it is presented as a fraction of logarithmically inverse documents that contain the words. It is mathematically denoted as

$$\mathrm{IDF}\ (\mathrm{t}) = \log\ \frac{\text{number of documents}}{\text{number of documents containing term}} \quad (2)$$

Simply, Equation (2) is logarithm of document number in corpus (nominator) divided by number of documents where particular term appears (denominator). It is likely to get words such as 'is', 'are', 'the', and 'an' in the calculation of most frequent words in the corpus. By removing buzz and stop words from the medical abstracts, we will get words like 'seafarers', 'accidents', and 'pathologies'. Thus, the TF-IDF metric measures the frequency of terms and weights them by how rarely they are used. The term frequency in medical documents refers to how frequently a particular term appears within an individual document. Seafarers' medical records are often referred to as 'frequency' in general. The terms 'seafarers', 'accidents', and 'pathologies' occurred very often in this work, and they are very frequently used in a given document, resulting in its low rating for TF-IDF.

2.6. Word Clouds

One way to visualize the high probability words in the text using TM packages is by using word clouds [26]. The word clouds can also be called text clouds and are created with the TM package (tm), and word cloud creator package (word cloud) [27], both of which are available in R for helping visualize words in text quickly. In the word cloud, the size represents the frequency of words. They may appear like a visualization of popular positive and negative words, but the size of words cannot be compared to the sentiment they convey.

2.7. LASSO Regression Model

LASSO takes advantage of shrinkage to accomplish linear regression. When a data value shrinks towards a central point, such as a mean, shrinkage occurs. As a result, it is well suited to models with high levels of multicollinearity. It also allows automated parts of model selection, such as parameter elimination and variable selection [28].

The LASSO regression model is being used more and more in medical diagnosis to predict disease outcomes and side effects. The model has been applied to brain modeling [29], biomarker selection [30], healthcare cost prediction [31], and early detection of cardiovascular diseases [32]. The classification of medical documents is widely used in healthcare, but few studies have been conducted on it. Our work demonstrates how LASSO is applied to text data using the principles of tidy data. This model extends supervised machine learning to text classification.

LASSO problems are quadratic programming problems that aim to minimize. In statistics, it was written as

$$\sum_{i=1}^{n}\left(yi-\sum_{j}x_{ij}\beta_j\right)2+\lambda\sum_{j=1}^{p}\left|\beta_j\right| \quad (3)$$

The above equation is the same as the minimization of the sum of squares with constraint $\Sigma\left|\beta_j\right| \leq s$. To interpret the model easily, some of β s can be shrunk to almost zero and results regression model to do easy interpretation. Here λ is a tuning parameter (i.e., amount of shrinkage). When $\lambda = 0$, no parameters are eliminated. When it increases, bias increases and when it decreases, variance increases.

2.8. Model Training and Evaluation

After the data were ready, they were divided into training and testing sets. The data are used both for building the model and evaluating its performance. LASSO regularization was applied for our logistic regression model with the glmnet package, and it can help to detect keywords in a prediction. We compare the LASSO model performance with two supervised models, namely Support Vector Machines (SVM) [33] and Random Forest (RF) [34]. We then validate the model using cross-validation (CV). As a resampling method for statistical analysis, this approach is known as rotation estimation. Therefore, in order to implement the CV technique, the data sample is segmented into different subsets. The analysis is performed on a subset called a training set. The results are then verified on the other subset called a testing set or a validation set [35]. By creating a data frame that can be displayed to each document in the dataset, the model's performance is evaluated by applying tidy data principles. Based on the percentage of correctly classified outcomes over the total outcomes, classification performance is calculated.

3. Results

A benefit of using tidy data is sentiment analysis, which can be performed as an inner join. The ability to perform sentiment analysis as an inner join is another practical example of using TM as tidy analysis, similar to removing stop words as an antijoin operation.

3.1. Sentimental Analysis

As part of our study, we examined how sentiments of each symptom varied across categorical diseases of ICD 10. We first determine the sentiment scores for each symptomatic word by using Bing lexicon and inner join functions. Figure 3 shows how sentimental scores (Y-axis) and the plotting of medical documents for certain diseases change and become more positive or negative over time (X-axis).

The data frame includes both a word and a sentiment, so we can easily determine the number of words that contribute to each statement. Figure 4a shows sentiment visualization in the form of word clouds, while Figure 4b shows the word distribution count for positive and negative sentiments.

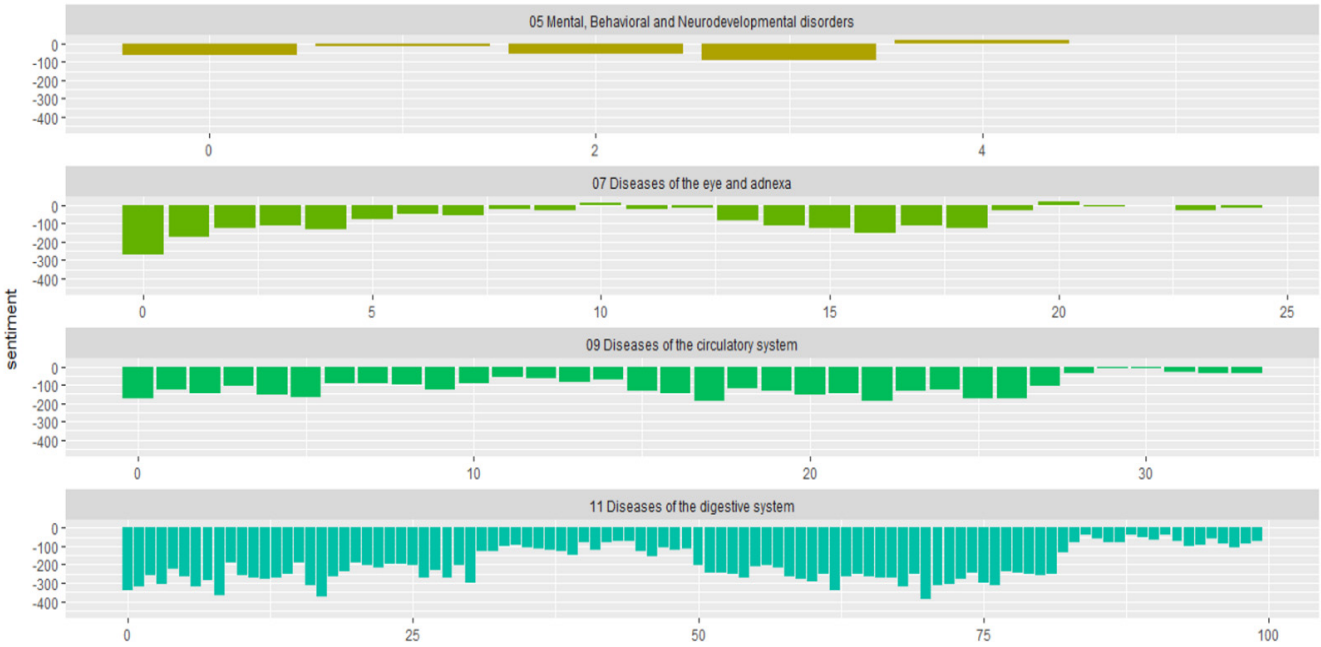


Figure 3. Lexicon based sentimental scores of the ICD 10 disease types (this is the plot of each disease sentiment changes towards more negative or positive over the times appearing in a dataset).

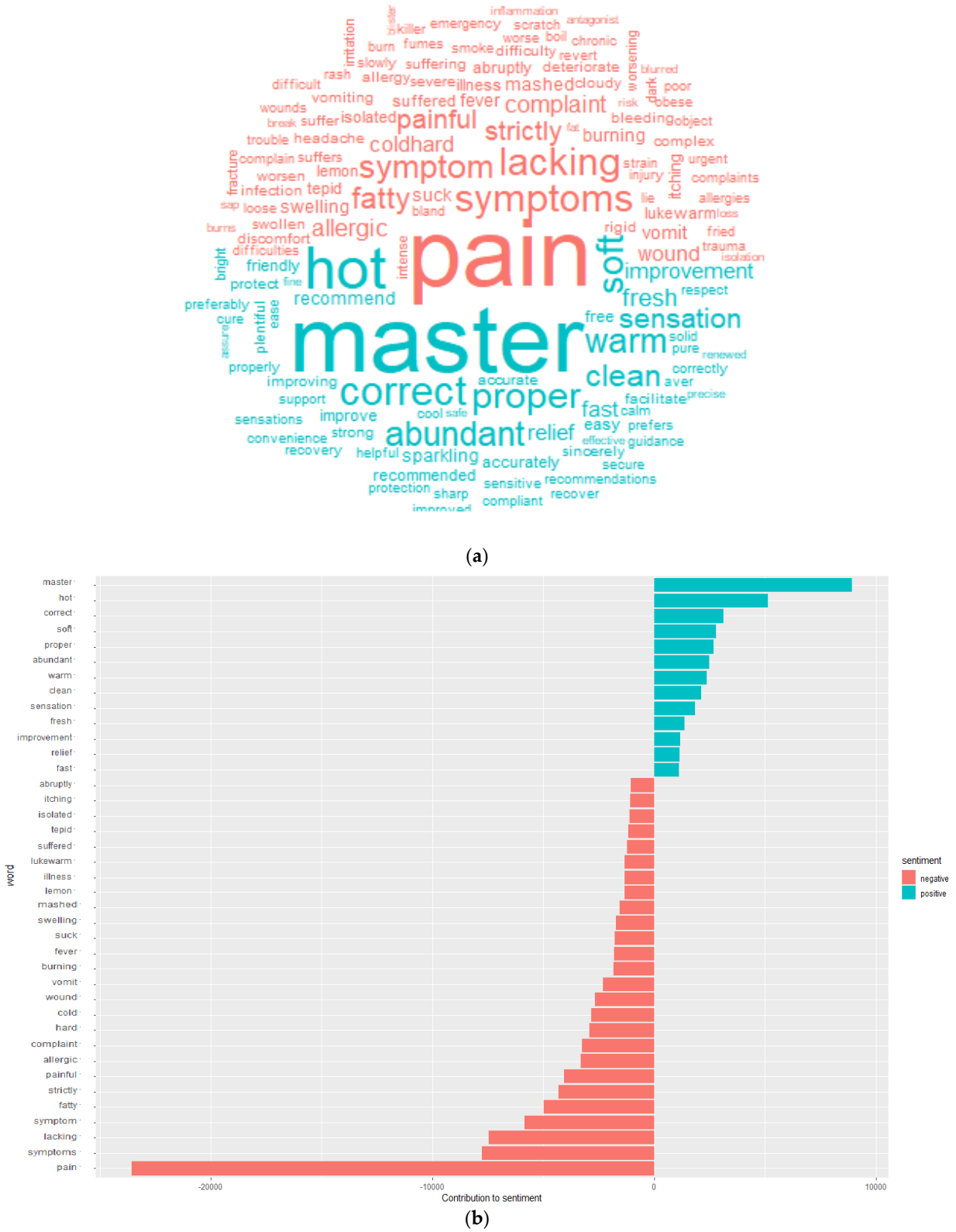
3.2. TF-IDF Calculation

By reducing the weight of commonly occurring words and boosting the weight of words that are less frequently used in the document corpus, TF-IDF identifies medical keywords associated with each disease category. We examined a large number of medical documents of seafarers, identifying symptoms of several disease categories. Using the ICD-10, we classified the documents into 22 groups. Most of the important words did not appear in all the categories. Figure 5 shows how disease documents categorize the major keywords. ICD code 05 (mental, behavioral and neurodevelopmental disorders) contains the keywords friendly, excited, dangerous, violent and depression with TF-IDF scores 0.001174, 0.001323, 0.001260, 0.001169 and 0.000754. Seafarers tend to suffer from anxiety and depression more often than onshore workers due to their long days away from their families [36]. As a result, tidy TM packages are able to identify a given disease's most common symptoms.

3.3. Bigrams and Correlations

Using Bigrams, we can also show how medical words relate to one another. Bigrams are visual representations of words arranged in a graph or network. In this study, we considered a graph with multiple nodes. Graphs were created using the igraph package, which has powerful manipulation and analysis functions. In Figure 6, we can see a relationship between different words in the medical records of seafarers. The diet nodes are connected to words including fatty, spicy, semiliquid, coffee, cigarettes, spices, etc. There are also triplets with similar meanings ('cloth', 'cotton', or 'woolen').

Additionally, correlation establishes a link between dependent and independent words. Having a negative correlation indicates a decrease in what we are measuring. This enabled us to determine which words are closely related to a particular medical term. In this experiment, we choose some popular words and find other words that are most related to them (Figure 7). There is 92.3% correlation between the word 'intestinal' and the word 'urinary'.



(**a**)

(**b**)

Figure 4. (**a**). Word cloud picturization of positive (green) and negative (red) sentimental words (most of the word alignments are associated with words pain, master, symptoms, hot, correct, lacking etc.). (**b**). Word count that contributes both negative and positive sentiments; the 'pain' word had the highest negative sentiment count (23,557) and the 'master' word has the highest positive sentiment count (8935).

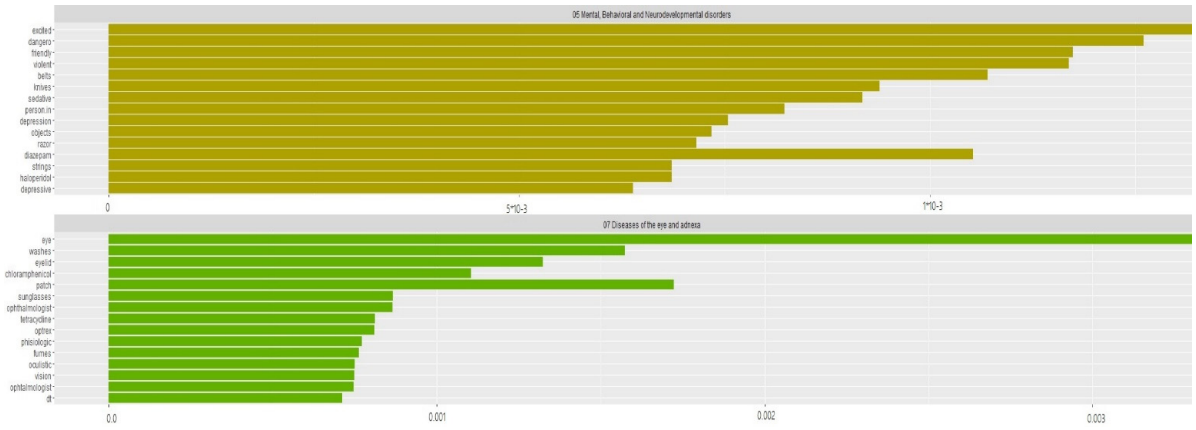


Figure 5. TF-IDF word count for mental health and eye diseases category; the highest frequency symptomatic words calculated by TF-IDF are vital to disease diagnosis. This outcome presents the proper distinguishment of keywords that are important to specific categorical documents within the collection in a group of documents.

Figure 6. Data visualization networks (Common bigrams that occurred in categorical disease documents).

```
  A tibble: 19,740 x 3
item1      item2      correlation
<chr>      <chr>            <dbl>
1 urinary    intestinal       0.923
2 intestinal urinary          0.923
3 functions  urinary          0.870
4 urinary    functions        0.870
5 pressure   blood            0.865
6 blood      pressure         0.865
7 dear       master           0.851
8 master     dear             0.851
9 functions  intestinal       0.830
10 intestinal functions       0.830
# ... with 19,730 more rows
```

Figure 7. Correlation table between the symptomatic words.

3.4. Text Classification with ML Modelling

From the large sample of medical documents, we selected two categorical documents, such as cardiovascular and digestive diseases. The document sample is 8803 and it is further divided into 70:30, where 70% of documents are for training and 30% are for test purposes. Three models were trained with an optimal parameter which was defined by CV validation. Each experiment was conducted with a 10-k value. The Receiver Operating Characteristics (ROC) curves can be used in medical diagnosis to test the model's ability to predict text in documents [37]. In particular, ROC curves are known for their ability to visualize binary classification. In Table 2, we compare the performance metrics in terms of accuracy, sensitivity, specificity, and ROC.

Table 2. Performance comparison of adopted models (k = 10).

Model	Accuracy (%)	Sensitivity (%)	Specificity (%)	ROC
SVM	64.2	68.3	45.3	0.597
RF	59.0	59.8	55.4	0.613
LASSO	93.8	97.9	80.6	0.976

The accuracy can be measured as the ratio between some of the true predicted documents and the total number of documents. Among the 2641 documents tested, the LASSO model correctly predicted 2477 documents, while 164 were incorrectly predicted, resulting in a 93.8% accuracy. The Figure 8 presents the ROC curve outcome for LASSO regression model where false positive rate (1-specificity) on *x*-axis and true positive rate (sensitivity) on *y*-axis. It is obvious that the ROC value of 0.976 shows a perfect classification of the categorical documents included. These results indicate that LASSO regression outperforms the other two classification models. Moreover, sensitivity is the percentage of correctly predicted outcomes, and this model scored 97.9%, a relatively high value for prediction problems.

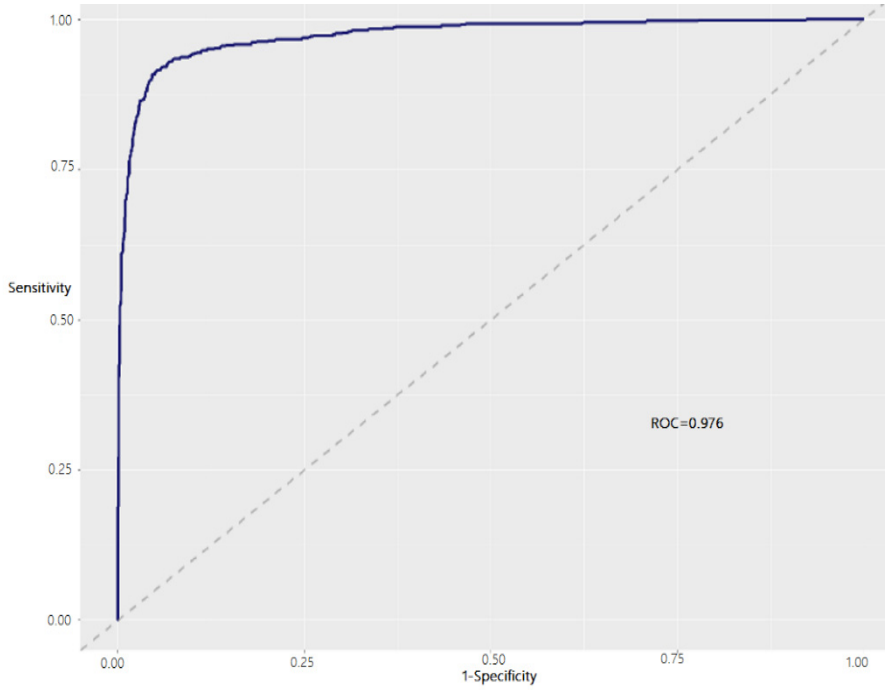


Figure 8. ROC curve for text classification using LASSO regularized regression.

4. Discussion

This paper presents an integrated analysis of medical documents of seafarers that incorporates TM and sentiment analysis. Due to sailors' distance from medical facilities, health care is difficult. When doctors onshore diagnose correctly, they can prescribe effective treatments [38–40]. Using electronic health records (EHRs) can help reorganize services, train staff on the benefits of working with different teams, and protect staff health, according to this study. A lack of assistance will put staff and seafarers at risk.

Seafarers often suffer from swelling, fatigue, general weakness, headaches, confusion, and other symptoms. Different studies have found a connection between symptoms, including hemoptysis, thrombocytopenia, and high C-reactive protein levels [41,42]. A hypoxemic patient can develop acute respiratory distress syndrome (ARDS), sepsis, and even multi-organ failure in a short amount of time [43]. A seafarer's disease type must be diagnosed quickly and treated according to his symptomatology.

Medical care professionals can utilize TM to collect and write information from the patient's EHRs to support decision-making and disease diagnosis [44]. Pattern-based mining from EHRs assists doctors, physicians, and laboratory experts by retrieving significant knowledge from the system [45]. Pletscher-Frankild and coworkers developed a TM software program that identifies human and disease genes in text and identifies disease-gene associations [46]. A study analyzed 100 posts from epilepsy patient forums to quantitatively analyze patient perspectives on treatments, which may aid medical experts in designing clinical decision making based on patient-derived information [47].

In recent reports, the importance of EHRs to the functioning of healthcare systems has been emphasized [48]. Seafarers, for example, have been provided with telematics services for years. Medical prescriptions are issued in a single, standardized format. Physicians and pharmacies are required to submit prescription data electronically. Online medical records are preferred by doctors when prescribing treatments. Text information is stored in these records. These types of data can be processed by healthcare experts, but they can only estimate which diseases they are dealing with.

TM has been used to predict hospital admissions based on emergency department initial medical records [49]. TM can provide valuable information and make it easier for bed management teams to make decisions. It is reported that TM also plays an influential role in the autonomous classification of hospital admissions. Moreover, it is reported that TM examines the performance of text classification from clinical data from hospital reports [50]. This describes how TM can identify hospitalized patients for the treatment of a given disease based on the information associated with patient admission. This study used a machine learning approach called LASSO regression to distinguish disease documents based on clinical terms. The application of statistical and epidemiological methods in medical research was done with TM. The authors in [51], review the last twenty-year reports to identify commonly encountered and emergent methods used to investigate medical research problems.

In medical research, TM was applied to statistical and epidemiological analyses. Meaney and colleagues reviewed reports from the last twenty years to identify commonly encountered and emerging research methods [51]. The TM has been used to predict hospital admissions using emergency department records [49]. Providing this information will help bed management teams make better decisions. TM is also utilized to classify hospital admissions as well as hospital reports [50]. The information is derived from the admission information for the patient. Through TM, patients can be identified for specific diseases.

In an emergency situation, TM knowledge is extremely valuable because it allows high-quality data to be generated in real time. It is imperative for patients and medical staff to be careful when providing information [52]. Therefore, a gap can develop between the data scientists, scholars, and medical professionals capable of producing the data. The importance of sharing data across care providers will also be affected by this gap. A tidy TM needs to be presented in these situations so that raw data can be visualized in a prescribed format and distributed evenly among specialists. Medical abstracts have been organized

neatly in this paper, and symptom maps for illnesses experienced onboard have been visualized. LASSO regression models are also used to validate the results. Remote doctors provide maritime telemedicine assistance, but these practices illustrate the limitations of using digital health records to produce quality data.

5. Conclusions

For the management of unstructured datasets, tidy-based TM has proven to be a comprehensive and efficient tool. It is relatively difficult to recognize treatments and relevant facts in medical documents written in languages other than English. By combining tidy TM packages and libraries with semantic manipulation, we developed a comprehensive approach to identifying onboard diseases. An ICD-10 symptom mapping was also undertaken. Symptom correlation plots, which measure how different health problems are linked together, were also presented. Using LASSO regression, this study successfully predicted text data among documents with 93.8% accuracy. These tidy TM libraries can effectively classify text documents in healthcare analysis projects. As well as delivering medical assistance, this approach may be used to develop health observatories and to classify diseases. We propose to apply the knowledge developed in this work to the Epidemiological Observatory of Seafarers Pathologies and Injuries, a collaborative initiative between the Ministry of Health, University of Camerino, and the International Radio Medical Center (C.I.R.M.).

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Data Availability Statement: Data examined for the present study were collected and stored in a closed database by the Centro Internazionale Radio Medico (C.I.R.M.), the Italian Maritime Telemedical Assistance Service (TMAS) in the frame of health surveillance activities performed onboard ships. Data were extracted from the database by C.I.R.M. operators and anonymized before being used for research purposes. C.I.R.M. President as legal representative of the entity where medical data are kept has authorized access to authors for collecting data of this work. The programing code for experiments that are involved can be found in https://github.com/nalinichintalapudi/Tidymodels-for-medical-text-data.git.

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References

1. Abila, S.S.; Acejo, I.L. Mental health of Filipino seafarers and its implications for seafarers' education. *Int. Marit. Health* **2021**, *72*, 183–192. [CrossRef] [PubMed]
2. Guillot-Wright, S. The changing economic structure of the maritime industry and its adverse effects on seafarers' health care rights. *Int. Marit. Health* **2017**, *68*, 77–82. [CrossRef] [PubMed]
3. Caruso, G. Do seafarers have sunshine. In Proceedings of the 8th International Symposium on Maritime Health (ISMH) Book of Abstracts, Rijeka, Croatia, 8–13 May 2005.
4. Laraqui, O.; Manar, N.; Laraqui, S.; Ghailan, T.; Deschamps, F.; Hammouda, R.; Laraqui, C.E.H. Prevalence of skin diseases amongst Moroccan fishermen. *Int. Marit. Health* **2018**, *69*, 22–27. [CrossRef] [PubMed]
5. Mahdi, S.S.; Amenta, F. Eighty years of CIRM. A journey of commitment and dedication in providing maritime medical assistance. *Int. Marit. Health* **2016**, *67*, 187–195. [CrossRef] [PubMed]

6. Sagaro, G.; Battineni, G.; Di Canio, M.; Amenta, F. Self-Reported Modifiable Risk Factors of Cardiovascular Disease among Seafarers: A Cross-Sectional Study of Prevalence and Clustering. *J. Pers. Med.* **2021**, *11*, 512. [CrossRef]
7. Antons, D.; Grünwald, E.; Cichy, P.; Salge, T.O. The application of text mining methods in innovation research: Current state, evolution patterns, and development priorities. *R&D Manag.* **2020**, *50*, 329–351. [CrossRef]
8. Battineni, G.; Sagaro, G.G.; Chintalapudi, N.; Amenta, F. Conceptual Framework and Designing for a Seafarers' Health Observatory (SHO) Based on the Centro Internazionale Radio Medico (C.I.R.M.) Data Repository. *Sci. World J.* **2020**, *2020*, 8816517. [CrossRef] [PubMed]
9. Chintalapudi, N.; Battineni, G.; Di Canio, M.; Sagaro, G.G.; Amenta, F. Text mining with sentiment analysis on seafarers' medical documents. *Int. J. Inf. Manag. Data Insights* **2020**, *1*, 100005. [CrossRef]
10. Ribeiro, J.; Duarte, J.; Portela, F.; Santos, M. Automatically detect diagnostic patterns based on clinical notes through Text Mining. *Procedia Comput. Sci.* **2019**, *160*, 684–689. [CrossRef]
11. Grover, P.; Kar, A.K. Big Data Analytics: A Review on Theoretical Contributions and Tools Used in Literature. *Glob. J. Flex. Syst. Manag.* **2017**, *18*, 203–229. [CrossRef]
12. Wu, C.-S.; Kuo, C.-J.; Su, C.-H.; Wang, S.; Dai, H.-J. Using text mining to extract depressive symptoms and to validate the diagnosis of major depressive disorder from electronic health records. *J. Affect. Disord.* **2019**, *260*, 617–623. [CrossRef]
13. Karami, A.; Ghasemi, M.; Sen, S.; Moraes, M.F.; Shah, V. Exploring diseases and syndromes in neurology case reports from 1955 to 2017 with text mining. *Comput. Biol. Med.* **2019**, *109*, 322–332. [CrossRef] [PubMed]
14. Guerreiro, J.; Rita, P. How to predict explicit recommendations in online reviews using text mining and sentiment analysis. *J. Hosp. Tour. Manag.* **2019**, *43*, 269–272. [CrossRef]
15. Denecke, K.; Deng, Y. Sentiment analysis in medical settings: New opportunities and challenges. *Artif. Intell. Med.* **2015**, *64*, 17–27. [CrossRef]
16. Nandwani, P.; Verma, R. A review on sentiment analysis and emotion detection from text. *Soc. Netw. Anal. Min.* **2021**, *11*, 81. [CrossRef] [PubMed]
17. Vij, A.; Pruthi, J. An automated Psychometric Analyzer based on Sentiment Analysis and Emotion Recognition for healthcare. *Procedia Comput. Sci.* **2018**, *132*, 1184–1191. [CrossRef]
18. Moreira, L.B.; Namen, A.A. A hybrid data mining model for diagnosis of patients with clinical suspicion of dementia. *Comput. Methods Programs Biomed.* **2018**, *165*, 139–149. [CrossRef]
19. Marir, F.; Said, H.; Al-Obeidat, F. Mining the Web and Literature to Discover New Knowledge about Diabetes. *Procedia Comput. Sci.* **2016**, *83*, 1256–1261. [CrossRef]
20. Abirami, A.M.; Gayathri, V. A survey on sentiment analysis methods and approach. In Proceedings of the 2016 Eighth International Conference on Advanced Computing (ICoAC), Chennai, India, 19–21 January 2017; pp. 72–76. [CrossRef]
21. Barlas, P.; Adam, S.; Chatelain, C.; Paquet, T. A Typed and Handwritten Text Block Segmentation System for Heterogeneous and Complex Documents. In Proceedings of the 2014 11th IAPR International Workshop on Document Analysis Systems, Tours, France, 7–10 April 2014; pp. 46–50. [CrossRef]
22. Zeng, D.; Peng, J.; Fong, S.; Qiu, Y.; Wong, R. Medical data mining in sentiment analysis based on optimized swarm search feature selection. *Australas. Phys. Eng. Sci. Med.* **2018**, *41*, 1087–1100. [CrossRef]
23. CRAN—Package Tidytext. Available online: https://cran.r-project.org/web/packages/tidytext/index.html (accessed on 23 February 2022).
24. Wickham, H. Tidy Data. *J. Stat. Softw.* **2014**, *59*, 1–23. [CrossRef]
25. Data Visualization with R and ggplot2 | the R Graph Gallery. Available online: https://www.r-graph-gallery.com/ggplot2-package.html (accessed on 1 March 2022).
26. Rathore, A.K.; Kar, A.K.; Ilavarasan, P.V. Social Media Analytics: Literature Review and Directions for Future Research. *Decis. Anal.* **2017**, *14*, 229–249. [CrossRef]
27. Emmert-Streib, F.; Dehmer, M. High-Dimensional LASSO-Based Computational Regression Models: Regularization, Shrinkage, and Selection. *Mach. Learn. Knowl. Extr.* **2019**, *1*, 359–383. [CrossRef]
28. Text Mining and Word Cloud Fundamentals in R: 5 Simple Steps You Should Know—Easy Guides—Wiki—STHDA. Available online: http://www.sthda.com/english/wiki/text-mining-and-word-cloud-fundamentals-in-r-5-simple-steps-you-should-know (accessed on 1 March 2022).
29. Dimitri, G.M.; Beqiri, E.; Placek, M.M.; Czosnyka, M.; Stocchetti, N.; Ercole, A.; Smielewski, P.; Lió, P.; Anke, A.; Beer, R.; et al. Modeling Brain–Heart Crosstalk Information in Patients with Traumatic Brain Injury. *Neurocrit. Care* **2021**, 1–13. [CrossRef] [PubMed]
30. Ternès, N.; Rotolo, F.; Michiels, S. Empirical extensions of the lasso penalty to reduce the false discovery rate in high-dimensional Cox regression models. *Stat. Med.* **2016**, *35*, 2561–2573. [CrossRef]
31. Kan, H.J.; Kharrazi, H.; Chang, H.-Y.; Bodycombe, D.; Lemke, K.; Weiner, J.P. Exploring the use of machine learning for risk adjustment: A comparison of standard and penalized linear regression models in predicting health care costs in older adults. *PLoS ONE* **2019**, *14*, e0213258. [CrossRef] [PubMed]
32. Khanji, C.; Lalonde, L.; Bareil, C.; Lussier, M.-T.; Perreault, S.; Schnitzer, M.E. Lasso Regression for the Prediction of Intermediate Outcomes Related to Cardiovascular Disease Prevention Using the TRANSIT Quality Indicators. *Med. Care* **2019**, *57*, 63–72. [CrossRef] [PubMed]

33. Shan, C. Research of Support Vector Machine in Text Classification. In *Future Computer, Communication, Control and Automation*; Zhang, T., Ed.; Advances in Intelligent and Soft Computing; Springer: Berlin/Heidelberg, Germany, 2012; Volume 119, pp. 567–573. [CrossRef]
34. Hassani, H.; Beneki, C.; Unger, S.; Mazinani, M.T.; Yeganegi, M.R. Text Mining in Big Data Analytics. *Big Data Cogn. Comput.* **2020**, *4*, 1. [CrossRef]
35. Tabe-Bordbar, S.; Emad, A.; Zhao, S.D.; Sinha, S. A closer look at cross-validation for assessing the accuracy of gene regulatory networks and models. *Sci. Rep.* **2018**, *8*, 6620. [CrossRef] [PubMed]
36. Iversen, R.T.B. The mental health of seafarers. *Int. Marit. Health* **2012**, *63*, 78–89. [PubMed]
37. Pencina, M.J.; D'Agostino, R.B.; D'Agostino, R.B.; Vasan, R.S. Evaluating the added predictive ability of a new marker: From area under the ROC curve to reclassification and beyond. *Stat. Med.* **2008**, *27*, 157–172. [CrossRef]
38. Woldaregay, A.Z.; Walderhaug, S.; Hartvigsen, G.; Guitton, M.; Seale, D. Telemedicine Services for the Arctic: A Systematic Review. *JMIR Med. Inform.* **2017**, *5*, e16. [CrossRef] [PubMed]
39. Mair, F.; Fraser, S.; Ferguson, J.; Webster, K. Telemedicine via satellite to support offshore oil platforms. *J. Telemed. Telecare* **2008**, *14*, 129–131. [CrossRef] [PubMed]
40. Dehours, E.; Vallé, B.; Bounes, V.; Girardi, C.; Tabarly, J.; Concina, F.; Pujos, M.; Ducassé, J.L. User satisfaction with maritime telemedicine. *J. Telemed. Telecare* **2012**, *18*, 189–192. [CrossRef] [PubMed]
41. Wang, D.; Hu, B.; Hu, C.; Zhu, F.; Liu, X.; Zhang, J.; Wang, B.; Xiang, H.; Cheng, Z.; Xiong, Y.; et al. Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus—Infected Pneumonia in Wuhan, China. *JAMA* **2020**, *323*, 1061–1069. [CrossRef] [PubMed]
42. The Novel Coronavirus Pneumonia Emergency Response Epidemiology Team. The Epidemiological Characteristics of an Outbreak of 2019 Novel Coronavirus Diseases (COVID-19)—China, 2020. *China CDC Wkly.* **2020**, *2*, 113–122. [CrossRef]
43. Paraskevis, D.; Kostaki, E.; Magiorkinis, G.; Panayiotakopoulos, G.; Sourvinos, G.; Tsiodras, S. Full-genome evolutionary analysis of the novel corona virus (2019-nCoV) rejects the hypothesis of emergence as a result of a recent recombination event. *Infect. Genet. Evol.* **2020**, *79*, 104212. [CrossRef] [PubMed]
44. Tsumoto, S.; Kimura, T.; Iwata, H.; Hirano, S. Mining Text for Disease Diagnosis. *Procedia Comput. Sci.* **2017**, *122*, 1133–1140. [CrossRef]
45. Metsker, O.; Bolgova, E.; Yakovlev, A.; Funkner, A.; Kovalchuk, S. Pattern-based Mining in Electronic Health Records for Complex Clinical Process Analysis. *Procedia Comput. Sci.* **2017**, *119*, 197–206. [CrossRef]
46. Pletscher-Frankild, S.; Pallejà, A.; Tsafou, K.; Binder, J.X.; Jensen, L.J. DISEASES: Text mining and data integration of disease–gene associations. *Methods* **2015**, *74*, 83–89. [CrossRef]
47. He, K.; Hong, N.; Lapalme-Remis, S.; Lan, Y.; Huang, M.; Li, C.; Yao, L. Understanding the patient perspective of epilepsy treatment through text mining of online patient support groups. *Epilepsy Behav.* **2019**, *94*, 65–71. [CrossRef]
48. Groenhof, T.K.J.; Koers, L.R.; Blasse, E.; de Groot, M.; Grobbee, D.E.; Bots, M.L.; Asselbergs, F.W.; Lely, A.T.; Haitjema, S.; van Solinge, W.; et al. Data mining information from electronic health records produced high yield and accuracy for current smoking status. *J. Clin. Epidemiol.* **2020**, *118*, 100–106. [CrossRef] [PubMed]
49. Lucini, F.R.; Fogliatto, F.S.; da Silveira, G.J.; Neyeloff, J.; Anzanello, M.J.; Kuchenbecker, R.S.; Schaan, B.D. Text mining approach to predict hospital admissions using early medical records from the emergency department. *Int. J. Med. Inform.* **2017**, *100*, 1–8. [CrossRef] [PubMed]
50. Kocbek, S.; Cavedon, L.; Martinez, D.; Bain, C.; Mac Manus, C.; Haffari, G.; Zukerman, I.; Verspoor, K. Text mining electronic hospital records to automatically classify admissions against disease: Measuring the impact of linking data sources. *J. Biomed. Inform.* **2016**, *64*, 158–167. [CrossRef] [PubMed]
51. Meaney, C.; Moineddin, R.; Voruganti, T.; O'Brien, M.A.; Krueger, P.; Sullivan, F. Text mining describes the use of statistical and epidemiological methods in published medical research. *J. Clin. Epidemiol.* **2016**, *74*, 124–132. [CrossRef] [PubMed]
52. Grantz, K.H.; Meredith, H.R.; Cummings, D.A.T.; Metcalf, C.J.E.; Grenfell, B.T.; Giles, J.R.; Mehta, S.; Solomon, S.; Labrique, A.; Kishore, N.; et al. The use of mobile phone data to inform analysis of COVID-19 pandemic epidemiology. *Nat. Commun.* **2020**, *11*, 4961. [CrossRef] [PubMed]

Psychological Stress and Mental Health Among Seafarers

Graziano Pallotta, Gopi Battineni, Giulio Nittari, and Francesco Amenta

Abstract **Objective**: This work aims to determine whether the mental health of seafarers is a significant problem, by providing actual epidemiological information, to identify the factors that are supporting or undermining the mental health of seafarers and to propose solutions and practices aimed at improving the health of this class of workers. **Methods**: This study is an epidemiological investigation of mental and behavioral disorders among seafarers onboard commercial ships without a physician. The aim is to propose solutions to improve the quality of life in this difficult working environment. We examined 38.477 requests of assistance from patients embarked on ships assisted by the CIRM from 2011 to 2019. All the diagnosed diseases have been categorized based on the ICD-10 classification system by the WHO. **Results**: From 2012 to 2020, 376 cases of "mental and behavioral disorders" were officially diagnosed. The most common form of mental disorder was anxious syndrome (119 cases), followed by depressive disorder (103 cases), insomnia (51 cases), panic attacks (35 cases), etc. Over the 9 years analyzed, a total of 37 suicide and 4 attempted suicide

Authors' contributions. GP: wrote the manuscript, organized the research, and conducted the statistical analysis, data collection, and interpretation. GR, GB: contributed to statistic and data interpretation. FA: supervision and final draft revision, and GN: conducted statistical analysis, data collection, and interpretation. All authors read and approved the final manuscript.

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cases occurred. The number of mental and behavioral disorders diagnosed on board—as well as the number of suicides—shows that the seafarers' mental problems are a concrete and serious issue.

Keywords Mental health · Seafarers · Telemedicine · Psychological stress · Epidemiology

1 Introduction

The specific and characteristic isolation of the naval environment can put a strain on the mental health of the crews. Being in the middle of the ocean, performing complex and sometimes dangerous tasks can significantly increase the stress of these workers, with important repercussions on the health of seafarers [1, 2]. Working always in the same spaces, isolated from the rest of the world, but at the same time always in contact with the same people, the same faces, feeling the same noises and smells, few hours' sleep, can cause a psychological deterioration that may lead to chronic disorders and even severe pathologies [3–5].

The logistics of the work onboard ships requires a rigorous division of roles in the various sectors (bridge, engine, etc.), which inevitably leads to a physical and human separation between seafarers—all of this exacerbates relationships, emphasizing the negative aspects [6]. It is no coincidence that the World Labor Organization (ILO) created a study group on the working conditions of maritime crews in 1993 [7], nor that the International Maritime Organization (IMO) first and the various national and community legislators after have launched precise protection rules for seafarers [8, 9].

On the other hand, it is a fact that research has often focused mainly on accidents and injuries or physical pathologies [9–11], sometimes neglecting psychological discomfort, which profoundly affects health, defined by the WHO as "a complete state of physical, social, and mental well-being" and, therefore, not just the absence of diseases or infirmities [12]. After all, if technology has ensured contacts with the mainland and with families via e-mail and the Internet, on the other hand, life onboard keeps on being, today as centuries ago, a highly penalizing dimension.

Several studies agree that the main cause of mental health problems of seafarers is the long absence from home [13]. A life inscribed in a dimension dominated by the roll of the ship, where the perception of existence is punctuated by work shifts, finds it difficult to deal with an ordinary life, albeit much desired. Nostalgia for home, that "pain for the desire to return," as the Greek etymology attests, from Homer onward, substantiates the individual even when he has returned to his family because he has been completely impregnated and altered by it.

By listening to many experiences, another data emerged to pay utmost attention to—the "transition" period, that is, the phase relating to the first days after returning home, a real period of re-adaptation, similar to what the seafarer will suffer before departure and in the early days spent on board. This is why, uneasiness and tension

are expressed in couples and families, while children, especially if they are young, see their fathers as "strangers," elements extraneous to their life, which becomes "normal" when they leave [14].

This work aims to determine whether the mental health of seafarers is a significant problem, by providing actual epidemiological information—furthermore, to propose solutions and practices aimed at improving the health of this class of workers. The research questions that we aim to answer by this work as follows.

RQ1: Do mental health disorders represent a health issue for seafarers and shipping companies?
RQ2: What factors can improve or worsen the mental health of seafarers?
RQ3: What initiatives can be applied to improve life on board?

2 Methods

This work is an epidemiological investigation carried out on 38,477 requests for assistance from seafarers embarked on commercial vessels without health personnel on board and assisted by the International Radio Medical Center (C.I.R.M.), in the 9 years 2012–2020, focusing on the mental health of seafarers.

As in these vessels, there is no medical personnel onboard—health care is provided through telehealth techniques. For each patient assisted by the C.I.R.M., an electronic medical report was established and called "electronic health record" (EHR), which has been updated following every contact with the ship [15]. These records represent the basis of the investigations carried out in this study. All the diagnosed diseases have been categorized accordingly to the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10) by the World Health Organization (WHO) [16].

Among the different ICD-10 categories, we took into consideration the diagnoses included in the ICD-10 Class "V," called "mental and behavioral disorders." All data were analyzed with standard statistic methods. Microsoft Excel was the software used for information processing and result analysis. Data are expressed in the text as means $\pm$ SD.

Data were anonymized before being used for research purpose. The survey is a part of the project called health protection and safety on board ships (acronym: HEALTHY SHIP). It is a project of disease prevention and health protection onboard sailing ships through information campaigns on the major health risks for seafarers and on their approved by ethical committee at International Radio Medical Center (C.I.R.M.) [17].

3 Results

The results of the epidemiological analysis are summarized in Tables 1 and 2, and Fig. 1 presents mental disorder distribution. The diagnoses were performed by competent physicians of the C.I.R.M., adequately trained, via telemedicine platforms capable of communicating with the patient by phone or video call. Available for

Table 1 Specific diagnoses and total cases included in Class "V" of the ICD-10 system, sorted by year

Disorder	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Anxious syndrome	16	14	14	15	13	8	12	15	12	119
Behavioral disorder	1	1	1	1	2	1	2	2	2	13
Confusion state	1	0	1	2	0	2	1	1	1	9
Depressive disorder	8	14	7	10	16	12	16	4	16	103
Generalized malaise	0	0	1	2	1	0	0	1	1	6
Insomnia	1	6	4	6	7	11	6	2	8	51
Panic attack	2	3	2	9	4	4	3	3	5	35
Psychomotor agitation	2	1	0	1	2	1	3	1	2	13
Psychotic syndrome	3	3	1	2	3	2	2	1	4	21
Spatiotemporal disorientation	1	0	0	1	1	0	1	1	1	6
Total	35	42	31	49	49	41	46	31	52	376

Table 2 A number of suicides and suicide attempts reported in the 9 years 2012– 2020

Year	Suicide attempts	Suicides	Total (suicides + attempts)
2012	0	4	4
2013	1	2	3
2014	0	5	5
2015	0	3	3
2016	1	3	4
2017	0	4	4
2018	1	4	5
2019	1	6	7
2020	0	6	6
Total	4	37	41

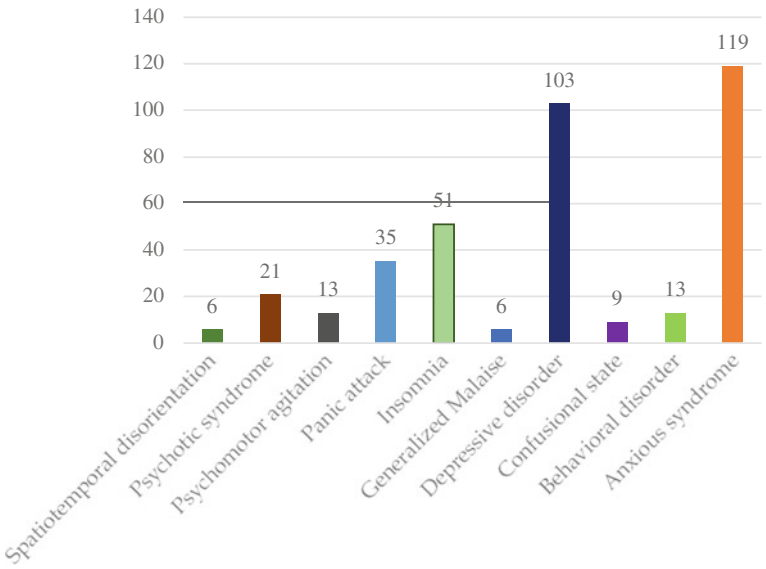

Fig. 1 Total cases of mental disorders recorded in 2012–2020, distinguished according to their specific diagnosis

doctors, the patient's electronic health record (EHR), which indicates all the known medical information of the subject, as well as their complete recorded medical history.

The diagnoses were confirmed following the guidelines of the ICD-10 system by the WHO and by the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) published by the American Psychiatric Association.

From 2012 to 2020, 376 cases of "mental and behavioral disorders" were officially diagnosed with a slight increase in cases over the years (refer Fig. 1), hand in hand with an increased number of patients treated in total. Between 2011–2019, the most common form of mental disorder was anxious syndrome (119), followed by depressive disorder (103), next are insomnia (51), panic attacks (35), psychotic syndrome (21), psychomotor agitation (13 cases), behavioral disorder (13), confessional state (9), spatiotemporal disorientation (6), generalized malaise (6). Over the 9 years analyzed, a total of 37 suicide and 4 attempted suicide cases occurred (Table 2). These are worrying numbers that may be strictly related to the mental disorders diagnosed and mentioned above. The number of suicides over the years appears fairly constant, without a visible tendency to increase or decrease. Also, worrying is the fact that the number of successful suicides is significantly higher than suicide attempts (37 vs. 4).

The main mental health problems onboard diagnosed from 2012 to 2020 are anxious syndrome (119) and depressive disorder (103). Anxiety disorders are a set of psychiatric disorders characterized by unjustified fear and anxiety, often associated with psychosomatic manifestations that create considerable discomfort for the

subject. Commonly, these are chronic disorders present in a latent form in the individual, and that occurs as a result of particular psychophysical stress, or following a traumatic event. They are characterized by a strong anxious and phobic component, in most cases unjustified. The naval environment may trigger these pathological conditions, as suggested by the high number of cases diagnosed on board.

A depressive disorder is a complex psychiatric pathological condition characterized by episodes of depressed mood, low self-esteem, loss of interest in normal life activities, etc. It is a disabling disease capable of compromising the patient's social, physical, and working life. It normally starts manifesting itself at 20 years of age, with a peak in subjects between their 30s and 40s [18]. For both anxiety and depressive disorders, drug therapy associated with targeted psychotherapy is essential [19]. Although the causes of depression are still being studied, it is now widely believed that both biological and genetic factors, as well as environmental and psychological factors, can determine the onset of depressive disorder [20].

4 Discussion

Epidemiological information relating to the mental health of seafarers has been rather scarce so far. This is mainly due to a historical lack of interest in the naval environment epidemiology and also to a greater emphasis on physical pathologies and injuries [9, 10].

After all, determining seafarers' mental health is quite difficult. First, we are talking about remote workers, located far from the land and difficult to reach. They are selected following specific medical examinations. This determines the immediate elimination of the most fragile and sick subjects, creating a population of workers we could define as "selected" and, therefore, theoretically "stronger." Therefore, even from a merely statistical point of view, it is difficult to compare maritime workers with the rest of the population, or with other groups.

Among the environmental and social factors that would seem to play a greater role in the etiology of depression, we have childhood trauma, family problems, bereavements, divorces, serious health problems, poverty, unemployment, social isolation, etc. [21] Work mobbing, bullying, and prolonged work stress are also recognized as possible causes [22]. There are situations that, according to the most recent literature, occur quite frequently on board [23]. Indeed, physical and/or verbal offenses, humiliation, bullying, persistent criticism, etc. often occur onboard ships [24]. The maritime authorities must consider these social issues like these can have harmful consequences for the health of seafarers. Aggressive, violent behavior (both physically and verbally) should be reported, and the perpetrators were identified and severely punished. Repeated physical and verbal abuse phenomena must be predicted and punished under the regulations in force.

The number of suicides may appear as low after a first observation of the data (Table 2), and this number takes a different perspective when compared to the number of confirmed deaths per year. For example, in 2020, the year with the highest number

of confirmed deaths (26), 6 suicides occurred (23% of all deaths). In 2018, 4 of the 27 deaths recorded were suicides (15% of all deaths). The same applies to 2016 where 3 suicides occurred out of 23 total deaths (13% of all deaths). This means that suicides account for an important part of all the deaths that occur on board. Although the number of mental illnesses diagnosed on board is low, it would be useful to understand why cases of suicide on board are such a significant constant in all the years analyzed. Data about repatriation could provide interesting information—however, it emerged that many seafarers prefer to suffer in silence, fearing to be diagnosed with a psychic and/or mood disorder, which may lead to repatriation and a possible compromise of their future job opportunities [23]. This may lead to a serious underestimation of diagnoses of mental illness and stress on board. Monitoring and support programs aimed at the psychophysical health of the maritime patient are, therefore, crucial.

According to the most recent literature, several factors can compromise the mental health of seafarers. First of all, the distance from home, followed by the condition of isolation, loneliness [25–27], few leave, too long work contracts [28], poor-quality food [23], bad social relationships on board, and [28] fear of losing their job [29, 30], fear of losing their family [26, 28, 31–33]. The researchers are also quite sure that the different tasks onboard significantly affect the mental stress to which seafarers are subjected. From this point of view, the most fragile category would seem to be the officers, engineers, and engine crew [4, 25, 31, 34]. The social relationships that can be established in the naval environment can have their impact as well-strong, and important friendships can improve life on board. On the contrary, enmities, bullying, fights, and bad relationships can significantly compromise an already difficult co-existence [23]. The mental health problems of seafarers are not limited to their period on board. The problems ashore can be just as serious. Separation and divorces are very frequent among seafarers [35]. The situation is complicated for those couples with children, where the maritime member is often not to see their child grow up, from whom he is then seen as a sort of distant relative [23]. Often, in the few months on the ground, the seafarer is forced to face problems such as family issues, illnesses, economic problems, bereavements in the family, bills, political and social situations.

The work done by ITF Seafarers Trust and Yale University has led to the identification of needs that seafarers have, by recognizing what they think would be good to make them happier and reduce stress [23]. Since naval isolation and distance from home are the main causes of depression and mood disorders on board, there is a need to enhance the possibilities of communication and contact with the mainland. Communicating with families and friends on the ground must be simpler and more immediate. At the same time, there is a need for something that breaks the daily routine and diversifies the working days, so that no two days are alike. Recreational activities, social events, the opportunity to practice sports, better quality food are the main needs on board. Themed events, group activities, customizable and thematic lunch/dinner menus are some of the seafarers' wishes to break the monotony of a work environment which can be insidious to their psyche. These are needs that can be met with a minimum of organization and method, but which may also have the great potential to improve the general health of this class of workers.

5 Conclusions

In terms of numbers the specific cases of maritime patients affected by mental disorders appear low when compared with other classes of pathologies, there is evidence that these health problems may actually be more widespread and often hidden by the seafarer himself. Equally worrying is the number of suicides that occur on board every year, covering an important number of all recorded deaths. Although epidemiological information does not show a large diffusion of mental disorders on board, from an elaboration of these and the analysis of the literature, the authors hypothesize that these data may be underestimated. The mental problems on board are concrete and capable of seriously compromising the seafarer's health, work, and life in general.

6 Recommendations

The problem has so far been acknowledged only by a small group of shipping companies, which are finally starting to seriously consider the problem of mental health, proposing strategies aimed at improving co-existence onboard commercial vessels. The scientific research will aim to better identify the needs of the seafarers to propose reactive solutions and guarantee mental well-being on board. Authorities and shipping companies need to take patient health more seriously and establish monitoring and mental support programs. The mental health of these people must become of interest to both naval authorities and societies.

Conflicts of interest The authors declare that they have no competing interests.

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References

1. Sandal GM, Leon GR, Palinkas L (2006) Human challenges in polar and space environments. Rev Environ Sci Biotechnol. https://doi.org/10.1007/s11157-006-9000-8
2. Palinkas LA (2003) The psychology of isolated and confined environments: understanding human behavior in Antarctica. Am Psychol. https://doi.org/10.1037/0003-066X.58.5.353
3. Doyle N et al (2016) Resilience and well-being amongst seafarers: cross-sectional study of crew across 51 ships. Int Arch Occup Environ Health. https://doi.org/10.1007/s00420-015-1063-9
4. Carter T (2005) Working at sea and psychosocial health problems. Report of an International Maritime Health Association. Travel Med Infect Dis. https://doi.org/10.1016/j.tmaid.2004.09.005.

5. Hystad SW, Eid J (2016) Sleep and fatigue among seafarers: the role of environmental stressors, duration at sea and psychological capital. Saf Health Work. https://doi.org/10.1016/j.shaw.2016.05.006
6. Forsyth CJ, Bankston WB (1984) The social psychological consequence of a life at sea: a causal model. Marit Policy Manag. https://doi.org/10.1080/03088838400000005
7. "Maritime Labor Convention (2006) International Labour Organization (ILO)
8. Nittari G, Pallotta G, Di Canio M, Traini E, Amenta F (2018) Benzodiazepine prescriptions on merchant ships without a doctor on board: Analysis from medical records of Centro Internazionale Radio Medico (CIRM). Int Marit Health. https://doi.org/10.5603/IMH.2018.0005
9. Pallotta G, Di Canio M, Scuri S, Amenta F, Nittari G (2019) First surveillance of malaria among seafarers: evaluation of incidence and identification of risk areas. Acta Biomed. https://doi.org/10.23750/abm.v90i3.8612
10. Nilsson R, Nordlinder R, Högstedt B, Karlsson A, Järvholm B (1997) Symptoms, lung and liver function, blood counts, and genotoxic effects in coastal tanker crews. Int Arch Occup Environ Health. https://doi.org/10.1007/s004200050166
11. Nittari G et al (2019) Comparative analysis of the medicinal compounds of the ship's 'medicine chests' in European Union maritime countries. Need for improvement and harmonization. Int Marit Health. https://doi.org/10.5603/IMH.2019.0023
12. WHO (2020) WHO frequently asked questions
13. Battineni G et al (2020) Cloud-based framework to mitigate the impact of COVID-19 on seafarers' mental health. Int Marit Health 71(3):213–214. https://doi.org/10.5603/IMH.2020.0038
14. Finkelman JM (1994) A large database study of the factors associated with work- induced fatigue. Hum Factors. https://doi.org/10.1177/001872089403600205
15. Battineni G, Sagaro GG, Chintalapudi N, Amenta F (2020) Conceptual framework and designing for a Seafarers' Health Observatory (SHO) based on the Centro Internazionale Radio Medico (C.I.R.M.) Data Repository. Sci World J 2020. https://doi.org/10.1155/2020/8816517
16. WHO (2011) International statistical classification of diseases and related health problems—10th revision. World Health Organization, vol 2, no. 5, pp 1–252, 2011, ISBN: 978 92 4 549165
17. Amenta F, Carotenuto A, Grappasonni I (2011) Healthy Ship: an innovative project for healthcare improvement and health promotion on board ships. Luxemburg (2011)
18. American Psychiatric Association (2012) Major depressive disorder and the bereavement exclusion. American Psychiatric Publications
19. Kirsch I, Deacon BJ, Huedo-Medina TB, Scoboria A, Moore TJ, Johnson BT (2008) Initial severity and antidepressant benefits: a meta-analysis of data submitted to the food and drug administration. PLoS Med. https://doi.org/10.1371/journal.pmed.0050045
20. Rutter M, Harrington R, Quinton D, Pickles A (1994) Adult outcome of conduct disorder in childhood: Implications for concepts and definitions of patterns of psychopathology. In: Adolescent problem behaviors: issues and research
21. Weich S, Lewis G (1998) Poverty, unemployment, and common mental disorders: Population based cohort study. Br Med J. https://doi.org/10.1136/bmj.317.7151.115
22. Kendler KS, Hettema JM, Butera F, Gardner CO, Prescott CA (2003) Life event dimensions of loss, humiliation, entrapment, and danger in the prediction of onsets of major depression and generalized anxiety. Arch Gen Psychiatry. https://doi.org/10.1001/archpsyc.60.8.789
23. "Seafarer Mental Health Study," ITF Seafarers' Trust & Yale University (2019)
24. International Chamber of Shipping (2016) Guidance on eliminating shipboard harassment and bullying
25. Mellbye A, Carter T (2017) Seafarers' depression and suicide. Int Marit Health. https://doi.org/10.5603/IMH.2017.0020
26. Jepsen JR, Zhao Z, van Leeuwen WMA (2015) Seafarer fatigue: a review of risk factors, consequences for seafarers' health and safety and options for mitigation. Int Marit Health. https://doi.org/10.5603/IMH.2015.0024

27. Battineni G, Amenta F (2020) Designing of an expert system for the management of Seafarer's health. Digit Heal 6(1):205520762097624. https://doi.org/10.1177/2055207620976244
28. Iversen RTB (2012) The mental health of seafarers. Int Marit Health 63(2):78–89
29. Swift O (2015) Social isolation of seafarers. ISWAN
30. Jezewska M, Iversen RTB, Leszczyńska I (2013) MENHOB–mental health on board, In: 12th International symposium on maritime health brest, France, 6 June 2013
31. Carotenuto A, Molino I, Fasanaro AM, Amenta F (2012) Psychological stress in seafarers: a review. Int Maritime Health
32. Leszczyńska I, Jezewska M, Jaremin B (2008) Work-related stress at sea. Possibilities of research and measures of stress. Int Marit Health 59(1–4):93–102
33. Oldenburg M, Jensen HJ, Latza U, Baur X (2009) Seafaring stressors aboard merchant and passenger ships. Int J Public Health. https://doi.org/10.1007/s00038-009-7067-z
34. Lefkowitz RY, Slade MD, Redlich CA (2019) Rates and occupational characteristics of international seafarers with mental illness. Occup Med (Chic. Ill). https://doi.org/10.1093/occmed/kqz069.
35. "Divorce Rate Among Cruise Ship Crew Members Rising," Crew Center

Telemedicine Services and Frameworks During COVID 19: A Case Study of Seafarers

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1 Introduction

COVID-19 is an individual disease from an enormous group of infections causing a few pathologies influencing the pneumonic framework going from the normal cold to extreme respiratory conditions like the severe acute respiratory syndrome (SARS) and the Middle East respiratory syndrome (MERS). The virus called SARS-CoV-2 causes the COVID-19 disease.

It is undeniably seriously a testing time and hard to treat the coronavirus of patients on-board a ship compared with onshore patients. Ships Ships are at sea for days or weeks before they can reach a port and in general do not carry doctor or qualified paramedics. The transportation area conveys 90% of worldwide exchange and is the fundamental conduit of worldwide stockpile chains [1].

The COVID-19 pandemic addresses a significant issue for sailors. According to an association's perspective, seafarers need to deal with extensive issues joining and leaving their deliveries in ports (every month, around 100,000 sailors are associated with group changes). The restriction or if nothing else delays in being permitted to get back, augmentation of voyages through obligation with the subsequent weakness brought about by an expanded responsibility, disconnection, and prevalent difficulties for sailors due to constrained detachment from their families all build mental pressure among sailors. The pandemic likewise has a direct impact on the medical issue of sailors. There are quarantine limitations for global sailors on being

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ready to go aground for clinical treatment or access port-based government assistance benefits just as limitations on the conveyance to boats of fundamental clinical supplies, in situations where ships are declined passage into ports.

The circumstance on the cruise ship called Diamond Princess is an ideal example of the troubles in giving clinical help on-board a boat during the outbreak caused by COVID-19 disease. The Diamond Princess is a British-enrolled voyage transport that showed up seaward of Yokohama port on the evening of February 3 (Monday), 2020, and on that day the quarantine started [2]. There were 2666 travellers and 1045 group individuals on-board the boat (a sum of more than 3700), and surprisingly however the boat had clinical offices locally available and was helped by Japanese health specialists; the quarantine went on until February 20, and 619 of 3700 travellers and team individuals (17%) were tested positive [3]. Despite the conversations about the viability of general health countermeasures taken on that event, the circumstance exhibits that it is so hazardous to oversee epidemic issue on-board ships.

On other hand, the COVID-19 crisis has required proceeding with alternate courses of action, making it important to re-examine the current way to deal with medical services just as the most effective method to adjust to the arising needs of medical services in the specific circumstance of a pandemic. Through the implementation of telemedical systems, it was figured out how to relieve the spread of infection by carrying out social distancing and avoiding patient-doctor interactions. The spread of infection among communities should be forestalled to limit the dangers of disease for health experts. In this regard, fundamental telemedicine administrations might assist with protecting public health in emergencies.

One of the benefits of telemedicine can be the everyday observing of certain health parameters and side effects like monitoring via mobile apps, which can also be measured or reported by patients. Telemedicine additionally permits admittance to patient visits who, for different reasons, face difficulty going to the hospital or the specialist's centres or who live in regions ineffectively associated with therapy habitats. Moreover, remote patients' consultants (and a few tests) have proved to be fundamental in this time of health emergency, to have the option to complete clinical preliminaries that in any case would have needed to stop.

A movement of frameworks has been proposed for infection prevention and control (IPC) that might control the COVID-19 danger. Telemedicine together with live videoconference and an essential valuable call license could contribute to identify the clinical situation which allows assistance of adequate treatement. It can likewise be applied for patient symptom recordings like respiratory, heartbeat, and oxygen level rates needed at home.

Moreover, telemedicine can give mental Web-based support to organizations in the setting of patient protection by diminishing the emotional health inconvenience from COVID-19 and sharing information about the symptoms of stress, demoralization, and anxiety. It is suggested that telehealth has a couple of advantages in giving comprehension of immunology behaviours, for instance confining the introduction of clinical specialists to possibly stained patients and induction to the quick evaluation for COVID-19 tainting.

It is reported that the exercises for the security of medical services, clinic staff, and patients should have to embrace the virtual frameworks to make staff timetables and do charging for clinical consideration organizations. There are some easy-to-set-up potential outcomes to monitor COVID-19 in live videoconferencing. Live videoconferencing helps to avoide the direct physical contact, likewise, diminish the risk of the show to respiratory deliveries and anticipating the normal transmission of tainting to specialists and other clinical benefits providers. Moreover, live video could be useful for patients who search for a gathering on coronavirus, and likewise for ship workers with high tension, rather than in-person visits in circumstances of persistent sickness reviews (for instance, diabetes and danger), some remedy checks, and emergency when telephone services are not available.

The need for telemedicine administrations for COVID-19 (i.e., Rather than anticipating that all outpatient practices should remain mindful of a rapidly developing proposition concerning COVID-19, medical frameworks made chatbots that imply moderate- to high-risk patients to sustain crisis lines). These facilities permit patients to design video visits with setting up or on-demand providers to avoid the travel to personal care centres.

In this chapter, we provide a discussion on recent telemedical technologies used for seafarers' health. In addition, this chapter also provides the telemedical frameworks used in controlling measures during the outbreak of COVID-19 for seafarers.

2 Attention to On-Board Psychiatric Issues During COVID-19 Pandemic

At present, the global pandemic caused by COVID-19 disease has changed all human lives because of its sheer magnanimity. Its rate of infection and death is unprecedented and is manifold as compared with other existing epidemics. This dangerous disease has affected people worldwide irrespective of nation, gender, and racism. Especially people from remote areas like seafarers are getting more attention due to their psychological issues, and their mental health will also be not in a good position.

When seafarers get mild symptoms, a greater risk of fear and stress would make them more vulnerable. This vulnerability causes various psychological problems like distress, depression, anxiety, insomnia, and even suicidal death. During COVID-19, social and economic factors (i.e. education, job status, and employment) were responsible for half of the overall individual well-being, and the remaining half was determined by individual behaviours (i.e. smoking, alcohol consumption, diet) and access to health [4]. Figure 1 presents the conceptual tree model of social determinants in the mental health competency of seafarers.

To lessen the psychological vulnerabilities, it is time to understand the science behind the disease rather than fearing it. Psychiatrists, psychiatric nurses, clinical psychologists, and other mental health workers should bridge the gap between fear and reality. The false news spreads are to be curbed; instead, solidarity towards frontline workers with kindness gestures would certainly motivate them to stay

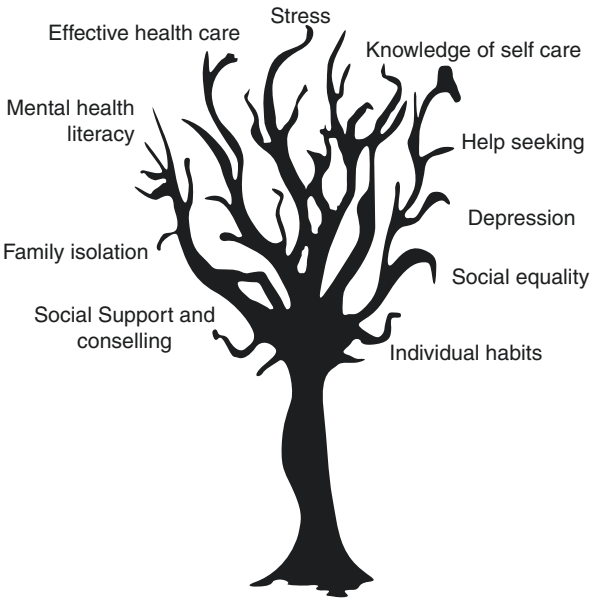

Fig. 1 Conceptual tree model of communal psychiatric issues among seafarers

energized with their mental status high. Online assessment to understand emotions and behaviour and fear assessment can be made available to ease out stress, depression, and fear [5]. Various computational and learning algorithms need to be put in place to pre-empt the psychological imbalance like the risk of suicide, lessen human manoeuvrability within the affected area, predict viral relapse, and classify and contain the disease, which would amend the calibre of effectiveness during emergency interventions.

Research initiatives have been taken to develop efficient and cost-effective medical devices for analysis of virus strains, etc. In closed environments like ships, testing facilities are needed to have access to each and every employee of the ship. There is also a sufficient amount of personal protection gear and equipment along with an insurance scheme for health and police personnel serving across the maritime industry. Yoga, meditation, and training sessions should be conducted on-board to overcome mental pressure. However, after all these commendable efforts, the sailor population is still scarred by the stigma of fear and distress about the contagion leading to psychological health.

Despite this, there is an instance of psychological imbalance among marginalized people and low-level workers. At this rate of infection and death worldwide, challenges are emerging to keep everyone psychologically well. On-board, psychiatrist intervention is much required today [6]. When a seafarer loses his/her job, it amalgamates financial burden, social stigma, and family disobedience leading to disorderly behaviour, disrupting mental health in such a stressful and chaotic environment.

As per the International Labour Organization report, 305 million full-time jobs are at risk of being lost due to this pandemic. This number is about 1.5 times the

previous estimation of around 195 million jobs being lost in the first quarter of 2020 [7], thus creating panic in the life of global seafarers and predominantly leading to various psychological disorders. Thus, this epidemic can be regarded as a mental health catastrophe [8]. It is quite evident that there is an inherent characteristic of epidemics including COVID-19 to have comorbidity with psychological disorders related to either fear or financial distress. Every other loss like economic slowdown or job loss can be recovered except the psychological disorders, which are more catastrophic to human life. Thus, timely intervention and medical management are the call of the hour in the current scenario.

To forestall psychological wellness issues among seafarers, all attributes of associations at sea, at the port, and in different sorts of vessels have to be remembered for prevention programmes, and more examination needs to be led on factors of weariness and stress among sailors and fishing workers. We worried about long-haul mental and social impacts on seafarers during the COVID-19 pandemic. In the initial segment, psychological disorders like despondency, uneasiness, and an expanded rate of suicide will show up. In a subsequent part, with uneasiness, social pressure from family, and financial challenges, we could estimate that various seafarers will not return on-board vessels and will leave the sea transport.

Increasing access and health information and in-person meetings with psychologists or by videoconference are imperative. Capacities of team changing, help from well-being administrations, and foreign workplaces are likewise required. Conversations between worldwide associations, transportation sectors, and labourer's institutions to assemble present-moment and long-haul counteraction activities could surely be beneficial for seafarers.

3 Reliability of Telemedical Services During COVID-19 Outbreak

Since the beginning of the national emergency from COVID-19, the Italian National Centre for Telemedicine and New Assistive Technologies of the Higher Institute of Health (Istituto Superiore di Sanità) has been collaborating with the operational realities on the Italian territory by providing its support to the realization of concrete, rapid solutions to be applied. It follows current regulations to offer the best guarantee of health safety for both patients and professionals. There are numerous needs for care and assistance both in hospitals and even more in the territories that are also rigorous in terms of medical practice and protection of safety, covering real needs, including non-local ones, with solutions that can be scaled according to needs and using the network to cancel the distance between people and create impassable barriers for the virus [9, 10].

In the COVID-19 health emergency, the National Health Service (NHS) was called upon to provide services to persons obliged to quarantine or in fiduciary isolation with unprecedented significant numbers. These services have the dual purpose of helping to combat the spread of COVID-19 and of ensuring as far as possible the continuity of care and assistance, to which people are entitled. Moreover, even

those who find themselves isolated at home as a result of the necessary rules of social distancing may still have needs for continuity of care and assistance [11–13].

Although it is a priority to increase the possibilities of home care for people affected by COVID-19, for the reasons just mentioned, at the same time the care and home care for those people who present it cannot be neglected because of their pathological conditions or frailty. Furthermore, all these needs must be addressed in conditions of a health emergency, with a relative lack of material and human resources and taking care to observe the anti-contagion rules for the greatest possible protection also of health personnel.

It should be noted in terms of the personalized surveillance of the clinical picture in these people, that the choice of signs and symptoms to be monitored can be organized in pre-established digitized files, suitably according to the pathologies taken care of and taking care to leave it to the doctor, with always the possibility to modify them. These operational aspects will be addressed in further specific insight documents, considering that even in the course of an emergency from COVID-19, the creation of a telemedicine service includes the assumption of responsibility to define when it can be indicated in the individual case and which ones are the methods of alternative service provision when contraindicated.

The use of remote services is therefore fully justified. They should be provided to people, where possible, primarily through modern digital and telecommunication technologies, which offer the best operational opportunities compared to the use of previous technologies. The possible services with telemedicine are manifold, where they were in operational conditions even before COVID-19 [14]. Instead, where telemedicine is not yet structured in a system of national significance, being in a situation of health emergency, it is, first of all, necessary to create and make available those solutions that can be activated quickly: in less time, which can be used by people at home with the technological equipment available to them immediately and that can be activated for periods corresponding with the needs posed by the situation of emergency.

Based on the Chinese experience of the evolution of the epidemic, as a first approximation, in creating remote services, the relational needs of users with the health system must be taken into account. The isolation inside one's home makes it particularly desirable to be able to count on a service that can be easily used remotely, being able to quickly access the interview with the healthcare professionals, as needed. Due to the limitation of travel, the person expects to receive already through the electronic contact the solution of his/her problem or the clear indication of how to solve it or at least to perceive the concrete possibility of being assisted effectively and safely. In the absence of the aforementioned feedback, the person will tend not to trust the proposed system and not to use it, especially when faced with urgent needs in reality.

Patients suffering from chronic diseases or requiring long-term treatments are usually managed in part or entirely by local services or residential structures (just think for example diabetes, chronic cardiovascular diseases, COPD, pain therapies, chemotherapy, psychiatric pathologies, disabilities), also including people suffering from rare diseases and frail conditions that require constant contact with healthcare

facilities and healthcare professionals of reference, or people who need particular assistance and/or support not in the hospital, but not deferrable (for example pregnant women, mothers, people with psychological problems).

The target of a home assistance service in telemedicine consists of bringing healthcare services to people in isolation who are isolated following the rules of social distancing, to proactively monitor their health conditions, in relation to both the prevention and treatment of COVID-19 and the continuity of assistance that may be necessary for other pathologies and/or conditions that require it.

This general objective is useful for directing organizational actions within the framework of a scientifically valid methodology that facilitates its implementation. However, this alone is not sufficient to provide individual services appropriate to the care of the individual. In building these telemedicine services, it is also necessary that the doctor identifies which diagnostic, therapeutic, and assistance activities can be carried out remotely, with the technologies available and usable by the person concerned. The physician responsible for the treatment must be able to choose from time to time the combination of organization and technology that proves best, in terms of efficacy and safety, for the person to be assisted. Equipping the patient with technology, however advanced, does not automatically lead to recovery. The patient can be cured if the technology is appropriately used within clinical reasoning that has as its purpose the care of the individual and not the use of technology.

Within healthcare facilities, the connectivity of the workstations is usually ensured optimally. However, it is recommended to perform connection speed tests and verify the real possibilities of the local network to support data traffic compared to the average volume of simultaneous download and upload requests, which will be useful both as guarantee of good functioning at the time of implementation and to document its quality in future analyses on the work carried out during the emergency period. This will not be an additional effort since the applications to perform such tests are very common and easy to use.

A particular case concerns the position of the doctor who works in telemedicine from the place where he/she is domiciled for quarantine. In this case, beyond the opportunity assessments, it is recommended to assess the same procedures described above in the paragraph relating to the recipient of the service, requiring the doctor to perform the above connection speed tests.

4 The Types of Telemedical Services

This section proposes the structuring of four different types of telemedicine services to respond as best as possible to health needs in different situations. Each of these services can be created and provided individually. With appropriate technical measures, the four services can be associated with each other in various combinations, or even implemented all within a single telemedicine system.

For the sake of simplicity, we considered the implementation option in which all four types of services are present. The four services can be applied on a single territory but can be extended in modular form in further areas, even if not contiguous

to the first, or be replicated separately, but in the latter case, it is necessary to duplicate all the parts that compose it, including the related health coordination centres.

It is useful to underline, before going into the details of the different types of services, that they are not aimed at a specific category of doctors but can work with the collaboration of any doctor. This is consistent with the health emergency and in particular should the relative shortage of doctors increase. However, the organization of remote work envisaged in these services is especially adequate for collaboration with general practitioners, who can contribute better than others to the more precise assessment of the situation and evolution. For their knowledge of patients, they can insert into the system the baggage of their specific knowledge of the patients entrusted to them, with anamnestic details and considerations.

The four types of telemedical services during COVD-19 that are in need are mentioned below.

4.1 Type 1: Active Remote Control of the Health Status of People to Detect the Possible Appearance of Signs and Symptoms of COVID-19 Infection

This type of service is aimed at people affected by diseases before the time when quarantine or isolation was required, asymptomatic and falling within the definition of close contact or confirmed case. This type of service is proposed to immediately identify in such people the appearance of symptoms and/or signs attributable to the beginning of the symptomatic phase of COVID-19. This service finds its direct utility in the remote control of the spread of the contagion, with a clear utility in the overall management of the emergency by the authorities, but it also has an individual utility as it allows to make the treatment of support to the individual, increasing the chances of recovery.

Furthermore, it facilitates the correct adoption of home hygiene and prevention measures by the person himself/herself and any cohabitants. Healthcare personnel must operate in a coordinated manner concerning the public health services of the relevant territory, to optimize the use of resources, and must also act according to national provisions and guidelines, to ensure uniformity of procedures and services. The remote control activities can be performed by adequately trained healthcare personnel; they are based on repetitive and standardized procedures of anamnestic update and detection of some simple objective signs (e.g. body temperature), together with regular interviews in a video call in which the collected data and information on the state of health are verified. At the same time, during the video call, the person is provided with useful information and advice. These contacts, regularly, also contribute to improving individual adherence to indications, prescriptions, and treatments.

For this type 1 service, the objective data that must be collected are all those that are indicated by official sources as necessary and sufficient to make a clinical diagnosis of COVID-19 or at least to suspect it [15]. The clinical symptoms most

commonly encountered in laboratory-confirmed COVID-19 cases were fever, dry cough, fatigue, sputum production, dyspnoea, sore throat, headache, etc. [16]. It is advisable to include all these symptoms in the computerized procedures for the detection of anamnestic and control information, asking the person in isolation to indicate only if one or more of them are present. This can also be done via a questionnaire in the app or during video-call interviews and is used exclusively to identify people in quarantine or isolation who become symptomatic or paucisymptomatic.

The video-call system, by its nature and always in consideration of the health emergency, does not require the high characteristics that are normally required to ensure health safety when making decisions in the differential diagnosis (e.g. precision image) and for which high- or maximum-level certifications are required. This allows us to be flexible in using various video-call systems to adapt to the technological possibilities available at the person's home.

4.2 Type 2: Tele-Surveillance of the Clinical Picture of People in a Situation for the Necessary Treatment Against COVID-19 and to Arrange for Any Hospitalization When Appropriate

This type of service is aimed at people related to a situation already illustrated ("people not affected by diseases before the time when isolation was required, who have mild to moderate symptoms compatible with COVID-19 infection, and who fall within one of the definitions of the suspected, probable, or confirmed case"). These are numerous patients who develop symptomatic forms of COVID-19, or symptomatologic pictures compatible with COVID-19 in suspected cases, with mild or moderate symptoms and signs, whose condition is manageable at home and in the absence of further pathologies.

The typical medical image of reference for inclusion in this service consists of fever between 37.5 and 38.6 °C, dry cough, cold symptoms (and/or other symptoms indicative of COVID-19 referenced in type 1), and without dyspnoea. The objective of this type 2 service is to treat the aforementioned patients remotely with suitable treatments, maintaining medical control at home, with greater proactivity than would be possible without telemedicine systems, providing an effective and easy-to-use tool for optimizing primary care in the current emergency and to safeguard the safety of healthcare professionals. The insertion of the patient in this type 2 service is associated with the reporting of the case to the public health services for the execution of the COVID-19 test, where required. The patient can be entered directly into type 2 service or addressed to it by type 1.

The changeover manoeuvre from type 1 to type 2 service allows the doctor to be placed in the best conditions to recognize as quickly as possible at the moment the symptoms that tend to increase in number and intensity, increasing control in telemedicine. Severe forms of the disease, with more intense symptoms, occur in 13.8%

of cases, and 6.1% of patients present a critical form of COVID-19 with respiratory failure, septic shock, and/or multi-organ dysfunction/failure, with further related symptoms [17–19]. Using telemedicine systems in this way means treating people at home instead of hospitalizing them, when this is possible and useful for the person, while it does not mean using telemedicine to delay hospitalization that is deemed necessary.

In type 2 service, the appropriate combination of measuring equipment can have a high level of standardization, but it cannot be established first rigidly for all people. The doctor based on the interviews with the patient, decides from time to time which measurement scheme is suitable, choosing from a basic set of measurements that he/she can modify in part. In case of need the same patient can transmit the measurements online or can report them during the follow-up video call with the doctor.

The control video calls, always associated with the detection of the symptoms and signs indicated above, have the meaning of allowing the patient's clinical and risk conditions to be assessed remotely, directly by the connected doctor, to complete the framing of the case, to decide on the treatment against COVID-19, and above all to react promptly in case of worsening towards serious forms of the disease. The video call allows to partially overcome the limits of simple telephone contact, also transmitting images and colours.

In this way, it allows the doctor to perform at least part of the normal medical examination including the collection of the anamnesis and partially the physical examination (inspection).

4.3 Type 3: Active Tele-Surveillance of the Overall Clinical Picture of People to Provide the Best Possible Continuity of Care and Assistance at Home, About the Underlying Condition and Any COVID-19 Infection

This type of service is aimed at people suffering from chronic diseases or rare diseases and people in fragile conditions, or who require long-term treatment or particular assistance and/or support not in the hospital, and who need to maintain the continuity of services during quarantine or isolation or in the period of application of the social distancing rules.

The objective of this type 3 service is to continue home care and assistance in favour of the aforementioned patients concerning their basic condition, placing them under the maximum protection obtainable against COVID-19. For these people, the damage produced by the interruption of care and assistance following forced isolation or social distancing has the same importance as that deriving from the contagion. The development of COVID-19 in people already suffering from other demanding pathologies, with reduced functional reserve, can more easily induce extreme consequences in a short time, but the interruption of the necessary treatments will cause damage that is difficult to recover, which will manifest itself in a long time but equally with serious consequences.

For these people, it is necessary to use telemedicine systems to keep the services dedicated to them actively, modifying, if necessary, the procedures to obtain the widest possible accessibility and usability even at a distance while maintaining medical control for both primary care and specialist services and also in these cases to safeguard the safety of health professionals. The patient can be inserted directly into type 3 service or addressed to it by type 2 in the manner described above. The changeover manoeuvre from type 2 to type 3 service allows the doctor to be in best conditions to keep the underlying pathological picture under control and at the same time monitor any appearance/evolution of symptoms and signs from COVID-19. The operational procedures relating to COVID-19 in this type 3 service are identical to those reported in types 1 and 2. However, in the activities in telemedicine for the contrast to COVID-19 aimed at these patients, measures of greater protection are applied based on the cases.

Upon the appearance of symptoms, the telemedicine system, using checks on the data detected by the devices and together with the daily verification of the doctor via video call, must allow the doctor to prescribe the appropriate and personalized treatment at home, as well as to immediately identify situations of worsening of conditions that require more care in a hospital setting. About the points in the list above, it should be borne in mind that, even in the health emergency due to COVID-19, the task of the telemedicine services offered at home for these patients essentially consists of limiting the frequency of episodes of exacerbation of chronic pathologies and/or preventing complications, reducing as much as possible the need for services for which it is essential to go to health facilities. This task, as already extensively studied and applied in telemedicine, can be carried out, in part or whole, by detecting and transmitting the necessary and personalized set of clinical parameters to the referring physician. However, in an emergency, it is possible to be forced by circumstances to organize home services in telemedicine having to accept the limits of the availability of hardware and software at the patient's home.

In cases where it is not possible to deliver the necessary instruments to the patient and either he/she or caregivers are not able to use them acceptably, it is necessary to organize an adequate sequence of alternative actions, until the material resources available are such as to guarantee safety and efficacy. It is recommended already in the organizational phase to define in which situations the assisted patient must be directed to face-to-face services, which in turn may be both at home and in health facilities.

4.4 Type 4: Psychological Tele-Support Regarding the Discomforts and Limitations of Isolation (at the Request of the People)

This type of service is aimed at any person who is in isolation or quarantine, or de facto isolated following the rules of social distancing, in the course of COVID-19. The service aims to put the person in isolation in audio-video contact with a psychologist [20]. The video call is activated on individual request, with a procedure

that allows the service to be provided in the shortest possible time, based on the available resources, directly at the person's home.

It is particularly indicated and recommended for this type 4 service that the coordination of the activities is assumed by the competent authorities. By definition, this type of activity cannot be standardized, and therefore coordination serves exclusively to optimize the provision of the service to guarantee its uniformity, especially concerning the application of scientifically correct intervention methods in safe conditions.

The interviews will in any case be subject to the code of ethics of the order of psychologists and will not be recorded. The service does not consist of medical assistance activities but consists exclusively of carrying out interviews with a psychologist, which have the purpose of giving support to people in isolation against the discomforts, limitations to relationship life, and fears caused by the specific situation. The psychologist, registered in the register, interacts via video call with the people who request it and can, once the first contact has been established and where he/she deems it necessary, arrange further interviews via video call with the person.

Before starting the interview, it is recommended that the psychologist identify the person to whom he/she is addressing, using the most appropriate methodology. The video-call system for psychological interviews, by their nature of individual interviews without the use of instruments and always in consideration of the health emergency, only requires good connectivity that allows the psychologist to adequately grasp the non-verbal language as well during his/her speech.

5 Telemedical Frameworks for Seafarers' Health

This section presents the two major telemedical frameworks that are helpful to mitigate the problems of on-board seafarers due to COVID-19. For example, cloud-based technologies have been intended to help patients from home by proactively overseeing mental worries like melancholy, tension, and different conditions with the work of prescient investigation controlled by artificial intelligence (AI) models.

5.1 Cloud-Based Technology

The fundamental commitment of this work is to introduce a theoretical system for the observing of psychological circumstances of COVID-19-contaminated patients. This system has been introduced in Fig. 2 to help the clinical consideration, mental issue appraisal, instructing of healthcare staff, and online self-evaluation of people just as depressed patients as seafarers. It can likewise assist with controlling mental issues using individual interchanges with different patients through basic chat sessions.

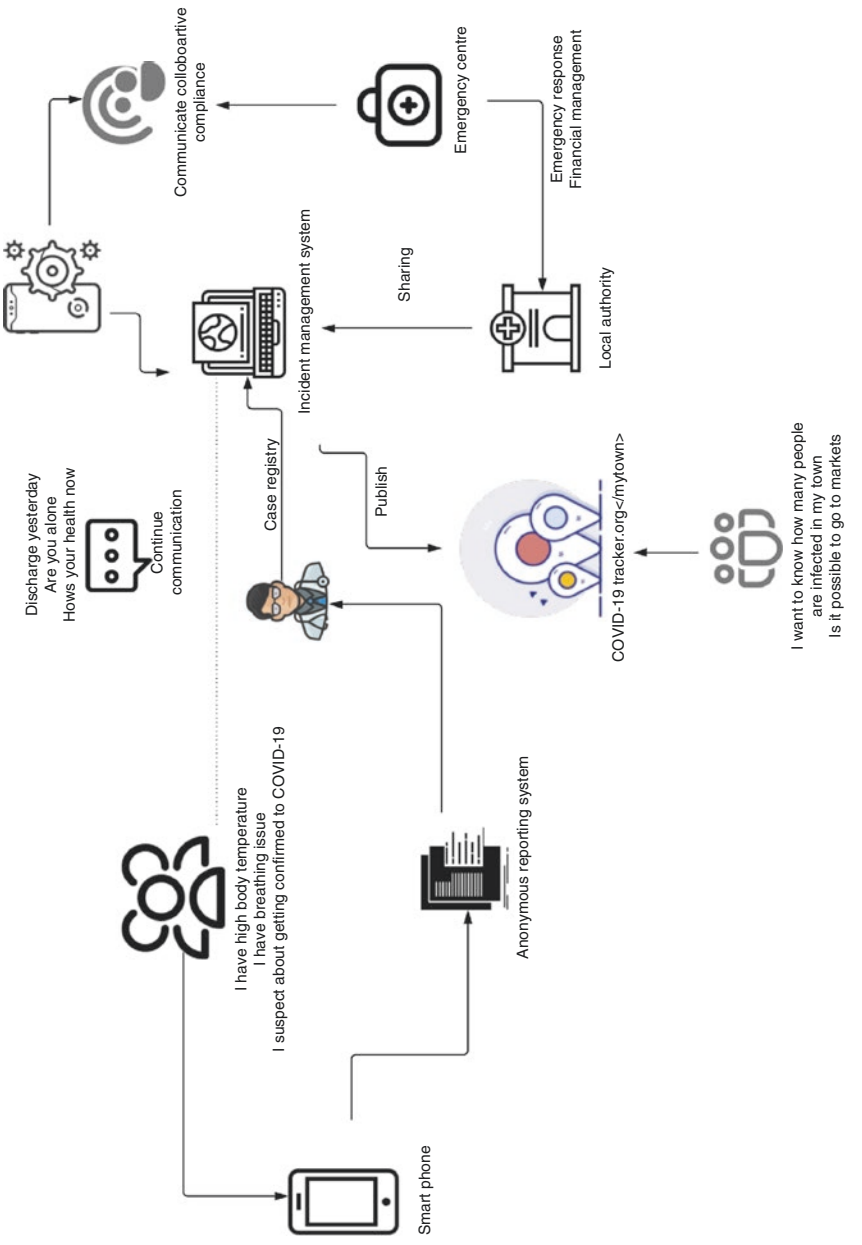

Fig. 2 Cloud-based telemedical framework

The presented model has been planned with the incorporation of both AI and cloud knowledge. The data set of occurrence of the executive's framework gathers the nearby information of mental and actual conditions of quarantined (or isolated) seafarers with COVID-19. The seafarer can be enrolled into the given application and record the health parameters (i.e. heartbeat, body temperature, body mass index (BMI), pulse) to screen normal health situations.

When a seafarer gets sick or feels that he/she has got an abrupt climb in internal temperature, or faces breathing issues, this application cautions the patient and makes a prompt arrangement to reach the emergency department. This incident is recorded in the management systems and records the number of on-board infections and offers the day-by-day successful implementation of COVID measures in the shipping environments. Distributing or sharing of recovered patient's experiences empowers infected persons to feel much improved and more certain to battle against COVID-19. Along these lines, the proposed system can open new ways to utilize public health technologies to save lives during this new pandemic by giving a far-reaching method of track and dealing with a person's COVID-19 reactions.

5.2 ICT Framework

Telemedicine has as of now been proved as an effective solution during SARS-CoV (severe acute respiratory syndrome coronavirus), MERS-CoV (Middle East respiratory syndrome coronavirus), Ebola, and Zika [21]. Another proposed system to mitigate the virus risk on-board is based on information and communications technology (ICT). The major aim of proposing this framework is to introduce a conceptual model for seafarers observing both COVID-19-suspected and -infected patients. This incorporated framework might ensure controlled supervision not just of positive patients but also of asymptomatic and constantly sick patients during novel coronavirus.

The proposed model is outlined with SIoT (Social web of things) and AI methods (i.e. deep learning, text mining, genetic algorithms) The SIoT is utilized to gather the suggestive data of COVID-19-contaminated patients (Fig. 3). The utilization of computerized gadgets, biosensors, and thermometers can assist with giving everyday data, for example pulse, body temperature, circulatory strain, and galvanic skin reaction. After having the required data, the model system with AI knowledge will be utilized to case extensive arrangement model to check the patient situation in three possible ways mentioned below:

- Assuming that the patient is asymptomatic, telemedicine checking will proceed till the finishing of the incubation period.
- If the patient is possessing mild to moderate symptoms, continuous support will be expected till the patient is recovered.

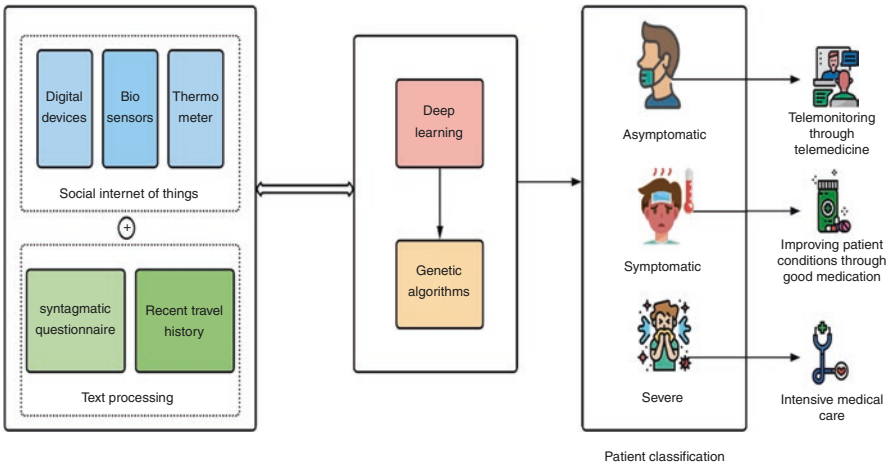

Fig. 3 ICT-based telemedical framework

- Assuming that the patient is in extreme conditions, immediate data can move to emergency clinical support to the extreme arrangement of concentrated medical care.

6 Conclusions

Telemedicine and telemonitoring technologies can treat patients with emergency conditions despite a physical appearance at the healthcare centre. These types of systems are largely helpful for remote-area patients (i.e. seafarers). With videoconferencing, telemedicine frameworks empower direct correspondence with patients by computers or mobile phones. The whole framework has to be overseen by uniquely planned programming to ensure stable associations, data stream, and information security. These frameworks are a combination of medical objects, which will autonomously record the patient biomedical data and review the seriousness of medical problems. Several efforts are needed by all global nations to guarantee that pandemics like the COVID-19 can be effectively managed. According to this viewpoint, assuming that telemedicine is completely incorporated into a public health framework, it could demonstrate a legitimate instrument all alone to ensure continuous care and reduce virus severity, particularly among well-being experts.

Conflicts of Interest No author produced any conflicts of interest.

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References

1. Sagaro GG, Battineni G, Chintalapudi N, Di Canio M, Amenta F. Telemedical assistance at sea in the time of COVID-19 pandemic. Int Marit Health. 2020;71(4):229–36. https://doi.org/10.5603/IMH.2020.0041.
2. Takeuchi I. COVID-19 first stage in Japan—how we treat 'Diamond Princess Cruise Ship' with 3700 passengers? Acute Med Surg. 2020;7(1):e506. https://doi.org/10.1002/AMS2.506.
3. J. Rocklöv, H. Sjödin, and A. Wilder-Smith, "COVID-19 outbreak on the Diamond Princess cruise ship: estimating the epidemic potential and effectiveness of public health countermeasures," J Travel Med, vol. 27, no. 3, pp. 1–7, May 2020, https://doi.org/10.1093/JTM/TAAA030.
4. Takian A, Kiani MM, Khanjankhani K. COVID-19 and the need to prioritize health equity and social determinants of health. Int J Public Health. 2020;0123456789 https://doi.org/10.1007/s00038-020-01398-z.
5. Battineni G, Kumar S, Mittal M, Amenta F. COVID-19 vaccine on board ships: current and future implications of seafarers. Int Marit Health. 2021;72(1):76–7. https://doi.org/10.5603/IMH.2021.0010.
6. Banerjee D. The COVID-19 outbreak: crucial role the psychiatrists can play. Asian J Psychiatr. 2020; https://doi.org/10.1016/j.ajp.2020.102014.
7. Coronavirus: nearly half the global workforce at risk of losing income. https://www.cnbc.com/2020/04/29/coronavirus-nearly-half-the-global-workforce-at-risk-of-losing-income.html. Accessed 29 June 2020.
8. World Health Organization. Mental health and psychosocial considerations during COVID-19 outbreak. World Health Organization; 2020.
9. Battineni G, Nittari G, Sirignano A, Amenta F. Are telemedicine systems effective healthcare solutions during the COVID-19 pandemic? J Taibah Univ Med Sci. 2021;16(3):305–6. https://doi.org/10.1016/j.jtumed.2021.02.009.
10. Siddiqui J, et al. Infectious Diseases Society of America position statement on telehealth and telemedicine as applied to the practice of infectious diseases. Clin Infect Dis. 2017;64(3):237–42. https://doi.org/10.1093/CID/CIW773.
11. American Geriatrics Society policy brief: COVID-19 and nursing homes. J Am Geriatr Soc 2020;68(5):908–911. https://doi.org/10.1111/JGS.16477.
12. Tseng TG, Wu HL, Ku HC, Tai CJ. The impact of the COVID-19 pandemic on disabled and hospice home care patients. J Gerontol A Biol Sci Med Sci. 2020;75(9):e128–9. https://doi.org/10.1093/GERONA/GLAA081.
13. Dosa D, Jump RLP, LaPlante K, Gravenstein S. Long-term care facilities and the coronavirus epidemic: practical guidelines for a population at highest risk. J Am Med Dir Assoc. 2020;21(5):569–71. https://doi.org/10.1016/J.JAMDA.2020.03.004.
14. Keesara S, Jonas A, Schulman K. Covid-19 and health care's digital revolution. N Engl J Med. 2020;382(23):e82. https://doi.org/10.1056/NEJMP2005835.
15. Huang C, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet (London, England). 2020;395(10223):497–506. https://doi.org/10.1016/S0140-6736(20)30183-5.
16. Chen N, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet (London, England). 2020;395(10223):507–13. https://doi.org/10.1016/S0140-6736(20)30211-7.
17. Eurosurveillance Editorial Team. Updated rapid risk assessment from ECDC on the novel coronavirus disease 2019 (COVID-19) pandemic: increased transmission in the EU/EEA and the UK. Euro Surveill. 2020;25(10) https://doi.org/10.2807/1560-7917.ES.2020.25.10.2003121.
18. Zhou F, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet (London, England). 2020;395(10229):1054–62. https://doi.org/10.1016/S0140-6736(20)30566-3.

19. Yang X, et al. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. Lancet Respir Med. 2020;8(5):475–81. https://doi.org/10.1016/S2213-2600(20)30079-5.
20. Wright JH, Caudill R. Remote treatment delivery in response to the COVID-19 pandemic. Psychother Psychosom. 2020;89(3):130–2. https://doi.org/10.1159/000507376.
21. Ohannessian R, Duong TA, Odone A. Global telemedicine implementation and integration within health systems to fight the COVID-19 pandemic: a call to action. JMIR Public Heal Surveill. 2020; https://doi.org/10.2196/18810.