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Original Article

Telemedical maritime assistance over three decades in Denmark

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ABSTRACT

INTRODUCTION. Seafaring is associated with higher occupational hazards and health risks than shore-based work. Telemedical maritime assistance services (TMAS) provide remote specialist medical support to seafarers. In Denmark, a unified national TMAS, Radio Medical Denmark (RMD), was established in 1995. This study aimed to describe the 30-year development and clinical activity of the RMD.

METHODS. This was a single-centre retrospective cohort study of all consultations provided by the RMD from 1 September 1995 to 31 December 2024. Data were extracted from annual reports based on original medical files, with organisational information from contracts and guidelines. No identifiable patient data were collected.

RESULTS. The RMD assisted 49,999 seafarers over 30 years, with annual consultations increasing from 240 in 1995 to 4,829 in 2024. The proportion requiring disembarkation or evacuation declined from >10% at the outset to approximately 5% today. The most common diagnoses were musculoskeletal (18.8%), dermatological (14.6%) and abdominal (11.5%). Since 2014, the proportion of Danish seafarers decreased from 38% to 15.1%, while Indian and Filipino seafarers increased substantially. Merchant vessels accounted for 55.7% of contacts, predominantly in the North Sea.

CONCLUSIONS. RMD has evolved into one of Europe's largest public TMAS providers. Centralisation within an academic emergency department, combined with structured training and research, has supported sustained growth, improved decision-making and reduced evacuation rates.

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Seafaring remains a high-risk occupation, characterised by hazardous environments and prolonged periods at sea. Seafarers face greater occupational hazards and health risks than shore-based workers [1-3]. Medical events often occur in isolated settings with limited access to proper healthcare, making timely and appropriate medical decision-making challenging. Maritime telemedical assistance services (TMAS) provide remote medical support to ships and address these challenges [4-6].

During the earliest naval voyages, seafarers were constantly exposed to health risks without any onboard medical support. Assistance could be sought only upon approaching a port. With the rapid development of communication technologies, most European nations gradually established national TMAS, especially following the 1912 sinking of the HMS Titanic. Sweden created its service in 1922, Norway in 1923 and Italy in 1935 [7].

In Denmark, smaller coastal radio stations were established from 1914, including Blåvand, Lyngby, Skagen and Bornholms Radio. For decades, these stations coordinated medical care on ships with local hospitals in Esbjerg, Skagen/Hjørring and Rønne, as well as with Rigshospitalet [8]. A national service was not created until 1995, when the Danish Maritime Authority (DMA) created Radio Medical Denmark. The goal was to establish a

specialised team of maritime physicians trained in telemedicine and providing specialist medical advice.

Esbjerg was selected as the base owing to its proximity to key maritime institutions: the Maritime Academy, which trained seafarers (established 1893); the Centre of Maritime Health Service, which trains medical officers; and the Research Centre of Maritime Health and Society at the University of Southern Denmark. This collaboration between clinical, educational and research facilities aimed to ensure the highest standard of maritime healthcare. On 1 September 1995, Radio Medical Denmark (RMD) was established at Esbjerg Hospital, providing seafarers with 24/7 access to specialist medical care. Since then, the RMD has served as the primary TMAS provider for all ships within the Kingdom of Denmark, encompassing Denmark, the Faroe Islands and Greenland.

Hitherto, no study has comprehensively examined the development of maritime health in Denmark. This study aimed to provide a descriptive overview of the 30-year development, structure and organisation of the RMD.

Methods

Study design

We performed a single-centre retrospective cohort study of RMD as a maritime telemedicine service from 1 September 1995 to 31 December 2024. Reporting followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist [9]. This study is purely descriptive without hypothesis-driven analyses.

Data collection

Data were obtained from the RMD's annual reports, based on original medical files. No identifiable data were collected. Outcome measures were the number of contacts, evacuations and patient demographics. Each case in the dataset represents an individual patient episode. When multiple communications were required for the same patient during a medical event, they were recorded in the same case and counted as a single contact in the present analysis. The RMD medical records include patient identifiers and individual-level patient data; however, for this study, we analysed only aggregate data. Data from the first three years are limited due to incomplete reporting. Similarly, no formal report exists for the year 2010. Data on the current organisation and structure were gathered from available contracts, strategy papers and internal guidelines.

Data availability

The datasets are available from the corresponding author on reasonable request.

Ethics approval

Ethics committee approval was not required according to Danish law. The project was approved as a quality-improvement project by Esbjerg Hospital (25/19570) and registered in the Internal Research Registry of the Region of Southern Denmark.

Trial registration: not relevant.

Results

Organisation

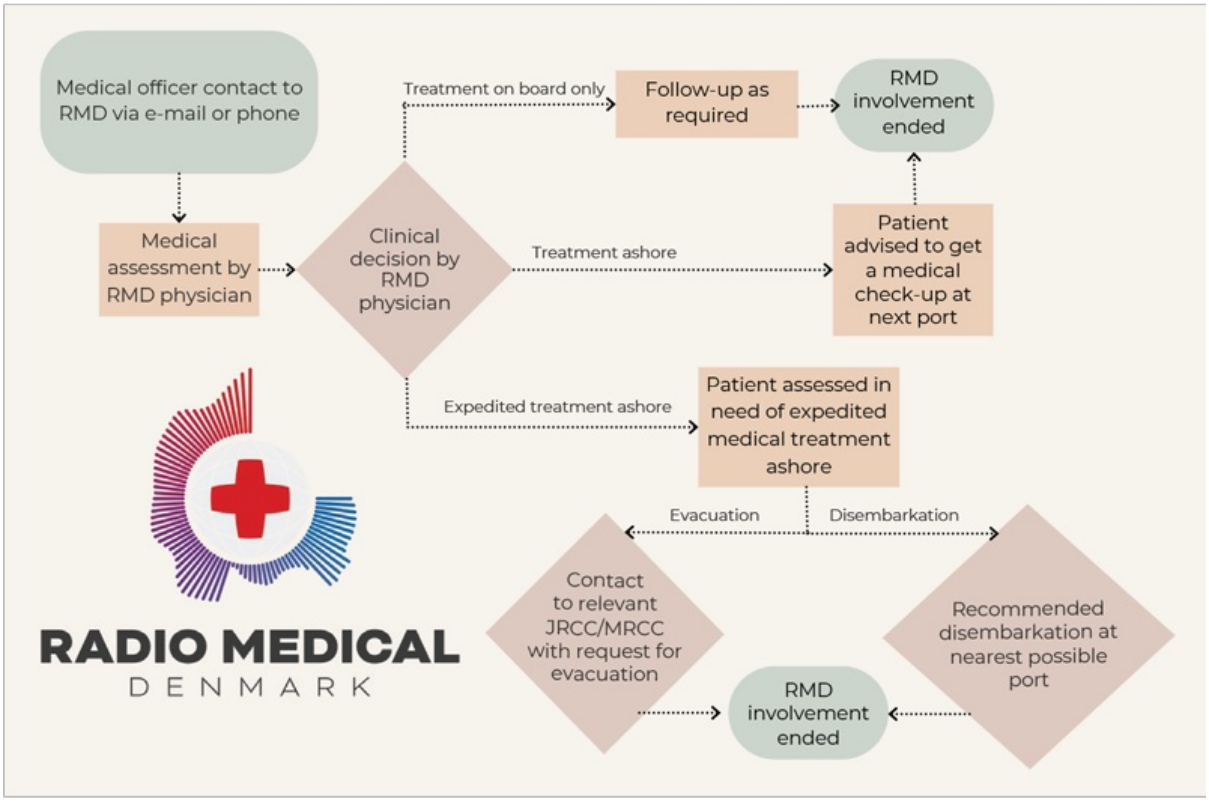
The RMD operates as a unit within the emergency department (ED) at the University Hospital of Southern Denmark, Esbjerg. In accordance with the DMA and the Maritime Labour Convention, the RMD provides

medical assistance to seafarers on Danish-flagged commercial vessels worldwide, as well as to foreign vessels in Danish waters. Additionally, on a contractual basis, the RMD provides telemedical support to other enterprises, including research expeditions and offshore installations. The RMD is funded by the DMA and through private contractual agreements. The staff are remunerated by the hospital for work performed beyond their regular duties. The RMD's organisation rests on three interconnected pillars:

Clinical operations

The 24/7 telemedical service is primarily staffed by senior ED consultants, with support from other medical specialists. The team has steadily grown to currently nine physicians, assisted by four administrators. Furthermore, specialists from all hospitals in the Region of Southern Denmark are available for complex cases, e.g., tropical medicine or complex ophthalmic cases. Seafarers may communicate with the RMD physician by e-mail, phone or video (**Figure 1**). Furthermore, medical information is collected by the ship's medical officer and submitted in a standardised report (Supplementary material). Interactions conclude with one of four outcomes: treatment on board, a physician visit at the next port, urgent disembarkation or immediate evacuation. Evacuation decisions are made jointly by the RMD physician and the vessel's most senior officer and may involve helicopter- or ship-based transport. Within Danish territory, the Joint Rescue and Coordination Centre organises evacuations. Any onboard treatment is limited to the contents of the ship's medical chest, which is regulated by flag state law.

FIGURE 1 Workflow of Radio Medical Denmark.



JRCC = Joint Rescue and Coordination Centre; MRCC = Maritime Rescue Coordination Center; RMD = Radio Medical Denmark.

Education

The RMD contributes to international efforts to standardise curricula for both medical officers and maritime physicians, and the training framework applied at the RMD follows international TMAS consensus [10]. Authorisation of maritime physicians requires certification from the DMA. In addition, RMD physicians are trained in maritime regulations, operational context and international rescue procedures. Clinical training encompasses emergency medicine, general and occupational medicine, mental health and remote decision-making. Communication skills are regularly refreshed to enable guidance across linguistic and cultural barriers.

Ongoing professional development includes international courses and conferences, such as the International Symposium on Maritime Health. RMD physicians also teach maritime officers through case-based sessions.

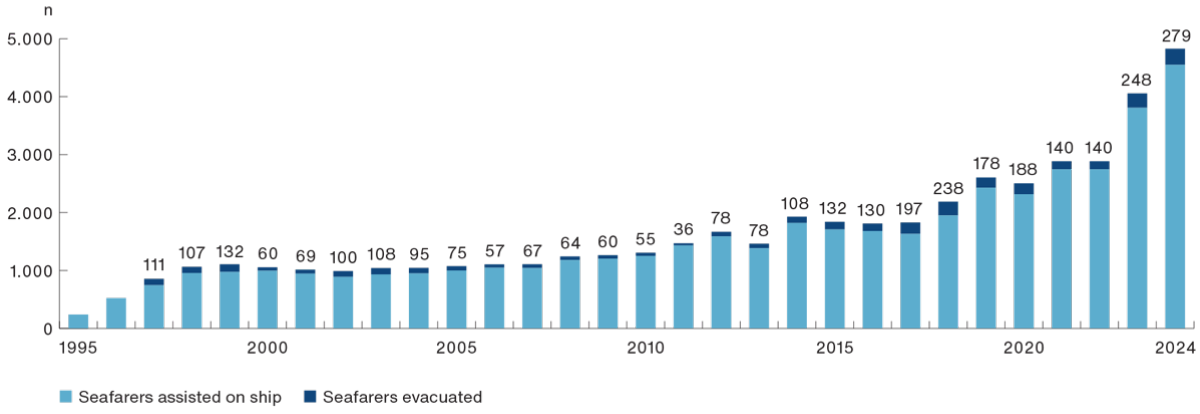
Research

The RMD collaborates nationally and internationally on maritime health research. Domestic partners include the Esbjerg Research Unit for Emergency Medicine and the Maritime Health and Technology Unit (previously known as the Centre of Maritime Health and Society). International partners are mainly European TMAS providers and universities. In 2022, the RMD allocated a research budget to fund projects on the remote management of acute illness.

Clinical outcome

The RMD assisted a total of 49,999 seafarers during the study period. Annual patient numbers increased from 240 in 1995 to 4,829 in 2024. Although the proportion of evacuations and disembarkations decreased over time to approximately 5% from 2020 onward, the absolute numbers increased in parallel with the overall rise in consultations (**Figure 2**). In total, the study period recorded 1,972 evacuated and 1,358 acutely disembarked patients.

FIGURE 2 Number of seafarers either assisted on ship or requiring either disembarkation or evacuation.



The most common reasons for contact to the RMD were musculoskeletal (18.8%), dermatological and allergic (14.6%), abdominal (11.5%), ear-nose-throat or ophthalmological (9.8%), sexually transmitted disease and infectious (9.1%), respiratory (7.4%), dental/oral (6.3%), neurological/psychiatric (5.6%) and cardiovascular (3.2%) conditions. Additional contacts were recorded as “Unspecified” or “Other”. These categories include cases that were not coded or fell beyond the diagnostic groups used in this analysis, such as administrative inquiries or social issues occurring onboard. Diagnosis codes by five-year intervals are shown in **Table 1**.

TABLE 1 Diagnostic groups over five-year intervals. The values are number of patients (%).

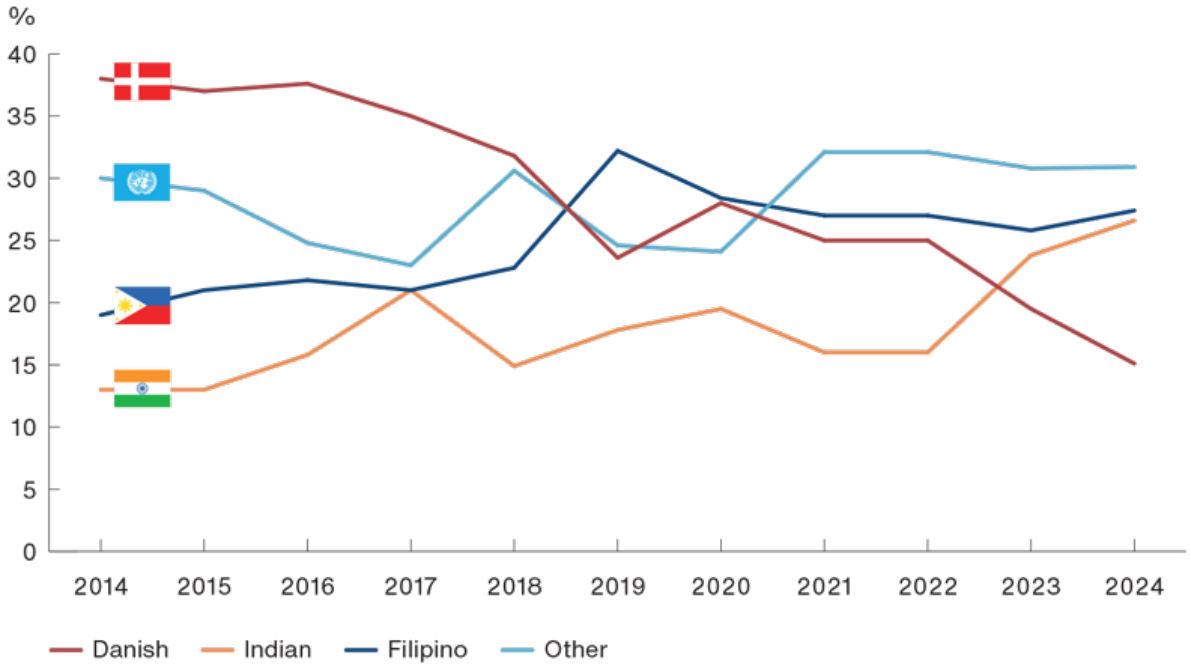
Diagnostic group	1995-1999	2000-2004	2005-2009	2010-2014	2015-2019	2020-2024
Respiratory	194 (6.4)	380 (7.4)	410 (7.1)	305 (4.7)	726 (7.1)	1,322 (9.4)
Musculoskeletal	801 (26.5)	639 (12.4)	744 (12.8)	1,335 (20.5)	2,094 (20.4)	2,804 (19.9)
Abdominal	517 (17.1)	474 (9.2)	527 (9.1)	688 (10.5)	1,105 (10.8)	1,845 (13.1)
ENT & ophtalmological	0	247 (4.8)	392 (6.8)	698 (10.7)	1,246 (12.1)	1,805 (12.8)
Infections & STD	466 (15.4)	178 (3.5)	471 (8.1)	1,017 (15.6)	889 (8.7)	1,077 (7.7)
Cardiovascular	184 (6.1)	163 (3.2)	90 (1.6)	274 (4.2)	403 (3.9)	334 (2.4)
Dermatology & allergy	212 (7.0)	479 (9.3)	680 (11.7)	994 (15.2)	1,605 (15.6)	2,572 (18.3)
Dental/oral	0	280 (5.4)	448 (7.7)	484 (7.4)	724 (7.0)	903 (6.4)
Neurological/psychiatric	247 (8.2)	379 (7.4)	532 (9.2)	263 (4.0)	579 (5.6)	525 (3.7)
Unspecified/others	405 (13.4)	1,926 (37.4)	1,502 (25.9)	466 (7.1)	902 (8.8)	874 (6.2)
Total	3,026 (100)	5,145 (100)	5,796 (100)	6,524 (100)	10,273 (100)	14,061 (100)

ENT = ear-nose-throat; STD = sexually transmitted disease.

Seafarers could contact the RMD only via radio and telephone until 2005, when e-mail was added. In 2024, 86.7% of contacts occurred via e-mail, 13.2% by phone and 0.1% by video.

Nationality has been recorded since 2014. During this period, the total number of annual Danish cases remained stable at approximately 700 patients, whereas the proportion of Danish seafarers declined from 38% to 15.1%. In the same period, cases from India and the Philippines increased from 13% to 26% and 19% to 27.4%, respectively (**Figure 3**). Seafarers from other countries - predominantly Poland, the United Kingdom, Romania, Norway and Ukraine – remained stable, accounting for 31% of cases. In 2024, 9.4% of patients were female.

FIGURE 3 Nationality of seafarers as a percentage of the total number of medical contacts. The group "Other" represents seafarers contacts from multiple nationalities who were either not consistently recorded or occurred in small numbers and have therefore been grouped together.



Merchant vessels, including container ships and bulk carriers, were the most common (27,187, 55.7%). Ferries (8,431, 17.6%), supply ships (8,407, 17.5%) and fishing vessels (2,424, 5%) were also frequently assisted. School

boats, recreational boats, platforms and other vessel types were rare, comprising only 3.2% (1,548) of contacts.

Ship location at the time of the medical incident has been systematically registered since 2012. Most cases occurred in the North Sea (31.4%), followed by the Atlantic (25.2%), the Pacific (18.6%), the Indian Sea (11.9%), the Mediterranean Sea (7.0%) and the Baltic Sea (3.9%). In 1.9% of cases, the location was not recorded. Geographic distribution showed minimal variation over time.

Discussion

Key findings

Over three decades, RMD has experienced substantial growth in telemedical activity, treating 4,829 seafarers in 2024 and nearly 50,000 in total. The proportion of patients requiring disembarkation or evacuation declined from more than 10% initially to a stable 5% in recent years. Most contacts involved merchant vessels in the North Sea, with increasingly diverse crews.

Relationship with previous studies

This is the first study to examine the 30-year development of the Danish maritime health system through the RMD. Previous studies have focused on foreign TMAS providers and/or have not reported data spanning three decades [7].

Since the RMD was established, the annual number of telemedical cases has increased more than 20-fold, largely reflecting the growth of the Danish merchant fleet. Recent reports identify the RMD as the second-largest provider of TMAS in Europe, managing nearly 5,000 patients annually [11]. For comparison, annual case volumes are reported as 7,054 by Italy (CIRM, Rome), 2,817 by France (Hôpital de Purpan, Toulouse), 2,006 by Norway (Radio Medico, Bergen), 1,014 by Germany (Medico Cuxhaven), 878 by Spain (Centro Radio Médico Español, Madrid), 528 by Sweden (Sahlgrenska University Hospital, Stockholm), 186 by Britain (Royal Infirmary Aberdeen and Queen Alexandria, Portsmouth), 55 by Finland (MRCC Turku and Helsinki) and 34 by Poland (Centre for Maritime and Tropical Medicine, Gdynia) [12-14]. No published data were found for Portugal or other European nations.

Although the distribution of registered diagnoses varied over the 30-year period, it has remained stable during the past decade. Earlier fluctuations, including an increase in unspecified conditions between 2000 and 2004, likely reflect changes in coding practices and documentation quality.

The declining proportion of Danish seafarers aligns with previous studies [15], signalling a shift within commercial shipping towards international crews, predominantly from India and the Philippines. Similar patterns have been reported in other maritime nations, suggesting a broader global trend [16].

The proportion of combined disembarkations and evacuations decreased from 13% initially to approximately 5% over time. This is lower than current rates reported elsewhere, which range from 8% in Spain [14] to 10-14% in Sweden [13]. The lower evacuation rate in Denmark may be owed to standardised training resulting in earlier identification of critical illness, as well as an increased number of consultations for less severe conditions. Additionally, integration within an academic ED, with certified emergency physicians, may have contributed to improved decision-making.

Strengths and limitations

To our knowledge, this is the largest published Scandinavian cohort of telemedical maritime consultations, comprising nearly 50,000 patients from a single national TMAS provider. The dataset uniquely combines information on vessel type, seafarer demographics and clinical outcome.

Our study also carries several limitations. As a single-centre retrospective cohort from a small country with a relatively large merchant fleet, findings may not be fully generalisable to other flag states. Our analysis was exclusively descriptive as the dataset did not allow for in-depth statistical analysis of clinical outcomes. Data from three years were limited due to incomplete documentation. Other parameters, including nationality, were recorded systematically only in later years.

Study implications

Our findings suggest that the establishment of a single, specialised national maritime health service has been successful in the Danish context. Centralisation within an ED may support consistent clinical decision-making and reduce the need for evacuation. Embedding TMAS within an academic environment further facilitates structured training and research collaboration, supporting long-term development of maritime medical services.

Conclusions

Over three decades, the RMD has become one of Europe's largest TMAS providers and an integral part of the Danish maritime sector. The Danish model illustrates how centralised maritime telemedicine, embedded within an academic ED, can support sustained service growth, standardised training and research activity. The RMD's organisation reflects the unique clinical, operational and communicative challenges of maritime telemedicine. Continued international collaboration is pivotal to further advance the development of maritime medical care.

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