

A mass casualty incident of infectious diseases at the port of Hamburg: an analysis of organizational structures and emergency concepts

Angelina Klein (✉ ak166297@uni-greifswald.de)

University Medicine Greifswald: Universitätsmedizin Greifswald <https://orcid.org/0000-0001-6150-9351>

Julian Heuser

University Medicine Greifswald: Universitätsmedizin Greifswald

Esther Henning

University Medicine Greifswald: Universitätsmedizin Greifswald

Nadine Spössel

University Medicine Greifswald: Universitätsmedizin Greifswald

Ann-Christin Kordsmeyer

Universitätsklinikum Hamburg-Eppendorf Zentralinstitut für Arbeitsmedizin und Maritime Medizin und Universitätsprofessur für Arbeitsmedizin

Marcus Oldenburg

Universitätsklinikum Hamburg-Eppendorf Zentralinstitut für Arbeitsmedizin und Maritime Medizin und Universitätsprofessur für Arbeitsmedizin

Natascha Mojtahedzadeh

Universitätsklinikum Hamburg-Eppendorf Zentralinstitut für Arbeitsmedizin und Maritime Medizin und Universitätsprofessur für Arbeitsmedizin

Jan Heidrich

Universitätsklinikum Hamburg-Eppendorf Zentralinstitut für Arbeitsmedizin und Maritime Medizin und Universitätsprofessur für Arbeitsmedizin

Kristina Carolin Militzer

Universitätsklinikum Hamburg-Eppendorf Zentralinstitut für Arbeitsmedizin und Maritime Medizin und Universitätsprofessur für Arbeitsmedizin

Lukas Belz

Universitätsklinikum Hamburg-Eppendorf Zentralinstitut für Arbeitsmedizin und Maritime Medizin und Universitätsprofessur für Arbeitsmedizin

Thomas von Münster

Universitätsklinikum Hamburg-Eppendorf Zentralinstitut für Arbeitsmedizin und Maritime Medizin und Universitätsprofessur für Arbeitsmedizin

Volker Harth

Universitätsklinikum Hamburg-Eppendorf Zentralinstitut für Arbeitsmedizin und Maritime Medizin und Universitätsprofessur für Arbeitsmedizin

Lena Ehlers

Hamburg Port Health Center, Institute for Hygiene and Environment

Jens de Boer

Hamburg Port Health Center, Institute for Hygiene and Environment

Scarlett Kleine-Kampmann

Hamburg Port Health Center, Institute for Hygiene and Environment

Matthias Boldt

Hamburg Port Health Center, Institute for Hygiene and Environment

Martin Dirksen-Fischer

Hamburg Port Health Center, Institute for Hygiene and Environment

Lyubomir Haralambiev

University Medicine Greifswald: Universitätsmedizin Greifswald

Denis Gümbel

University Medicine Greifswald: Universitätsmedizin Greifswald

Axel Ekkernkamp

University Medicine Greifswald: Universitätsmedizin Greifswald

M. Sinan Bakir

University Medicine Greifswald: Universitätsmedizin Greifswald

Research Article

Keywords: Civil protection, mass casualty incident, maritime medicine, emergency management, medical hazard prevention, port, infectious outbreak

Posted Date: March 17th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-307791/v1>

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Abstract

BACKGROUND

The project "ARMIHN" (Adaptive Resiliency Management in Port) focuses on strengthening the capability to act in a mass casualty incident (MCI) due to an outbreak of infectious diseases (MCI-ID). In addition to the current threat from the COVID-19 pandemic and associated outbreaks on cruise ships, an MCI-ID can also be caused by pathogens such as Influenzavirus or Norovirus. The first step was, to get an overview of processes and resources using the example of the Port of Hamburg, and to show the relating interaction of involved parties. This will serve as a basis for developing an operational strategy and offers the opportunity to optimize current work processes.

METHODS

A selective literature research using specified key words was performed and existing MCI concepts were received from local authorities. Identified structures and processes were analyzed in a multiple step process and also brought together through discussions in workshops with involved organizations and other experts. Additionally, the distances between the nearest rescue stations and selected hospitals from the Port of Hamburg were analyzed.

RESULTS

The current available concepts are proven, but an adaptation to an MCI-ID shows opportunities for a further cross-organizational development. The organizational structure of an MCI-ID in the Port of Hamburg was described, including a large number of involved organizations (n = 18). There are 17 involved fire and rescue stations and the port can be reached from these locations within 6 to 35 minutes. Based on their specialist expertise, 14 of the 31 listed clinics were selected.

CONCLUSION

Based on identified existing structures and the determination of medical resources, an operational concept for an MCI-ID in the port can be adapted and can contribute to enhanced coping with this situation. Subsequently, the derived operational concept will be tested for practical suitability in several exercises within the present project.

Background

The threat posed by the current COVID-19 pandemic and associated outbreaks on ships like the Diamond Princess in February 2020, shows the urgency to develop concepts for infectious diseases at points of entry like ports in order to retain the ability to act in the event of an infectious disease (ID) outbreak (1, 2). The continuous growth of the cruise ship sector, gives reason to be concerned about further outbreaks on ships and also shows the need to implement emergency plans (3). Outbreaks do not have to be caused by novel pathogens, such as the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). A mass outbreak of already known pathogens such as Influenza or Norovirus can also quickly push the medical care on ship and the subsequent rescue chain to their limits, due to a simultaneous high number of sick people (4, 5). An analysis of existing structures and basic conditions on ships and in the port is the first step in creating an operational strategy for mass casualty incidents due to an outbreak of infectious diseases (MCI-ID). It forms the foundation and offers the possibility to identify areas for improvement.

Recent security research has increasingly dealt with the topic of mass casualties of injuries (6–11). However, the existing emergency plans are primarily designed and tested for onshore use (12–21). A MCI at sea or within a port, has rarely been focused (22, 23). The literature mostly describes studies on outbreaks of infectious diseases on ships, while the rescue procedures in port are hardly reported (1, 2, 4, 5). An analysis of a MCI on ships showed that existing structures and processes must be recorded as well as concepts have to be created in order to ensure better preparation in such an emergency (22). A recent publication dealing with digital versus analogue record systems for MCI at sea underlines that improvements are also required there. The superiority of digital triage of patients over analogue was examined showing less mis-triage, since this can be particularly dangerous for patients on the high seas (24).

Knowledge of the existing structures and basic conditions in a port, as well as the ascertainment of the existing medical resources are necessary in order to manage an MCHD on a ship. By presenting the actual situation, optimization potentials can be worked out, and adapted hazard prevention can be ensured.

A first aim of the project "ARMIHN" (Adaptive Resiliency Management in Port) is to record the basic conditions and structures due to an outbreak of infectious diseases, including recommendations, guidelines, laws, and existing emergency concepts. In addition, existing (medical) resources in the port areas, rescue services and hospitals will be shown. An important aspect is the analysis of the interfaces of involved parties and their collaboration during an MCI-ID. The relevance of the analysis is also shown by the fact that there is no experience of an MCHD in the Port of Hamburg, so far, and that this scenario has been rarely practiced in the port area yet.

Methods

The Port of Hamburg, Germany, is set in a highly industrialized infrastructure directly adjacent to the urban area and will serve as an example for the analysis. This enables a future transfer of coping strategies to similar facilities. In a selective literature research, information was collected from different documents using the following various keywords: "Maritime medicine", "Mass casualty incident", "Mass casualty of infectious diseases", "Hamburg Port Health Center",

“Maritime Declaration of health”, “International Health Regulations”, “Rescue service Hamburg” “Fire Department Hamburg”, “Emergency concepts”, and “Hospitals Hamburg”. Therefore, available international, national, and local recommendations, guidelines, legal texts, and manuals from the PubMed and Google Scholar databases and public documents from local institutions accessed from their website were included. Additionally, non-confidential unpublished instructions and existing concepts for an MCI from local authorities were obtained, while confidential material has been excluded from analysis. Information was also collected through discussions with members of the fire and rescue department and the Hamburg Port Health Center. Current processes were also discussed in a workshop with 1–3 respective representatives from other involved parties, for example Hamburg Port Authority, the Telemedical Maritime Assistance Service, ship pilots, the waterway police, aid organizations, and the German Seamen’s Mission. With the addresses of the rescue stations, the distance and arrival time was calculated using Google Maps® (25). The port of Hamburg extends over a relatively large area, so a general fixed point in the center of the port was selected, which is used by Google Maps® after entering “Port of Hamburg”. The distance and travel time from the port to the hospitals was calculated the same way. Tables were created, then sorted by distance. For visualization, rescue stations and hospitals were presented on maps (25–27). The ARMIHN project is funded by the Federal Ministry of Education and Research Germany (13N14925) and started in March 2019. The study was registered with the German Clinical Trials Register (DRKS; DRKS00022327) and approved by the local ethics committee (BB 051/19). All institutions and local authorities gave their informed consent in collecting and publishing data.

Results

This study revealed that there are no documented experiences with MCI-ID in the Port of Hamburg until the beginning of the COVID-19 pandemic. In addition, the responsible authorities have not carried out any major damage exercises on this topic so far. During the project, an organizational chart of all these involved parties was developed, which reflects the complexity of MCI-ID at the port (Fig.). In general, the parties can be divided into different key areas. The section *Shipping* is represented by several organizations. The section *Port Area* is structured into two separated operational units, consisting of the *Port* and the *Rescue Services*. The section *City* is represented by several major players. The existing medical concepts (Hamburg Port Health Center, emergency service) are tested only by themselves within the organization and in some non-practical command-staff exercises (18, 28, 29).

Guidelines

The diversity of the current state on maritime and health sectors include international, national and local laws, guidelines, and regulations for an infectious emergency on ships and in the port area. The International Health Regulations (IHR) published by the World Health Organization (WHO) regulate the prevention of illnesses and form the basis of all further health regulations, also in response to the increase in international travel and trade (30). A part of the implementation of the IHR in the maritime sector are manuals. They comprise topics relating to public health on ships, ship inspections and ship hygiene (31, 32). They deal with hygiene standards, the implementation of WHO recommendations, and legal requirements on ships and ship inspection (4, 33).

In Germany, the Infection Protection Act regulates the investigation, protective measures, the observation, and the quarantine of infection events (34). With these guidelines, an outbreak of an infection disease can be fought. Another basis concerning the resources of medical personnel is determined by the Federal Ministry of Transport and Digital Infrastructure, which constitutes the medical standard for ships flying under the German flag (35). The Federal Office for Maritime Shipping and Hydrography also regulates whether a doctor and other medical personnel must be on board the ship (36). Factors such as ship type, number of people on board, travel destination and duration are considered.

Process of reporting infectious diseases in the Port of Hamburg

For ships off and in German waters, the Telemedical Maritime Assistance Service or the German Central Command for Maritime Emergencies in Cuxhaven provides medical advices (37, 38). This can be the first reporting station in the event of an outbreak if the ship is not located on inland water.

Regularly, a ship reports the current state of health of its persons on board via the Maritime Declaration of Health (MDH) at least 24 hours before entering the port (39). All cases of illness “since the start of the international trip or within the last 30 days” have to be listed in order to be able to draw conclusions about possible contamination and infection chains on board (39). The National Single Window (NSW) is implemented as an electronic reporting system for ships entering a German port. Information such as the MDH can be made available to the competent authority via the system after a single report (40).

The Hamburg Port Health Center (HPHC) as the responsible authority in Hamburg will be informed about the MDH via the NSW. If there is a conspicuous MDH like a huge number of sick passengers or deaths, further information about the ship, the itinerary, and the measures already taken, can be obtained from the responsible port agent or the ship. If there is an MCI-ID, the HPHC can initiate various measures based on the initial assessment, inspection, and, if necessary, the expertise of the Hamburg Institute for Hygiene and the Environment. Crisis management documents, which regulate further alerting, the reaction, and decision making in the event of health emergencies in the port of Hamburg are available (28, 29). A Hamburg-specific interdisciplinary committee called the “Fachstab Seuchenschutz” (Disease Control Unit) can be alerted in the event of possible epidemic or pandemic incidences (28, 29). Experts from different specifications evaluate the emergency situation, advise and give recommendations for action and instructions. As one of five designated ports in Germany, the HPHC keeps protective clothing (smocks, gloves, mouth protection) and medical materials for sampling and diagnostics.

MCI Infrastructure of Hamburg

If patients on a ship need to be hospitalized, the HPHC alerts the Hamburg Fire Brigade, which is responsible for providing emergency and rescue services in the city. The fire department is represented in Hamburg with 17 fire and rescue stations (41, 42). The rescue workers reach the port from the different locations in an average of 6 to 35 minutes (Fig. 2).

The fire department has several available vehicles from material-carrying equipment vehicles, to large-scale ambulances, to combat an MCI (41, 42). There is an instruction to cope with an MCI, additionally to material resources (18). It regulates the alert levels as well as the steps of the first arriving forces, the

organization of deployment, types of alarm, the patient distribution and documentation, and the communication at the place of operation.

The rescue control center and the head of operations on-site organize the distribution of the patients after examining the capacity of the hospitals. The Hamburg Hospital Plan 2020 lists 31 clinics in the city with a total inpatient bed capacity of 12,294 beds (43). An exact number of currently existing and available isolation rooms or beds cannot be shown because the occupancy of the hospitals varies daily. Due to the focus of research in relation to the MCHD, clinics with appropriate specialist departments for the treatment of infectious patients have been selected (Fig. 3). Inclusion criteria for these clinics have been an intensive care unit and a department for internal medicine. Accordingly, purely surgical clinics are not included.

Experts from the Bernhard Nocht Institute for Tropical Medicine (BNITM) and the University Medical Center Hamburg-Eppendorf (UKE), which focusses on infectiology, tropical medicine and gastroenterology, can treat patients in the treatment center for highly contagious infectious diseases (BZHI), as designated by the Robert Koch Institute (RKI). Highly contagious patients with infections and tropical diseases such as Ebola can be treated in special isolation rooms, which have their own locks (44, 45).

As a critical part of their infrastructure, hospitals are required to maintain their own alarm and response plans in preparation for major damage situations (10). The Hamburg Hospital Act already wrote the emergency care in the hospital in April 1991 and requires the creation of alarm plans for external and internal large-scale operations (46). The Authority of Labor, Health, Social, Family and Integration has been carrying out regular exercises in hospitals in order to be prepared for an MCI since 2005. This includes the construction of additional treatment areas (for example tents), triage and treatment of patients. These experiences and practiced processes can also be transferred to an MCHD with a necessary adaption concerning the different triage and treatment of the patients.

Discussion

Using Hamburg as an example of a city with a major port and points of entry, the current planning and rescue equipment provision for MCHD and thus the implementation of civil protection was shown for both perspectives, administrative as well as operational. The created organizational chart shows how many different organizations would be involved in an MCHD in the Port of Hamburg and concurrently reflects the complexity. It can be assumed that if more parties are involved in such a situation, they will have more challenges on the communicational and operational level (47). Cooperation between different organizations in an emergency situation can only be efficient if existing concepts are brought together, coordinated, and most importantly tested regularly.

In 2012, an analysis of an operation on the high seas showed that the preparation, the determination and provision of resources, as well as training, are important factors for effectively coping with an MCI in the maritime setting (22). Another study shows that also regular refreshments of seafarers' medical skills are also important in order to achieve a training effect and to be able to initiate appropriate treatment in emergencies (48). Current studies still warn about lack of adequate preparations, in this example about analog mis-triages in an MCI on the high seas (24). European projects such as SHIPSAN ACT, SHIPSAN Trainet, and subsequently the Healthy Gateways Joint Action, provide initial approaches on the preparation and prevention, as well as the occupational health practices, of possible outbreaks of infectious diseases (4, 33, 49). In this regard, the linking of medical concepts to a special infrastructure, like that of a port, not only appears very useful and necessary for current events such as the COVID-19 pandemic.

It should be kept in mind that medical standards on ships are dependent on the country and the flag under which the ships sail. Therefore, there are discrepancies, and it might be not possible that same standards are being used overall. This affects both medical resources and staffing (33, 35, 36). Regionally different MCI concepts must also be taken into account (11–14, 17). Thus, we recommend carrying out large-scale infection disaster exercises in the port that have not been implemented so far. Several organizations such as the HPHC, rescue services and all those involved ship and port workers are able to test and develop common processes in order to become reliable and resilient against an MCI-ID.

A cross-organizational task force that can be alerted in medical emergencies, such as the "Fachstab Seuchenschutz" (Disease Control Unit) in Hamburg, has various advantages (32, 33). Through quick identification and assessment of the situation, decisions can be made quickly, which would serve to better deal with such a situation. In this way, the city of Hamburg aims at clarify competencies in advance and guarantee security of action in infectious emergencies.

The selection criteria made by an intensive care unit and internal specialist department in clinics can be extended to surgical clinics in the event of resource shortages. This is possible in Hamburg as a city of over a million inhabitants with over 12,000 fully inpatient beds (43). However, such a selection cannot be made everywhere, especially with regard to smaller municipalities and cities. Additionally, the distribution of patients could be optimized via a central (or regional) register of available beds for infectious patients, whereas in Germany IVENA (IVENA by mainis IT-Service GmbH, Offenbach am Main, Germany) is a potential system that is already used in a similar way and is the most widespread. By expanding this system, existing resources for COVID-19 patients can be displayed (50). This can be linked and used analogously to the national register for intensive care capacities, which was implemented in the course of the COVID-19 pandemic and has gained in importance in Germany (51, 52).

The Port of Hamburg can be approached in any emergency due to its special function as one of five designated ports in Germany. This port was chosen as an example, since it is infrastructural embedded in an industrialized urban area. However, our findings are not completely transferable to other national or even international ports. Individual adaptation to the local situation and different local or national conditions make transferability more difficult. In contrast to Hamburg, and all other designated ports (in Germany), smaller port cities cannot offer such a comprehensive rescue service and at least 14 clinics available to treat a large number of infectious patients (18, 26, 27, 41–43). Nevertheless, the basic patterns of the analyzed influencing factors should be the same and could be applied to other ports. We assume, that this enables a future transfer of coping strategies to similar facilities.

Based on this analysis and the gained knowledge due to the COVID-19 pandemic and the outbreaks on ships, where ports had to deal with an MCHD and, if necessary, adapt their emergency plans, an operational strategy that integrates existing concepts will be adapted to the special infrastructure of the port. One

aim of the ARMIHN project is to practice and to test the operational strategy through the modeling of damage scenarios and disease patterns, in three theoretical exercises and one practical exercise with all involved parties, so that a first training effect can be achieved. The developed operative strategy can be expanded in a future-oriented way to deal with a new type of pathogen such as SARS-CoV-2. Finally, the results of the project should be adapted to other port facilities. Although our analysis and future concept will be created for the Port of Hamburg, we assume that our final recommendations are going to be widely universally applicable and could be adapted by most of the major ports in Europe (and worldwide) to improve their prevention against MCI-D. The need for standardized cross-organizational concepts and the preparation for MCHD was underlined by the COVID-19 pandemic and associated outbreaks on ships.

Conclusion

This research shows that coping an MCI-D in the port is a multilayered complex collaboration involving several stakeholders from different organizations. Most organizations have their own concept for MCI without focusing infectious diseases, but there is still potential to uniform and practice the procedure. The external conditions such as the multitude of legal bases and laws, different medical standards and lacking cross-organizational concepts even complicate the situation. By identifying the existing structures, processes and resources, an emergency concept for an MCI-D in the port can be improved and be tested for practical suitability. It can contribute to an improved resilience dealing with an MCHD.

Abbreviations

ARMIHN Adaptive Resiliency Management in Port

BNITM Bernhard Nocht Institute for Tropical Medicine

BZHI Treatment center for highly contagious infectious diseases (Behandlungszentrum für hochansteckende Erkrankungen)

DGzRS Deutsche Gesellschaft zur Rettung Schiffbrüchiger (German Maritime Search and Rescue Association)

HPHC Hamburg Port Health Center

ID Infectious disease

IHR International Health Regulations

MCI Mass casualty incident

MCHD Mass casualty incident due to an outbreak of infectious diseases

MDH Maritime Declaration of Health

NSW National Single Window

RKI Robert Koch Institute

SARS-CoV-2 Severe acute respiratory syndrome coronavirus 2

SHIPSAN ACT EU Ship Sanitation Programme

SHIPSAN Trainet EU Ship Sanitation Programme to develop training programs

UKE University Medical Center Hamburg-Eppendorf

WHO World Health Organization

Declarations

Ethics approval and consent to participate

Approved by the local ethics committee of the University Medicine Greifswald with the reference number BB 051/19, but the study does not use data of any animal or human or tissue.

Consent for publication

Not applicable

Availability of data and materials

The dataset(s) supporting the conclusions of this article is(are) included within the article (and its additional file(s)). Instructions and existing concepts for an MCI from local authorities (HPHC, Fire Brigade) are not publicly available, because of sensitive information and has been excluded from analysis.

Competing interests

The authors declare that they have no competing interests.

Funding

The ARMIHN project is funded by the Federal Ministry of Education and Research Germany (13N14925). The Federal Ministry of Education and Research Germany had no influence whatsoever on the results and/or the interpretation of the data.

Authors' contributions

AK designed the conceptualization, the original draft, the preparation and the visualization. JH and EH made the conceptualization, the preparation, review and editing. NS supported the preparation, review and editing. ACK, MO, NM, JH, KCM, LB, TM, VH, LE, JB, SKK, MB, MDF did the review and editing. LH, DG, AE were also responsible for the conceptualization, review and editing. MSB was the supervisor and also created the conceptualization and accomplished the review and editing. All authors read and approved the final manuscript.

Acknowledgements

We thank all institutions and local authorities for providing their existing concepts for an MCI. We also want to thank the Federal Ministry of Education and Research Germany for funding the ARMIHN project.

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Figures

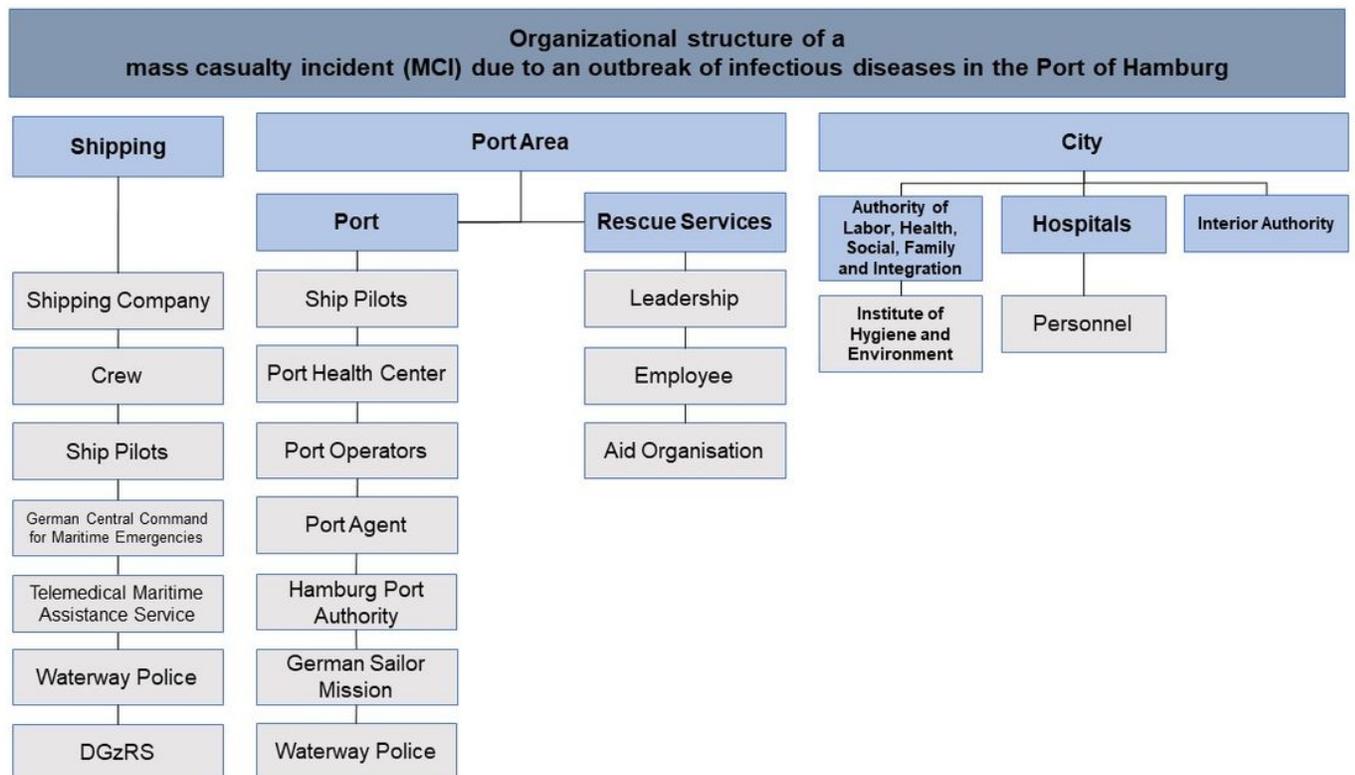


Figure 1

Organizational structure of a mass casualty incident (MCI) due to an outbreak of infectious diseases in the Port of Hamburg. DGzRS = Deutsche Gesellschaft zur Rettung Schiffbrüchiger (German Maritime Search and Rescue Association).

Fire and rescue stations

- 1 F 34
- 2 F 33
- 3 F 31
- 4 F 36
- 5 F 22
- 6 F 35
- 7 F 15
- 8 F 25
- 9 F 11
- 10 F 14
- 11 F 23
- 12 F 12
- 13 F 21
- 14 F 26
- 15 F 13
- 16 F 16
- 17 F 24

Port of Hamburg

- ⊗ Port

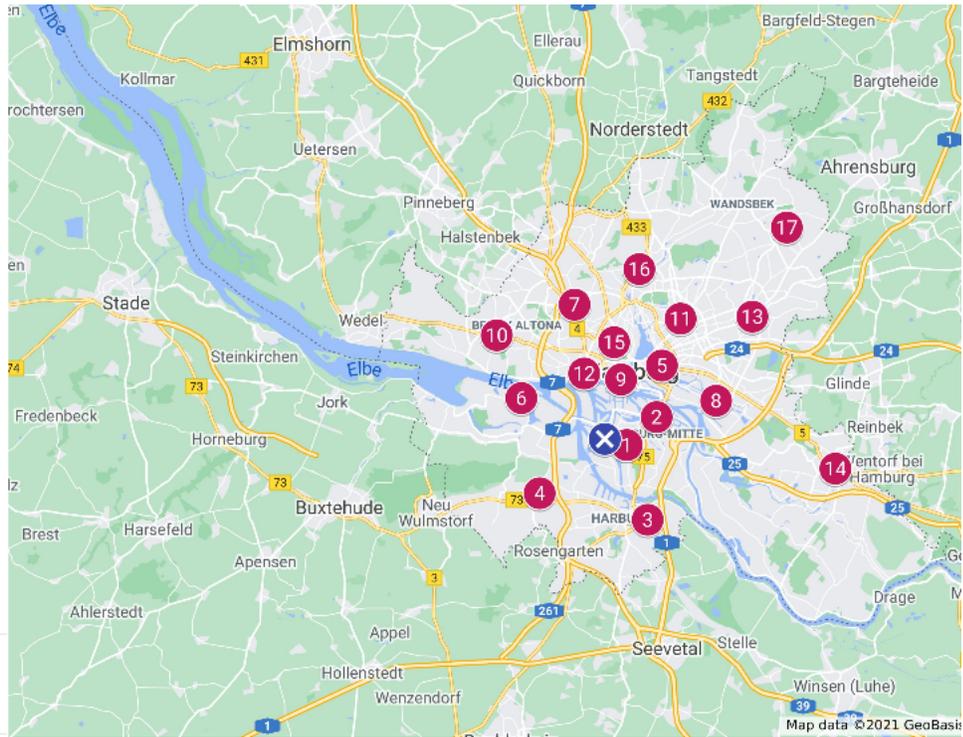


Figure 2

Fire and rescue stations in Hamburg (26).

Selected hospitals

- 1 Wilhelmsburger hospital
- 2 Asklepios hospital Harburg
- 3 Helios Mariahilf clinic
- 4 Asklepios clinic Altona
- 5 Asklepios clinic St. Georg
- 6 Katholisches Marienkrankenhaus
- 7 Agaplesion Diakoniekrankenhaus
- 8 Asklepios Klinik Wandsbek
- 9 Bethesda Krankenhaus Bergedorf
- 10 Asklepios Westklinikum
- 11 Bundeswehrkrankenhaus Hamburg
- 12 Universitätskrankenhaus Hamburg-Eppendorf
- 13 Asklepios Klinikum Barmbek
- 14 Asklepios Klinik Nord

Port of Hamburg

- ⊗ Port

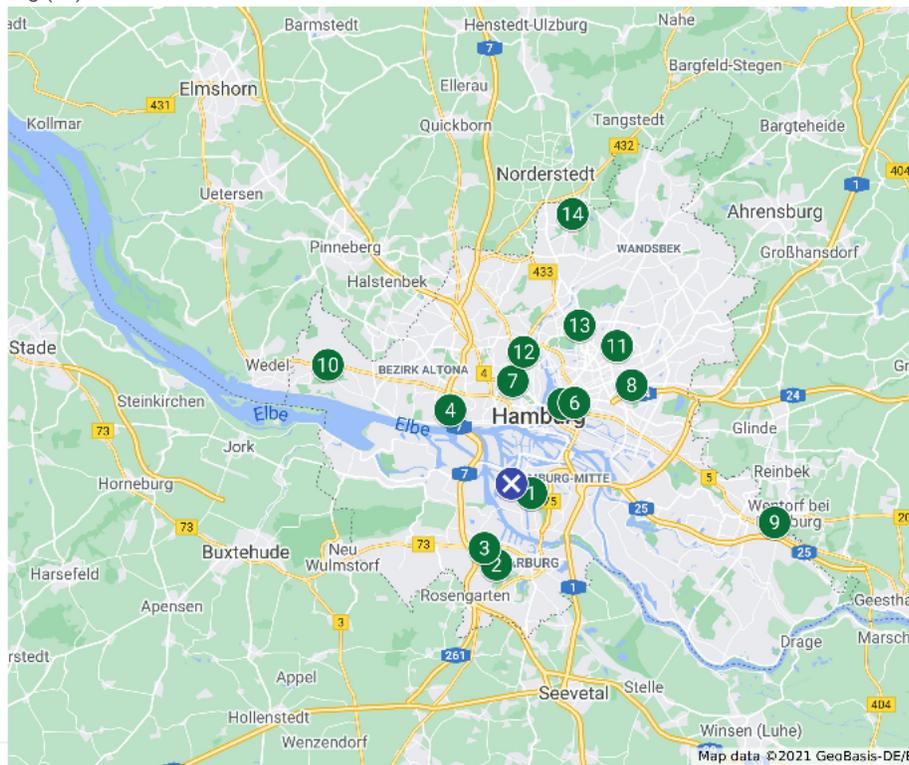


Figure 3

Selected hospitals in Hamburg with appropriate specialist departments for the treatment of infectious patients with an intensive care unit and a department for internal medicine (27).