

# Use of morbidity and mortality conferences to analyze causes of death at sea: a useful tool in the process of training in maritime medicine

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## ABSTRACT

**Background.** Morbidity and mortality conferences (M&MC) are collective reviews of records of patients, whose evolution was marked by an undesirable event: death or the occurrence of complications. The M&MC aim to improve the quality of care. This article intends to present three cases analyzed in M&MC in the French Telemedical Assistance Service (TMAS).

**Material and methods.** Three cases were selected according to the occurrence of a death at sea or according to particular cases of pathology on board. The case presentation was done in plenary session in our French TMAS, describing the facts, analyzing the defective processes, and suggesting possible improvements for each case.

**Results.** Description of 3 cases: Gastroenteritis in Papua New Guinea with septic shock; traumatic brain injury on a training boat with organizational and evacuation problems, and fever in the Gulf of Guinea with negative thick blood smear test.

**Conclusions.** The M&MC tend to develop in all medical fields and are of particular interest in maritime medicine. The achievement of M&MC in our TMAS highlighted some difficulties in our daily work: diagnosis difficulty in tele-consultation and organizational or operational difficulties related to maritime medicine. However, we hope that the proposals for improvement will be applied to improve the quality of maritime medical care.

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**Key words:** morbidity and mortality conference; maritime medicine; quality; tele-consultation

## INTRODUCTION

Morbidity and mortality conferences (M&MC) are collective reviews of records of patients whose evolution was marked by an undesirable event: death or the occurrence of complications. The exercise consists of considering whether the patient's care was appropriate and in identifying any possible failures that may have contributed to the occurrence of complications [1]. They enable the identification and

analysis of potential defective practices and processes, to propose corrective actions in order to reduce the likelihood of risk and to monitor and evaluate the effectiveness of undertaken actions. This method has been recognized by the French National Authority for Health (HAS) as an ongoing evaluation program that allows physicians to fulfil their obligation to evaluate professional practices [2]. Originally proposed as a pedagogical tool for the initial training

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of surgeons in the United States (US), the M&MC tend to develop in many medical specializations [3–6] and are an integral part of training programs for US emergency physicians [7]. In maritime medicine and during our medical tele-consultations, we face frequent constraints: difficulty of diagnosis and monitoring for some patients, death occurring at sea, and geographical isolation slowing down the rescue. Each “difficult” case is analyzed afterwards, and the most significant records are presented in our annual M&MC. The aim of our study is to present three cases analyzed in M&MC in the French TeleMedical Assistance Service (TMAS), describing the facts, analyzing the defective processes, and suggesting possible improvements for each case.

## MATERIAL AND METHODS

### SELECTION OF FILES

The Centre for Maritime Medical Consultation (CCMM) is located in the University Hospital of Toulouse, France and is integrated in the emergency medical services. Three cases were selected based on the occurrence of a death at sea or the occurrence of an unusual or severe pathology onboard. The files were selected from our databank; personal names in the audiotapes of the tele-consultation were erased and integrated in the presentation. All the case presentations were made in a conference session, all the service staff being invited with an attendance of 25 persons (mainly physicians and nurses). The conference was conducted by an experienced physician, and an electronic interactive voting system was used by the audience. The presentation started with descriptions of the ship and its geographical position, a quick introduction to the patient (age, medical history, significant symptoms, etc.). The audience was then invited to listen to the audiotape of the consultation. Multiple-choice questions were included in the presentation for the members of the audience. Analyses of their responses during the meeting initiated the discussion on the diagnosis and prescriptions, or on the operational procedures. The following of the case progress was then described, until its conclusion: death, improvement, or worsening. The following part of the work consisted of classifying the case based on two main questions: was the management of the patient consistent with the published recommendations? Were there further medical aggravating circumstances for the patient? The case presentation was concluded by proposals from the staff in order to improve the patients' man-

agement. A report was written, sent to all the services, and put to the record [2].

A preliminary description of the organization of the French system for medical assistance at sea is required for further understanding.

### THE FRENCH PROTOCOL FOR MEDICAL ASSISTANCE AT SEA

Medical Assistance at Sea was set up in France in 1983 in accordance with a government decision, updated in 2011. The French protocol involves three partners: Centre de Consultation Médicale Maritime (CCMM – TMAS), Centre Régional Opérationnel de Surveillance et de Sauvetage (CROSS – MRCC: Maritime Rescue Coordination Centre), and the SAMU de Coordination Médicale Maritime (SCMM: SAMU for medical maritime coordination). This protocol is regulated through the Maritime Authority. In compliance with both the Maritime Authority and European Directive 92/29 on medical assistance on board ships, the protocol is defined as follows: any management of a patient (sick or injured aboard), whatever the position of the ship at sea, leads necessarily to a medical tele-consultation by the CCMM based in Toulouse (officially designated in March 1995). The captain is officially “responsible for medical care on board”, and as such he must examine the patient, collect any symptom and medical data before calling CCMM, and transmit the results to the physician. In our institution, in 75% of the calls, the patient is supported, treated, and observed aboard thanks to repeated calls. In case the tele-consultation suggests that maintenance of the patient on board the ship is inappropriate, the CCMM physician gives the captain appropriate advice to organize the patient evacuation through the Search and Rescue Services (SAR). Then the CROSS/MRCC, following the CCMM advice, organizes the MEDEVAC operation together with the associated SCMM. The MEDEVAC operations represent approximately 25% of the calls in our TMAS. The mission of the CROSS/MRCC is to provide and coordinate any maritime or air resources for rescue at sea. The mission of the SCMM is to provide the medical team involved in the evacuation and to organize land rescue and reception of the patient in the appropriate hospital.

## RESULTS

### CASE N° 1. GASTROENTERITIS IN PAPUA NEW GUINEA

**Case description.** Aboard an oceanographic research ship located 24-hours sea route from the

nearest port in the south-western Pacific Ocean, the commanding officer made a call regarding a 43-year-old sailor with a two-days of persistent gastroenteritis. The sailor, who had no significant medical history, had eaten shrimps two days earlier on land. Approximately six hours after the meal he had suffered from nausea, vomiting, and diarrhoea without fever. Before embarking he had consulted a physician on land who had prescribed a symptomatic treatment with loperamide and metopimazine. Despite the persistence of symptoms, the sailor insisted on boarding the ship. During the call, the patient complained about abdominal pain, vomiting, and diarrhoea with intense weariness. The TMAS physician prescribed continuation of symptomatic treatment in addition to paracetamol/acetaminophen, proposed a rerouting of the ship to the port of Rabaul in Papua New Guinea, and gave instructions to call back in six hours. Meanwhile, the clinical picture became even more complicated with extreme asthenia, persistent gastrointestinal symptoms, a 90/60 mm Hg BP, a heart rate of 70 bpm, and a rectal temperature of 35.5°C. The French regional operational centre for monitoring and rescue (CROSS) in charge of the area confirmed that there was no possibility for a helicopter to pick up the patient from the ship. The decision was then made to inform the dispensary of the patient's arrival and to add an antibiotic in order to target potential salmonella: ciprofloxacin. The third call was made six hours after the second one, with an ETA of four hours from the port of Rabaul. The patient felt faint and was pale, he had no loss of consciousness, and remained very weak. His heart rate was 80 bpm. Blood pressure was not known. The patient was disembarked at Rabaul 20 hours after the initial call to TMAS, and the situation worsened quite rapidly. He had a cardiac arrest in the dispensary and died despite immediate resuscitation.

**Discussion.** Post-mortem bacteriological blood results revealed a multidrug-resistant *Escherichia Coli*. The cause of death was probably a state of hypovolemic/septic shock with severe dehydration. During the conference presentation, the discussion led to the collective conclusion of a probable further medical aggravating circumstance for the patient. The patient was probably very dehydrated, and septic shock management recommends early appropriate antibiotic therapy associated with appropriate and immediate fluid therapy [8]. The discussion went round the placement of an intravenous cannula by the officer ahead of worsening. In this particular case, it was possible for the patient to drink and he drank

the salty broth the physician had advocated. Moreover, the officer was so stressed that asking him to place an intravenous access seemed extremely difficult. Finally, the impossibility of rapid evacuation of the patient, the difficulty of clinical evaluation, and the fact that the boat was close to the coast were distressing elements to the decision. This case demonstrates the difficulty of clinical evaluation of a patient by phone and the limitations of tele-consultation.

**Proposals for improvement.** Any seafarer presenting a persistence of gastroenteritis symptoms for more than 24 hours with symptomatic treatment should be perfused and receive large spectrum antibiotherapy. The criteria for clinical monitoring should be more frequent (every three hours) with monitoring of blood pressure, heart rate, temperature, and diuresis. These simple criteria must be assessed by the caregiver (the commanding officer mostly) and should be taught to officers in charge of medical care aboard ships during their training.

## CASE N° 2. TRAUMATIC BRAIN INJURY ON A TRAINING BOAT

**Case description.** The case took place in Brittany (France) on a training leisure boat manoeuvring one mile offshore. The TMAS received a call from a sailing instructor concerning a 16-year-old teenager that presented a one-minute-long loss of consciousness consecutive to a traumatic brain injury following a jibing manoeuvre. Unfortunately, the communication was very bad. The initial data gathered indicated a patient who moaned, with a hemorrhagic wound above the left ear and secondary cephalalgia. While the TMAS doctor was giving instructions to stop the bleeding and to bring the patient to the nearest port on shore, the instructor told him he had just docked on a small island located two miles offshore. Twenty minutes later, the patient's condition deteriorated: he presented consciousness confusion, he was obsessive, and he was vomiting. The TMAS physician requested the recovery position for the patient and tried to organize the arrival of rescue teams on site. A police helicopter practicing in this area landed on the island, but the policemen did not want to transport the patient because he was unconscious. Then, a medical team was sent by boat, the sending of a helicopter being slower. The patient was intubated and ventilated (difficult intubation): at this time, despite the injection of mannitol he still presented a state of mydriasis with unresponsive pupils. Five hours and thirty minutes after the first call, the patient arrived in the intensive care room of

the local hospital where there was no neurosurgeon. The head CT found a voluminous epidural hematoma with signs of ventricular compression. His transfer to a neurosurgical service in another hospital was not performed, with no explicit reasons. The patient was declared brain dead during the night.

**Discussion.** This case demonstrates a chain of events that occurred against the logical proposition of the TMAS physician from the start. Indeed, the boat was located one mile offshore, a 15-minute sail from the mainland and the nearest port, but the initial proposal to bring the patient on shore was not followed, probably due to an important state of stress by the sailing instructor. The instructor explained secondarily that he wanted to dock at the nearest island which corresponded to his base. The management and sailing time were long and could have been dramatically reduced if the boat had headed for the mainland immediately. The collective conference conclusion was further medical aggravating circumstances for the patient, due to an unexpected chain of negative events. Concerning the care, the recommendations of the treatment of severe traumatic brain injury were respected, with the notable exception of the organizational/time factor which remains in the centre of the debate. All these considerations highlight the paradox of supporting a patient near the coast. The question concerning the non-completion of a neurosurgical intervention remains unresolved until this day.

**Proposals for improvement.** Ahead of any problem occurring on a ship near the coast, the ship must be rerouted to the nearest mainland port in order to qualify for the offer of land rescue operations, which are very well organized in France around the pre-hospital medical emergency services (SAMU). Moreover, in cases of suspected traumatic brain injury with severe signs, the patient should be immediately transferred to a level 1 trauma centre.

### CASE N° 3. FEVER IN THE GULF OF GUINEA

**Case description.** A supply ship in the Gulf of Guinea located at 24-hour sea route from the nearest hospital. The TMAS received a call regarding a 23-year-old chief engineer without medical history who was suffering from abdominal pain and diarrhoea. For two days, the patient had had a flu-like syndrome with asthenia, headache, chills, and myalgia. He had severe abdominal pains with 12 liquid stools since the day before. The abdomen was found supple by the commanding officer, there was no rash, and his blood pressure was 135/75 mm Hg, heart

rate 75 bpm, and rectal temperature at 37.2°C. The patient reported a recent travel to India (Mumbai) three weeks before without specific chemoprophylaxis. The French boat was equipped with medical supplies "A" in conformity with French recommendations. The TMAS physician asked for a thick blood smear aboard, which was negative. Faced with this intense abdominal clinical picture, a symptomatic treatment was started with loperamide combined with ceftriaxone therapy. The boat was then rerouted to the nearest port in Soyo, Angola. The evolution was marked by the appearance of fever spikes with marked tiredness. The patient had a convulsive seizure on arrival on land and was hospitalized in a local hospital. Blood samples were positive for *Plasmodium falciparum*, and antimalarial treatment was started. The patient was secondarily transferred to France for further treatment, and presented a complete cure after one month.

**Discussion.** This case emphasizes the difficulties in front of this digestive picture with a delayed fever. One may wonder if the fever was not already present two days before the call. The picture was made even more difficult by the negative first thick blood smear. This case is interesting because it concerns a very common disease in the world, which is feared by seafarers sailing in malarial areas. Despite good knowledge of this disease, of treatments, and chemoprophylaxis [9, 10], this case demonstrates the difficulty of diagnosis by tele-consultation. The conference conclusions were no further medical aggravating circumstances for the patient, and the initial support was appropriate. Concerning the thick blood smear test, we must take into account any possible false negatives that may be related to a technique badly performed or badly interpreted by untrained staff members, or related to a parasitaemia lower than the detection threshold. This case was chosen for its educational impact.

**Proposals for improvement.** Any infectious symptomatology including fever in a tropical environment may suggest a malarial cause requiring immediate antimalarial treatment. In view of any misinformed infectious symptomatology, expert advice by infectious and tropical disease specialists may be requested by TMAS doctors.

## DISCUSSION

As far as we know, this study is the first to describe cases of M&MC in the maritime environment. The success of M&MC lies in the development of quality control and evaluation in the medical com-

munity: a survey of professional practice, audits [11], cost-effectiveness investigations, M&MC, etc. All the difficulty of the implementation of M&MC and its perpetuation in a service lies in the way of presenting cases. The investigation of malfunctions involves human, material, and organizational factors. The M&MC is not a court of justice or a forensic examination and must enrol in a non-punitive approach [12]. As regards this aspect, one must assume that error is inevitable and that the principle of fault or personal guilt must be dismissed. The analysis of the incident becomes a valuable opportunity to see how a service actually works, and to become aware of this collectively.

The achievement of M&MC in our TMAS has highlighted some difficulties in our daily work in maritime medicine. However, it permitted us to make proposals for improvement in order to enhance the quality of seafarers' care. In the first place, these proposals permitted the creation of service protocols: for example, any fever in a tropical environment may suggest a malaria-related cause and require immediate anti-malarial treatment. Furthermore, the second case has highlighted the logical decision to reroute all ships to the nearest port when a medical problem occurs near the coast. The case with the septic shock has put the stress on the importance of intravenous line placement. During their training, we must remember that captains make a hospital rotation to learn medical procedures. Nevertheless, our experience in the French TMAS shows that the necessity of a perfusion is rare and concerns only cardiac arrest. We hope this example will increase the number of intravenous line placements in the future. Finally, another proposal for improvement concerned the monitoring of vital signs such as blood pressure, heart rate, or body temperature by the captain. The TMAS physicians spend one third of their medical time teaching in a French maritime university. They insist on the importance of clinical description and the monitoring of vital signs before the call to the TMAS, but also on the repetition of the monitoring during the medical patient's follow-up.

Analysis of the literature shows that publications on M&MC are rare. A recent review [13] analyzed the different types of publications on M&MC. Real differences appear between M&MC surgery and medicine [14]. The M&MC surgery mainly concerns medical practices and individual factors, while M&MC medicine mostly concerns collective factors or care organization. There are very few studies with descriptions of cases [15], and most publications are

assessments on the interest of M&MC in their educational dimension or benefits in medical formation [16–18], or about opinion polling on M&MC [19, 20]. Thus, residents reported that M&MC brought them some confidence in their ability to cope with similar situations [21]. All studies described some proposals for organization, prescription, communication or training problems improvement [22–24].

Many authors insist on the absence of standards or precise methodological framework for the implementation of M&MC [25, 26]. This observation is related to the great diversity of methods of organization and functioning of M&MC. The lack of a precise methodological framework leads each team to organize its M&MC by its own objectives. This point is often presented as a limit to the effectiveness of M&MC [4, 25, 26]. Within our team, we are considering creating a toolbox for the practical implementation of M&MC in emergency medicine and *a fortiori* in maritime medicine.

The analysis of the literature on the achievement of M&MC remains poor and heterogeneous. However, it is likely that the current development of M&MC will result in an increase in the number of publications on this subject, and we believe that the M&MC must integrate maritime medicine publications. Thus, we propose regular analyses of the most interesting and educational cases encountered in our TMAS.

One of the limitations of our study lies in the fact that we made the M&MC without all the concerned stakeholders. We focused our analysis on the medical problems, but we also highlighted organizational problems. However, our partners for medical aid at sea were not invited because our M&MC took place within the strict framework of our service. It would thus be interesting in the future to organize a meeting with all stakeholders of French sea rescue teams during a global meeting in which we could present some typical cases. That could lead to further improvement of our system.

## CONCLUSIONS

The M&MC tend to develop in all medical fields and have to be developed in maritime medicine. The achievement of M&MC in our TMAS highlighted some difficulties in our daily work: diagnosis difficulty in the tele-consultation and difficulty of accurately assessing a telephone situation. This also permitted us to highlight some organizational/operational difficulties inherent to maritime medicine by focusing on a particular point: the difficulty of care when the ship is very close to the coast. However, we hope that the

proposals for improvements will be applied for the quality of maritime medical care. It would be interesting in the future to continue and to extend this work on medical files related to occurrences of serious adverse drug reactions aboard, or on a systematic analysis of deaths at sea. Finally, it would be interesting to join with other TMAS to discuss common problems in our maritime medicine activity.

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### CONFLICTS OF INTEREST

All authors declare that they have no conflicts of interest.

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