VIA MEDICA

ORIGINAL ARTICLE

TelePharmaSea: proposing a novel approach to automate, organize and simplify management of medical chest on board commercial vessels

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ABSTRACT

Background: The on-board pharmacy is the kit that allows the implementation healthcare on board ships, since it should contain everything that may be needed to guarantee proper and efficient health care interventions for seafarers. There are several problems that can lead to a difficult and non-optimal management of the on-board pharmacy. This work illustrates the "TelePharmaSea" software, specifically developed to optimise the management of the on-board pharmacy of commercial vessels without medical personnel.

Materials and methods: We collected the Medical Scales of the various Flag States and brought them all into a standardised format which could be used. The Active Ingredients and Pharmaceutical form of each medicine is linked with the ATC Codes. Active Ingredients having similar effect are linked by ATC codes. Items that did not have an ATC code were given a unique system-generated code. Due to the proprietary nature of the software of which the database structure and functioning is unique, we cannot share the exact structure; however, the approach regarding the same has been highlighted.

Results and Conclusions: The proposal of the TelePharmaSea software can be an effective tool capable of a significant improvement of the overall quality of medical and pharmacological assistance provided on ships without a doctor on board. The system can guarantee a better management of the on-board pharmacy's inventory, and it may also reduce the risks of mistakes in drugs administration.

(Int Marit Health 2020; 71, 4: 291–295)

Key words: digital health, seafarers, health, safety, drug, monitoring

INTRODUCTION

From the eighteenth to the nineteenth century, the physicians who embarked on board were carrying a cassette containing therapeutic prescriptions to be used in case of emergency [1].

Since the nineteenth century, many nations began to regulate hygiene matters aboard ships, and required the presence of a "medicine box" containing all the medicines used by sailors, with instructions for their use [2].

That is why, even today, all the medicines and all the medical supplies on board is called "ship medicine chest". The types of activities performed on board a ship are entirely different from the ones performed onshore [3].

The situation is complicated by the fact that ships become both a workplace and a living environment for an extended period of time. Also, cargo ships do not carry qualified medical or paramedic personnel and sailors have a higher risk of accidents which may result in death or a serious injury [4].

One of the main problems arising from the early use of these chests was the diversity of content between different flag vessels. In this sense, the best solution to this problem is in international agreements, to be reviewed periodically to establish a scale of medicines, especially in relation to those which are the main health problems in which sailors are involved [5].

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The on-board pharmacy or "medical chest", is a kit that allows the implementation of health care, providing therapeutic interventions of first aid. It is therefore a vital asset, which must contain everything that might be needed to ensure proper and complete health care for sailors [6–8].

Nowadays, it is no longer a container enclosing medicines and medical devices, but rather a real pharmacy on board that has a wide range of health products. The manager of drug management is the master, or a designated officer, who also holds the responsibility of keeping the on-board pharmacy always stocked and efficient [9].

A large number of national and international regulations (World Health Organization [WHO], European Union) [10] makes it difficult for ship officers managing the ship's pharmacy to perform their tasks.

Medicinal products are identified by the international non-proprietary name of the active principle and/or by their chemical or invented (branded) names [11]. This may make the identification of a medicinal product difficult, primarily if it is purchased abroad and the box and instructions are written in the language of the country where it is marketed [5].

Medicinal products considered restricted by some countries are not restricted in the others. This could create confusion worsened by the fact that ship's personnel do not usually have enough knowledge of pharmacology/pharmacy regulations to prepare a cabinet for restricted products before they stop in different countries [12, 13].

Another problem may occur as a result of a language barrier; if a given medicine has expired or has been used, it would be difficult to replace it with a local product, especially if it is labelled in a rare language [14].

Therefore, there is a simpler classification system of the medicinal compounds — the ATC (ATC: Anatomy, Therapeutic properties, Chemical, pharmacological properties) [5].

After carefully understanding the challenges, we decided to create an application that would have the potential to provide the solutions. Thus the idea of "TelePharmaSea" was developed.

The purpose of TelePharmaSea is to provide standard procedures for handling the on-board pharmacy and to automatise some actions which are still carried out manually, offering unique opportunities to simplify the management of the ship's pharmacy and consequently, to improve the quality of medical assistance on board ships.

MATERIALS AND METHODS

We collected the Medical Scales of the various Flag States and brought them all into a standardised format which could be used. For the purpose of this exercise, we have only taken into consideration the scales pertaining to merchant vessels with no doctor on board.

The Active Ingredients and Pharmaceutical form of each medicine is linked with the ATC codes. The ATC/DDD system since its inception in 1996 has continued to expand and include most drugs promoted by WHO as the global standard for medicine classification and utilisation [15].

Active ingredients having similar effect are linked by ATC codes [16].

Items that did not have an ATC code were given a unique system-generated code.

The first step was to ensure that each item across the data had a Unique Code which would either be the ATC code or the Unique System-Generated Code and similar active ingredients documented.

Due to the proprietary nature of the software of which the database structure and functioning is unique, we cannot share the exact structure; however, the approach regarding the same has been highlighted (Fig. 1).
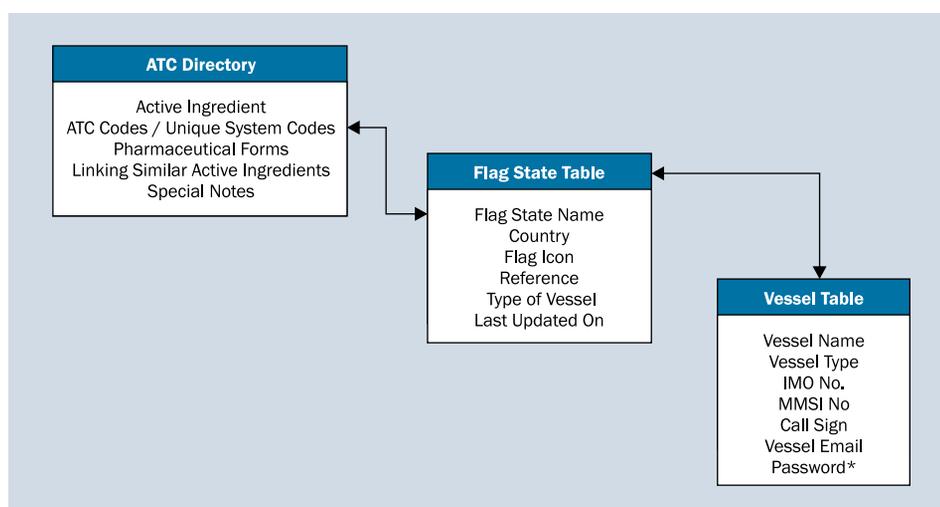
Figure 1. The figure shows the simplified relation of some of the various master tables; *defense against unauthorised access

Thereafter a detailed database structure with several master tables was created to document the following:

1. Active Ingredient
2. ATC Code/Unique System Code
3. Pharmaceutical Forms
4. Similar Active Ingredients
5. Special Notes

Another master table was created to save Flag State details:

1. Flag State
2. Flag Icon
3. Country Associated

Corresponding tables were thereafter structured to link the Active Ingredients and the Flag States as well as record the additional information:

1. Flag State
2. ATC Code/Unique System Code
3. Type of Vessel
4. Minimum Quantity
5. Special Notes

Data was meticulously added into the database by approved and experienced pharmacist to ensure correct data transfer to the system. The data was further validated and screened by another pharmacist for the same purpose.

Each vessel is provided with a secure login for using the application for updating inventory, interacting with a qualified pharmacist as well as completing the requirements for the remote inspection and e-certification.

THE CHECKLIST FOR VESSELS

A detailed medical checklist has been developed to enhance the standards of sickbay management on board. The checklist was developed after detailed analysis on the factors leading to good practices and those requiring to be monitored routinely.

SECURITY

Any system that involves issuing certificates or holds any user information needs to have adequate security mechanisms to avoid misuse.

Methods used in the application are:

— 2-step verification: The User is required to enter an OTP which is sent to the registered ID for authorisation. This is mainly seen at the pharmacy side of the application;
— Fingerprint verification: For added security a fingerprint scan mechanism is used to grant access to authorised protocols of the application.

RESULTS

A web-based platform with user access rights was developed as described above. A first step was to compare the different contents of the ship pharmacy as required by the different Flag States. The platform has two intended users: (A) The vessel; (B) The pharmacist.

FEATURES — FLAG STATE COMPARISONS

We were unable to find any previously published paper that compared all the Flag State Medical Scales and attempted to propose for a common standardised scale. This paper presents the solution whereby this can be easily achieved with the technological solution being put forth in this paper.

FEATURES — THE PHARMACIST

The pharmacist controls the information in the master tables as well as completes the certification protocol of the system to generate an E-Certificate of conformity or non-conformity for the vessel (Table 1).

FEATURES — VESSEL

The tasks required from the vessel side are summarised in Table 2.

DISCUSSION

LIMITATIONS

Most of the Flag State medical scales are in PDF format with varying formats which posed a serious challenge in the initial data format standardisation. Sourcing the medical scales was a challenge and very few could be easily found on the website. Our collection of Flag State Medical Scales was based on information from only approved state sites for the Flag States, companies with vessels plying under the Flag State and data from Centro Internazionale Radio Medico (C.I.R.M.).

Mentioned flag stated and sources are the following: mentioned flag states and sources are the following: Australia, Cyprus, C.I.R.M. Medical Scale, France, Gibraltar, Italy, Isle of Man, Liberia, Malta, Marshall Islands, Netherlands, Singapore, WHO [17–28].

STANDARDISED MEDICAL SCALE

The objective of this effort was to propose a viable solution that can be further evaluated to automate, streamline and make easier the management of the medical chest and also provide a means that would allow for creating a standardised medical scale taking into consideration the various Flag States. There are limited studies that suggest the use of medicines with respect to medical scales to identify medicines and stocks that are no longer effective or used for care onshore. These can be replaced or delivering cost effective measures for the industry.

Therefore, we believe this easy to use system will lead the way to well-formatted medical scales that can easily be compared with various Flag States and thereafter champion the cause towards a standardized medical scale to benefit

Table 1. Workflow of pharmacist's activity

Add/edit item to master database	The pharmacist can add an item to the Master Tables. For this the pharmacist must mention the globally accepted ATC code or if not available ask the system to generate a Unique System Code
Add/edit flag state	Flag State Medical Scales are not routinely updated. However, if there will be updates, the system permits the pharmacist to make changes which will automatically sync across and intimate the vessels and companies
Add/edit pharmaceutical forms	Over time medicines may be made available in multiple pharmaceutical forms or be available for different purposes. It is essential to mention the pharmaceutical form as the use and indications can vary. Should there be a need to update or add, the pharmacist is permitted to make the required change
Add/edit company and vessel	To be able to perform E-Inspection and E-Certifications it is important to link the system with the vessel//company. This allows for 2-wayflow of information required
Digital review of checklist from vessel	The checklist which was initially completed and shared using more conventional digital formats such as word or excel, now have a more secure and easier way of sending this information directly through the platform. No additional email and attachments would be required. The system which is secure can only be accessed by the authorized personnel
Digital review of inventory from vessel	The updated inventory of the vessel is synced periodically with the checklist which allows the pharmacist to easily review the quantities. The system provides automated alerts to the vessel and the pharmacist thereby allowing them to easily review the same
Assisted E-Certificate generation (2-step verification)	The automated system assists the pharmacist to quickly review the inventory based on required minimum quantities and the responses from the checklist to authorize the compliance certificate or alert the vessel of any incomplete measures
Assisted order form generation (2-step verification)	Order forms generally take the longest time and can be confusing with the correct pharmaceutical form; active ingredient, etc., should be mentioned for it to be correctly supplied to the vessel. Therefore, to mitigate the challenges, the system allows the pharmacist to auto generate an order form by automatically calculating the minimum quantities required. This saves time and prevents manual errors that could arise using the conventional forms of order forms

Table 2. Workflow of crew activity

Add new inventory (batch numbers)	The officer responsible for the medical chest on the vessel can easily update the inventory and manage stocks with different expiry dates. This allows for more accurate analysis of the medical chest and timely restocking alerts
Update inventory	With the system being pre-setup as soon as the vessel logs in, the work of the officer responsible is reduced to ensuring the stock is routinely updated
Complete checklist	Ideally it is recommended for the vessel to complete the checklist every quarter. This is also the frequency for the E-Certification. However, the officer responsible can run through the checklist at any time to document the medical management. These records are synced to the pharmacist
View certificate of compliance	Once the certificates are issued by the pharmacist, the officer responsible is able to view the same on the platform ensuring an automated digitalised archive of the records

the ship owners and management companies having fleets of various Flag States.

The C.I.R.M. medical scale has been developed using this system and by comparing the medical scales of the most commonly used Flag States. It also specifies the similar medicines which makes it essentially useful for a ship that needs to restock in a foreign port where the same active principle is not available.

E-COMPLIANCE FOR STOCKING AND DISPOSAL OF MEDICINES ON BOARD VESSELS

The system is complemented by service of TelePharmaSea which includes access to skilled and experienced pharmacists. The connected framework allows for easy compliance tracking, E-Inspections and guidelines for smart re-stocking and disposal of medicines on board. Continued efforts can lead a generally smart re-stocking effort for the industry bringing huge savings if correctly implemented [29].

CONCLUSIONS

The system developed holds specific database structure and functioning to make it effective. The system can be used to assist Tele Medical Assistance Service (TMAS) centres as well as Tele-Pharmacists, shipping companies with the trends of consumptions of medicines which can be easily linked with the type of medical event. For data security and keeping in mind General Data Protection Regulation (GDPR), patient information will not be available; however,

while providing medical assistance the tool can save considerable time for reviewing the medicines available based on the Flag State of the vessel. Later features could include where seafarer can track his/her consumption of medicines to be more aware of one's health. The better inventory solution and classification guaranteed by TelePharmaSea may also reduce the risk of mistakes in the administration of medicines, with the potential of improving the handling of the ship's pharmacy together with an overall enhancement of healthcare provided on board. The system can easily be expanded so as to have an impact on studying the effectiveness of medicines and general prescription patterns. This can lead to several insightful studies and a collaborative approach on highlighting the use of Medical Chest on board.

This paper proposed a solution derived from understanding and referencing the challenges that currently exist in achieving the same.

ACKNOWLEDGEMENTS

FUNDING

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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