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**Research Project**

# Development of an intelligent system for improving medical assistance to seafarers

# FEASIBILITY STUDY

*Rome, October 2018*

**CONTENTS**

## 1. Executive Summary:

It has been challenged to provide adequate medical assistance in case of diseases or accidents on board ships to those who have the sea as their own work environment since centuries. In fact, the lack of onboard healthcare staff, the limited medical knowledge of onboard personnel and medical supplies make seafarers in a disadvantageous condition compared to people living ashore. Centro Internazionale Radio Medico (CIRM) mission is to provide telemedical assistance to seafarers, embarked on ships without a doctor on board, of any nationality, in navigation on all seas. CIRM has its headquarters in Rome and its medical services are free. CIRM follows patients requiring medical advice from the first request of assistance to patient's recovery, arrival to the port of destination or hospitalization.

CIRM service is delivered in Italian and English by doctors on duty 24hours a day, for 365/366 days per year. Italian Maritime Authorities recognized CIRM in 2002 as the Italian Telemedical Maritime Assistance Service (TMAS). The number of cases assisted by CIRM per year makes it as the TMAS with the largest number of seafarers assisted worldwide. Figures on the number of cases assisted by the Centre in the last 3 years are detailed in subsequent sections of this application. Moreover, CIRM coordinates missions of patient's transfer for hospitalization in case of serious situations requiring immediate medical interventions.

We are trying to update our services every year by new methodologies and technologies, as of this CIRM come up with an idea implementing artificial intelligence techniques by using machine-learning tools. This project is mainly concentrate on to provide adequate and accurate medical assistance to people on board with help of special software, which will developed by our team. Currently, we are working on basic model software, which named as "**Easy CIRM".** The complete details and instructions of Easy CIRM are enclosed (Enclosures 1 and 2) .

The results obtained in terms of outcome of medical assistance thanks to the use of Easy CIRM are impressive. As shown, using standard referral procedures we obtain the results summarized below:

| **TELECONSULTATION** | 2016 | 2017 | TOTAL |
|---|---|---|---|
| PATIENTS ASSISTED | 4,777 | 5,095 | 9.,872 |
| No OF MEDICAL MESSAGES | 29,294 | 27,399 | 56,693 |
| INCOMING MESSAGES | 16,912 | 15,480 | 32,392 |
| OUTCOMING MESSAGES | 12,382 | 11,919 | 24,301 |
| MEAN MESSAGES PER CASE | 6.1 | 5.37 | 5.74 |
| MEAN INCOMING MESSAGES PER CASE | 3.5 | 3.03 | 3.28 |
| MEAN OUTCOMING MESSAGES PER CASE | 2.5 | 2.33 | 2.46 |

| **TOTAL CASES OUTCOME** | | | |
|---|---|---|---|
| | 2016 | 2017 | TOTAL |
| IMPROVED | 2,282 | 2,597 | 4,879 |
| UNCHANGED | 1,560 | 1,503 | 3,063 |
| WORSENED | 98 | 82 | 180 |
| NO INFO | 837 | 913 | 1,750 |

| TOTAL CASES POST-TREATMENT | | | |
|---|---|---|---|
| | 2016 | 2017 | TOTAL |
| FULLY RECOVERED ON BOARD | 1,215 | 1,464 | 2,679 |
| VISITED ASHORE ON PORT OF CALL | 2,200 | 2,552 | 4,752 |
| DIVERSION | 410 | 371 | 781 |
| NO INFO | 837 | 708 | 1,545 |

Requests prepared with EasyCIRM, although their number was lower due to the limited number obtained with this facility gave the results summarized below:

| TELECONSULTATION | 2016 | 2017 | TOTAL |
|---|---|---|---|
| Patients assisted | 65 | 144 | 209 |
| No OF MEDICAL MESSAGES | 781 | 2,222 | 3,003 |
| INCOMING MESSAGES | 389 | 1,115 | 1,504 |
| OUTCOMING MESSAGES | 392 | 1,107 | 1,499 |
| MEAN MESSAGES PER CASE | 12.02 | 15.4 | 14.36 |
| MEAN INCOMING MESSAGES PER CASE | 5.98 | 7.74 | 7.19 |
| MEAN OUTCOMING MESSAGES PER CASE | 6.03 | 7.62 | 7.17 |
| | | | |
| **TOTAL CASES OUTCOME** | | | |
| | 2016 | 2017 | TOTAL |
| IMPROVED | 56 | 118 | 174 |
| UNCHANGED | 9 | 24 | 33 |
| WORSENED | 0 | 2 | 2 |
| **TOTAL CASES POST-TREATMENT** | | | |
| | 2016 | 2017 | TOTAL |
| FOUND DEAD ON BOARD | 1 | | 1 |
| FULLY RECOVERED ON BOARD | 41 | 61 | 102 |
| VISITED ASHORE ON PORT OF CALL | 23 | 78 | 101 |
| DIVERSION | 0 | 5 | 5 |

Here the comparison with the 2 approaches in preparing requests of medical advice:

| OUTCOME | Ontology-based request (EasyCIRM) | Standard request |
|---|---|---|
| **IMPROVED** | 83.25% | 49.42% |
| **UNCHANGED** | 15.79% | 31.03% |
| **WORSENED** | 0.96% | 1.82% |
| **FULLY RECOVERED ON BOARD** | 48.80% | 27.46% |
| **VISITED ASHORE ON PORT OF CALL** | 48.33% | 48.70% |

| | | |
|---|---|---|
| **DIVERSION** | 2.39% | 8.00% |
| **DIVERSION AVOIDED** | 73.7 % | 43.7 % |

Differences are relevant and the above data collectively suggest that providing systems for guiding the ship in preparing accurate requests of medical advice results not only in time optimization, but in quicker diagnoses with all the advantages that this can offer.

## 2. Description of Products and Services:

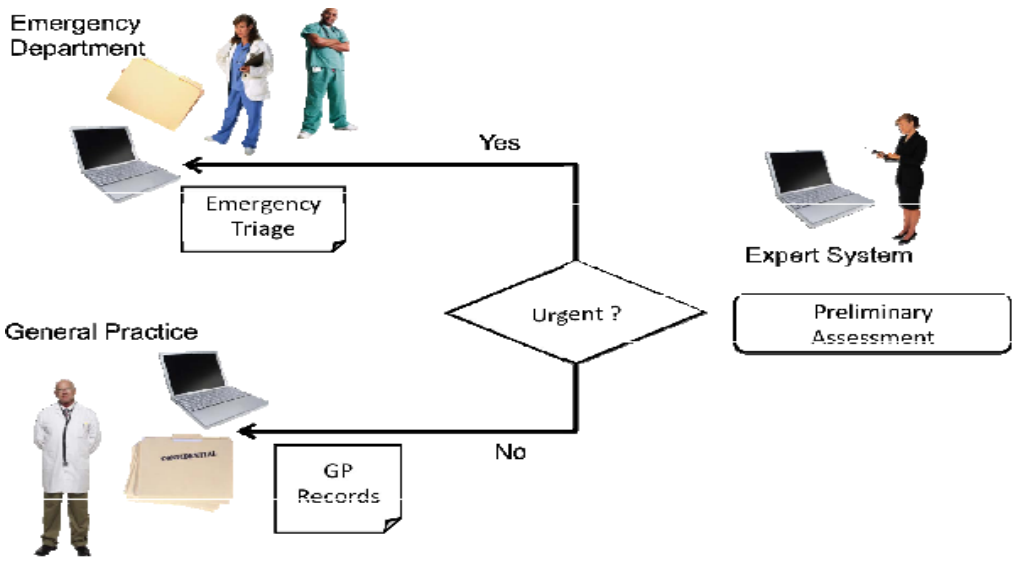
CIRM is considering a move to create and provide an online platform by using Intelligence network technologies for better accessibility of medical assistance to seafarers. Until now CIRM has only provide their services through e-mail/telephone. Once the person in CIRM has receive the mail or call from the seafarer. then he/she will connect this to the doctor on duty. Concerned doctor will respond based on his free time. which meant that it would take more time than expected to provide medical service. By doing so. CIRM has not been able to provide accurate information to our customers within time.

By offering. the Artificial Intelligent network service. CIRM can expand services entirely too new technologies and growth projections. and allow seafarers to monitor their personal health issues from the convenience of their onboard ships. There are no proposed changes to CIRM current services offerings because of this study as these services are free of cost. Artificial intelligence network study will include all the initial services offered by CIRM along with implementation of new intelligent software technology.

## 3. Technology Considerations:

A realistic possibility to obtain medical care for patients located in remote sites such as seagoing vessels. in which health professionals are not available. is to contact a doctor via telecommunication systems. In general. the medical knowledge of who on board ships is in charge of medical care is quite limited and therefore. in a first level telemedical consultation. The flow of information should be correct and its efficiency should be maximized. Upgraded technological capability will be required for CIRM to move toward offering a Software Platform. which is accessible to everyone on-board. An expert system helping in diagnosis of most common pathologies for seafarers using Artificial Neural Network (ANN) will be developed. The system described here allows people responsible of medical care on board ships to forward detailed requests of assistance containing symptom-guided information on patient clinical conditions. This may represent an innovative tool for medical consultations at distance allowing the remote center to provide more precise and quicker medical advice.

While CIRM maintains an Information Technology (IT) group with the good expertise and trying to recruit more professionals. We had strong IT team with high experience in machine learning and data mining technologies and our team has worked on **Easy CIRM** software. Compared to the conventional consultation systems based on telephone and e-mail. the proposed device is more accurate and complete in terms of information contained in the request of assistance. Moreover. data received by the medical center can be more easily managed. as they can be standardized.




*A basic example of expert system in medical care*

CIRM service center currently maintains a high-speed internet connection. web server. and the latest software. With the addition of an artificial intelligence networks and designing expert systems. it is expected that there will be an overall cost increase of 5-10% for web server operations and maintenance costs.

## 4. Service Market Place. organization and staffing :

In the last 19 years. CIRM has assisted 46.784 patients on board ships. with an average of approximately 2.500 patients per year. All those requiring medical advice from CIRM. the number of which is increasing every year could benefit of the system we propose to develop of help in preparing requests of telemedical advice. A majority of CIRM patient's base are returning patients and referrals from existing patients. By providing a more convenient means of using our services. it is expected that we will retain our patients while conducting an online marketing campaign for new patients as well. Such a facility would require a significant capital investment as well as increased operation and maintenance costs. However. based on anticipated growth projections. CIRM must ensure that all doctors available entire 365 days/year in order give better health accessibility to our patients.

We are currently. total team of 23 members working under CIRM including part-time and volunteer staff. With providing new services and technologies. there may be a need for additional staffing or for CIRM to restructure in order to accommodate the change. These are important considerations as they may result in increased costs or require an organization to change its practices and processes. However. our staff is expertise in IT technologies. adopting new technologies and implementing expert systems. which enforces us to conduct training sessions regarding these technologies. As mentioned in the application. in first year it is important to conduct data mining on CIRM medical data to analyses distinct pathologies of patients. As of this. we are trying to recruit some more professionals who expertise artificial intelligence technologies. All of these positions work within existing departments and report to department managers.

Staff Position#1: Data Mining Expert – This is full-time position. which provides full training course to our staff in order to make them more efficient in analyzing the patient data and work in CIRM labs in ROME

Staff Position#2: A medicine doctor - will supervise data collection and transfer of these data in the ANN algorithms. This professional will also supervise testing of the system for a reasonable number of ships

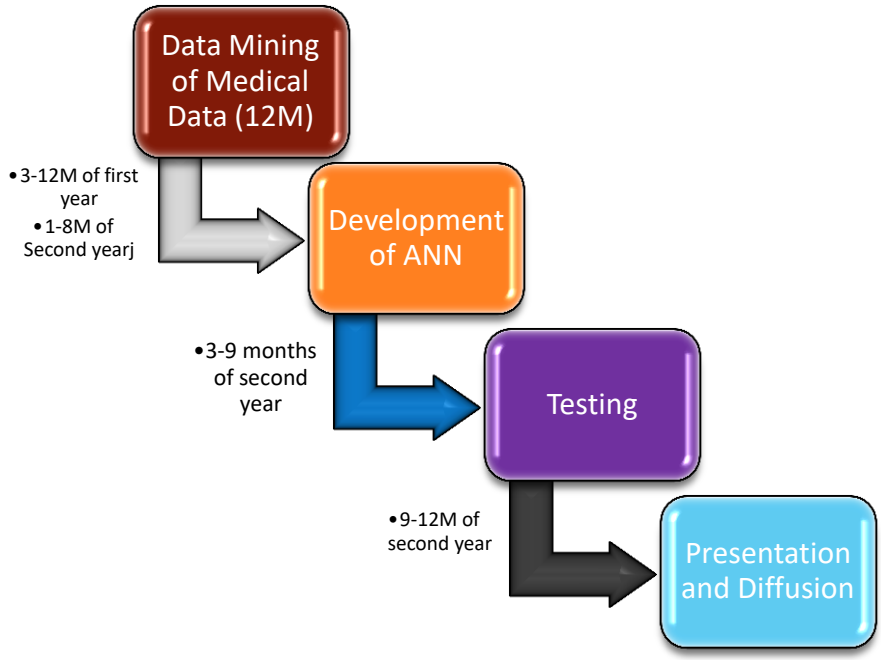
Staff Position#3: A knowledge engineer - He/she is a person who can design. build. and test the expert system. The knowledge engineer solicits the experience and knowledge from the human expert and discovers how a problem can be solved

## 5. Schedule:

The proposed project will be articulated into 4 phases:

- Data mining of medical data of CIRM assistance (first 12 months of the project).
- Development of the 'Artificial Neural Network (ANN)' (months 3-12 of the first year; months 1-8 of the second year)
- Testing of the system (months 3-9 of the second year)
- Presentation and diffusion of the system (months 9-12 of the second year).

The following diagram will give concise description of Project.




*Project Plan*

The first one will include collection of medical data of CIRM assistance from 2000 to 2017. In these 18 years. the Centre has assisted 45.691 patients and this assistance has required approximately 270.000 teleconsultations. All teleconsultations (via telephone or e-mail. with each teleconsultation recorded) will collected and analyzed for developing the artificial intelligence system. As a technological infrastructure a server with good performance capabilities. computers for data collection and elaboration and specific programs for identification of keywords to be used for elaborating the medical data into an artificial intelligence system. The purchase of this technological infrastructure will be the first step of the project.

Telemedicine assistants (No. 2) will make data collection and transfer from user interface to the memory of the intelligent system. A knowledge engineer (No. 1) will be recruited for the project. He/she is a person who can design. build. and test the expert system. The knowledge engineer solicits the experience and knowledge from the human expert and discovers how a problem can be solved. The system proposed will be an 'Artificial Neural Network (ANN)'. ANN is the group of mathematical algorithms. generated by computers. ANNs learn from standard data and capture the knowledge contained in the data. Trained ANNs approach the functionality of small biological neural cluster in a very fundamental manner. They are the digitized model of biological brain and can detect complex nonlinear relationships between dependent as well as independent variables in a data where human brain may fail to detect. A medicine doctor (No. 1) will supervise data collection and transfer of these data in the ANN algorithms. This professional will also supervise testing of the system for a reasonable number of ships.

In the last 3 months of the project. a campaign of presentation of the innovative software and offer of it to ships will be organized.

## 6. Financial Projections:

The financial projections for implementing software platform for CIRM medical service was highlighted in the table below. These figures account for Technological infrastructure. Data collection. Development of the artificial neural network (ANN). System testing. Dissemination campaign and General expenses.

The assumptions for these projections are as follows:

| Measure | Year 1(€) | Year 2(€) | Sub Total(€) |
|---|---|---|---|
| **Estimated Projection** | **207.000.00** | **122.000.00** | **329.000.00** |
| | | | |
| Technological infrastructure | 40.000.00 | 13.000.00 | 53.000.00 |
| Data collection | 80.000.00 | 42.000.00 | 122.000.00 |
| Development of ANN | 72.000.00 | 30.000.00 | 102.000.00 |
| System testing | 20.000.00 | 21.000.00 | 41.000.00 |
| Dissemination campaign | 10.000.00 | 5.000.00 | 15.000.00 |
| General expenses | 20.000.00 | 16.000.00 | 36.000.00 |

## 7. Findings and Recommendations:

Based on the information presented in this feasibility study. it is recommended that CIRM approves the design ANN and begins project initiation. The findings of this feasibility study show that this initiative will be highly beneficial to seafarers and has a high probability of success. Key findings are as follows:

*Technology:*

- Will utilize existing technology along with new implementations which lowers project risk
- Implementation of Data mining and ANN networks which makes project more feasible
- Once in place this technology is simple to operate and give quick access of medical assistance

*Marketing:*

- This initiative will allow CIRM to reach large number of patients electronically at a low cost
- CIRM can expand patient base beyond geographic areas where ships are currently located

*Organizational:*

- Minimal increases to staffing are required with no changes to organizational structure
- No new facilities are required and CIRM will cover using surplus from the financial year 2017 the 19.5% of the project costs.

## 8. Enclosures

VIA MEDICA

ENCLOSURE 1

ORIGINAL PAPER

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# An ontology-based consultation system to support medical care on board seagoing vessels

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## ABSTRACT

***Background:*** *A realistic possibility to obtain medical care for patients located in remote sites such as seagoing vessels, in which health professionals are not available, is to contact a doctor via telecommunication systems. In general, the medical knowledge of who on board ships is in charge of medical care is quite limited and therefore, in a first level telemedical consultation, the flow of information should be correct and its efficiency should be maximised. This paper describes an application conceived to improve requests of medical assistance from sailing ships. The ultimate objective of this system is a) to standardise as much as possible the requests of medical advice at a distance, b) to overcome language barriers and jammed-related troubles that could make difficult or not understandable a telephone conversation.*

***Materials and methods:*** *The application is based on a software engine extracting data from an ontological knowledgebase built ad hoc using Protégé.*

***Results:*** *Compared to the conventional consultation systems based on telephone and e-mail, the proposed device is more accurate and complete in terms of information contained in the request of assistance. Moreover, data received by the medical centre can be more easily managed, as they can be standardised.*

***Conclusions:*** *The system described here allows people responsible of medical care on board ships to forward detailed requests of assistance containing symptom-guided information on patient clinical conditions. This may represent an innovative tool for medical consultations at distance allowing the remote centre to provide more precise and quicker medical advice.*

*(Int Marit Health 2016; 67, 1: 14–20)*

**Key words: teleconsultation, remote medical advice, ontology, Protégé, medical assistance on board ships**

## INTRODUCTION

Telemedicine, consisting in the application of information and communication technology (ICT) to the solution of medical problems and in the exchange of medical information, is changing our approach in the delivery of several health services. Telemedicine includes a growing variety of applications and services the use of which will increase in the near future.

Teleconsultation (e.g. the medical visit made via ICT) can be divided into different levels based on the players involved and the complexity of the information exchanged. A basic (first level) teleconsultation is the electronic/telephonic communication between a client (patient) and a physician. A second level teleconsultation involves a physician or another health professional and a specialist delivering health care services and information over small and large distances. In the second level teleconsultation, data, information, images and/or voice are exchanged. A higher level of teleconsultation (third level) involves a medical team of a hospital addressing specific questions to the team of

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a specialised centre. In primary care, generally, teleconsultation takes place between a patient/caregiver and health care professionals for diagnostic or therapeutic advice or for educational purposes.

Medical assistance of good quality is a right of all citizens, but it is not always easily deliverable in remote areas, such as seagoing vessels as well as small islands, rural regions, or in developing countries. Remote teleconsultation therefore represents the only realistic way to deliver health care to patients not able to obtain direct medical assistance such as seafarers on board ships without medical facilities. Seagoing vessels represent a prototype of isolated place, and could remain at sea for days or weeks before reaching a port. The largest majority of merchant ships do not carry doctors or expert paramedic personnel and an officer with medical duties (the captain or the first mate) is the person in charge of the patient in case of accidents or diseases. For more than 80 years, several radio medical services have been operational, starting by using radio signals and Morse code [1], evolving through telephones to full blown telemedicine solutions. Today specialised ashore centres called Telemedical Maritime Assistance Service (TMAS) offer medical assistance to ships with no doctor on board [2]. Telemedical consultations, however, have some innate limitations. One consists in the fact that the great majority of people asking for medical advice by means of ICT resources do not have proper medical training. The communication of symptoms or specific clinical situations can therefore be difficult or misleading in case of absence of objective information such as biomedical data and/or video support [3].

This paper presents a system conceived to improve the first level teleconsultation by allowing the correct flow of the relevant information on the status of a patient, avoiding problems related to verbal communication or jammed transmission. This system guides the ship captain in the medical examination, increasing the preciseness of the information transmitted with the consequent possibility to obtain more accurate and quicker diagnosis.

Potential users of the system besides seafarers could be also other isolated populations such as personnel on board of commercial aircrafts or oil-rig workers or people living in rural areas. Hence, a potential high number of users can benefit from the system that will allow, starting from a given sign, the identification of the cohort of other signs and symptoms present.

## MATERIALS AND METHODS

### THE KNOWLEDGE BASE

A knowledgebase was built in the shape of an ontology. The ontology represents concepts and their logical relations and has a hierarchical structure. It is a suitable solution for data managing and sharing, allowing a universal codification of concepts. In this sense, the effort of the Open Biological Ontologies (OBO) Foundry to create a set of interoperable ontologies enabling scientists and their instruments to communicate with minimum ambiguity should be mentioned [4]. An ontology also permits the reuse of knowledge and the inference of new knowledge, through automatic reasoning [5, 6].

In the present work this ontology has been developed using the existing software Protégé 3.4.1 [7], aggregating free-text data from the relevant literature [8]. When possible, our terms for clinical signs were associated as synonyms with the ones from SYMP (the OBO Foundry Symptom Ontology) [6] exploiting the "Bioportal" function of Protégé that allows linking to external resources.

Two main classes were created: "Sign" and "Detailed info". A series of instances for the class "Sign" has been created to represent the main signs a patient could manifest, in example "Fever", "Cough", "Breathing difficulties", "Diarrhea", etc. Each main sign has relations (object property "hasDetailedInfo" in the ontology) with a series (1,n) of detailed information to be communicated to the medical centre. These information are represented in the ontology as instances of the class "Detailed info", or better, of its subclasses.

Each main sign has relations (object property "hasAdditionalSign" in the ontology) with a series (1,n) of other signs (other instances of the class "Sign"). For instance, "Fever" has relations with "Cough", "Breathing difficulties", "Diarrhea", etc., that represent possible associated clinical signs requested in the final application to the patient to be considered selecting "Fever" as main sign (Figs. 1, 2).

In the same way, to each detailed information has been assigned an answer that finally would represent the option the user should select or fill in the final application. A SPARQL query has been then created to retrieve data from the ontology. The following represents the general syntax to retrieve the detailed information and their relevant superclasses for the main sign "Fever" i.e.:

```
"SELECT ?detail ?answer ?superclass
 WHERE { :Fever :hasDetailedInfo ?detail.
?detail rdf:type ?superclass }".
```

### THE APPLICATION

A software application was then built as the engine to interact with the ".owl" generated Protégé file.

### Basic software technology and JSP

The system is based on a web service implemented in JSP. JSP seemed to be the most suitable solution, providing a Java library capable of interacting with the OWL standard. Java methods and classes can easily be called in a JSP page. The following are the main JSP pages (Fig. 3).

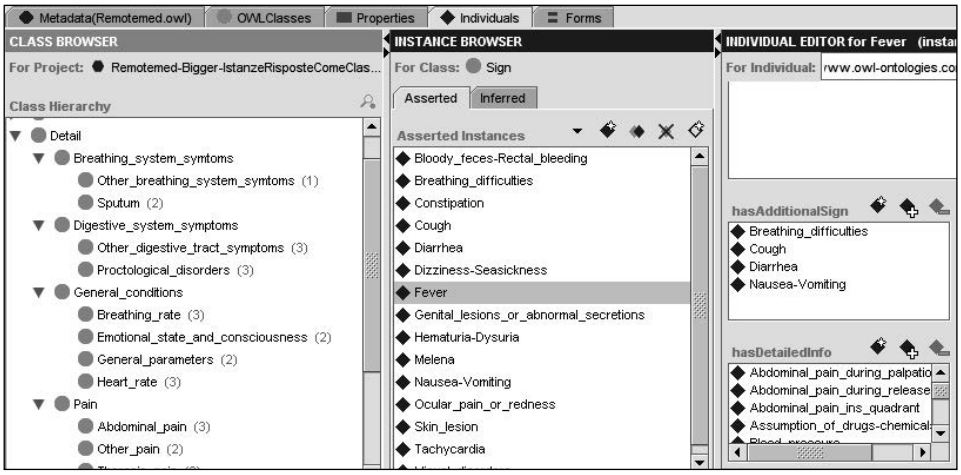


**Figure 1.** Protègè — some of the detailed information and additional signs (in the right) for the instance "Fever". Some of the super-classes in the left

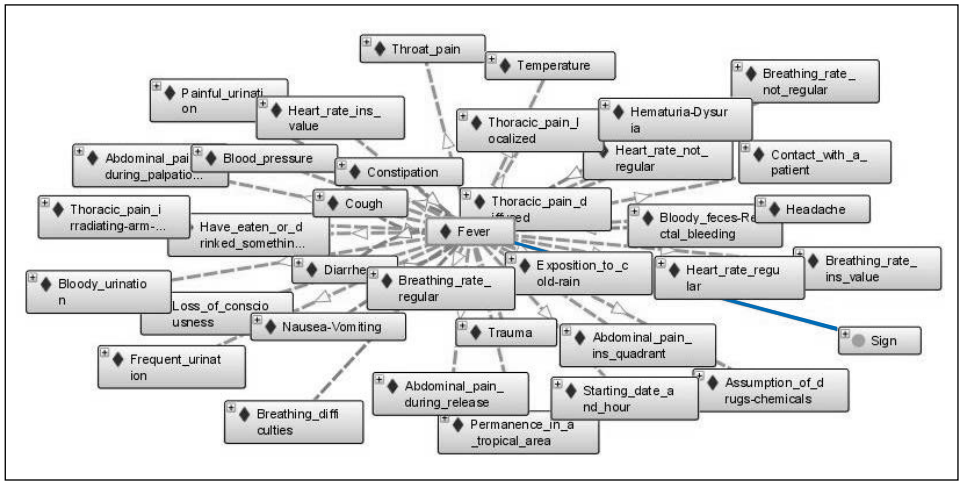


**Figure 2.** OntoGraph showing Additional Signs (blue line) and Detailed Info for the sign "Fever"

The system allows for saving data in an XML database:

- main.jsp, main page that allows the user to select the principal sign and answer the detailed information and the additional signs; it contains all the JavaScript functions related to the web service, such as the "Yes/No" functionality (Fig. 4);
- save.jsp, process page that saves the information inserted by the user in the XML database;
- menu.jsp, a navigation page;
- style.css, defines the CSS style of the elements.

The system even allows the doctors of the medical centre to answer the requests inserting a diagnosis and the admin to edit saved data. These are the relevant JSP pages:

- save_diagnosis.jsp, process page that saves the diagnosis inserted by the doctors in the XML database;
- view_data.jsp, allows doctors and admin to see and edit all the records. Admin could then, for instance, decide to delete one or more users' records and doctors to add or modify a diagnosis;
- delete_users.jsp, process page that permits to delete users' records from the XML file.

The two principal pages concerning the final user (patient, doctor or admin) are "main.jsp" and "view_data.jsp", the first to insert, the second to view data. The other pages, excluding "menu.jsp", are processing pages and have the task to interact with the XML database and to modify it.

## The Java classes

The Java classes work as interface between the application, the ontology and the XML database (Fig. 3). The main Java classes used were:

- **OWLAPI**, it acquires all the information contained in the ontology. For instance, when the page "main.jsp" is loaded, this Java class gets all the principal signs or when a user selects a principal sign, a method of the OWLAPI acquires

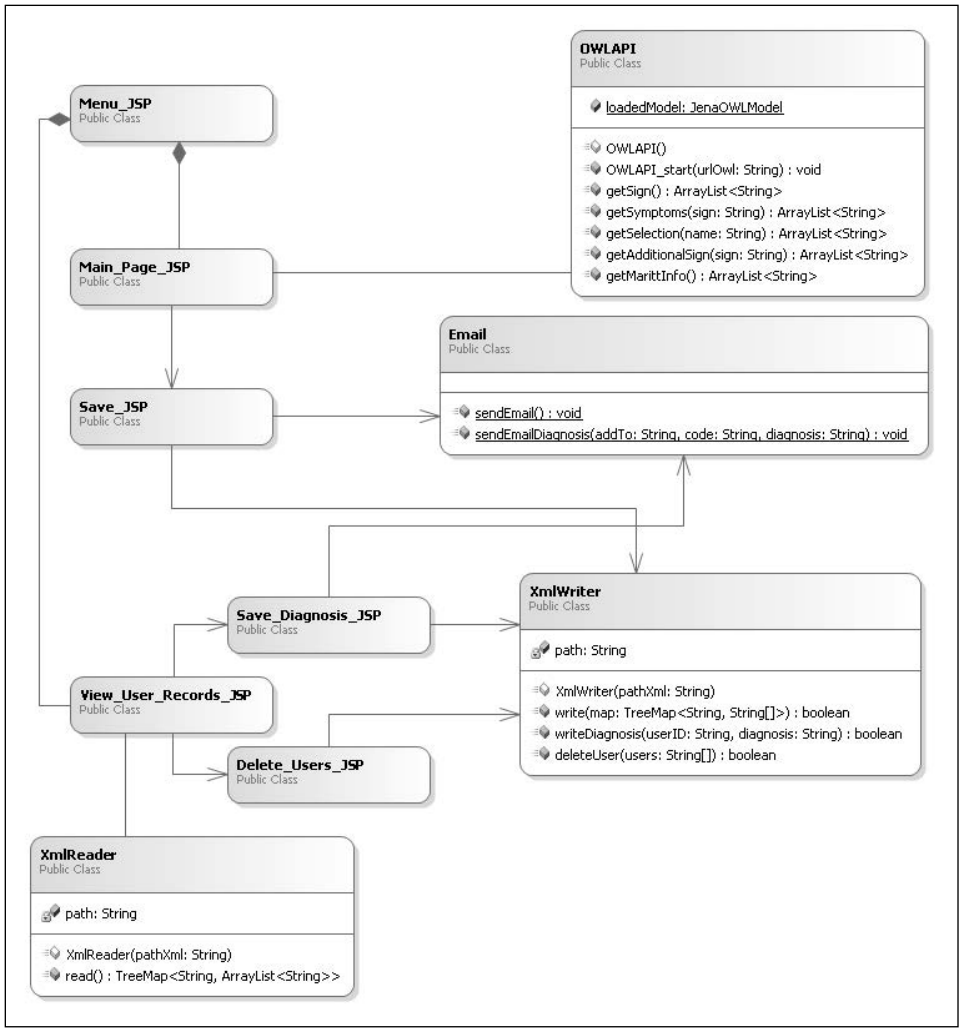


**Figure 3.** The main JSP pages and Java classes

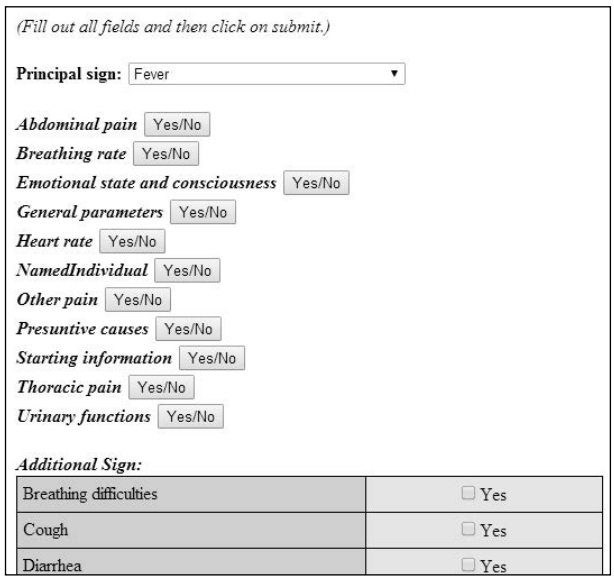


**Figure 4.** Groups of detailed information (ontological superclasses) to be explored/opened for the main sign "Fever"

from the ontology all the related detailed information and additional signs. This class takes advantage of the Protégé Java Library that permits to interact with an RDF/XML model that in fact is the structure of the ontology;

- **Email**, the task of this class is to send email to the medical centre with the list of information inserted by the user and to the user if a doctor has inserted or modified a diagnosis;
- **XmlReader**, this class is called when the page "view_data.jsp" is loaded. It takes all the records contained in the XML database;
- **XmlWriter**, as XmlReader it interacts with the XML database and inserts users' records and doctors' diagnosis.

## THE PATIENT'S USER INTERFACE

### Detailed info navigation and answering

The hierarchical organisation of concepts and the superclasses make easier and less time-consuming for the user to navigate the information. Selecting the main sign, the system asks to consider a series of additional signs and detailed infor-

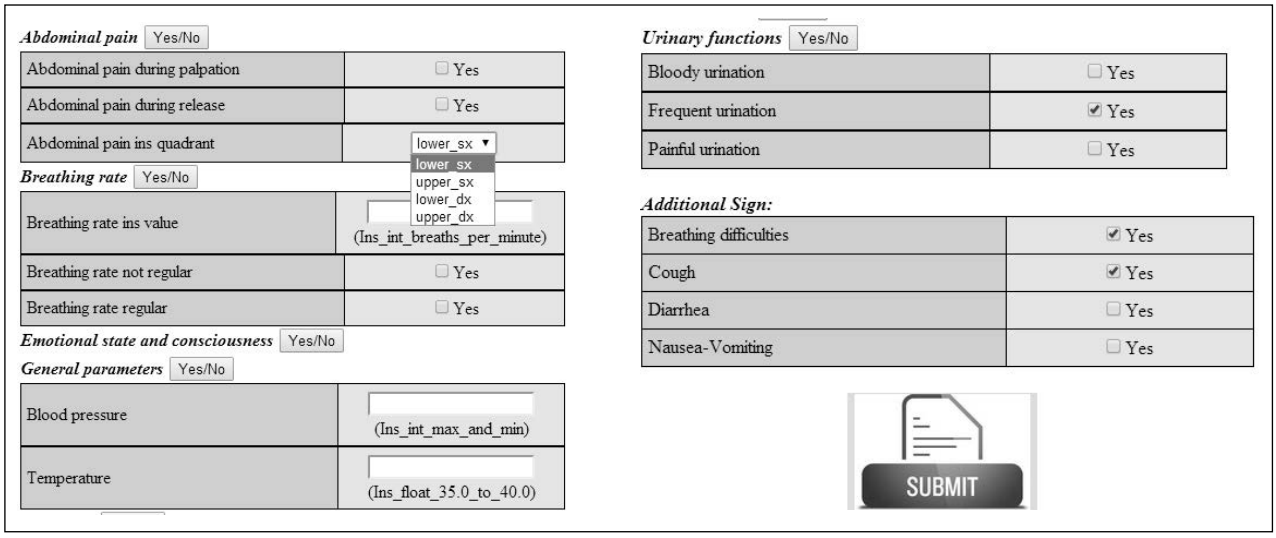


**Figure 5.** Left part shows a detailed information referring to each superclass with the relevant answer options to select or fill in. The right part of the figure shows the procedure ends with the submission of the compiled form

mation. These are organised in big groups (superclasses). If the patient doesn't manifest the sign to which the group is referring or doesn't want to consider that superclass, he can simply answer "No" (or don't click) to the relevant superclass (Fig. 4).

By clicking on a superclass, the series of detailed info about that clinical status appears. They can be answered in the following three main ways (Fig. 5):

— boolean selection (Yes/No);
— multiple selection;
— typing (generally a string or a number).

## Other information

**Patient's general info.** Some basic details on the patient needing medical assistance and simple information on his personal history should be provided:

— age;
— name;
— birthdate;
— sex;
— nationality;
— rank.

**Patient's clinical history and drugs administered.** Basic medical history and drug history of the patient should be included in the following order:

— previous most significant diseases;
— chronically administered drugs;
— drugs administered for the actual condition.

## Submission of data

Once answered all the detailed information referring to all the superclasses as described above, the user can submit them, sending the data package to the maritime telemedical centre (TMAS) (Fig. 5).

The system has been adapted in particular for naval communication. Then, a series of information about the ship is required to be inserted, such as:

— ship name;
— ship type;
— ship owner;
— call sign;
— master;
— ship nationality;
— port of departure;
— port of arrival;
— speed;
— position;
— telephone/fax/e-mail.

## SYSTEM TESTING

Tests of the system are ongoing in collaboration with Centro Internazionale Radio Medico (CIRM), the Italian TMAS [9] using seagoing vessels as a prototype of isolated places. CIRM medical assistance is given to ships of any nationality sailing worldwide. The service is provided 24 h a day and 365/366 days per year by doctors on duty. The centre receives the request of assistance and gives instructions for the case. For assessing the quality of the system, 150 teleconsultations between seagoing participating voluntarily to the experiments (users) and CIRM medical team (experts), were evaluated. Evaluation of the system involved both the user's and the expert's side and both user's satisfaction and technical aspects. The parameters listed below were considered compared to standard communication systems:

— accuracy of the request (number of non-ambiguous signs communicated per request);

**Table 1.** Evaluation of the system effectiveness using 150 teleconsultations from seagoing vessels (user) and Centro Internazionale Radio Medico (CIRM) headquarters in Rome (expert)

| Parameter | Tester | Score |
|---|---|---|
| Accuracy of the request | Expert | High |
| Accuracy of the possible diagnosis | Expert | High |
| Speed — overall | User-Expert | Medium |
| Speed — diagnosis | Expert | High |
| Usability | User | High |
| Wiliness to use | User | Medium |
| Completeness of the info | User-Expert | High |
| Easiness of data managing | Expert | High |
| Reliability of the system | Expert | High |

"High", "Medium" and "Low" indicate respectively for better, same as, and worse compared to standard (telephone or e-mail) previous communication systems.

- accuracy of the diagnosis made by the centre (number of correct verified diagnosis/total cases);
- speed of a complete round: time to make the request/ /time to provide the answer;
- speed of the diagnosis;
- usability (easiness of use, even by an inexpert user);
- wiliness to use;
- completeness of the information;
- overall reliability of the system.

A score from "High" to "Medium" to "Low" was assigned by the testers (users and experts) for each of the above parameters.

## RESULTS

The system described here has shown the capability to forward accurate remote requests of assistance with no technical problems in terms of software functionality and integrity of data transmission.

Differently to other tools that are diagnosis-oriented [10], the proposed system does not provide diagnostic solutions, but results efficient in guiding the user towards the collection of appropriate signs, already codified according to the guidelines provided by the maritime telemedical centre, with no possibility for self-ambiguity and ensuring the information transmitted to be as complete as required.

Table 1 summarises the results reporting the prevalent mark on the total number of evaluations provided by the testers. The system has shown, in respect to the existing consultation tools, a higher completeness and accuracy of the request of assistance in terms of information transmitted, a quicker and more accurate diagnostic possibility and an overall high usability and reliability.

## DISCUSSION AND CONCLUSIONS

The system allows the user to prepare telemedical requests of advice with precise and circumstantial information. A substantial advantage derived from adopting the application for telemedical consultation consists in the fact that a great number of specific information about the patient (automatically suggested starting from the main symptom) could be transmitted to the physicians in charge of medical assistance, increasing the chance to get a correct and faster advice. Moreover, data transmitted are encoded using a standard vocabulary and a standard formulation. The information transmitted is therefore more easily managed by the centre. The system will also contribute to constitute a patient's historical data repository as a support for further teleconsultations.

Thanks to the ontologies, an easy to obtain multi-language selection is available. This option could reduce communication barriers caused by language troubles, misunderstandings and verbal hesitations mostly due to the unavoidable use of technical clinical terms. Problems of jammed telephonic communication are also eliminated through the direct transmission of data.

As a result, the user is able to get a faster and more accurate answer of assistance from the maritime telemedical centre. Referring to the maritime assistance, a correct and quick diagnosis could avoid unnecessary transfers of the patients, limiting costs for changes of course/evacuations and discomforts for the crew.

In 2013, CIRM reported several problems in providing correct diagnosis due to imprecise information from the ship side. The test of the support communication system described here, showed an improved definition of the medical problems to be treated. The potential advantages of the system appear therefore promising.

## FUTURE IMPLEMENTATIONS

As a possible future enhancement of the system, we are considering the possibility of crowdsourcing the requests, through a server, from the mobile terminal of the patient

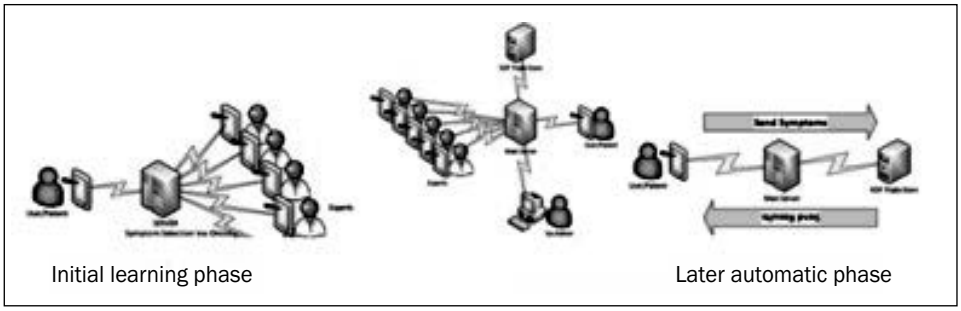


**Figure 6.** General architecture showing the flow of the information for a future possible distribution system. The users' request dispatched to the server would be redistributed to a set of experts and the answers would be both returned to the user and stored into a knowledgebase creating the basis for automatic diagnosis

(a mobile version should be first developed) to a pool of clinicians. Once the clinicians will answer the requests, these data will be returned back to the patients and stored into a knowledgebase (as actually for the XML database), creating the fundamentals for further automatic processing of medical information (Fig. 6).

This will allow the development of a medically-validated, punctiform, status-diagnosis association. In the second automated phase, the clinicians' work will be significantly reduced, but reliable medical answers could be still obtained since they will be inferred from researches and learning processes on the knowledgebase.

Considering the application, it would be interesting to investigate the possibility to perform automatic reasoning on the main ontology in order to infer new knowledge and to rearrange the existing data structure such as the subclasses hierarchy and the positioning of the instances.

## ACKNOWLEDGEMENTS

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**ENCLOSURE 2**


# EASY CIRM USERS' MANUAL

## Instructions on how to use the EASY CIRM Software and associated tele medical devices on board ships

**by**

**Fabio Sibilio, Vincenzo Di Pietri and Francesco Amenta**

**Centro Internazionale Radio Medico (C.I.R.M.)**
**TABLE OF CONTENTS**

Rome, Italy July 2015

A cura di:
Prof. Francesco Amenta
Fabio Sibilio
Vincenzo Di Pietri
Grafica e Illustrazioni: Vincenzo Del Regno



Stampato in Italia – Roma 2016

# EASY CIRM USERS' MANUAL

Instructions on how to use the EASY CIRM Software and associated tele medical devices on board ships

# TABLE OF CONTENTS

# 1. USEFUL HINTS

Procedures, software and devices described in this booklet are the result of a couple of years of studies and research in the frame of the collaboration between **Centro Internazionale Radio Medico (C.I.R.M.),** the Italian Telemedical Maritime Assistance Service **(TMAS)**, and **CMA Ships**.

C.I.R.M. is the TMAS with the largest experience worldwide of medical assistance to sailing seafarers and will offer to CMA Ships a dedicated high quality assistance service in case of diseases or accidents on board ships.

**IF MEDICAL ADVICE IS REQUIRED**

## C.I.R.M. will offer to CMA Ships subscribing our Maritime High Quality Health Care (MILIARE) service

1. A dedicated e-mail account **cirmpremium@cirmservizi.it** and telephone number **+39-06-87759563** to contact CIRM Medical service.
   **Please use always these contacts to guarantee prompt identification of your ship as a vessel entitled to our MILIARE service.**
   The above e-mail and telephone number will be effective since April 1, 2016.
2. Availability of full Telemedical service 24 hours a day
3. Priority in delivering medical advice
4. Personalized and dedicated medical service
5. Direct contact with shipping company doctor in case of serious cases requiring landing of the patient or diversion of the ship from the route
6. Collaboration/agreements of what to do in cases of disease/accidents on board.

*For allowing C.I.R.M. to provide the best quality service we always recommend to consult promptly CIRM even for all those symptoms that apparently insignificant, may evolve into pathological complexes.* ***Do not forget to enclosed in your first request of medical advice lists of medicines available on board.***

**IN CASE OF TECHNICAL PROBLEMS WITH EASY CIRM SOFTWARE OR MEDICAL DEVICES**

C.I.R.M. will offer to CMA Ships subscribing our Maritime High Quality Health Care (MILIARE) service from Monday to Friday a consulting/counselling service held by the supervisor of the project Mr Fabio Sibilio.

**He can be reached from 09:00 to 18:00 (CET) either by e-mail: fsibilio@cirmservizi.it or telephone: 0039 389 7978025**

***Please do not forget to introduce yourself as a CMA Ship partner of MILIARE***

## 2. Introduction

Treatment of injuries or pathologies in remote sites lacking of doctors or adequately trained paramedic personnel is not an easy task. This happens for merchant ships the majority of which does not carry medical or licensed paramedic personnel.

In these circumstances it is necessary to rely to a telecommunication system. This requires on board of the ship personnel able to interact with a specialized center as well as a stockpile of drugs and medical equipment/devices.

The possibility to give medical support to ships through the telecommunication system started out after **1897**, the year in which **Guglielmo Marconi** developed the radiotelegraphy. For centuries, the cure of pathologies has been entrusted to the ship's captain and to his knowledge in medicine and hygiene. In the following years, the first coastal radio stations were established and ships were equipped with radio allowing them to communicate with the mainland or between ships. On board of the ships, personnel could have spontaneous initiatives and inquire medical suggestions to ships with medical facilities on board (transatlantic ships or big cruise lines with passengers) or , through coastal radio operators, to medical personnel on land [1]. Due to the lack of procedures and centers for curing ill people on board of the ships in remote locations, those initiatives were limited to the single individual. The first project going from an amateur system to a permanent organization specialized in providing medical care to seafarers dates back to 1920, when the New York Seaman Church get a radio license to provide medical care to sailing seafarers. The initiative has had considerable success and several countries subsequently have organized their own radio medical services for ships [1,2].

Seagoing vessels represent a prototype of isolated place, and could remain at sea for days or weeks before reaching a port. The largest majority of merchant ships do not carry doctors or expert paramedic personnel and an officer with medical duties (the captain or the first mate) is the person in charge of the patient in case of accidents or diseases. For more than **80 years**, several radio medical services has been operational, starting by using radio signals and Morse code [2,3], evolving through telephones to full blown telemedicine solutions. Today specialized ashore centres called Telemedical Maritime Assistance Service (TMAS) offer medical assistance to ships with no doctor on board [4]. Telemedical consultations, however, have some innate limitations. One consists in the fact that the great majority of people asking for medical advice by means of ICT resources do not have proper medical training. The communication of symptoms or specific clinical situations can therefore be difficult or misleading in case of absence of objective information such as biomedical data and/or video support [5,6].

A first prerequisite to provide high quality telemedical assistance at sea is to provide to the doctor of TMAS in charge of the patient's assistance detailed and precise information about the patient's conditions and symptoms to allow as much as possible a correct diagnosis in the shortest time.

**Centro Internazionale Radio Medico (C.I.R.M.)**, the Italian **TMAS** is the centre with the largest experience worldwide of medical assistance to seafarers on board ships [2]. CIRM has developed a system called Easy CIRM and conceived to improve the first level teleconsultation by allowing the correct flow of the relevant information on the status of a patient, avoiding problems related to verbal communication or jammed transmission [5,6]. This system guides the ship captain in the medical examination, increasing the preciseness of the information transmitted with the consequent possibility to obtain more accurate and quicker diagnosis.

Besides helping ship's captains in guiding examination of patients and in providing correct information to C.I.R.M. about patient's conditions, the system is linked to a series of medical devices now available on board. These devices, the type and functioning of which is detailed in this booklet will allow to assist patients on board ships with a full blown telemedicine system with all the advantages it can offer compared to the inexpert simple description of symptoms by the ship's office in charge of medical assistance on board.

## 3. EasyCIRM

EasyCIRM is a new informatic system developed by **C.I.R.M.** to help the ship's captains to prepare a precise and correct request of medical advice.

The idea to develop this system derives from the over the years experience of CIRM. Quite often, the incoming requests to CIRM medical staff were incomplete with consequent loss of time to clarify some doubts.

Thanks to EasyCIRM the person preparing a request of medical advice from a remote site will be guided in the compilation of the medical message so that no informationis omittedandthe CIRM'smedicalstaffcangiveapropermedicaladvice.

The system in completed by the possibility to use medical devices and to transmit their measurements.

In the subsequent pages we will learn of how to use the EasyCIRM system, to take the measurements using medical devices available on board and to transfer the results of the instrumental measurements into the system.

### 3.1 The login phase


The above screenshot is the first page the user see when he starts to interact with the Easy CIRM system. The login is mandatory and for that you need to insert some information. The system should know:

- **Username**: the name of the user who wants log in;
- **Password:** the password of the user just inserted;
- **Owner of Ship:** you need to select the ship owner;

Furthermore, you can press over the grey square (check button) if you want that the system remembers the password for future accesses to avoid the insertion of the passphrase every time.

Finally, after you fill every white field of the page you can click the "Submit" button and you get ready to interact with the system.

**Note:** if you forget to choose the "Owner of ship" and you click "submit" button, the user cannot access and the login page is reloading with empty fields.

# 4. The System Heart

Here you can find all the information and tips necessary to interact in a correct way with the system.

## 4.1 Main page


The figure above represents the first page shown to the user after login.
Here you can add owner details. As an example readers can see is "CMA CGM" owner and one ship registered (Ships registered(1)).

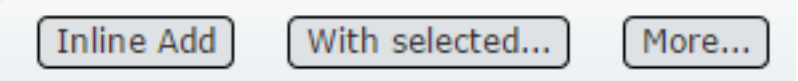
In the table other information such as the owner logo and owner name are shown. If you click on in the left side of the table you can edit the information of the selected row. In this stage, you can modify "Owner name" and "Owner Logo".

In the bottom of the CIRM Logo, there are two text buttons "Log out" and "Admin Area" for logging out from the system and for entering inside the administrator area respectively. Moreover, is shown the currently user logged in the system:

In the graphical example there is one row in the table. If you have more rows and you need to perform a specific search, you can use the search bar below:


It allows the search a specific text present in the "Owner name" column of the table;

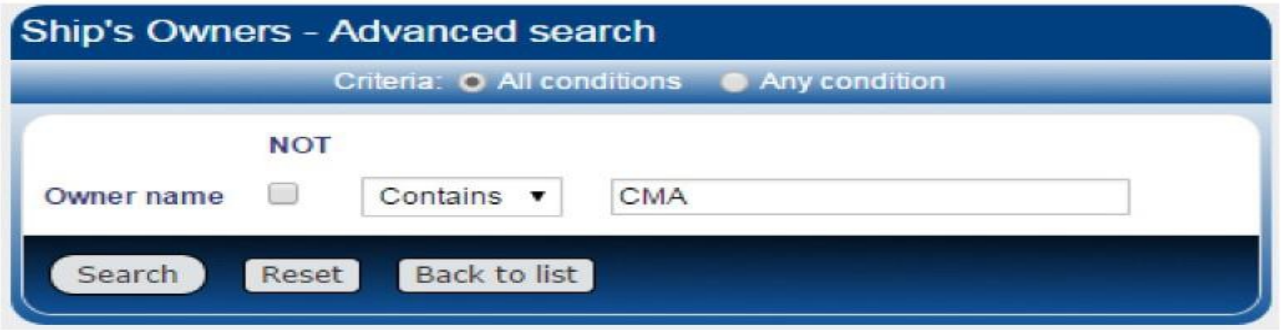
Tip: Use the advanced search when your table is filled with a huge number of rows.




You can add with the **"Inline Add"** button a new row of the table and so a new "Owner name" eventually with a "Owner Logo".

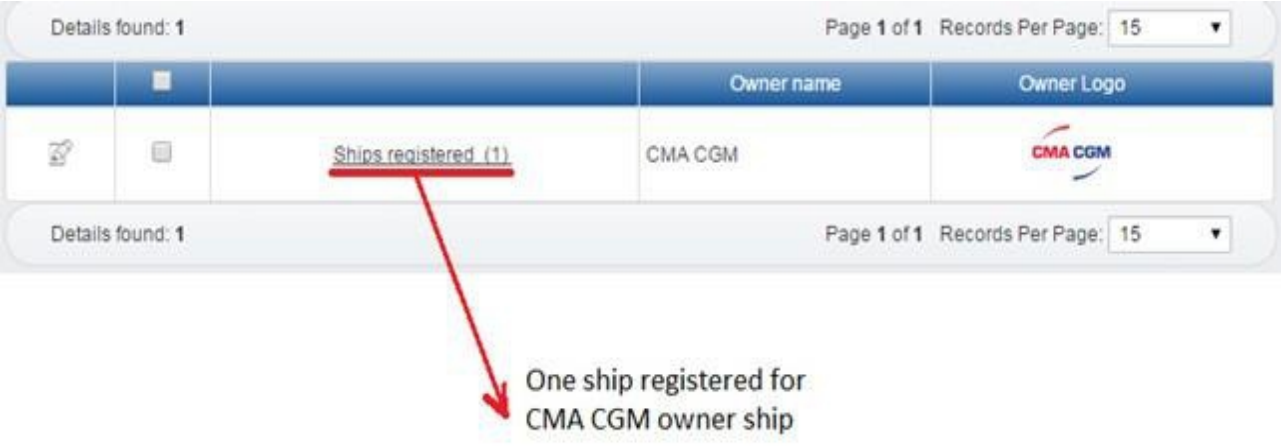
The **"With selected"** button allows to execute the Edit or the Delete actions in more rows simultaneously.

Finally, you can use **"More"** button to perform another type of the advanced search:




The table represents the main part of this page.

In this example, we have just one row with 1 ship registered given by the third column (i.e. Ships registered (1)). In this case the CMA CGM ship owner has just one ship registered. The number of the ships registered is given by the digit inside the brackets.



## 4.2 Ship Information

If you want to see the information about a registered ship you should click on "Ship registerd (1)" text and a new page with several information will appear:


In this page two tables can be seen. The first one in the bottom of the CIRM logo indicates the ship owner of the information below. In this case there is just one ship owner, CMA CGM.

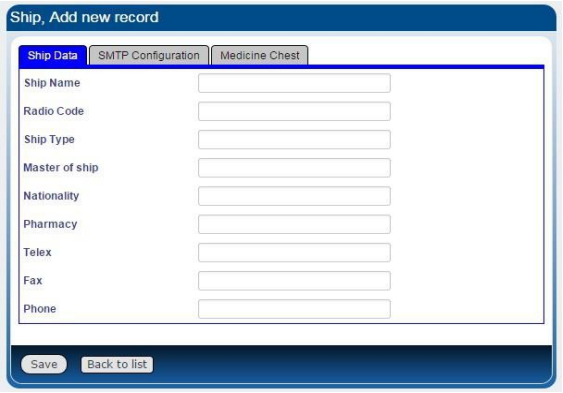
The heart of the page is represented by the main table with 12 columns:

- Edit technical information about the ship;
- Select a row. Is possible to select a set of rows and applied some actions simultaneously;


- It is the main field of each row. It contains several information. In this case are presented:
  - Call to CIRM(2): the number in brackets represents the number of emergency calls to CIRM (i.e. 2 calls). If you click on the text a new web page will be opened with technical information about the calls. In this page you can create and manage a new emergency call. For more information see section **2.3 Manage and create a new Emergency**.
  - Patient Tab (3): the number of the registered patients of the specified ship (i.e. 3 patients). If you click on the text a new web page will be opened with personal data information. For more information see section **2.5 Manage and register a new Patient**.

- Ship Name The name of the ship (i.e. Jules Verne);
- Radio Code The radio code;
- Ship Type The ship type (i.e. ship cargo);
- Master of ship The master of the ship (i.e. captain);
- Nationality The nationality of the ship;
- Pharmacy The inventory of the medicine on board to synchronize the CIRM. Usually is a file;
- Telex Number for the telex transmission if any;
- Fax The number of the fax telecommunication;
- Phone Phone number of the ship;

As in the main page of the application, you can use the "Add new" button (shown above close to main table) to add a new ship with all the mandatory technical information:



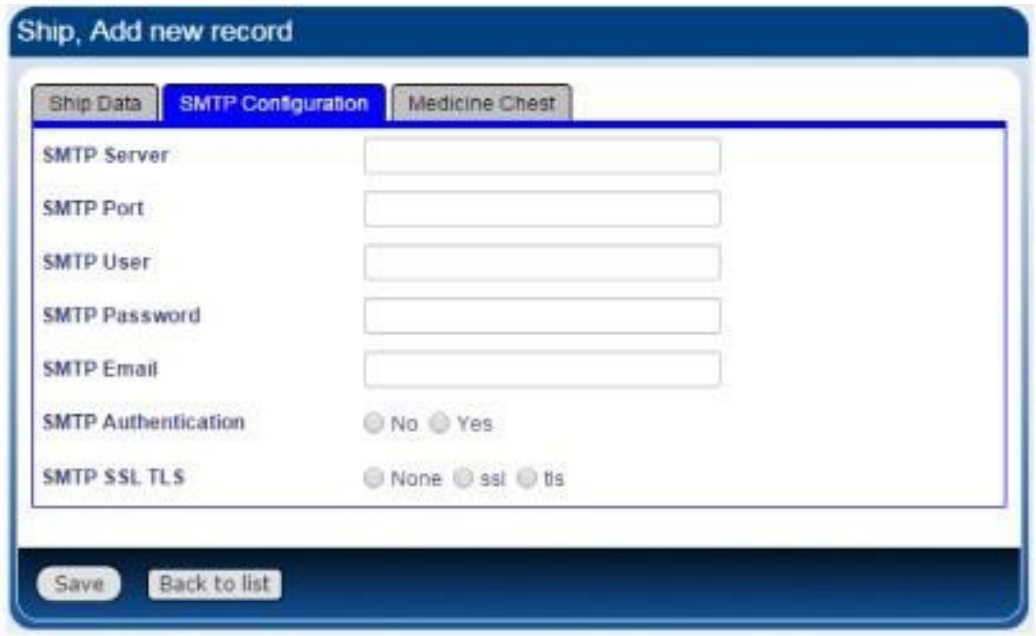

Through this function 3 functions indicated by 3 different labels can be activated.

**Ship data:** all the fundamental information about the ship:

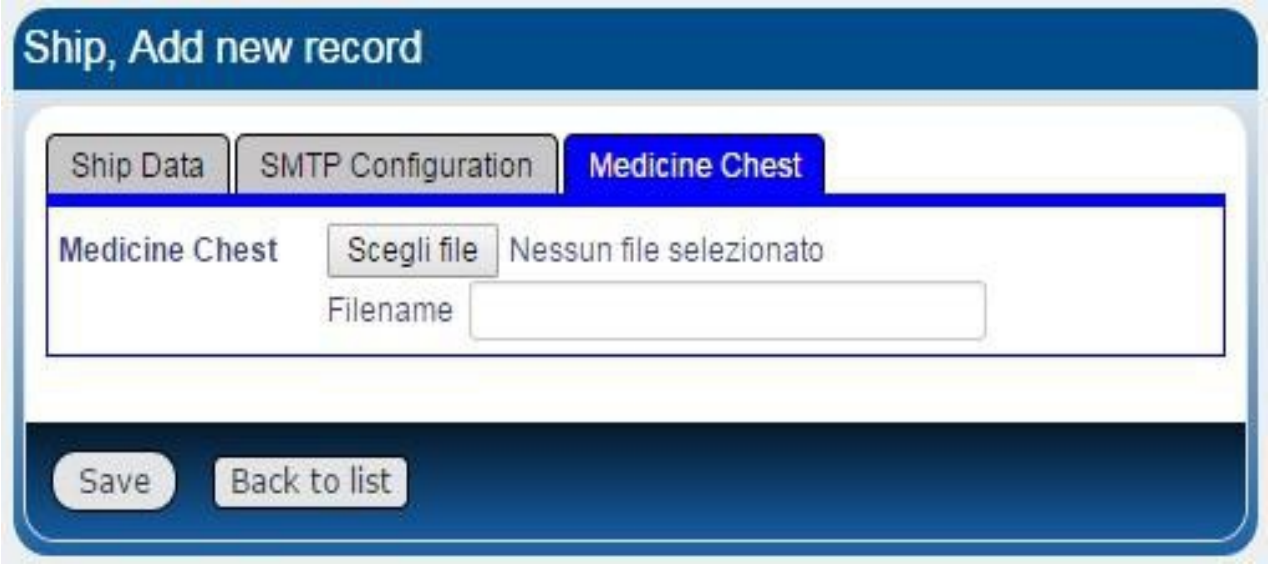
- Ship Name: the name of the ship (i.e. Jules Verne);
- Radio Code: the radio code;
- Ship Type: the ship type (i.e. ship cargo);
- Master of ship: the master of the ship (i.e. captain);
- Nationality: the nationality of the ship;
- Pharmacy: the inventory of the medicine on board. Usually is a file;
- Telex: number for the telex transmission;
- Fax: the number of the fax telecommunication;
- Phone: phone number of the ship;

**Ship data:** all the fundamental information about the ship:

- Ship Name: the name of the ship (i.e. Jules Verne);
- Radio Code: the radio code;
- Ship Type: the ship type (i.e. ship cargo);
- Master of ship: the master of the ship (i.e. captain);
- Nationality: the nationality of the ship;
- Pharmacy: the inventory of the medicine on board. Usually is a file;
- Telex: number for the telex transmission;
- Fax: the number of the fax telecommunication;
- Phone: phone number of the ship;

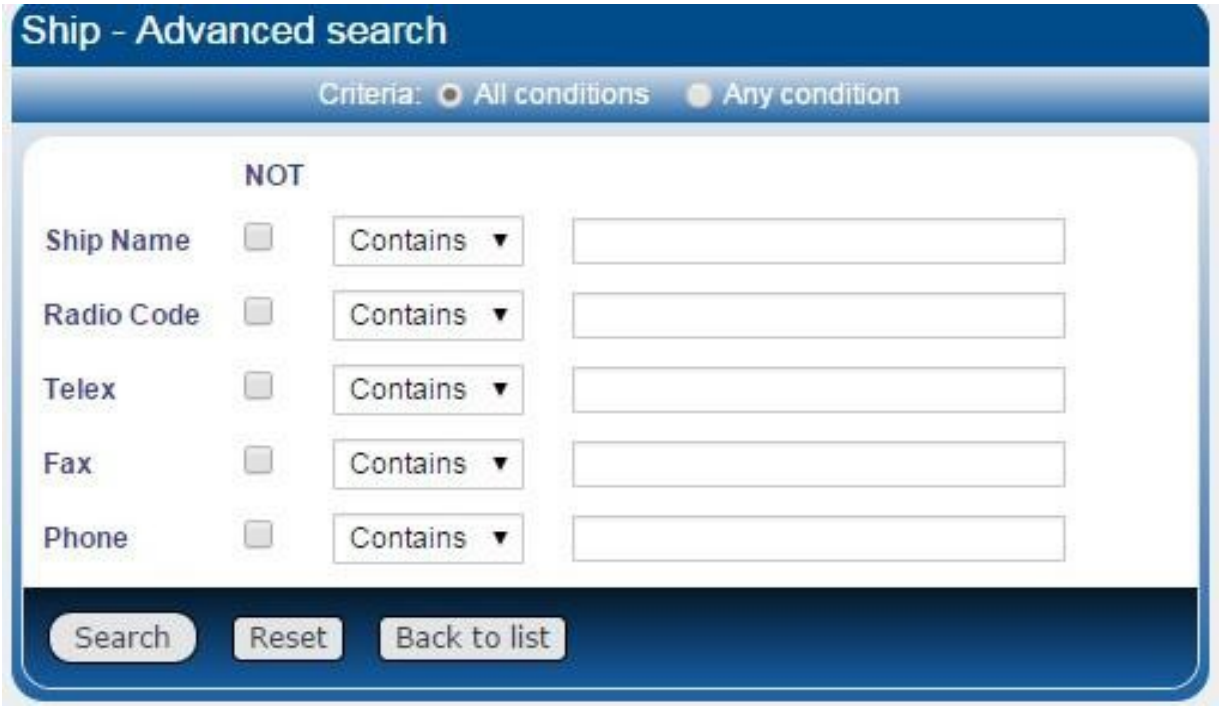


- **Medicine Chest:** medicine chest information. You need to attach the file of the supply of medicines currently on board .




The button "With selected" has the same functionalities of the same button in the main page. It is therefore possible to execute the Edit or the Delete action in more rows simultaneously.

Take care of the "More button" because it allows to perform the advanced search. In this case you can search for: ship name, radio code, telex, fax and phone. As in the main page's advanced search a new window appears such as in figure below:



### 4.3 Manage and create a new request of medical advice

The main features of the Easy CIRM system is the possibility to create and organize a request of medical advice. To do it, you should click on the button text where highlighted in the figure below:


In the example above, the text highlighted, "Call to CIRM (2)" tell us that there are 2 request of medical advice registered. A new page will appear filled with the emergencies already registered:

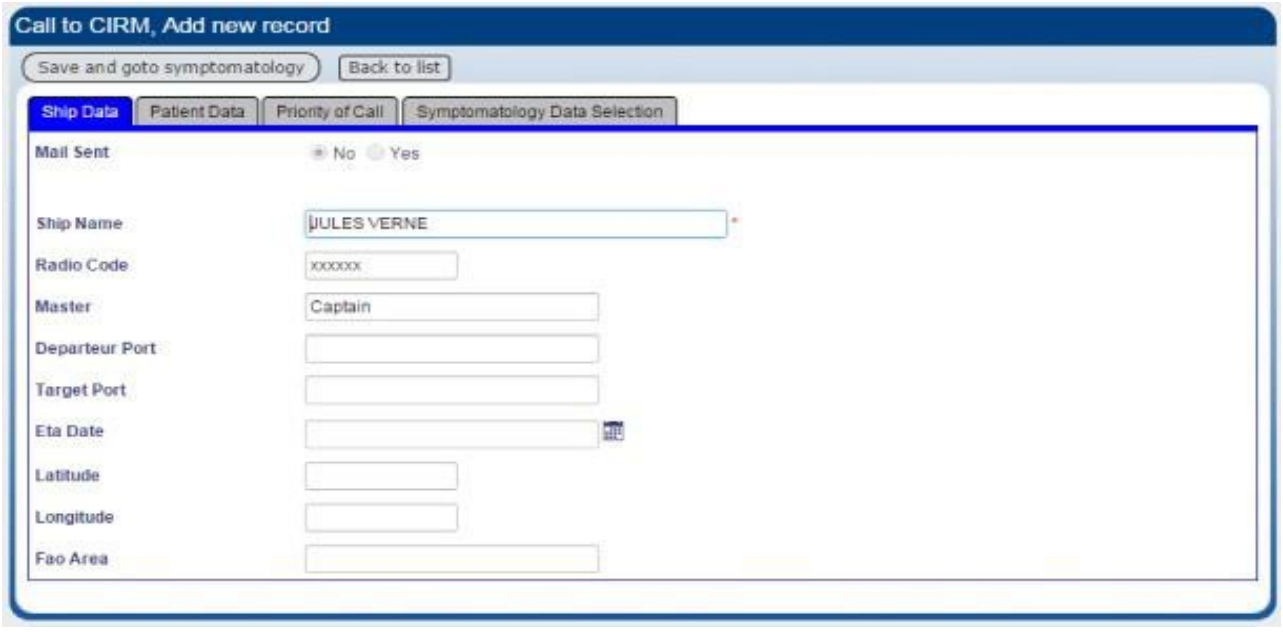
There are two tables. The first one is a reference to the ship who wants call the emergency while the second one describes the technical information of the request of medical advice registered.

The columns of the emergencies table are:

- : modify the information of the row;
- : select a row. Is possible to select a set of rows and applied some actions simultaneously;
- Attachments Images : It is possible to attach some files to emergency through the "Attachments" button and an image with the "Images" text button;
- **ID:** unique identifier of the emergency. It doesn't matter for the user point of view;
- **Mail Sent:** It tells to the user if this request of medical advice was sent to the CIRM. "Yes" tells that the request in detail is already sent to CIRM while "No" tells that the request is not already sent to CIRM;
- **Ship Name:** name of the ship which call for request of medical advice;
- **Radio Code:** radio code of the ship;
- **Patient name:** name and surname of the patient needing assistance.
- **Call date:** the date and time of the emergency call (format (dd/mm/yyyy hh:mm:ss).

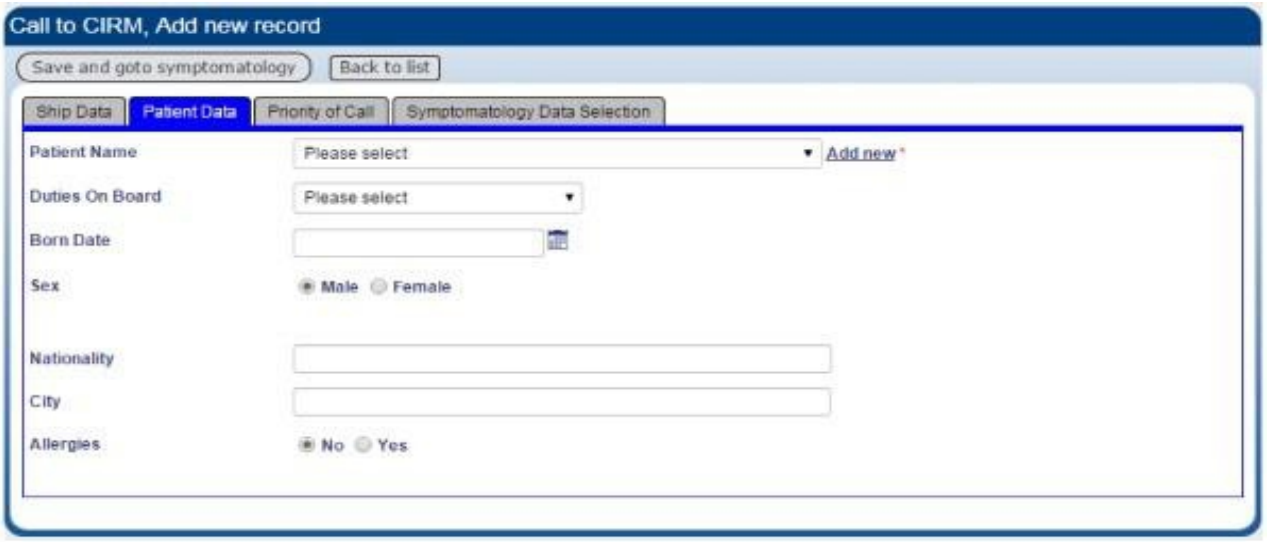
The page has the same structure and functionalities of the other page in the system. The unique difference is the "Refresh Grid" button. This allow to refresh the page to update the information shown in the table.

To add a new request of medical advice is easy. There is the "Add new" button. A new window will appear:



Here 4 fields (labels9 can be seen:

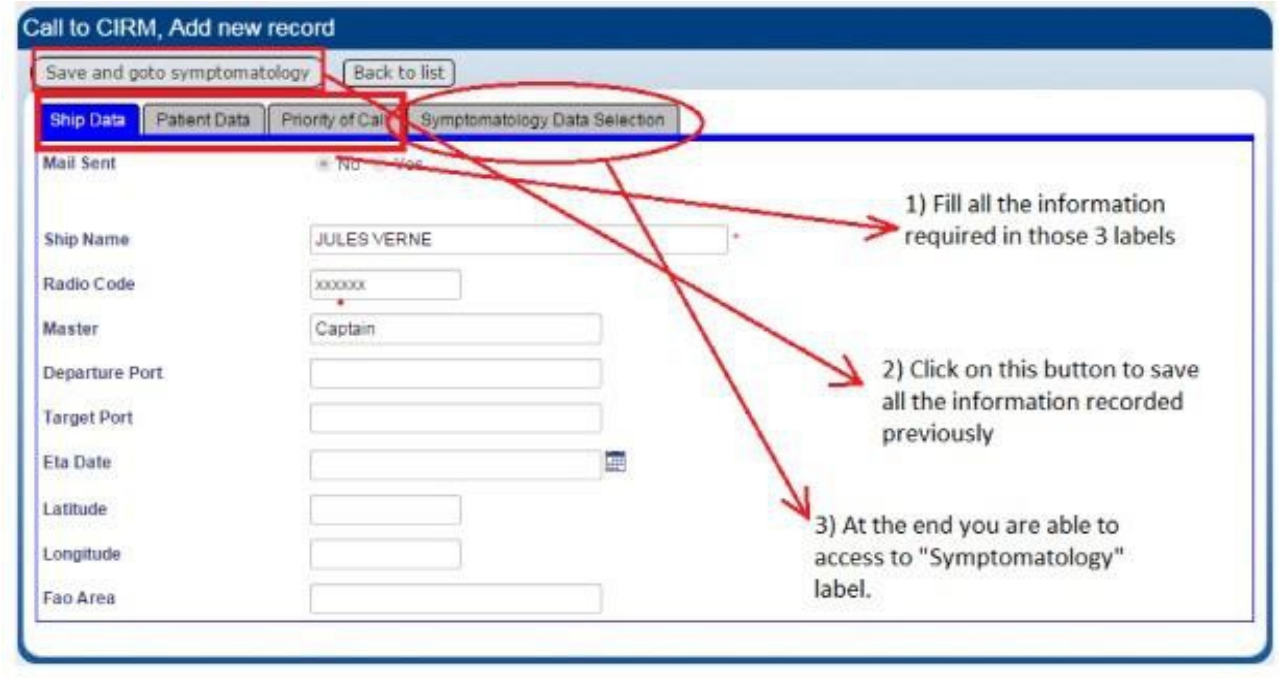
- **Ship Data:** all the information about ship and the emergency status:
  - **Mail Sent:** it could be "Yes" or "No". "Yes" if is already managed "No" otherwise;
  - **Ship Name:** name of the ship;
  - **Radio Code:** radio code of the ship;
  - **Master:** master of the ship;
  - **Departure Port:** departure harbour of the ship;
  - **Target Port:** destination harbour;
  - **Eta Date:** sailors arrival date;
  - **Latitude:** latitude of the ship at emergency call;
  - **Longitude:** longitude of the ship at emergency call;
  - **FAO Area:** FAO area of the ship;
- **Patient Data:**
  - **Patient Name:** the name and surname of the patient. If he is already registered you can select him from the selection bar. If the patient is not already registered you need to add through the "Add new*" text button.
  - **Duties On Board:** duty on board of the patient;
  - **Born Date:** birthday of the patient;
  - **Sex:** patient sex;
  - **Nationality:** nationality of the patient;
  - **City:** hometown of the patient;
  - **Allergies:** Yes or No, it depends if the patient has an allergy or not.



- **Priority of call:** select problem's patient. You can choose between 10 main symptoms:

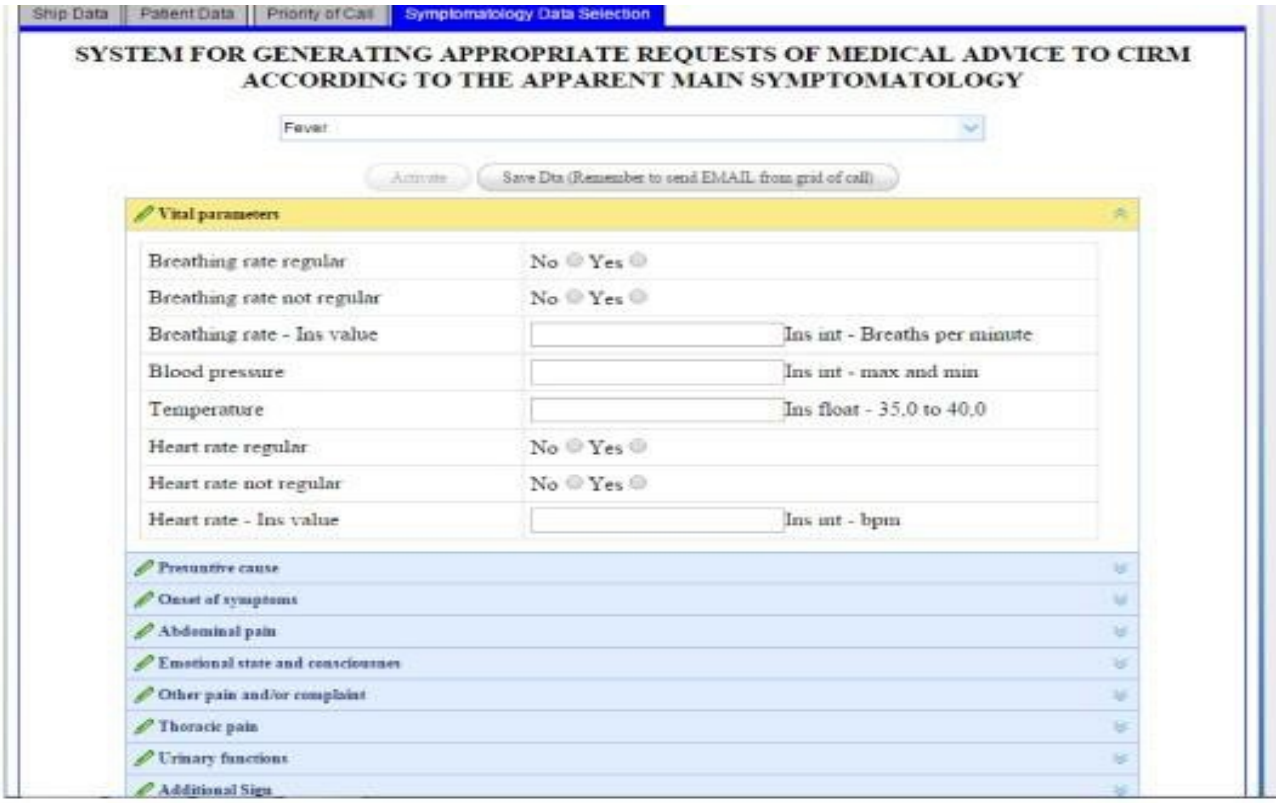

After the choice, you must click on the "Save and goto symptomatology" button to continue. After that you are ready to explain the Symptomatologies of the patient.

Note: A the beginning, in the creation of a new request is mandatory to fill-in all the information requested in the first 3 labels "Ship data", "Patient Data"and "Priority of call". Save the pages filled-in "Save and go to Symptomatology" before inserting patient's symptomatology. As you can see if you do not follow this flow of information you cannot access to "Symptomatology Data Selection" label and will be not able to create a request. In the picture below there is a graphical representation in numerical order of the actions you need to do:



- **Symptomatology Data Selection:** select the Symptoms of the patient.


For example, if you choose "Fever" a new page will appear with some fields to fill.




The fields shown in the new window depend on the symptom previously chosen and they allow to delineate the problem of the patient.

After you insert all the information necessary you should to save all of them inside database through "Save data Remember to send EMAIL from grid of call" button.

### 4.4 Deliver the request of medical advice to CIRM

Right now you have registered a new request of medical advice. The request is not already delivered to CIRM and in the grid of request you will have a row like this:



Request of medical advice is not sent to CIRM

To deliver the request just created you need to click "Send Call" button, the row will change and the square becomes green with the "Yes" text.

#### 4.4.1 Problems in delivering a request of medical advice

It could happen that when the user try to send an e-mail for such a reasons the e-mail couldn't be delivered. In this case the system give you some information to solve the problem. For instance the user could obtain:

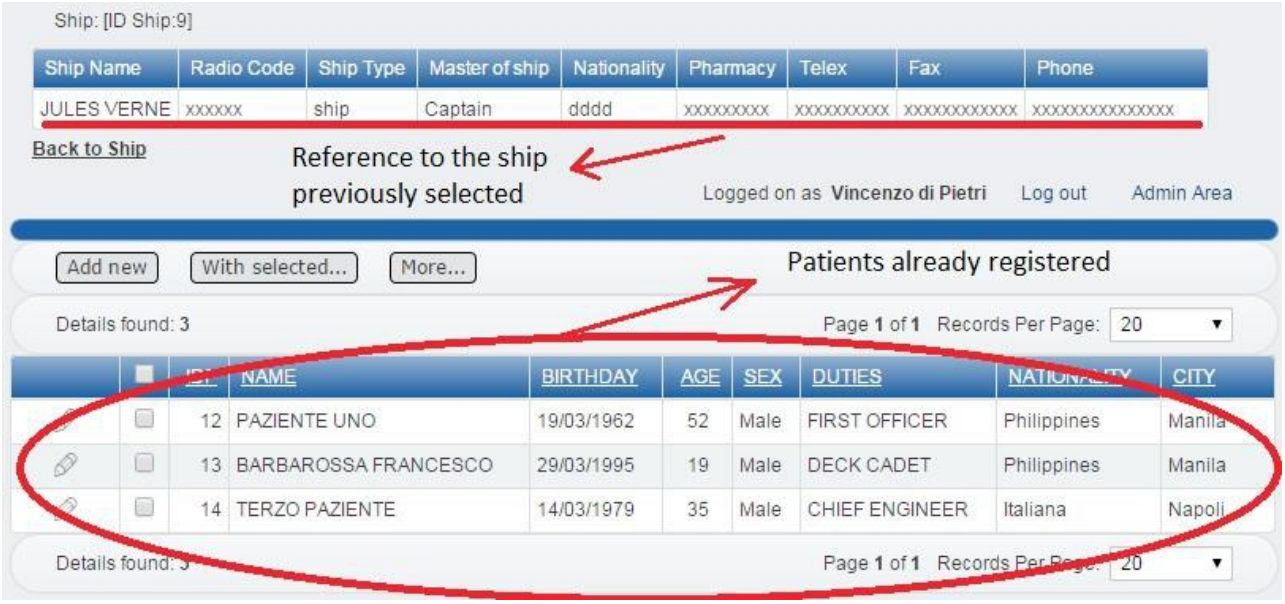

In the above picture, the problem is that the symptomatology of the patient was not inserted properly or something is missed. Please re-insert all the mandatory information and retry.

Note: If and only if you get the "Message sent ok" the request call is delivered to CIRM. You can also verify the delivering in the grid of emergency calls.

## 4.5 Manage and register a new patient

Toregisteranewpatientiseasy.Youshouldclickonthebuttontexthighlightedinfigure:


A new window will be opened with the list of the registered patients:

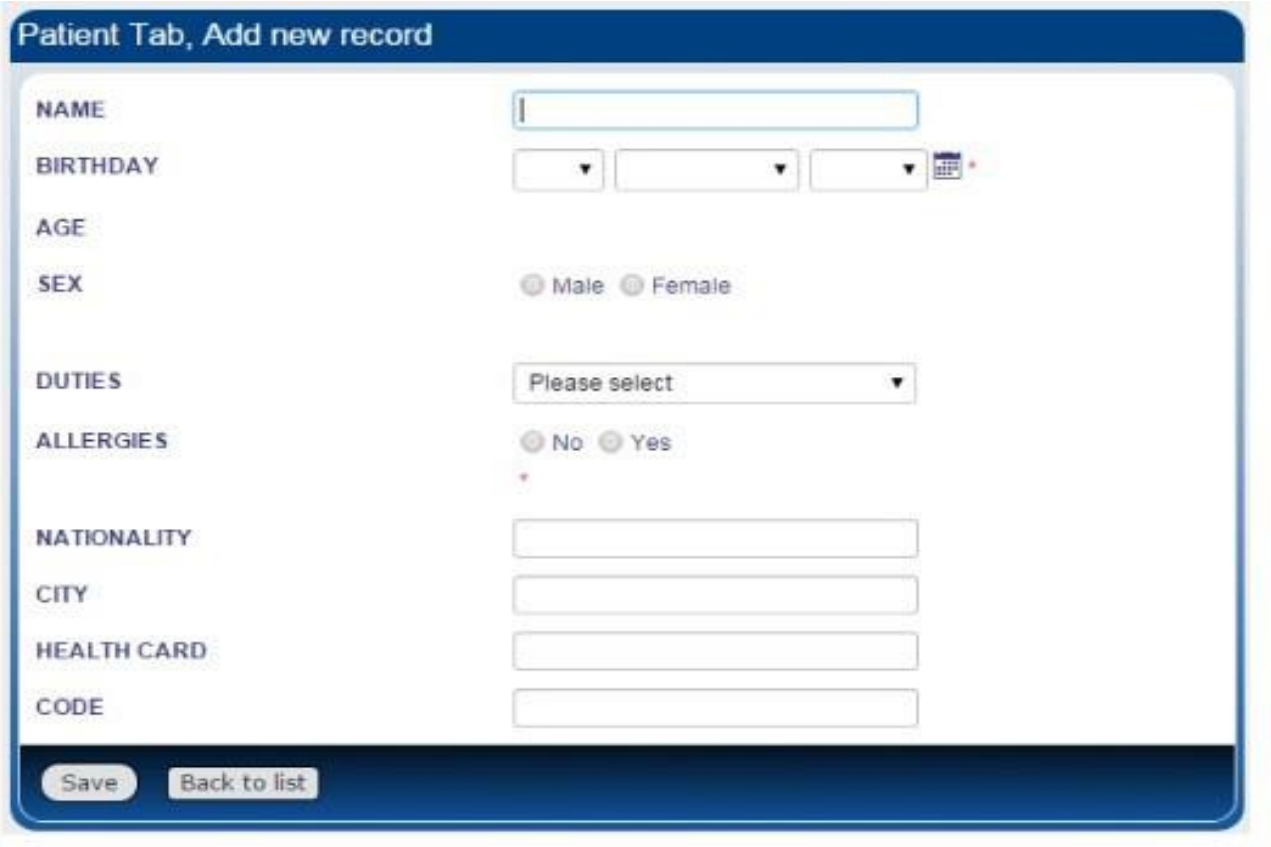


There are two tables. The first one represents the reference of the ship selected before, while the second one has all the fundamental information of the registered patients. In the figure above there are 3 patients already registered. For each patient the following information is reported:

- **IDP** (identification person): a number to identify univocally the person inside the database. You don't care about that because is just used by the system engine;
- **NAME:** name and surname of the person;
- **BIRTHDAY:** birthday of the person;
- **AGE:** age of the patient;
- **SEX:** sex of the patient (M = male, F = female);
- **DUTIES:** employment on board the ship;
- **NATIONALITY:** nationality patient;
- **CITY:** hometown of the patient;

If you want to modify a patient previously inserted you need to click on the button in the left-most column of the main table.

To add a new patient there is a button called "Add new". A new window will appear and you are able to insert a new patient:



## 5.0 Data transfer from medical devices

EasyCIRM besides guiding the preparation of correct requests of medical advice can collect data from medical devices available in the orange case that can become an attached file to the EasyCIRM message.

Here the main information on the use of medical devices of the orange case.

When EasyCIRM application starts the "FacileCARE" toolbar will appear as shown in the figure on the right side.

In this toolbar all medical examinations that you can perform with the equipment present in the orange case are shown.

At the end of the list, there the instruction on how to use the devices are available pushing "Please select function".

## 5.1 $SPo_2$ measurement

Pulse oximetry is a non-invasive method for monitoring a person's O2 saturation. A blood-oxygen monitor displays the percentage of blood that is loaded with oxygen. More specifically, it measures what percentage of hemoglobin, the protein in blood that carries oxygen, is loaded. Acceptable normal ranges for patients without pulmonary pathology are from 95 to 99 percent. For a patient breathing room air at or near sea level, an estimate of arterial pO2 can be made from the blood-oxygen monitor "saturation of peripheral oxygen" (SpO2) reading.

First of all we should activate the pulse oximeter by clicking the "SPo2" button present in the toolbar.

After clicking the note "SAT activated" will appear in the "FaciliCARE" toolbar's as shown in the picture in the left side.

**Now we must follow these procedure:**

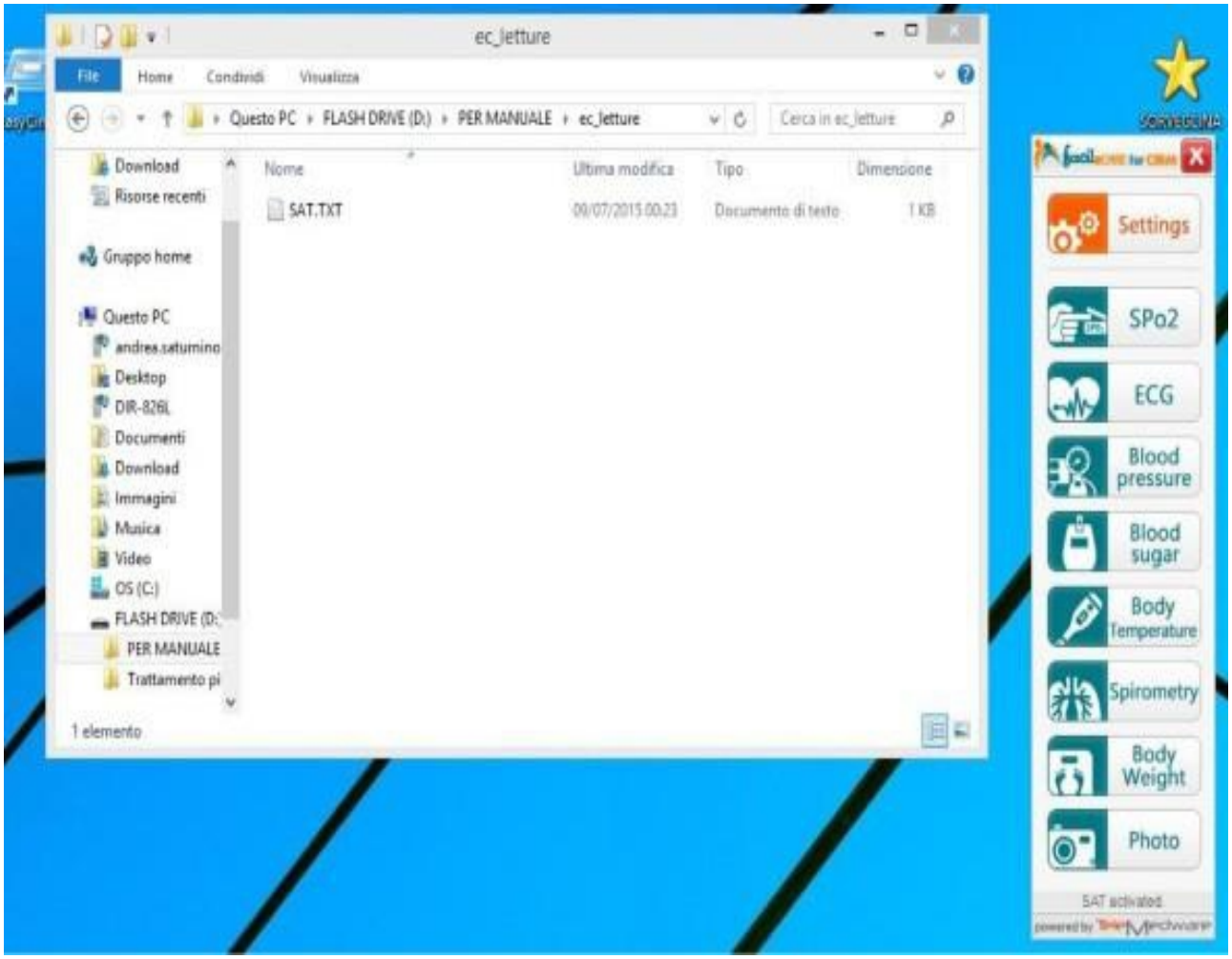
Open the clip as shown in the figure;

Put finger into the rubber cushions of the clip (make sure the finger is in the correct position), and then clip the finger;

The device will power on automatically in 2 seconds, and start displaying software version number;

Next enter into data display screen. Anew window will appear in the pc's screen. This means that the device is transmitting the data to the pc;


At the end of the transmission the instruction "Please select function" will appear again in the FacileCARE toolbar and in the folder "ec_lecture" present on the pc's desktop the file “SAT.txt” will appear how it is shown in the figure below”



## 5.2 ECG

An electrocardiogram (ECG) is a test which measures the electrical activity of the heart to show whether or not it is working normally.

An ECG records the heart's rhythm and activity on a moving strip of paper or a line on a screen.

An electrocardiogram can be a useful way to find out whether high blood pressure has caused any damage to heart or blood vessels. Because of this, people may be asked to have an ECG when they are first diagnosed with high blood pressure.

Some of the things an ECG reading can detect are:

- cholesterol clogging up your heart's blood supply
- a heart attack in the past
- enlargement of one side of the heart
- abnormal heart rhythms

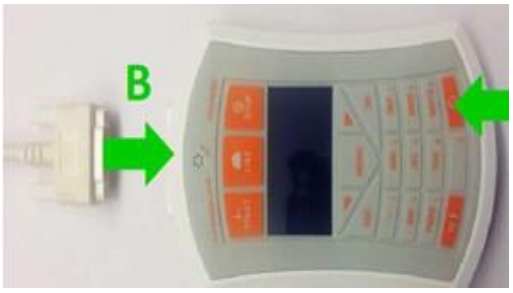
Before to transfer data from the device to pc we need to perform an ECG Registration.

### 5.2.1 Preparation to an ECG Registration

Here the preliminary steps to register an electrocardiogram. In particular is detailed how to connect the patient and prepare the patient and apply the electrodes.

### 5.2.2 Connect Patient Cable

Connect terminal plug of the patient cable to the connector located on the top side of the "Cardioline MicrotelBT" device.




**Note**: to avoid breaking the patient cable, remove it from the connector by grasping the plug, avoiding snags.

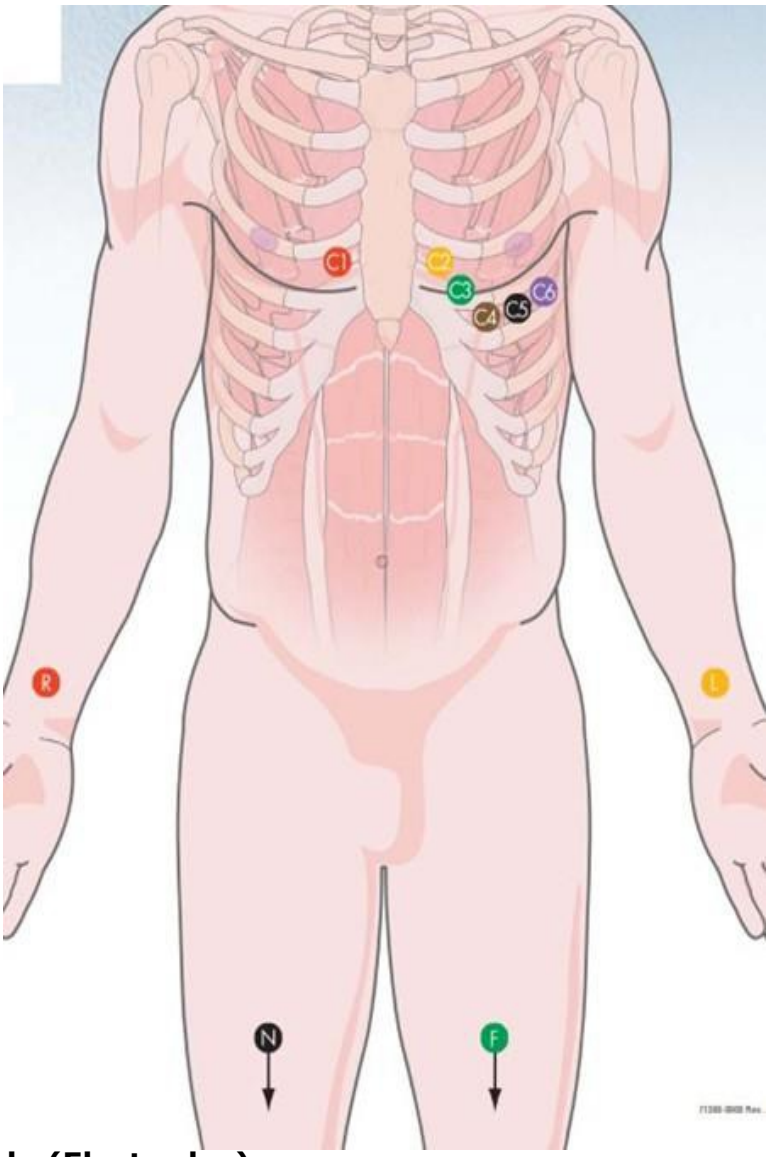
### 5.2.3 Place the Electrodes

Careful preparation of the patient and the correct positioning of the electrodes is a fundamental part to have a high quality ECG.

1- Laying the patient with arms and hands along the body on a bed large enough to contain whole body. This will decrease the risk of getting a path disturbed by tremors muscle;

2- Clean with alcohol or ether the skin where you will place the electrodes;

3- Connect each unipolar plug of the patient cable with a precordial electrode (see figure below).




**10-Wired Cable (Electrodes)**

| Colour | Symbol | Electrode Position |
|---|---|---|
| Red | R | Right arm |
| Yellow | L | Left arm |
| Green | F | Left leg |
| Black | N | Right leg |
| White – Red | C1 | Fourth intercostal space at the right border of the sternum |
| White – Yellow | C2 | Fourth intercostal space at the left border of the sternum |
| White – Green | C3 | MidwaybetweenlocationsC2andC4 |
| White – Brown | C4 | At the mid-clavicular line in the fifth intercostal space |
| White – Black | C5 | At the anterior axillary line on the same horizontal level as C4 |
| White – Violet | C6 | At the mild- axillary line on the same horizontal level as C4 and C5 |

### 5.2.4 ECG Registration

| | | | |
|---|---|---|---|
| 1 | ECG Registration | Press START  | Press **START** button and the registration of 10 seconds takes place. The stored exam will be in Single ECG memory and is now available for the transmission. **The exam is deleted when a new registration takes place.** |
| | | **A c t i v a t e** the measurement's receiving clicking the "ECG" button present in the toolbar. After that, the note "ECG activated" will appear in the "FaciliCARE" toolbar's down part | |
| 2 | Trasmission | Press SEND  | Press **SEND** button for the transmission. The transmitted exam will be available for a second transmission. The exam will be deleted if a new registration takes place.The transmission end when the instruction "Please select function" will appear again in the FacileCARE toolbar and in the folder "ec_lecture" present on the pc's desktop we will find the file "ECG. png". |

**Note:**

Refer to the "User Manual" given for more details about Cardioline MicrotelBT.

## 5.3 Blood pressure measurement

Blood pressure (BP) is the pressure exerted by circulating blood upon the walls of blood vessels. When used without further specification, "blood pressure" usually refers to the arterial pressure in the systemic circulation. It is usually measured at a person's upper arm. Blood pressure is usually expressed in terms of the systolic (maximum) pressure over diastolic (minimum) pressure and is measured in millimeters of mercury (mm Hg). It is one of the vital signs along with respiratory rate, heart rate, oxygen saturation, and body temperature. Normal resting blood pressure in an adult is approximately 120/80 mm Hg.

Blood pressure varies depending on situation, activity, and disease states. It is regulated by the nervous and endocrine systems. Blood pressure that is low due to a disease state is called hypotension, and pressure that is consistently high is hypertension. Both have many causes which can range from mild to severe. Both may be of sudden onset or of long duration. Long term hypertension is a risk factor for many diseases, including kidney failure, heart disease, and stroke. Long term hypertension is more common than long term hypotension in Western countries. Long term hypertension often goes undetected because of infrequent monitoring and the absence of symptoms.

| **Classification of blood pressure for adults[1][2]** | | |
|---|---|---|
| **Category** | **systolic, mm Hg** | **diastolic, mm Hg** |
| Hypotension | < 90 | < 60 |
| **Desired** | **90–119** | **60–79** |
| Prehypertension | 120–139 | 80–89 |
| Stage 1 hypertension | 140–159 | 90–99 |
| Stage 2 hypertension | 160–179 | 100–109 |
| Hypertensive emergency | ≥ 180 | ≥ 110 |
| Isolated systolic hypertension | ≥ 140 | < 90 |

First of all we have to activate the measurement's receiving clicking the "Blood pressure" button present in the toolbar.


After that we clicked it, the note "SPHYGMO activated" will appear in the "FaciliCARE" toolbar's down part how shown in the picture.

1. Place the cuff on the arm (preferably the left arm).
Sit quietly during measurement.

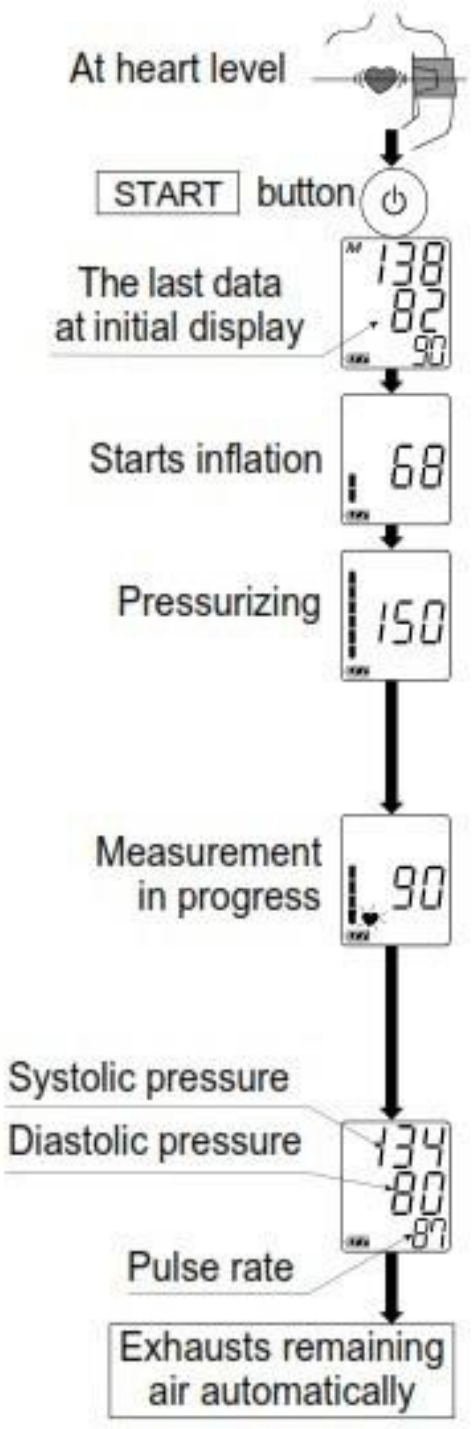
2. Press the START button.
The last data of systolic and diastolic pressure and pulse rate are displayed briefly. Then the display changes, as indicated in the figure at the right, as the measurement begins. The cuff starts to inflate. It is normal for the cuff to feel very tight. A pressure bar indicator is displayed, as in the figure at the right, during inflation.

3. When inflation is complete, deflation starts automatically and the ♥ (heart mark) blinks, indicating that the measurement is in progress. Once the pulse is detected, the mark blinks with each pulse beat.

**Note**: If an appropriate pressure is not obtained, the device starts to inflate again automatically.

4. When the measurement is complete, the systolic and diastolic pressure readings and pulse rate are displayed. The cuff exhausts the remaining air and deflates completely.

Contemporaneously the device transmits the data to the pc. At the end of the transmission the instruction "Please select function" will appear again in the FacileCARE toolbar and in the folder "ec_lecture" present on the pc's desktop we will find the file "SPHYMGO.txt".



## 5.4 Glycemia (blood sugar)

Glycemia refers to the concentration of sugar or glucose in the blood.
In the rich Western countries, it is expressed as milligrams per deciliter(mg/dl). Blood glucose is one of the most important blood parameters to measure, as abnormal levels can cause severe complications.

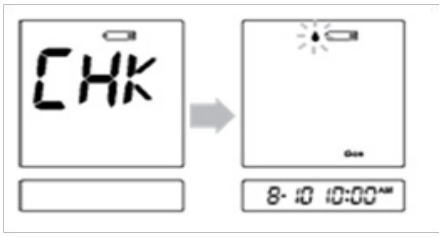
Glycemic control in the body is achieved through several physiological mechanisms. Some examples of how the blood sugar level fluctuates and is controlled are given below:

- The blood sugar levels tend to drop to its lowest point in the morning, after a night of sleep and therefore hours of fasting.
- After a meal, glycemic levels increase as carbohydrates are broken down into simpler sugars such as glucose and absorbed from the intestine into the bloodstream.
- The glycemic level drops after a bout of severe exercise when the blood sugar is used as a source of energy for muscular activity.
- Extremely cold temperatures also cause much of the blood sugar to be used up, therefore lowering the blood glucose level.
- Glycemia levels are also as glycerol, fatty acids and glucogenic amino acids.
- In another metabolic pathway affected by the process of gluconeogenesis, where glucose is produced from non-carbohydrate sources such called glycogenolysis, glycogen in the liver is broken down to release glucose into the blood.Glycemia is one of the most important parameters in homeostasis (body well being), since glucose is needed to provide the metabolic energy required for many cell functions. Several important hormones are involved in the regulation of blood glucose. One is insulin, which promotes the uptake of glucose from cells when the glucose level is raised. Another is glucagon, which has the opposite effect and increases the blood glucose level when it has dropped too low. Glucagon promotes the conversion of glycogen in the liver to glucose, which is then released into the bloodstream. Adrenaline also raises the blood sugar level, as do glucocorticoids and steroid hormones.

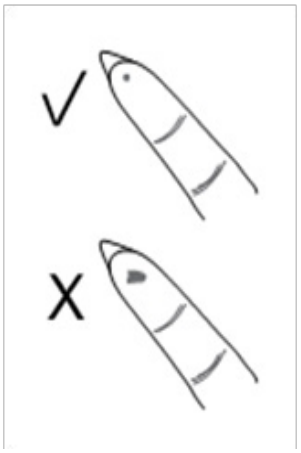
- Normal blood glucose level in humans is about 72 mg/dL;
- When operating normally the body restores blood sugar levels to a range of 82 to 110 mg/dL;
- Shortly after a meal the blood glucose level may rise temporarily up to 140 mg/dL.

For this examination you must proceed as a normal measurement with a glucometer. Below the steps to follow.

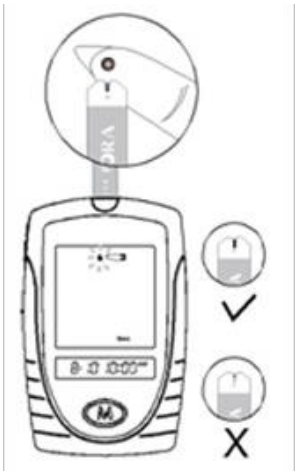
1. **Insert the Test Strip to Turn on the Meter**
   Wait for the meter displays the test strip and blood drop symbols.




**2. Obtain a Blood Sample**
Use the pre-set lancing device to puncture the desired site. After penetration, discard the first drop of blood with a clean cotton swab.
Gently squeeze the punctured area to obtain another drop of blood. Be careful NOT to smear the blood sample.
The volume of blood sample must be at least 0.5 (μL) of volume.



**3. Apply the Sample.**
Hold the blood drop to touch the absorbent hole of the test strip. Blood will be drawn in and after the confirmation windows is completely filled, the meter begins counting down.



**4. Read the Result.**
The result of your blood glucose test will appear after the meter counts to 0. This blood glucose result will automatically be stored in the memory.

**5. Eject the Used Test Strip.**

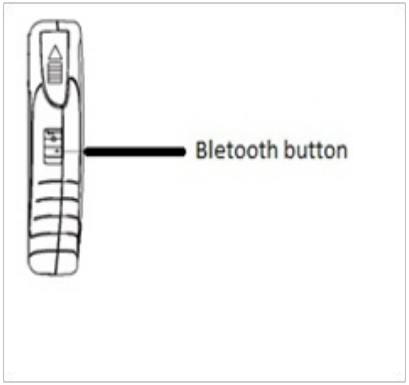
To eject the test strip, pint the strip at a disposal container for sharp items.
The meter will turn itself off automatically after the test strip is ejected

**6. Activate the measurement's receiving clicking the "Blood sugar" button present in the toolbar.**

After that we clicked it, the note **"GLYCEMIA activated"** will appear in the **"FaciliCARE"** toolbar's down part.


**7. Activate the device's bluetooth sliding the lever in the left side;**
**the bluetooth's light, in the front side of the device, starts flashing.**

At the end of the transmission the instruction **"Please select function"** will appear again in the **FacileCARE** toolbar and in the folder **"ec_lecture"** present on the pc's desktop we will find the file **"GLYCEMIA.txt".**



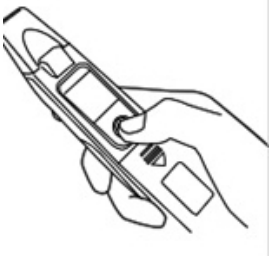

**Note:** Refer to the "User Manual" given for more details about the device and the lancing device.

## 5.5 Body temperature

Most people think of 'normal' body temperature as 37°C , measured using a thermometer in the mouth.However, the concept of there being a normal body temperature is somewhat misleading. In fact normal body temperature can vary according to a wide range of factors including a person's age, the time of day and whether someone is active or not.
The 'normal' benchmark for body temperature was established by a 19th century German physician Dr Carl Wunderlich. He is credited with taking temperature readings from thousands of patients, which led him to propose that 37°C was normal body temperature.

**1.** Activate the measurement's receiving clicking the **"Body temperature "** button present in the toolbar.
After the click, the note "TEMPERATURE activated" will appear in the "FaciliCARE" toolbar's down part.


**2. Turn on the thermometer.**
Make sure the probe cover is capped. Press and release the On / Memory button. The thermometer displays the last measurement.



**3. Put the probe on the temple.**
Press and hold the Scan button. Make sure the probe is flat on the temple, not at an angle.

**4. Read the result.**
Release the button and read the result. Results are shown together with a temperature value and beeps.

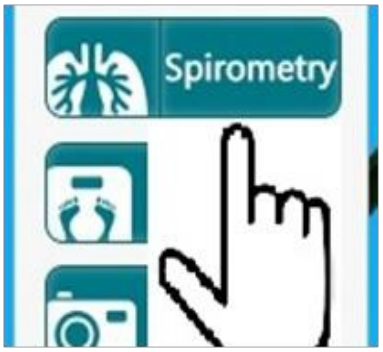

Contemporaneously the device transmits the data to the pc. At the end of the transmission the instruction "Please select function" will appear again in the FacileCARE toolbar and in the folder "ec_lecture" present on the pc's desktop we will find the file "TEMPERATURE. txt".

**Note:** Refer to the "User Manual" given for more details about the FORA IR21.

## 5.6 Spirometry

Spirometry is a common test used to assess how well your lungs work by measuring how much air you inhale, how much you exhale and how quickly you exhale. Spirometry is used to diagnose asthma, chronic obstructive pulmonary disease (COPD) and other conditions that affect breathing. Spirometry may also be used periodically to check whether a treatment for a chronic lung condition is helping you breathe better.

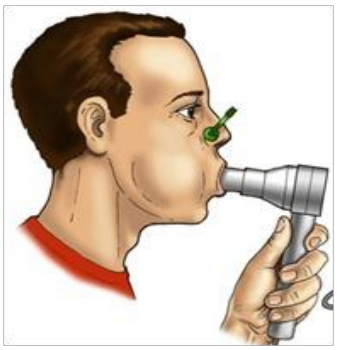
**1.** Activate the measurement's receiving clicking the **"Spirometry"** button present in the toolbar.
After that we clicked it, the note "SPIRO activated" will appear in the "FaciliCARE" toolbar's down part.



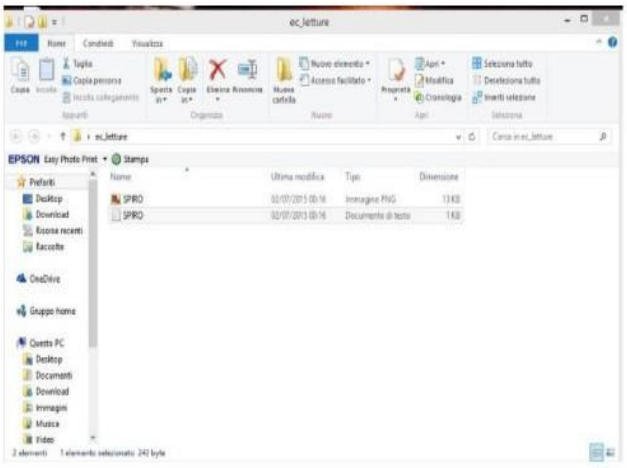

After that a new window appear; click on "FAC"

**2. Switching on the SPIRODOC**
To turn on the SPIRODOC press and release the power key placed in the middle on the side of the device

**3.** Ask to patient to take a deep breath and then to exhale into the disposable turbine as hard and as long as possible for at least 6 seconds.



**4.** The registration will be transmitted automatically to the pc via Bluetooth. At the end of the transmission the instruction "Please select function" will appear again in the FacileCARE toolbar. In the folder "ec_lecture" present on the pc's desktop we will find two files "SPIRO.txt" and "SPIRO.png" as shown in the picture.



**Note:** Refer to the "User Manual" given for more details about the MIR Spirodoc.

## 5.7 Body weight

Reaching and maintaining a healthy weight is important for overall health and can help to prevent and control many diseases and conditions. If someone is overweight or obese, is at higher risk of developing serious health problems, including heart disease, high blood pressure, type 2 diabetes, gallstones, breathing problems, and certain cancers. That is why maintaining a healthy weight is so important: It helps to lower the for developing these problems, helps to feel good about himself, and gives more energy to enjoy life.

Overweight is having extra body weight from muscle, bone, fat, and/or water. Obesity is having a high amount of extra body fat. Body mass index (BMI) is a useful measure of overweight and obesity.

Many factors can contribute to a person's weight. These factors include environment, family history and genetics, metabolism (the way your body changes food and oxygen into energy), and behavior or habits.

Energy balance is important for maintaining a healthy weight. The amount of energy or calories someone gets from food and drinks (energy IN) is balanced with the energy body uses for things like breathing, digesting, and being physically active (energy OUT):

- The same amount of energy IN and energy OUT over time = weight stays the same (energy balance)
- More energy IN than OUT over time = weight gain
- More energy OUT than IN over time = weight loss

To maintain a healthy weight, energy IN and OUT don't have to balance exactly every day. It's the balance over time that helps you maintain a healthy weight.

We can reach and maintain a healthy weight we should:

- Follow a healthy diet, and if you are overweight or obese, reduce your daily intake by 500 calories for weight loss
- Are physically active
- Limit the time you spend being physically inactive

**1.** Activate the measurement's receiving clicking the "**Body Weight"** button present in the toolbar. After the click, the note "WEIGHT activated" will appear in the "FaciliCARE" toolbar's down part.


**2. Press the measurement switch gently.**
All display segments are displayed for several seconds

**3. Wait until ○ symbol is displayed.**
Wait until "0.0 kg/0.0lb" and the Ready/Complete symbol ○ are displayed.

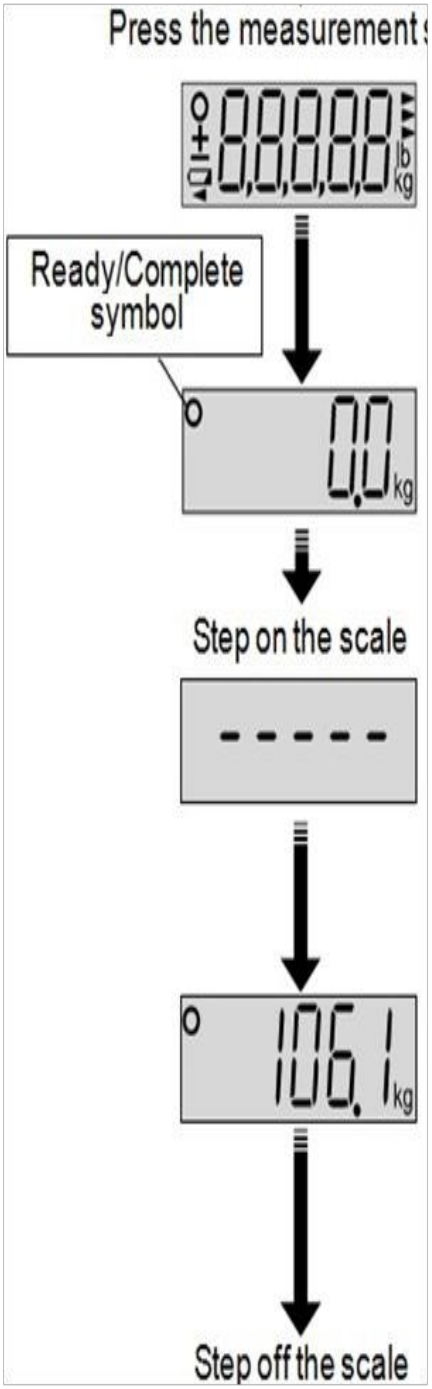
Note: if "0.0 Kg / 0.0 lb" and the Ready/Complete symbol ○ are displayed about forty-five seconds, the scale will automatically turn off.

**4. Step on the scale gently and stand still during the measurement.**
You will see the display changed to dashes. Please remain still as much as you can.

**5. Body weight value is displayed after the ○ symbol is displayed.**
After about fifteen seconds, the scale will automatically turn off.

**6. Step off the scale**

**7.** The registration will be transmitted automatically to the pc via Bluetooth. At the end of the transmission the instruction "Please select function" will appear again in the FacileCARE toolbar and in the folder "ec_lecture" present on the pc's desktop we will find the file "WEIGHT.txt"

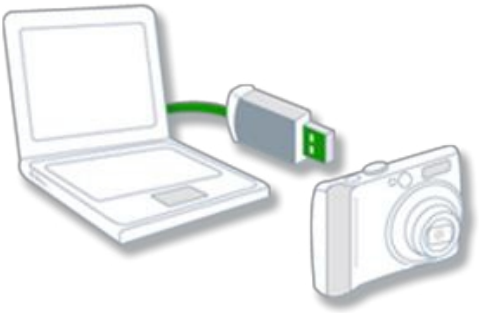



**Note:** Refer to the "User Manual" given for more details about the A&D UC-321 PBT SCALE.

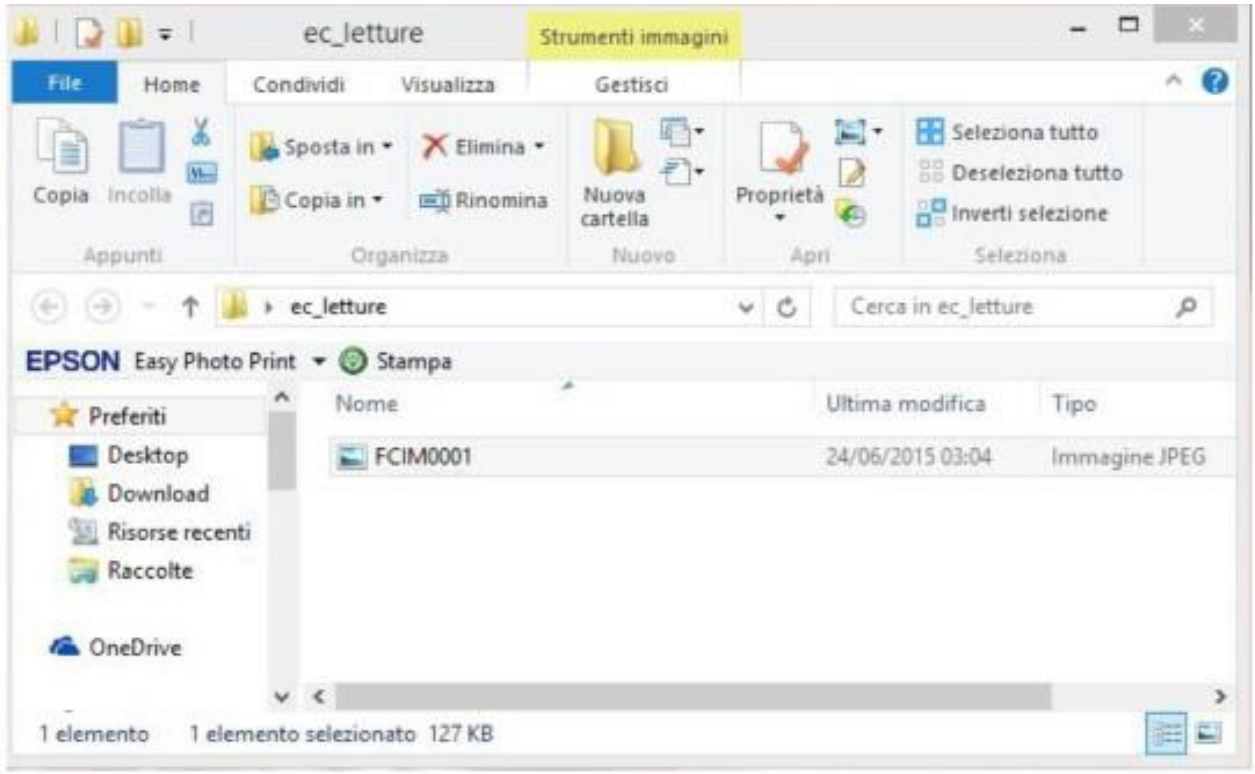
## 5.8 Photo

The camera is the only device that hasn't a bluetooth connection.
So you must use it how you could do with another one.


After you take photos, connect the camera to pc with the USB cable and press the button "Photo" in the FacileCARE toolbar.



The system transfers the photos in the "ec_lecture" folder and deletes the same from the internal memory automatically



## 6.0 How enclose the "ec-lecture" folder to a message

To enclose the measurements transmitted to the pc and saved in the "ec_lecture" folder is very easy. Before sending out the mail generated with EasyCIRM application, mark the box "attachments" as shown in the picture, so that when the button "Send Call" will be clicked all the files in the folder will be sent too.

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