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MIGHT TELESONOGRAPHY BE A NEW USEFUL DIAGNOSTIC TOOL ABOARD MERCHANT SHIPS ? A PILOT STUDY

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Slaven Jaksic is the employee of the company that represents SonoSite Inc. whose ultrasound equipment was used in the test

ABSTRACT

Background: Developments of new, ultra-light diagnostic ultrasound systems (UTS) and modern satellite telecommunication networks are opening new potential applications for diagnostic sonography. One such area is maritime medicine. It is our belief that ship officers can be trained to use diagnostic ultrasound systems with the aim

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to generate ultrasound images of sufficient quality to be interpreted by medical professionals qualified to read sonograms.

Methods: To test our thesis we included lectures and hands on scanning practice to the current maritime medicine curriculum at the Faculty of Maritime Studies at the University of Rijeka. Following the didactic and practical training all participating students examined several patients, some with pathology some without. Images obtained by students were then submitted for interpretation to a qualified physician (specialist of general surgery trained in UTS) who was unaware of the patient's pathology.

Results: In total, 37 students performed 37 examinations and made 45 ultrasound images, on 3 patients. In this paper, results on this pilot study are presented.

Conclusion: It is possible to teach ship officers to produce diagnostically usable ultrasound pictures aboard ships at sea. But before reaching final conclusion about applicability of telesonography on board merchant ships, further studies are necessary, that would include studies of economic feasibility, and on validity of introducing such a diagnostic tool to the maritime medical practice.

Key words: Ultrasound, maritime medicine, telemedicine

MEDICAL ASSISTANCE AT SEA

The work on seagoing vessels is associated with an increased risk of loss of health and life. This is attributed to specific conditions of work at sea, non availability and delays of medical assistance to sick seafarers, difficulties in possible evacuation of a patient from the ship to the hospital on shore, high accident rate among crews, exposure to extreme weather conditions, and mental and physical stress during service (1-10).

Although the medicine has made significant advances in the last decade, not that much has changed in the approach to illnesses aboard isolated vessel at sea. On merchant ships where there are no doctors, the captain or the deck officer who is properly trained, provides medical assistance (11). Radio medical advice or "Radio-medico" is available in all parts of the world, by direct radio-telephone contact with the doctor from a port (12). More than 300 coastal radio stations throughout the world provide that service (13). Modern satellite communications (INMARSAT – International Maritime Satellite Organization) make it accessible (from 70°N to 70°S) wherever ships sail. Radio medical advice is free of charge and it is organized and coordinated according to international conventions (1-17). Every vessel today has to be equipped with a radio transmitter, and this is of vital importance to the security of voyage, and protection of life at sea (18, 19).

The health care that should be provided to crews of ships exceeds the level of simple first aid. The aim is not only to treat an injured or ill person until the professional help is reached on shore. A medically trained crew member should be capable of treating injured or sick person for longer periods of time. This aim can only be achieved by getting the radio medical advice, making use of medical guide and drugs from the ship's medicine chest (20). This medical training (21) should enable the officer in charge of the health care to do the correct observations, perform certain diagnostic procedures and be able to communicate them to the doctor on shore.

This officer should also be able to perform some interventions like cardio-pulmonary resuscitation (CPR), and be able to provide the treatment following advice from shore.

Nowadays, a medical training is compulsory for getting a seafarers license, and all marine schools have special medical courses for seafarers. IMO propose standards of such medical training for seafarers (22). In the Level I – the goal is to train all seafarers in basic first aid and basic cardiopulmonary resuscitation. This is equivalent to first responder e.g. American Red Cross standard first aid training. In Level II training, in addition to basic first aid, the seafarer learns how to intervene in life-threatening situations, how to stabilize a critically ill patient and how to exchange medical information. This is equivalent to Emergency Medical training (EMT) – basic. Upon completion of both Level II and Level III training, designated ship's officers will be able to provide medical assistance and advanced medical care, including techniques such as insertion of catheters and intravenous lines and administration of specific medication.

OBJECTIVES

To explore whether it is possible to train future marine officers in a sophisticated diagnostic medical procedure (UTS), to produce usable UTS pictures that could be used in tele-medical consultation at sea.

MATERIALS AND METHODS

Preparation for the Test

General idea was to include a lesson about ultrasound examination in their current curriculum of medical training and to bring students as close as possible to the situation that they could encounter at sea.

Regular medical training curriculum of our future ship officers at the Faculty of Maritime Studies in Rijeka where the test was performed consists of 52 hours of training: 34 hours of theoretical and 16 hours of practical training (Table 1). In the lecture about pain in the abdomen we included a 90-minute-part about diagnostic ultrasound and presented to the studets pictures of healthy organs: kidney, liver/gall bladder and urine bladder as well as the picture with their main pathology. The lecturer, who was a specialist in general surgery and trained in UTS, was also the one who read the images at the end of the test. We noticed that the concept of ultrasound was clear to them because they already studied ship's echo-sonder equipment and technology. In previous lectures they also learned about basic anatomy of the human body and already had knowledge of the use of computer (e-mails). Next week they had a practical training with ultrasound equipment that was used in the test. The same specialist conducted that part of training. Students were examining healthy patient in 30-minute sessions for each student. We also designed drawings with four basic UTS examinations marked as A, B, C, D, and they were allowed to use them during the training and in the test.

Table 1.

Training curriculum in maritime medicine at the Faculty of Maritime Studies Rijeka

	Lecture	Hours of theory (+ practice)
1.	Introduction to maritime medicine	2
2.	Medical help aboard ship	2
3.	Hygiene and environment control	2
4.	Basics of Anatomy and Physiology	2
5.	Emergency I *CPR*	3 +2
6.	Emergency II *Glasgow coma scale. Triage. Evacuation at sea. Death aboard ship*	3 +2
7.	Injuries I *Bleeding, Shock.*	2
8.	Injuries II *Wounds, Burns, Fractures. Injuries of the head and spine. Treatment of the pain.*	2 +2
9.	Injuries III *Exposure to heat and cold. Drowning and near drowning*	2 + 2
10.	Propedeutics of maritime medicine *Treatment procedure. Surgical procedures. Ships medicine chest. Medical manual.*	3 +2
11.	Surgical problems	3 +2

	Pain in the abdomen.	
	Febrile patient *Approach to the febrile patient. Infectious diseases. Control of epidemics aboard ship.*	2 +2
	Sexually transmitted diseases and dermatological problems	2
	Other illnesses *Pain in the chest. Eye and ear problems. Urgent stomathology,*	2 +2
	Neuro-psychiatric problems aboard	2

Equipment

We used SonoSite (23)

The first of modern all-digital, high resolution, ultra-portable system was SonoSite 180, developed by SonoSite, (Bothell, WA). It weights less than 2.5 kg and operates on battery or AC power. The battery is a rechargeable lithium ion battery allowing for 1.5 to 4.0 hours of work. The system has image storage capability of 120 images, and output to video and black and white thermal printer. It was linked to a PC for telemedicine applications.

In the test we used: linear C60/5-2 curved array (5-2MHz) intended for general-purpose abdominal, obstetric, and gynecologic applications. For transferring data we used PC Penthium II.

Patients examined

The patients were examined and chosen before the test by ultrasound specialist (radiologist) who did not participate in the test while the ultrasound lecturer (specialist of general surgery trained in UTS) who was reading ultrasound pictures that students had made did not know the patients' pathology. The anamneses were the real situations picked up from our radio-medico protocols and from the cases in which the final diagnosis was made. During the test, on which ultrasound lecturer was not present, 3 patients with following anamnesis were examined:

A. Male, 40 years old, has severe pain in abdomen without precise localization, without vomiting. Last stool was one day before examination. Body temperature 38 C°, pulse 96. Abdomen is soft on palpation, sore on right side. Urine test normal. (There was none ultrasound pathology).
B. Male, 35 years old, has severe pain in abdomen, which appeared about 20 minutes after the meal. He has pain every few minutes and vomited once without blood presence in vomited material. Abdomen is soft on palpation; pain is stronger on right side. Body temperature 36,5 C°, pulse 85. (There was known gall bladder stone; 8 mm in diameter).
C. Male, 40 years old, in the last two hours had severe pain in right site of abdomen. Pain is very strong, it continues. Body temperature 36,2 C°, pulse

75, the patient sweats, is exhausted, vomited twice. Abdomen on palpation normal. (There was a known right kidney stone, 6 mm in diameter).

Test

Students were randomly assigned to the patients and instructed to present kidney on 25 pictures, gall bladder on 15, and urine bladder on 5. Instructions on which organ to present by ultrasound were made previously by the specialist (radiologist), who had chosen the patients and "attached" the anamnesis to particular patient.

After being made, those pictures were transferred via e-mail to the ultrasound lecturer who was not present on examinations and was not previously informed about patients' pathology. He had evaluated the pictures and written his comments - ultrasound diagnosis. Later, the third doctor (general practitioner) who was present at the time of the tests compared those results with anamnesis and pathology of the patients.

RESULTS

Thirty-seven students performed 45 ultrasound pictures, 8 in two scans (Table2). Out of 25 pictures of kidneys, (21 with known presentation of stone and 4 without), all 4 (100%) pictures of normal kidney were correctly performed and out of 21 with stone in 12 (57%) cases kidney was presented with stone, in 6 (29%) kidney was presented without stone and in 3 (14%) there was no presentation of kidney structure. On all 15 pictures of gall bladder the presentation of intraluminal stone was expected. Twelve (80%) scans were correctly performed, in 2 (13%) gallbladder without stone was presented and 1 (7%) picture was unusable.

All 5 (100%) scans of urine bladder (fulfilled with urine) were correctly performed.

Table 2. Results of presentation of 45 ultrasound pictures with two main pathologies: kidney and gall bladder stone

	Stone presented in K (N=21) or GB (N=15)	Normal K (N=4), or UB (N=5)	K or GB without presentation of known stone	Unusable pictures
KIDNEY	12 (57%)	4 (100%)	6 (29%)	3 (14%)
GALL BLADDER	12 (80%)		2 (13%)	1 (7%)
URINE BLADDER		5 (100%)		

(K=kidney, GB=gall bladder, UB= urine bladder)

DISCUSSION

Radio-medical advice is the only possibility for the ship's officer when he has a problem with a patient on board. However, the potential of this assistance is often overestimated. Very often the opinion is heard that radio medical advice can replace the medical training of seafarers. This is not a correct view (24).

Usually, no medical records or visual contact with the patient are available for the doctor on shore. Until recently, there was no possibility to transfer digitalized pictures from ship to shore. As a result of the inevitable ambiguity in diagnosis and the limitations of the radio-medical system itself, misdiagnosis or unnecessary evacuation of the sick seafarer or diversion of the ship to the nearest port can occur, with high costs to shipping insurance and/or potentially serious consequences to the patient (25).

According to the research conducted in the City Hospital in Cuxhaven providing radio-medical advice to ships at sea, a crew member had started to treat the case on board already before the radio contact was established with a doctor on shore in 63,6% of cases (482 cases in 7 years period). In 71,8% (544) of cases the doctor from shore was able to take responsibility for further treatment on board at least to the first next port, and in 5,4% (41 cases) the doctor did not establish diagnosis. In the remaining 717 cases, the crew member has diagnosed the case himself in 429 (59,8%) cases and the doctor had confirmed it in 346 (80%) of the cases. The therapy on board was recommended in 51,2% of the cases, diversion of the ship to the nearest port in 18,7% of cases, getting treatment in the next planed port in 20,6% of cases, and urgent evacuation of the patient in 9,7% of cases. If we translate this data to the costs that ship owners had sustained due to the diversion of ships, unnecessary delays in schedules of ship voyages or costs of evacuation of seafarers, it means that these costs occurred in 214 cases (28,4%) (26).

Data from other sources confirm that majority of the calls from the ships are due to the injuries and pain in the abdomen and that majority of ship diversions from the course are caused by that reasons (27, 28).

The data that would show the accuracy of the diagnosis made via radio-medical assistance are not available because there is no system that would follow up the seafarers when they report to the doctor in next port.

Recent advances in technology enabling the transfer of images between distant places allow us to avoid the above mentioned problems currently present in the radio-medical system. To help in overcoming these problems and improving the standard and availability of medical care at sea, the European Commission, trough its Healthcare Telematics Applications Programme, has funded a NIVEMES project (29). The project has developed the technology to link ships and remote communities with the centers of expert medical assistance that were previously unavailable to them. By transmitting medical data – such as ECGs, blood pressure and digital pictures of the patient (in emergencies or as part of routine check-ups) - the chances of providing the correct treatment of patients in remote areas can be drastically improved.

This form of remote diagnosis between distant areas is called telepresence. Specialist medical attention is already being given to people injured in the recent hostilities in Somalia. Thanks to satellites, Army doctors at the 86th Evacuation Hospital in Mogadishu were using Inmarsat-A sat phones to transmit X-rays and other medical images including UTS pictures from Somalia to specialists at the Walter Reed Hospital (30).

Telesonography is one practical application of telemedicine. It is used to provide interpretation of sonograms for centers where a qualified radiologist is not available. In recent years various manufacturers of diagnostic ultrasound equipment have developed hand-carried ultrasound systems which combine high quality image with extreme portability. Some are capable of performing a full range of ultrasound examinations (abdominal, obstetrical, gynecological, vascular, and small parts), and as such are theoretically suitable for use in maritime medical practice

Although there is also a question of refreshing the acquired knowledge and skill in our trainees, our initial results seem to be quite satisfying. In our opinion, it is possible to teach marine officers to produce diagnostically useable ultrasound pictures aboard ships with the aim to send them to specialists ashore and help them to establish a differential diagnosis between abdominal pain caused by gall bladder or kidney stone, inflammatory diseases of intra-abdominal organs. Other potential indications where this method could find application could be acute urine retention, abdominal aorta aneurysm or traumatic injuries of abdomen with free fluid in it. Those are the situations (as shown by radio-medical protocols presented before in this text) when doctors, via radio medical system often advise evacuation of the patient or diversion of the ship from the usual course, and distinguish the problems that can be treated on ship from the problems that need urgent treatment of a patient in a hospital on shore. In this way, they can save life and money.

The cost of such equipment used in our test is about 9000 USD and the cost of a ship diversion could be from 5000 to 10000 USD a day.

Nevertheless, a study of economic feasibility of introducing this technology to ships should be made, based on the shipping company's interest (analysis of the numbers and actual costs of ships diversions, etc), before any decisions would be made.

CONCLUSIONS

Results of this pilot study suggest that it is possible to teach marine officers to produce diagnostically usable ultrasound pictures aboard ships. Before reaching any conclusions whether it would be worth while to introduce this method into maritime practice, further studies should be made of economic feasibility of this proposal, and the value of such a diagnostic tool on board ships.

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