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Research Article

Simulation Training of Practical Exophthalmometry Skills

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Abstract

Simulation training of practical exophthalmometry skills is carried out using an inelligent robot. The hardware part is a model of the patient's facial area for teaching exophthalmometry in conditions as close as possible to real examinations in various clinical conditions. The computer program controls the movement of artificial eyeballs in the hardware depending on the diagnostic task. To control the correctness of the implementation of the practical skills of exophthalmometry, a video recording and subsequent analysis are made by both the student and the teacher. Based on the survey results, a reporting form is created, which is saved and can be used for comparison. This technique is based on digital technology and the use of computer analysis. It is possible to use the hardware and software complex in a remote version with data transmission via Internet channels.

Keywords: Exophthalmometry; Simulator of Practical Skills; Apparatus-software Complex; Ophthalmology; Endocrinology; Simulation Training

Introduction

The training of medical professionals has changed significantly in recent years. The acquisition of practical skills both of a diagnostic nature and various manipulations is carried out on simulators. This is necessary in order to work out all the necessary skills without danger to the patient. To do this, universities have created special centers where training is carried out with the use of simulation technologies and certification of doctors. The training equipment has a high level of realism and is as close as possible to the practical activities of a doctor. The most important are interactive learning robots that interact with the learner and can change parameters and clinical situations [1]. Integrated robotic training systems enable the interaction of simulators and medical equipment. A single system is being created: a robot simulator of a patient + a virtual simulator + medical equipment. Not only changes in the clinical figures are demonstrated but also the reaction to the actions of the student. At the highest stage of realism, remote-controlled robot simulators are used. At this stage, not only manual skills, but also clinical thinking are fully practiced [2]. In a simulation clinic, one can create scenarios of various clinical situations, including rare ones. The use of simulation technologies increases the efficiency of the educational process and the level of professional training. Currently, this is the main method of acquiring practical skills for doctors of various specialties. Simulation training is integrated into the system of continuous professional training of medical specialists. The ultimate goal of simulation training is to be able to perform various diagnostic and therapeutic manipulations and ensure that medical decisions are made. The number of ophthalmic simulators is constantly increasing. They are becoming more and more technologically advanced.

There are various robotic simulators in ophthalmology. Determination of the position of the eyeballs in the orbit is used in the diagnosis of many diseases [3]. Exophthalmometry is a widely used diagnostic method that allows to identify the stability of the eyeball in relation to the surrounding tissues. The exophthalmometry technique requires special training of specialists. Practical skills in exophthalmometry are necessary when making a diagnosis of endocrinological and ophthalmic diseases. Along with the rapid introduction of simulation education methods, there is a problem of access to modern methods of teaching doctors in remote regions where there are no training centers. For various reasons, primarily of an economic nature and the availability of personnel, the creation of modern training centers in the regions is practically impossible or is postponed for an indefinite period. The epidemiological situation hinders the possibility of training in large educational centers. In addition, the applied scheme of raising the level of qualifications presupposes on-the-job training, that is, the scheme of continuous professional education [4-6]. Eliminating the existing imbalance in the system of training medical specialists is possible only with the development of distance learning methods and the wider introduction of digital methods. Special requirements arise in the context of the epidemiological situation of COVID 19. First of all, this is the possibility of distance learning using Internet information channels.

This will provide the opportunity to maintain the level of training.

Purpose of the Study

The purpose of the work is to creating an intelligent robot for simulation training in practical exophthalmometry skills.

Materials and Methods

The position of the eyeballs in the orbit is determined by using a special device - the Hertel exophthalmometer. The design of the exophthalmometer represents axes with measuring rulers, along which two frames with mirrors attached to them, move. During the examination, the support elements are fixed at the edges of the eye sockets and the distance to the edge of the orbit is determined by the position of the upper point of the cornea. The distance is determined on a millimeter scale. There is a number of necessary requirements - good lighting of the examination area, the correct position of the exophthalmometer. The main requirement is the correct measurement and interpretation of the results. There are two clinical forms - exophthalmos in which there is a displacement of the eyeball from the outside. It occurs with endocrine diseases, injuries, inflammation or tumors in the eye socket. Oenophthalmos is a displacement of the eyeball inside. Most often the causes of oenophthalmos are injuries, congenital reductions in the size of the eye.

The method of exophthalmometry requires special training of specialists. An intelligent robot has been developed to teach practical exophthalmometry skills. The hardware part is an imitation of the facial part of the subject and the orbital part, with the ability to perform exophthalmometry in conditions as close as possible to real clinical conditions. The eyeball simulators have the ability to move around to create different clinical situations. It is possible to provide a combination of their position both in the variant of unilateral or bilateral exophthalmos, and enophthalmos. This is provided by their movement of high-precision micro-motors. Any combination of the position of the eye imitators of apples is possible both in the program version and when choosing a task by the teacher. The new robot for teaching exophthalmometry Ophthalmo Sim 4 consists of a simulator, an exophthalmometer, a tablet computer, and a retainer.

Figure 1: Robot for exophthalmometry skills.

The software part of the complex is adapted for solving the problems of acquiring practical skills in exophthalmometry. First, the user is registered in the training system. At the same time, the system registers the user according to the identification program and subsequently recognizes him by the image of the iris. An electronic account is created for each user according to the training program. It records the entire learning process both in terms of volume and time spent. The knowledge map shows how the theoretical course was studied. General information about exophthalmometry is presented both in the form of lecture and training videos. The teaching robot is controlled by voice commands. One can choose from different sections of the training program - theoretical course, practical course, training, control, debriefing and exam. The practical course provides the development of skills under visual control. A video camera is installed in the hardware and allows to observe the student. The pattern recognition system monitors the correct position of the hands during training and reports errors. The teacher can remotely observe the learning process by connecting the hardware to the video camera. The training course includes 84 clinical situations with different combinations of parameters for the position of the simulators of the eyeballs. The computer program controls the movement of artificial eyeballs in the simulator depending on the clinical task. The offset parameters are set in a special control program using a tablet computer. To control the correctness of the practical skills of exophthalmometry, a video recording and subsequent analysis are made by both the student and the teacher. The degree of displacement of the eyeball and its compliance with the clinical case are determined. These clinical options cover the entire clinical range of both exophthalmos and enophthalmos (unilateral and bilateral). The training program is built on the principle of free generation of clinical cases. The simulator has the ability to transfer the video recording to the teacher. Based on the results of mastering the practical skills of exophthalmometry, a reporting form is generated, which is saved and can be used for comparison. To confirm the mastery of practical skills, it is necessary to get the result of correct measurements in at least 85 percent of the tasks. This technique is based on digital technology and the use of computer analysis. The study of the position of the eyeball takes place not only in eye diseases, but also in endocrine, neurological, in pediatric practice.

Figure 2: Simulation training of practical exophthalmometry skills.

The teaching structure is protected from external access. Only an identified user has access to the tutorials. The transition to each section is possible only after complete mastering of the program materials and control of the time spent. Any deviations from the implementation of the training program are monitored and the reporting form is sent to the teacher. It is possible to use the hardware and software complex in a remote version with data transmission via the Internet channel. One of the main stages of a doctor's training is a debriefing. It is a structured process feedback on the results of the learning process. During the debriefing, the teacher asks a series of questions, according to the answers, which determine the degree of the doctor's readiness to perform independent examinations, their interpretation and use for making a diagnosis.

Debriefing of the results of mastering the training program is carried out according to test tasks and video of the results of control studies of exophthalmometry.

Results

The robot is used in the training of ophthalmologists, endocrinologists, therapists, and pediatricians. Training in the techniques of exophthalmometry on patients was not possible, since planned hospitalization is not performed. Some of the students were taught remotely. All students completed the full course, and the results were used to form report forms and control the development of knowledge. The course duration is 36 hours. Of these, 18 hours were theoretical training. It included sections on the types of exophthalmometric studies and their practical use. Separately, the diseases in which exophthalmos occurs are considered. Debriefing revealed a good readiness of doctors to work independently and perform exophthalmometry. According to the training results, the accuracy of the survey results was 85 percent. The average training time for practical exophthalmometry skills and their clinical analysis by exophthalmometry is 18 hours.

The final exam can be conducted both in person and remotely. In this case, a video monitoring system is used via the Internet channel. In the current epidemiological conditions, the system of distance learning and monitoring opens up new opportunities and areas of use.

Basic parameters of the training robot:

- There is a database of real clinical cases in accordance with the international classification.
- It is possible to create all possible clinical conditions for the purpose of diagnosis by exophthalmometry.
- The ability to create individual training scenarios and control knowledge.

Detailed description of diseases in which there are anomalies in the position of the eyes in the orbit.

- Intelligent control of the correct execution of the exophthalmometer position.

Exotalmometry is taught using a training robot in a sitting position. The learner (student) and the learning robot are positioned opposite each other. Ergonomics is as close as possible to the real conditions of examination by exophthalmometry.

Discussion

Learning robots are used in various higher education institutions. These are simulation training centers at universities in various cities. There are various robots, in particular for teaching ophthalmoscopy. The experience of using both in the training of students and doctors in postgraduate education has shown their high efficiency. Both standard programs and individual ones are used, depending on the level of the student's professional training. The training program is prepared by the teacher.

The medical decision making program is based on comparing patient data with similar data in the archive and selecting the closest analogs.

Simulation methods of teaching fundus examination in infants have a number of advantages: dynamic formation of curricula taking into account changing conditions, the possibility of quick modification of the course of study, personalization of the learning process [7]. Also, it becomes possible to assess the degree of preparedness of a specialist when creating clinical cases of varying complexity. A wide range of fundus diseases can be used in staged training, when courses are targeted and short in time (18-36 hours), which ensures greater efficiency in training specialists.

We believe that the focus of the training process is not only the development of practical skills of the fundus examination, but also the further use of the acquired knowledge in the diagnostic process and medical decision making. Technical capabilities of the training robot provide the ability to control the skills obtained by the teacher and the student [8]. The volume of training materials are aligned with international standards.

To teach practical skills and make medical decisions, a training system based on digital technologies and remote methods was developed.

Conclusion

The results of using the simulator to teach practical skills of exophthalmometry are presented. It is a hardware and software complex and is used to create clinical situations, on the example of which the acquisition of practical skills of exophthalmometry is made, which are used in the practice of ophthalmologists and endocrinologists. During the acquisition of exophthalmometry skills, standard equipment is used - the Hertel exophthalmometer. The hardware part is an imitation of the front part for exophthalmometry in various clinical conditions. The computer program controls the movement of artificial eyeballs in the simulator, depending on the clinical task. To control the correctness of the practical skills of exophthalmometry, a video recording and subsequent analysis are made by both the student and the teacher. Based on the survey results, a report form is generated, which is saved and can be used for comparison. This technique is based on digital technologies and the use of computer analysis. It is possible to use the hardware and software complex in a remote version with data transmission over the Internet.

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