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Telemedical Technologies at the Pre-Hospital Stage: Practice of Application

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ABSTRACT Telemedicine technologies for transmitting digital information about the patient are presented and characterized in the practice of application at the prehospital stage for clarifying the diagnosis, correcting the measures taken, efficient logistics and routing. High diagnostic accuracy and the possibility of round-the-clock diagnostics anywhere significantly improves the quality of medical care provided.

Keywords: telemedicine technologies, ultrasound examinations, video laryngoscopy, evacuation, triage, prehospital stage
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BP – blood pressure
ECG – electrocardiography
HR – heart rate
RR – respiratory rate
UE – ultrasound examination

The challenges we face stimulate the development of new technologies. Thus, in a metropolis, for the effective provision of medical care in the event of an immediate threat to people's health, modern technologies and special conditions for their development and implementation into practice are required [1].

In our opinion, the addition of telemedicine technology with the possibility to perform ultrasound examinations (UE) in real time will provide conditions for identifying many urgent conditions and monitoring the condition of patients both at the pre-hospital and hospital stages.

Telemonitoring technology includes monitoring basic physiological parameters: blood pressure (BP), heart rate (HR), respiratory rate (RR), blood oxygen saturation (SpO2), body temperature, electrocardiography (ECG), as well as ultrasound monitoring using portable ultrasound POCUS (Point-of-Care-Ultrasound - ultrasound in any place and at the right time) devices [1-4] (Fig. 1). The obtained data can be converted into digital format and transmitted via the Internet (Wi-Fi, 4G, 5G) to any mobile device (smartphone, tablet, laptop) or a stationary doctor's console for consultation in the form of a dialog box based on the patient's visual parameters with image transmission from the cameras of the telemedicine complex at the place of consultation [5] (Fig. 2).

Fig. 1. The SmartScan portable ultrasound scanner (Registration certificate of Roszdravnadzor No. RZN 2021/15918 dated October 25, 2022) St. Petersburg, Russia

Fig. 2. Working monitor of the consultant physician of the competence center (data of the patient's physical parameters, images from the portable ultrasound device, cameras of the telemedicine complex from the place of consultation, and digital data from the patient's electronic medical documentation (EMIAS type)

The technology makes it possible to conduct an ultrasound examination within the framework of the EFAST (extended focused assessment with sonography for trauma), RUSH (the rapid ultrasound in shock), BLUE (the Basic Lung Ultrasound Examination) protocols, including in patients with COVID-19, taking into account all recommendations for infection prevention and control, as well as to carry out invasive ultrasound-guided procedures (vascular catheterization, puncture of the pleural, pericardial and abdominal cavities, blockade of nerve trunks and plexuses) [6, 7]. If necessary, it is possible to obtain a second expert opinion online, in particular on issues of image interpretation or correction of the position of an ultrasonic sensor. In addition, it is possible to conduct an ultrasound remotely, when nursing staff places the ultrasonic sensor at standard scanning points, and the doctor remotely evaluates the result, controlling the entire examination process and monitor indicators based on basic values (BP, HR, RR, SpO2, body temperature, ECG) [8] (Fig. 3).

Fig. 3. Dialog window of the telemedicine complex during ultrasound examination with the possibility to comment on the resulting standard ultrasound image using markers of different colors (red and yellow) by each participant of the consultation, as well as the second tab of the window of monitored physical parameters from the patient

The described technology can be implemented according to the scenario of a planned consultation in an outpatient setting or home nursing, at the hospital stage between departments, in the operating room, at an interhospital consultation, and at the prehospital stage of emergency medical care during a remote consultation, when the doctor sees the actual indicators of the monitor and, if necessary, performs an ultrasound examination (according to the EFAST protocol), on the basis of which a decision is made on the further tactics of the work of the emergency medical team or the territorial center for disaster medicine (Fig. 2, 3).

This technique can also be used in patients with COVID-19 [6] and a respiratory failure clinical picture, when nursing staff or a doctor conduct medical monitoring and lung ultrasound zone by zone (the palm principle or 6-zone assessment for each lung), and on this basis, they perform an assessment according to the protocol, and make a decision on the spot or conduct a remote consultation in real time [1].

This technology plays an important role when conducting medical triage, when, during a single admission to the hospital of victims or patients with somatic pathology, it is necessary to divide their flows into triage groups according to the severity of their condition. This optimizes treatment algorithms, reduces decision-making time and increases the survival rate of patients, especially those with polytrauma [9–12]. It should be noted, that this technology can also be used when sorting casualties in combat conditions: the parameters are read from sensors on the soldier, and a compact communication device transmits medical monitoring data to the command console.

If tracheal intubation is necessary, either routinely or urgently, a video laryngoscope is connected to the monitor with simultaneous display of the patient's capnography and saturation parameters. This technique makes it possible to exclude iatrogenic damage and perform airway prosthesis in any setting - at the prehospital (by a doctor and paramedic) and hospital stages of medical care. In addition, it can be used to diagnose foreign bodies at the level of the larynx, which often cause respiratory arrest. The manipulation is also carried out under the control of capnography and saturation parameters, and the result of tracheal intubation is immediately displayed on the screen (Fig. 4).

The technology has a built-in function for transmitting the resulting image remotely, via the

Fig. 4. Use of various video laryngoscopy gadgets (wireless and wired) during tracheal intubation, connected to the telemedicine complex with simultaneous display of saturation (SpO_2) and capnography parameters

Internet, with recording and fixation at the time and place of the event [8].

The technology of telemedicine consultations is distinguished by a multidisciplinary approach and wide possibilities of use, since it allows you to monitor the condition of patients both routinely and urgently, conduct remote consultations online, and carry out medical triage at a qualitatively new level. It can be used in a pandemic at all stages of the organization of medical care and contribute to the choice of tactics for managing such patients.

The telemedicine complex has a clear and intuitive interface. Its use will simplify control and search for the right solution in complex clinical situations.

Telemedicine monitoring technology is promising and necessary in the near future for fast, affordable and high-quality medical care in a metropolis.

CONCLUSION

The described method of using the telemedicine complex opens up new possibilities for diagnostic search in urgent situations, and allows specialists to quickly obtain a second expert opinion in complicated cases. The proposed technology increases the success of invasive procedures and provides airway protection. Ultimately, this has a positive impact on patient survival and continuity of medical care.

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