Journal of Engineering and Applied Sciences 14 (Special Issue 3): 6131-6134, 2019
ISSN: 1816-949X

Hand-Held Tele-Ultrasound the Hype of the Heart

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Abstract: Ultrasound technology has grown by leaps and bounds, so much so, it has become synonymous as the visual 'stethoscope' of the 21st century. Healthcare workers use them in scanning images of the heart, lungs, abdomen and the musculoskeletal system for diagnostic and therapeutic purpose. With current advances, ultrasound machines have become smaller and compact, easily portable and more efficient. This enables its use in any setting, including emergencies, avoiding lengthy patient travel and is cost-saving. With the advent of telemedicine, ultrasound gained a further edge in enhancing healthcare. Hand-held cardiac ultrasound are miniature devices which can be used as a point-of-care examination of the heart. They are suitable for quick real-time assessment of cardiac structure and function such as the chambers, walls, linings and valves of the heart. The use of telemedicine via. these devices resulted in the development of innovative digital health, wherein imaging, data interpretation and patient management could be done via. remote transmission guided by experts in the field. Notably, this has been shown to improve diagnostic and patient workflow. Limitations to its use is mostly due to competition by cart based ultrasound. Also, dedicated teaching and training programmes needs to be provided to operators for efficiency of diagnosis and management. These devices also offer remote education, augmented communication as well as training and supervision of healthcare workers. These are in the form of enhanced virtual interactions with augmented reality and video overlay, utilization of multi-media assets as well as optimized video streaming in low bandwidth conditions. This technology also allows for expansion beyond the traditional hospital environment to a range of under resourced settings such as the battlefield, onboard aircrafts or ships, onsite at natural disasters and even in space expeditions as demonstrated by NASA aboard the International Space Station. In recent years, new applications such as artificial intelligence and robotics have brought disruptive innovation into every industry on a global scale. Considering the speed of technological development, these applications may have future potential to serve as linkups for tele-ultrasound to benefit the community at large.

Key words: Hand-held cardiac ultrasound, telemedicine, tele-ultrasound, artificial intelligence

INTRODUCTION

Ultrasound is a widely used clinical imaging device which can be used to scan images of the heart, lungs, abdomen and musculoskeletal system. It is used widely by healthcare workers for clinical, diagnostic and therapeutic purpose. It is effective and accurate and with current innovations has become compact, portable and easy to use. It is perfectly suited to operate in a variety of settings including in under-resourced and remote regions and in emergencies. Furthermore, it avoids lengthy patient travel and is cost-effective. For these reasons, the ultrasound of today is much sought after in many healthcare centres, especially, in middle and lower income countries as it requires less infrastructure and training modules when compared to other imaging modalities. With the advent of Information and Communication Technology (ICT) and telemedicine, this has further helped provide affordable and accessible of after medical speciality services as well as training of healthcare providers, clinical trainees and students in health related fields (Raju and Prasad, 2017). All this has made ultrasound a reliable technological tool in bridging communities and enhancing healthcare among them.

MATERIALS AND METHODS

Hand-held cardiac ultrasound with telemedicine: The Hand-held cardiac ultrasound or echocardiography came into existence after decades of technological experiments. These miniature devices can be used as point-of-care examination of the heart at patient bedside. They can be used for quick real-time assessment of cardiac structure and function such as the chambers, walls, linings in valves of the heart. Thus, they serve as a useful adjunct in triaging, diagnosing and in treatment of patients with

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a variety of cardiac illness. As the use of point-of-care ultrasound spread worldwide, so too did its potential (Liteplo *et al*., 2010). Training all users and potential users of ultrasound in image acquisition and interpretation would be a formidable and extremely challenging endeavor (Liteplo *et al*., 2010). This is where telemedicine with remote transmission of real-time images came to play an important role. The use of telemedicine via. these devices resulted in the development of innovative digital health. In a nutshell, this enabled healthcare workers in remote settings with basic ultrasound application training to scan a patient and submit images via. real-time to experts in the field located distantly for a diagnosis. With the right diagnosis, some of these patients need not even be sent to larger instituitions for surgeries or procedures but to continue with medical treatment at their respective healthcare centres. As such, cardiac ultrasound has now become a natural application for telemedicine as hand-held devices and cloud based transmission solutions make it possible to perform a test at a remote site and have consultation in real-time with an expert located at a distance.

Smart phone technology has driven the demand for cardiac ultrasound more strongly in the short term to become commercially available (Andersen *et al*., 2011; Panoulas *et al*., 2012). These devices can connect to both wireless computer networks as well as to wireless telephone networks, enabling independent access to patient data irrespective of their location (Raju and Prasad, 2017). Cellular phones, apart from being easily portable could also serve as a viewing device, thus, obviating the need for 'dedicated reading rooms' (Liteplo *et al*., 2010). An example of these products are the iPhones (Apple, Inc.) which have revolutionized the abilities of hand-held phones and have made high-speed wireless transmission and reception of data via. 3G network accurate and immediate (Liteplo *et al*., 2010). Another example is the Phillips Lumify device. This used the REACTS (Remote Education, Augmented Communication, Training and Supervision) platform that enabled a fully integrated and real-time tele-ultrasound solution for remote collaboration (Royal Philips, 2018).

A needs-analysis study in Queensland, Australia showed that upto 8% of studies done in community hospitals would have benefited from tele-ultrasound consultation in diagnostic advise, scanning technique and patient management advise (Lewis, 2005). All these new innovations paved the way for a vastly improved diagnostic and patient management pathway.

In the current 21st century, the World Heath Organization and the United Nations have advocated and stressed on prevention of diseases in communities with wellness programmes and rehabilitation in addition to cure of disease. As such, prevention and wellness programmes have sprouted abundantly in many countries in keeping with raising the standards of healthcare on a global scale. In the context of cardiovascular disease, there is a great demand for a common telecardiology platform with shared access nationwide or even internationally. Ultimately, the technology of telemedicine will enable the sharing of health data and patient clinical resources within a wider healthcare spectrum.

RESULTS AND DISCUSSION

Other usage: Hand-held ultrasound can also be used in other situations apart from hospitals and in health care clinics. It was shown to be feasible for use in the pre-hospital setting (Garrett *et al*., 2003; Strode *et al*., 2003) as well as in home-care, at natural disasters (Shah *et al*., 2010), austere environments as in the battlefield (Huffer *et al*., 2004), by ship officers on merchant ships and even in outer space missions (Arbeille *et al*., 2001) such as on the International Space Station (ISS). In the case of pre-hospital care and home-care, the use of hand-held cardiac tele-ultrasound had great potential to reach the masses in remote communities. In this regard, the convenience of consultations and basic diagnostics at home has an important role in our future (Raju and Prasad, 2017). In natural disasters and in the battlefield with the military, there is a lack of access to power, a large number of victims and an urgent need of a triaging system. In the Haiti earthquake in 2010, the use of a hand-held ultrasound device at disaster sites made an important impact in the management of victims (Shah *et al*., 2010). The National Aeronautics and Space Administration (NASA) has also used tele-ultrasound machines on the ISS to gauge the health of astronauts onboard (Sargysan *et al*., 2005). With future planned missions to Mars and other distant space exploration projects using miniature versions of this device with telemedicine may have potential to play a significant role.

CONCLUSION

The technology of hand-held tele-ultrasound has grown by leaps and bounds through the years. Linking telemedicine with these miniaturized devices, especially cardiac devices has made it possible to have patients always networked, despite their location, thus, maintaining continuity in healthcare. This allows for more timely diagnosis of patients, appropriate medication and relevant refferals as well as second opinions and vastly reduces the cost of mobilizing patients. Surrounded with new, hyped and evolving technologies, it is imperative

that, we surge ahead to experiment with novel methods to complement and fascilitate an efficient and modern healthcare system for the benefit of all.

LIMITATIONS

Previously, there were difficulties in transmitting cardiac images via. telemedicine due to differences in interphase, software and hardware issues. With rapid advances in computer solutions and increased bandwidth with newer algorhithms, these limitations have been overcome.

Hand- held ultrasound devices still face competition with cart based machines. This is especially so, in larger instituitions whereby diagnostic and therapeutic modalities favour the latter modality. With healthcare now focusing more on home care with methodologies to provide for chronic patients and prevention programmes, the shift to using these hand-held devices more frequently may be the future norm (Raju and Prasad, 2017).

Another issue is the education, teaching and training skills programme for cardiac ultrasound operators, mainly those based in remote locations. This is because the level of interest and willingness to adapt to newer technologies and changes had met with some resistance (Raju and Prasad, 2017). The same applied to patients who are the end-users and must feel comfortable receiving the treatment given. The acceptance of these new technologies in terms of security, liability and data privacy and their accessibility to it plays an important role in the success of telemedicine (Raju and Prasad, 2017).

Despite being recognized as essential to healthcare development, telemedicine still faces barriers from organizations and government bodies which include approval of advancements and procedures. The challenge here is to adopt an integrated approach whereby there is interdisciplinary work corporation. This is where international societies such as the American Heart Association and the European Society of Cardiology, manufacturers of software and hardware companies, insurance companies, healthcare workers and doctors as well as government bodies, work in unison to bring everyone together and definene the necessary training programmes to integrate seamlessly (Bruining, 2014).

The final limitation will be to contain the cost of using these devices and systems. This appears promising with technological advancements and the miniaturization of diagnostic instruments which has led to decreasing healthcare costs and improving outcomes.

RECOMMENDATIONS

The expansion of new innovations such asartificial intelligence (AI) and robotics involving many industries worldwide has also raised questions and discussion in the healthcare industry. From 'would these new innovations rob us of our jobs?' to 'how efficient and safe are these as opposed to human operators?' are some of the common conundrums we encounter. With the continuous development and dynamic innovation of the internet and other ICT platforms, this may further propel the use of AI and robotics as a potentially efficient healthcare delivery link. Past studies have shown that robots may be used in the acquisition of images via. tele-ultrasound (Boman *et al*., 2009; Takeuchi *et al*., 2008). In future, robotic drones may have potential to link-up with hand-held devices using AI to serve the community at large. In our quest for a modern and efficient healthcare system, we should aim higher to study all these new and emerging technologies for the future benefit of our communities.

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