

A Narrative Review on the Advantages of Portable Ultrasound Machines in the Emergency Department

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Received: August 28, 2018; **Published:** September 28, 2018

Abstract

Health care management has advanced exponentially largely due to medical technology. Health records, diagnosing and treatment have all been made easier and more convenient in hospitals, clinics and other outpatient centers. Medical technology has become the center stone for breakthroughs in finding causes and cures for diseases. The emergency department (ED) serves as the first line of aid in health crises or trauma situations. The goal of the ED is to establish stability in a patient's condition. Time is crucial especially in trauma situations and an ultrasound is most often used as it is highly sensitive and uses a non-invasive approach. It can detect many abnormalities including hemorrhage, stones, pregnancy, which are amongst many others. In November 2015, a new portable ultrasound machine was introduced as a transducer with the ability to connect to a compatible android device. This was made possible by the Phillips Lumify application. This application, downloadable onto the android device, made possible for a tablet or phone to become an ultrasound machine. Not only did this become a small, wireless option, it also eliminated the need of expensive equipment and provided more fluid options in emergency settings. More patients can undergo the procedure using the portable ultrasound machine, eliminating delays or the need to transfer to a specific department for the same purpose. This has the potential to beneficially transform the way the ER works especially during trauma or when there are a high number of incoming patients. This paper will examine the advantages of portable ultrasound machines in emergency rooms.

Keywords: *Medical Technology; Portable Ultrasound Machine; Emergency Room; Transducer; Non-Invasive Instrument*

Introduction

The study of sound began as far back in the 6th century. It was in 1880, however, the transducers became a useful tool to generate and detect ultrasonic waves in air and water [1]. The human body is made up of mostly liquids and soft tissue, and these waves can help see structures such as the tendons, blood vessels, muscles and internal organs. The most specific function of the ultrasound machine is to diagnose a pathology in real time.

The ultrasound machine is a manipulation of sound waves designed to produce structural images for better imaging. This is one of the most prominent applications that has been implemented in the medical field. The probe transmits high-frequency sound pulses into the area of interest. These sound waves travel until they encounter resistance, such as a mass, and is then reflected back to the probe. If there is no structure to impede the waves, they waves keep travelling. The machine picks up the reflected waves which then calculates the distance of the probe to tissue or organ and forms a two-dimensional black and white image [2].

The ultrasound machine is constructed from the following fundamental pieces as follows; a transducer probe, the central processing unit (CPU), transducer pulse controls which can manipulate amplitude and frequency of the pulses from the probe, a display, a keyboard, a disk storage device, and printer [2]. All these components take up space and require special vehicles to transport from place to place in a healthcare setting.

The ultrasound machine became portable in 1975. It was designed by Martin H. Wilcox and became the first to be commercially available in the United States called the ADR 2130 [3]. The current leading brands in portable ultrasound machines on the market are CX50 from Philips, Logiq E, Vivid i, Voluson i from GE, Viamo from Toshiba, Acuson P300 and Acuson P500 from Siemens [4]. The greatest evolution of the portable ultrasound machines came in November 2015, where the company Phillips launched the Lumify portable ultrasound machine [5]. This worked by connecting a transducer to the USB port of a compatible Android device, such as a tablet or smartphone. The Lumify application is a necessary component to be able to properly use the Phillips Lumify ultrasound machine.

Objective of the Study

There are many types and models of portable ultrasound machines and their manufacturers are continuing to produce more efficient products. This paper will highlight upon the different kinds of models used in the ED and their specifications. Hospitals are expressing more interest in these devices as they become more widely used by a growing number of specialties [6]. This paper will also discuss how these models have aided in efficiency in the ED.

Discussion

Size

Since the dawn of the ultrasound machine production, the most notable change has been size. It started as a large machine with a multitudinous amount of parts connected to each other, mainly the main computer, screen and transducer. All these components connected can either be kept stationary in one area or could be wheeled onto a mobile frame for transportation. Despite the use of a mobile frame, it still did not warrant full portability as the machines took a considerable amount of space.

Current models of portable ultrasound machines range from the size of a laptop to that of a mobile device. One such example is the Titan model of the Sonosite Manufacturer. It is a portable ultrasound machine with a laptop style system [7]. Regardless of its size, it is fully capable of carrying out all the features for diagnostics and imaging.

When used alone, the laptop sized ultrasound machine is sufficient for portability. However, most hospitals and ED use a 4-wheeled trolley-cart to mount this ultrasound machine. The Keebomed produced KM-5 Universal Medical Trolley -110 cm is priced on average at \$499.00 [8]. This cart is about 3 - 4 feet tall and weighs approximately 40 pounds on its own. The total weight increases when all the equipment of the ultrasound machine is added. Its benefits include providing a strong support for the machine and multiple holders for the probes. Despite the efforts of manufacturers to reduce the ultrasound machine to a portable size, the use of these trolley-carts reduces ease of portability for the laptop-sized ultrasound machines. In addition, trained personnel are required to handle the equipment properly adding to the burden of additional costs. If hospitals opt to find a better option instead of this, they will reduce costs significantly.

In 2009, GE Healthcare released a handheld ultrasound device named VScan. This was slightly larger than a typical mobile phone but had the capability to complete the same functions as the laptop styled machine. This device was small enough to be carried in a pocket and can be easily traveled with [9].

As of recently, in 2015, the Phillips Lumify application was available for Android devices including phones and tablets. The Phillips Lumify application is downloaded onto the compatible android devices. Once installed, the Lumify transducer is connected through a USB port after which, scanning can begin. There are three different types of transducers; S4-1, L12-4, C5-2. The S4-1 assists in examining

cardiac function or quick Focused Assessment with Sonography for Trauma (FAST) exams. The L12-4 transducer helps in best identifying pneumothorax or deep vein thrombosis. The Lumify C5-2 transducer has a curved shape to best assist in for imaging gallstones [10]. The application can be downloaded on multiple devices and the transducers can be interchanged from device to device, thus allowing the ultrasound machine to be smaller in size, portable and versatile.

Phillips Lumify has been shown to provide clear images. Its most notable feature is easy accessibility to patient Picture Archiving and Communication System (PACS) using cloud sharing technology, ability to share images, videos and notes. In addition, as an android device, it provides access to the internet for browsing [11]. The Phillips Lumify portable ultrasound machine meant that now realistically, everyone in the healthcare field can have access to an ultrasound machine ready on standby. This becomes a very powerful tool in the Emergency room where the need for an ultrasound is mostly warranted.

Bedside ultrasound in the emergency department

The Phillips Lumify has made possible, a portable ultrasound machine at bedside. This is known as the Point-of-Care ultrasound (POC US). Some applications of the POC US include abdominal ultrasonography of right upper quadrant and appendix, obstetric, testicular, soft tissue/musculoskeletal and ocular ultrasonography. The alternative to POC US is consultative ultrasonography in which the ED physician order the examination to be performed by radiologists or cardiologist in a timely and clinically relevant manner [12]. The American College of Emergency Physicians state the guidelines and benefits of POC US which include providing real-time clinical information making triage and diagnosing patients efficiently [13]. This is ideal in Emergency departments as time can be the difference in saving a life or losing one.

During times of trauma, invasive procedures may be required. If equipped with bedside POC US, ED doctors do not have to use blind landmark techniques, but rather use the machine to accurately perform procedures [14]. This can result in better outcomes and fewer complications.

The bedside PCOS has also had a positive impact on patient satisfaction. A second study in the Annals of Emergency Medicine studied 240 patients and of these, 186 responded to the satisfaction survey. Patients who were given bedside ultrasound perceived their physicians as more capable and had more confidence in their diagnosis. Not only this, the patients trusted their doctor more [15].

Faster diagnosis with portable ultrasound machine in the ED

Emergency Department wait times depend on triage, number of beds available, and number of on-call staff members and doctors. These limitations with the combination of high levels of incoming patients, can mean longer wait times. If hospitals are equipped with bedside POC US, this wait time can be significantly reduced. A prospective observational study in the Annals of Emergency Medicine, sampled women in early pregnancy that required a pelvic ultrasound evaluation by emergency physicians; this is known as emergency physician-performed pelvic sonography (EPPPS). This can be achieved with portable ultrasounds provided by, for example, the Phillips Lumify. The Length of Stay (LOS) in the emergency department was compared to EPPPS and those who received pelvic sonography administered by radiologists or obstetrics-gynecology consultants. The LOS in patients who underwent EPPPS was 60 minutes and Obstetrics-gynecology consultation was 170 minutes; $P < 0.001$. The study concluded pelvic ultrasound performed by emergency physicians shortens ED LOS in these women when not involving trained radiologists [16].

Cost

It is known that the cost of diagnosing patients is quite expensive through the means of different medical equipment and machines. Among these machines, one of the most expensive is the ultrasound machine. It is required to be handled with caution by trained workers. If mishandled, the cost of replacing these parts to fix can prove to be further expensive.

The Titan Model of Sonosite costs \$5,000 [7]. The GE VScan Ultrasound Equipment is listed as \$5,850 [17]. The prices vary from manufacturer to model type. The Phillips Lumify application is available on the Google Play Store for a subscription price of \$199 per month. The monthly subscription includes a transducer, application, access to the company's online portal, warranty and customer support [18].

The bundle pricing is \$2,388 per year [19]. This one account can be accessed on more than one device. The transducer can be disconnected from the device and connected to another as long as the application is installed on the other device. In addition to a near 50% decrease in price per machine compared to other ultrasound machines, the major advantage Phillips Lumify has over its competitors, is the interchangeability from device to device yet providing the same software platform when in use. In addition, this will not only make patient care more efficient, but it can potentially reduce the cost of medical bills for the patients as well as cut down costs for hospitals.

Decreased need to transport patients

Prior to the introduction of the portable ultrasound machine, it was required for patients to be transferred one department to the other in order to be examined by an ultrasound machine. This required trained professionals to transport the patient inevitably resulting in increase length of stay at the hospital. The deficit in portable ultrasound machines not only delay in initiation of treatment plan but it can further create more stress and anxiety in patients.

This added time delay due to transporting patients for diagnostic tests can be reduced with the use of portable ultrasound machines. The transport teams can be utilized in other high demanded areas within the hospital for maximum efficiency.

Conclusion

The Emergency Department is the first point of care for many patients in need. The swiftness of the patient care depends on a variety of factors such as triage, technology and medical equipment available and on-call physicians staff present. Among the medical equipment used, the portable ultrasound machine is one of the most sensitive and essential piece of technology utilized by the ED. It has the ability to provide real-time images and is an important diagnostic tool due to its non-invasive approach. Currently, newer models have been introduced, such as the Phillips Lumify, which have added to the versatility and functionality of the portable ultrasound machines, hence, benefitting ED and other areas where this can be a useful tool.

Limitations

The major limitation is maintaining the integrity of the tablet itself and the application. If for some reason, the tablet is non-functional, the application cannot run without it. Therefore, it is important to keep up with the updates and ensure the products are working optimally. It is not ideal to have lags while completing an ultrasound procedure. The devices are all connected to the internet for the application to work. Any disruption in the internet connection can cause a delay in running of the application. This is not ideal in the ED as time is of most importance and any delay can compromise the health of the patient. Android devices also are coming out with newer models every year with better processors and software. The replacement of an android device may be expensive for hospitals, however, the amount of replacing one device compared to an entire ultrasound machine is still a much more cost-efficient option.

Conflict of Interest

There are no conflicts of interest in this study.

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Volume 2 Issue 2 October 2018

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