An Introduction to Ultrasound Equipment and Knobology

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KEYWORDS

• Ultrasound • Equipment • Knobology • Probes • Transducers • Doppler • B-mode • M-mode

KEY POINTS

- The use of ultrasonography in medical practice has evolved dramatically over the last few decades and will continue to improve as technological advances are incorporated into daily medical practice.
- Although ultrasound machine size and equipment have evolved, the basic principles and fundamental functions have remained essentially the same.
- Becoming familiar with the machine and the controls used for image generation optimizes the scans being performed and enhances the use of ultrasound in patient care.

INTRODUCTION

The use of ultrasonography in medical practice has evolved dramatically over the last few decades and will continue to improve as technological advances are incorporated into daily medical practice. Although ultrasound (US) machine size and equipment have changed over time, the basic principles and fundamental functions have remained essentially the same. This article reviews the general US apparatus design, the most common probe types available, and the system controls used to manipulate the images obtained. A detailed discussion of the physics involved in medical ultrasonography is presented elsewhere in this issue of *Critical Care Clinics*.

US MACHINES

The fundamental principle of ultrasonography can be traced to approximately 200 years ago when Lazzaro Spallanzani, an Italian biologist, theorized that bats used echolocation to hunt in the dark.[1] During the late 1800s, the concept of sound

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was expressed mathematically by the English physicist Lord Raleigh.[2] In 1880, the piezoelectric effect of crystals was first described by Pierre and Jacques Curie.[3] These principles in physics were initially incorporated into industrial applications (eg, identifying structural metal flaws) and eventually were applied in medical practice.[1] The first known published medical US application was in 1942 by the Viennese brothers, Karl and Friederich Dussik.[1] It was not until 1963 that the first real-time commercial US machine became available by Vidoson Siemens, Corp.

Almost 50 years after the first bulky US machine made its debut, compact and portable US machines started making their way into standard bedside use. Many of the popular US machines being used in patient care areas are no larger than small laptop computers. As technology continues to evolve at a dramatic pace, there are US machines being developed that are comparable with the size of an average cellular phone (**Figs. 1** and **2**).[4–6] Furthermore, there are applications for actual smart phones that connect to a scanning probe enabling the operator to perform ultrasonography without an actual US machine (**Fig. 3**).

The discussion here is limited to the compact, laptop size US machines used most frequently for point-of-care (POC) scans in the acute care setting. There are a variety of US machine brands (**Figs. 4–6**) available for POC US at the bedside. All of the machines include a user interface with a keyboard and, depending on the brand, a variety of knobs, buttons, track ball, or touch screen for manipulation and storage of the images. Deciding which US machine to purchase for POC scans depends not only on the price of the machine, but also its durability, the life span of the battery, need for AC energy, boot-up time, portability, and previous experience with a particular US machine brand.

Most of the US machines for POC use are attached to a cart that not only provides a base for the machine itself, but also facilitates portability to different areas of the department and hospital. These carts also have the space to store different probes, cables for AC connection, sterile probe covers, bottles of gel, and other supplies that can be used as needed during the scans (**Fig. 7**).

A secondary viewing screen can be attached to the cart, above the main US screen. This secondary screen can be used for patient viewing or for bedside teaching (**Fig. 8**).

US PROBES

Although there are many US transducers designed for specific uses in medical practice, most of POC ultrasonography can be accomplished using one of four basic types of probes: (1) curvilinear, (2) linear, (3) sector/phased, and (4) intracavity (**Figs. 9–12**).

Fig. 1. Portable handheld ultrasound machine Acuson P-10. (*Courtesy of* Siemens Healthcare Copyright 2013; with permission.)