

# Sonography Tech

Essentials of Physics & Sound, Image Interpretation, Tools, Techniques, Equipment & Terminology

## OVERVIEW

### Scope of Practice

- **Ultrasound** (s.k.a., **ultrasonography** and/or **sonography**) involves the following aspects of skills, practice and technology:
  - patient care
  - quality control
  - diagnostic procedures
  - computer data acquisition & processing
- **Ultrasound technology** is a **multidisciplinary** field, in which medicine is linked to mathematics and quantitative sciences, including:
  - **geometry**
  - **physics**
  - **computer technology**
- **Ultrasound diagnostic imaging technique** is used to visualize **subcutaneous body structures**, for possible **pathology** or **lesions**.
  - structures best suited to sonographic imaging include:
    - tendons
    - muscles
    - joints
    - vessels
    - internal organs
- In physics, the term "**ultrasound**" applies to all acoustic energy with a **frequency above human hearing** (20,000 hertz [Hz] or 20 kilohertz [kHz]).
  - Typical diagnostic sonographic scanners operate in the frequency range of **2-18 megahertz [MHz]**, hundreds of times greater than the limit of human hearing.
- However, the choice of frequency is a trade-off between **spatial resolution** of the image and **imaging depth**.
  - **lower frequencies** produce **less resolution**, but **image deeper** into the body.

(NOTE: See page 6 for a Glossary of Sonographic Terminology)

### How Ultrasound Works

- Sonography is effective for imaging soft tissues of the body.
  - **superficial structures** such as muscles, tendons, testes, breast and the neonatal brain are imaged at a **higher frequency** (7-18 MHz), which provides **better axial and lateral resolution**.
  - **deeper structures** such as liver and kidney are imaged at a **lower frequency** (1-6 MHz), which provides **less axial and lateral resolution** but **greater penetration** (i.e., increased imaging depth).
- A **general-purpose sonographic machine** may be used for most imaging purposes; specialty applications may be imaged by use of a **specialty transducer**.
  - Most ultrasound procedures are done using a transducer on the surface of the body, but **improved diagnostic procedures** are often possible if a transducer can be placed **inside the body**.
    - for this purpose, **specialty transducers** (including **endorectal**, **endorectal** and **transesophageal transducers**) are commonly employed.

## PHYSICS & SOUND

### Understanding Sound Waves

- In physics, all waves carry energy from one location to another.
- **Sound** is a **mechanical wave** in which particles move (i.e., the molecules vibrate back and forth from a fixed position).
- Sound travels in a straight line and sound waves are **longitudinal waves**.
- Sound waves are identified by the following acoustic variables: pressure, particle displacement, density and temperature.
- In diagnostic ultrasound, **pulses** (i.e., sound) travel through tissue.
- **Reflections** arising from structures in the body return to the transducer and are processed into images.
- To understand exactly how that happens, let's review how sound waves work.

#### Pressure

- The ratio of force acting on a surface object.
- If there were no forces, or pressure, everything would be in a state of constant rest.
- The **Law of Inertia** explains that a body in motion will remain in motion; likewise, a body at rest will stay at rest until acted upon by an outside force.
- **Ultrasound moves human soft tissue out of its state of rest.**

#### FORMULA

Pressure = Force/Area OR  $P = F/A$   
 Units of measure: Newtons/Area or  $N/m^2$

#### Particle Displacement

- The distance the body has moved after being impinged upon by a force (i.e., how far the particles moved from their equilibrium positions).

#### Density

- The property common to all matter and the one property that makes each type of matter unique.
- Density is defined as **mass per unit volume**; the more mass confined to a given volume, the greater the density.
- In ultrasound, density is referred to as **mass density**, which can be defined as the mass of the object divided by its volume.

#### FORMULA

Density = Mass/Volume OR  $D = M/V$   
 Units of measure:  $Kg/m^3$ ,  $g/cm^3$

#### Temperature

- The measurement of relative coolness or warmth of an object.
- Temperature in ultrasound becomes important because the **speed of sound** varies with the temperature of the tissue that is being scanned.

### 7 Parameters of Sound Waves

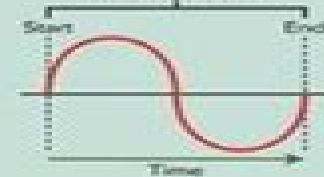
- The seven parameters of sound waves are: period, frequency, amplitude, power, intensity, wavelength and speed.
- Period and frequency describe the speed of the wave.
- Amplitude, power and intensity describe the strength of the wave (s.k.a., **magnitude**); these parameters tend to be directly related; when intensity increases so do power and amplitude.

#### Period

- **Time it takes for a wave to vibrate a single cycle** (i.e., from the start of one cycle to the start of the next cycle).

- Reported in units of time (seconds, milliseconds, hours, days)
- The value of **period in diagnostic ultrasound** is one tenth to one half of a millionth of one second.
- **period determined by the sound source only**, not by the tissue being scanned.
- **period is NOT adjustable** by the sonographer (ultrasound tech) with a particular transducer.

#### Wave Period



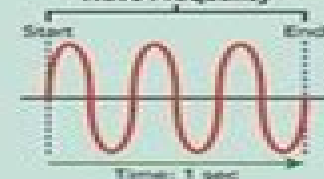
#### Frequency

- **Number of events that occur in a specific duration of time**.
- In **diagnostic ultrasound**, the frequency of a wave is described as the **number of cycles occurring in one second**.
- **Frequency** is important in diagnostic ultrasound because it affects **penetration and image quality**.
- Measured in units per second or Hz (1 cycle/second = 1 Hz).
- Frequency ranges are from 2MHz to 10 MHz (2 million to 10 million per second).
- **frequency determined by the sound source only**, not by the tissue being scanned.
- **frequency is NOT adjustable** by the sonographer with a particular transducer.

#### Frequency Spectrum of Sound

infrasonic: less than 20 Hz  
 audible: sound between 20 Hz and 20 kHz  
 ultrasound: greater than 20 kHz

#### Wave Frequency



#### Amplitude

- Defined as the "**bigness**" of the wave, it is the difference between the minimum value and the average value of the acoustic variable.
- Measured in units of **pressure (pascals)**, **density (g/cm)** and particle motion (any distance).
- **Amplitude is determined by the sound source**, but **amplitude decreases** as it travels through the body.
- **decrease in sound** depends on the characteristic of the sound and the body tissue the wave is traveling through.
- the sonographer can **alter the initial amplitude** on an ultrasound machine.
- **Amplitude is measured from the middle value to the maximum value**.

# Medical Terminology Study Guide Ultrasound

**Agnes Clare Frenay, Rose Maureen  
Mahoney**



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**Vol. 2** Gale, Gale Group, 2004-09      **Radiologic Technology**, 1987      *Medical Terminology* Davi-Ellen Chabner, 1999 Davi Ellen Chabner's step by step method is the easiest way to learn medical terminology A Short Course shows you how to quickly decipher the meaning of useful medical terms by breaking them down into smaller word parts The self teaching format reinforces what you learn and instantly improves your communication in the medical setting Book jacket      Lange Review Ultrasonography Examination: Fifth Edition Charles S. Odwin, Arthur C. Fleischer, George Berdejo, 2021-03-22 Trust the 1 selling ultrasonography study guide 1 000 images 3 000 review questions answers content from leading experts in the field Lange Review Ultrasonography Examination has long been the go to guide for anyone seeking certification or recertification in ultrasonography This unbeatable study aid summarizes the entire ultrasonography curriculum in concise readable narrative helping you understand and retain key concepts Covering the latest ultrasonography technologies and techniques this new edition brings you fully up to date on the topics you need to know most and it includes all new chapters on 3D sonography in obstetrics and gynecology musculoskeletal ultrasound and breast sonography With its authoritative and engaging coverage combined with thousands of sample questions and detailed answers that reinforce learning Lange Review Ultrasonography Examination provides the fully rounded learning experience you need to ace the exam      **Understanding Medical Terminology** Agnes Clare Frenay, Rose Maureen Mahoney, 1984      **Lange Review Ultrasonography Examination with CD-ROM, 4th Edition** Charles S. Odwin, Arthur C. Fleischer, 2012-08-22 Rev ed of Appleton Lange review for the ultrasonography examination edited by Carol A Krebs Charles S Odwin Arthur C Fleischer c2004

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