Quantitative ultrasound (QUS) analysis attempts to gain further understanding of tissue pathology through analysis of the underlying echo signals. QUS is effectively as old as medical ultrasound imaging. A notable example is the initial application of ultrasound to breast tissue. The developers concurrently attempted to differentiate between benign and malignant tissues through an analysis of the echo signals they saw.

There have been a many "successes" and a few "failures" during QUS development, but there has been a great deal of progress in QUS methods. Although Lord Rayleigh described the basics of acoustics in the late 1800's, tissue classification with QUS requires a more detailed analysis of wave propagation in tissue. Modern methods more accurately model the interaction of an acoustic wave propagating in inhomogeneous media (like tissue) and more use more sophisticated models of tissue.

We (the UW-Madison Ultrasound Group) and our collaborators (at the University of Illinois, University of Iowa, Intrermountain Healthcare, Duke, Boston University, and Rensselaer Polytechnic Institute), as well as many others around the world, are actively developing QUS methods. The goals of this presentation are to provide a description of some of the key underlying physical principles involved in QUS, some of the key successes and notable failures. From this, it is clear that a rigorous understanding of both the underlying physical principles and basic biology are necessary for maximizing the potential of QUS techniques. Further, the motivation for system-independent QUS parameter descriptions of tissue will be presented.

The prospects for the future development and application of QUS methods are very encouraging. Current clinical ultrasound systems provide higher center frequency, broader bandwidth, and lower noise echo signals, and these lead to improved QUS accuracy and precision. Some of those developments will also be highlighted.

Learning Objectives:

1) Understand the basic concept of quantitative ultrasound (QUS) analysis
2) Understand the range of QUS parameters that describe tissue properties
3) Understand the desire for system-independent QUS
4) Begin to appreciate the prospects for clinical application of QUS