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Mathematical models for contrast bubble dynamics

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Theoretical investigation of the acoustic responses of albumin-encapsulated microspheres began over fifteen years ago when Albunex, the first agent approved for clinical use in the US, was still in development. Since that time, the number of potential ultrasound contrast agents has grown considerably. Depending on the agent, the shell may comprise a layer of proteins, synthetic polymers, surfactants, or lipids with a thickness from a few nm to 500 mm and surrounding air, sulfur hexafluoride, perfluorocarbon, or other gas. A thorough understanding of the interaction between ultrasound pulses and contrast microbubbles is essential for the successful clinical application of a particular agent. In this talk, the behavior of various contrast agents will be discussed, and appropriate models for each will be described. The basis for each of these theories is a free bubble model "supplemented" by the effect of the encapsulating shell. The differences among these models lie primarily in their treatment of the encapsulating layer and, to some extent, the surrounding medium. Comparisons among models will include predictions of radial responses, thresholds for bubble destruction, and clinically significant acoustic properties (resonance frequency, scattering strength, nonlinearity, etc.). [Supported by NIH 2 RO1 EB000350-04A2 (CCC) and by NIH 2 G12RR003061-21 (JSA).]