NCRP Report No. 113, Exposure criteria for medical diagnostic ultrasound: Criteria based on thermal mechanisms. Issued June 1, 1992. National Council on Radiation Protection and measurements. 7910 Woodmont Avenue, Bethesda, MD 20814-3095, USA. 278 pp. Price, not known.

The popularity of clinical ultrasonography is well known. Patient tolerance, repeatability, ease of operation and the economy of the test have all contributed to the daily increase in the clinical application of ultrasound. The number of medical and paramedical personnel using this modality is increasing day-by-day.

There has been no restriction to the use of ultrasound whether the patient is a foetus or an aged individual. A safe limit so far has not been prescribed for the application of ultrasound taking for granted. It is absolutely safe to handle the source to any amount. This is partly due to the fact that there is paucity in the available literature regarding safety rules for the use of ultrasound and partly because the need for any safety precaution has not been advocated.

The NCRP report No. 113 is a correct step toward achieving this goal of presenting safety regulation in the application of clinical ultrasound and also to find out any untoward effect of ultrasound in the clinical practice. The present report by the scientific committee 66 (SC66) of the National Council on Radiation Protection (NCRP) is a response to the recommendation of the previous report No. 74 (NCRP, 1983) on biological effects and mechanisms of action of ultrasound.

The general purpose of this book has been to formulate quantitative guidelines for diagnostic ultrasound in methods for defining conditions in which there is risk or the risk is negligible. The scientific committee constituted to achieve this purpose has taken up the thermal mechanisms of ultrasound to evaluate the risk.

The book is divided into ten sections including a summary and followed by an appendix.

A comprehensive description of the methods available for studying the heat-producing characters of ultrasound is given in the beginning.

A person who browses through the first two sections of the book gets easily an idea of the methods to study and understand the physical principle behind the production of heat and physiological consequences of raising the temperature at cellular or multicellular levels.

In the third section the details of heat generation in different mammalian tissues and the difference in absorption by different tissues, such as fatty tissue, muscle, ovary and foetal skeleton, are given.

The methods of estimating *in situ* values of acoustical quantities are described in section five in which use is made of assumed linear relationships between these quantities and values of the same quantities in a free field in water which is based on simplified models of tissues along the paths traversed by ultrasound beams. Five tissue models and the temperature calculations made in each of them are described in detail including a propagation-path model for obstetrics. Several algorithms are made available for estimating the steady state temperature rise when either a homogenous tissue model or a two-layer tissue model is used.

A review of all experiments to study temperature elevation in mammalian tissues or media which mimic tissue characteristics is given in section six. Few areas worth mentioning are the time course of temperature rise produced by unfocused ultrasound in foetal tissue and temperature elevation produced by diagnostic ultrasound in soft tissues by its interaction with bone. Two important revelations are that bone stands out from other tissues in effectiveness for converting acoustic energy into thermal energy and that when ultrasound propagates through a lightly absorbing medium, most of the energy conversion occurs in a short distance.

The biological effects of heat are extensively dealt with for focal lesions in cat brain and its dependence on the threshold and pulse frequency separately in cat brain. It is said that under certain circumstances one can predict with confidence whether or not ultrasound will cause a designated biological change to occur in a mammal.

A brief description of nonthermal effects of ultrasound is given towards the end of the book. This includes description of non-thermal processess and mechanisms and also conditions and subject properties which determine the prevalence of thermal versus nonthermal processes. Acoustic streaming effect, active bubble formation and cavities are the nonthermal ultrasonic bioeffects described. There is suggestion to explore the possibility of synergistic effects of thermal and nonthermal effects which may be very significant.

The aim of this report as to what should be the limit of ultrasound power which can be safely given without jeopardizing the diagnostic yield is considered in the last section. The factors affecting intensity of ultrasound and various exposure parameters which affect diagnostic information and the potential for inducing biological effects, factors determining effective penetration, conditions in which increased power does not result in improved diagnostic information are all described in detail.

The example given to show that certain machines do not necessarily produce adequate or even optimum image quality when maximum intensity of power is used is by studying a 3.5-MHz linear array transducer while imaging placenta. Similar results were obtained by many authors from both *in vivo* and *in vitro* studies. It is shown that all these studies have paved the way for equipment improvizations such as one-knob technique, multiple receive lines on a single transmit pulse and exploso-scan technique. One of the suggestions is to have a single control for overall system sensitivity which would control the system for maximum use with minimum acoustic emission in a fool proof manner.

The conclusions and recommendations of this scientific committee are given at the end. Here a summary of all the chapters is given, followed by the recommendations. This includes a flow chart for the prudent use of ultrasound which would be a great source of information and guidance to all those who work with clinical ultrasound, soft tissue models, and algorithms for estimating upper limit to the temperature rise in the form of tables, graphs and formulae.

A good part of the book is devoted to a large source of general information given in the appendix. This includes discussion on temperature elevation produced by commercial ultrasound equipment, on tables and formulae and also on self-heating of transducers.

Altogether this report from NCRP fulfils a long felt need for guidelines for researchers in ultrasonography.

I recommend this book for those who are in the teaching profession of ultrasonography and its physical aspects. This would be a great reference book for those who have to set standards of ultrasound machine during its manufacture as well as for the regulatory agencies.

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Erratum

In the column 'In this issue' (Vol. 64, Number 7) on page 445 there is a misprint regarding the year of the death of Dr Kothari. Please read 1993 instead of 1983.