Editorial

Social Consciousness and Radiation Treatment in India

I must admit that as editor of this newsletter which belongs to scores of medical physicists of India I presumed that my responsibility encompassed medical physics subject, profession and professionals and all allied areas which dissolved seamlessly among themselves. It was consistent prod from Dr M.R. Raju, a medical physicist par excellence, Padmsri awardee and founder of International Cancer Centre, Bhimavaram, Andhra Pradesh which forced me to consider the “patients” also as an inevitable foundation of medical physics profession. It is a reality that in the rustle-bustle of high-tech, corporate culture, globalisation, marketing and expectation of fast and high return we may forget the patients who are supposed to be benefitted by all these developments. There is no denying to the fact that technological development is must and has brought better treatment but it is also a reality that our sight for appropriateness of treatment (or overtreatment) and evidence based treatment may be lost if we are not aware of our larger responsibility to return our bits to society as we get enormously from the same society. Developing low-cost and appropriate treatment strategy and gadgets should be our priority for the segment who can’t afford. As the private-public partnership in radiation treatment is expanding we have reasons to believe that cancer hospitals would come-up in smaller cities as well giving near-home feelings and benefits to the vast rural population. Development of sustainable infrastructure in smaller cities must be undertaken so that professionals may not hesitate to serve there. We must remember that we are service provider at just one place but service-takers at all other places. This vision must define actions of manufacturers, marketing companies, professionals and entrepreneurs of healthcare industry.

A divergent note:
AMPI has inalized guidelines and mandate of various committees which shall spearhead various tasks. It is the best example of inclusiveness of all yet maintaining the quality since Executive Committee may choose appropriate members to accomplish the high worth agendas. It, in addition, does impart accountability to the AMPI EC for its performance in coming years.

References

Pratik Kumar
HIGH INTENSITY FOCUSED ULTRASOUND THERAPY

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Introduction

High intensity focused ultrasound is a medical procedure that applies high intensity focused ultrasound energy to locally heat and destroy diseased or damaged tissue through ablation. HIFU is a hyperthermia therapy, a class of clinical therapies that use temperature to treat diseases. HIFU is also one modality of therapeutic ultrasound, involving minimally invasive or non-invasive methods to direct acoustic energy into the body. Clinical HIFU procedures are typically performed in conjunction with an imaging procedure to enable treatment planning and targeting before applying a therapeutic or ablative levels of ultrasound energy. When Magnetic Resonance Imaging (MRI) is used for guidance, the technique is sometimes called Magnetic Resonance guided Focused Ultrasound, often shortened to MRgFUS or MRgHIFU. MRgFUS was approved by the USFDA in October 2004, with more than 2000 patients treated to date worldwide. Currently, HIFU is an approved therapeutic procedure to treat uterine fibroids in Asia, Australia, Canada, Europe, Israel and the United States. HIFU is approved for use in Bulgaria, China, Hong Kong, Germany, India, Italy, Japan, Korea, Malaysia, Mexico, Poland, Russia, Romania, Spain and the United Kingdom.

History

The first investigations of HIFU for non-invasive ablation were reported by Lynn et al. in the early 1940s. The Fry brothers are credited with the first application of HIFU for neurologic disorders in humans. In 1970s, US were used to induce hyperthermia (elevation of tissue temperature to about 43°C) in the entire tumor volume for an extended time (about 1 h). A rediscovery of HIFU for the treatment of tumors occurred in the 1990s with the refinement of modern technologies in transducer design, modes of energy delivery, and real time imaging. Precise targeting and good treatment follow-up techniques (with anatomical and functional imaging) were available with diagnostic US scanning and MRI techniques. The first commercial HIFU machine, called the Sonablate 200, was developed by the American company Focus Surgery, Inc. (Milipitas, CA) and launched in Europe in 1994. The ability of HIFU to target subcutaneous tissue volumes and produce almost instantaneous cell death by coagulation necrosis in the selected regions of deep-seated soft tissue tumors has made it a candidate for direct and rapid treatment of tumors.

Basic Principle and Physics

Focusing the sunrays onto a small spot with a magnifying glass to start a fire is a childhood experiment that many of us tried. High-intensity focused ultrasound (HIFU) therapy is a technology with similar principles using ultrasound (US) instead of sunrays (Fig. 2). In HIFU therapy, ultrasound beams are focused on diseased tissue and due to the significant energy deposition at the focus, temperature within the tissue can rise to levels from 65° to 85 °C, destroying the diseased tissue by coagulation necrosis and hence, increase the temperature or bring about other biological interactions in an absolutely non-invasive manner. No significant negative biological effects on the intervening tissue occur as long as that the ultrasonic energy is appropriately located and focused.

Sound is defined as a disturbance of mechanical energy that propagates through a medium in the form of waves. As this definition implies, sound can transport energy from its source to another area as long as a medium is present. US is a form of sound that has a higher frequency (> 20,000 Hz) than the human ear can detect (20-20,000 Hz; audible ranges). While other minimally invasive therapies such as radiofrequency ablation or microwave ablation use an electrode or antenna to deliver electromagnetic waves, HIFU therapy makes use of US waves as carriers of energy, which is propagated through human tissues. US has been shown to have no detrimental effect on the human body within the diagnostic ranges used. However, it must be noted that US waves carry energy that causes biological reactions in various ways although these are usually minimal. The main challenge of this technique is to maximize energy-accumulation at the target area in order to induce significant biological reactions without causing harm to the intervening tissues such as the skin and the tissues surrounding the target area.

Sonic intensity (SI) can be defined as a time-average rate of sonic energy-flow through a unit area (SI unit: W/cm2). The sonic intensity is proportional to sonic pressure square and has a positive correlation with the power and energy of sound. This implies that the higher the sonic pressure or intensity is, the larger the energy accumulation at the target area. Sonic intensity varies with space and time, and it is usually expressed as peak or average intensity, and both quantities can refer to either a spatial or temporal dimension (e.g. ISP = spatial peak intensity, ISATA = spatial average, temporal average intensity). Work (W) = Force (F) X distance (d)

Power (Po) = Work (W) /time (t) = F X d/t = F X Velocity (V)

Intensity (I) = Power/Area = F X V/A = Pressure (P) X V

Ultrasound wave Pressure (P) = Density (p) X Sound speed (c)

Therefore, I = P X V = P²/c

Figure 1. Highly focused Ultrasound Transducer. Ref. 2

Figure 2. (A) Focusing the sunrays with a magnifying glass (B) Focusing the ultrasound onto a small spot. Reference no. 3
Sonic intensity, defined as energy passing through unit area within unit time, is derived from plane wave. As seen in equation, intensity is proportional to square of acoustic pressure and is also function of property of medium (density and speed of sound) through which waves are propagated. In general, tissue-heating by US absorption is best predicted by the average intensity and the activity of acoustic cavitation by peak intensity. High-intensity US generally refers to US with an intensity (ISATA) higher than 5 W/cm². This type of US can transfer enough energy to cause coagulation necrosis of tissue and is usually used for ultrasonic surgery. By contrast, low-intensity US (ISATA = 0.125-3 W/cm²) causes non-destructive heating, therefore, it stimulates or accelerates normal physiological responses to an injury. This range of US is usually used for physiotherapy.

**Focusing**

The various methods of focusing US waves have been another important issue. The simplest and cheapest (often most accurate) method may be a shelf-focusing, for instance, a spherically curved US source (transducer). An US transducer constructed according to this method, has a beam focus fixed at the position determined from the geometrical specifications of the transducer. To compensate for its lack of versatility, a flat US transducer with an interchangeable acoustic lens system was devised. The acoustic lens enables variation of focusing properties such as focal length and focal geometry. However, a drawback of the lens system is that US waves undergo sonic attenuation due to absorption by the lens. Recently, a phased-array US transducer technique was adopted for HIFU therapy. By sending temporally different sets of electronic signals to each specific transducer component, this technique enables beam-steering and focusing, which can move a focal spot in virtually any direction within physically allowed ranges. This system is not only more versatile than other systems but also highly efficient without any sonic attenuation (Fig. No. 3).

**Therapeutic Application**

HIFU devices for clinical use fall into three main categories: extracorporeal, transrectal, and interstitial. Extracorporeal transducers are used for targeting organs that are readily accessible through anacoustic window on the skin, whereas transrectal devices are used for the treatment of the prostate and interstitial probes are being developed for the treatment of biliary duct and esophageal tumors. Therapeutic applications use ultrasound to bring heat or agitation into the body. Therefore, much higher energies are used than in diagnostic ultrasound. In many cases the range of frequencies used are also very different. Ultrasound sources may be used to generate regional heating and mechanical changes in biological tissue, e.g. in occupational therapy, physical therapy and cancer treatment. However the use of ultrasound in the treatment of musculoskeletal conditions has fallen out of favor. Focused ultrasound may be used to generate highly localized heating to treat cysts and tumors (benign or malignant), this is known as Magnetic Resonance guided Focused Ultrasound (MRgFUS) or High Intensity Focused Ultrasound (HIFU). These procedures generally use lower frequencies than medical diagnostic ultrasound (from 0.250 to 2 MHz), but significantly higher energies. HIFU treatment is often guided by MRI. Focused ultrasound may be used to break up kidney stones by lithotripsy. Ultrasound may be used for cataract treatment by phacoemulsification. Additional physiological effects of low-intensity ultrasound have recently been discovered, e.g. its ability to stimulate bone-growth and its potential to disrupt the—bloodbrain barrier for drug delivery.

**The Advantages of HIFU**

HIFU is an outpatient procedure general performed under local or general anesthesia that is completely radiation free. Because HIFU is non surgical, there is no incisions or blood loss and recovery is quick. HIFU therapy can be repeated, if necessary. Because it uses clean, ultrasound energy it doesn't cause harm to any tissue surrounding the targeted focal point.

**Limitations and Complications**

Despite its promising noninvasive and nonionizing effects in the therapy of malignancies, particularly those that are widespread or inoperable, the application of HIFU has certain limitations. Continuing research is still in great need in the area of focusing the HIFU pulses, the technique of gradual pulsed exposures to achieve a cumulative therapy result, improving imaging quality for accurate tumor determination and post-treatment evaluation, and developing a real-time monitoring modality for lesion generation and temperature elevation. Magnetic Resonance guided Focused Ultrasound (MRgFUS), MRI has excellent anatomical resolution and high sensitivity for tumor detection, thereby offering accurate planning of the tissue to be targeted. In order to be used in the high magnetic fields of MRI, HIFU transducers must be specially designed for compatibility. The lead zirconate titanate (PZT) ceramic material, commonly used for US transducers, contains nickel, which is necessary for the high levels of electrical excitation and mechanical stress induced. However, nickel causes magnetic field distortion. Therefore, the new piezo-composite materials are usually used to develop MRI-compatible transducers.

![Figure 3. Various methods of focusing US waves: A. Spherically-curved transducer, B. Flat transducer with interchangeable lens, C. Phased-array transducer causing only steering, and D. Phased-array transducer causing steering and focusing at same time. Reference no. 4](image-url)
References

2. Figure no. 1. http://www.ondacorp.com/continuous_beams.shtml
4. Figure no. 3 https://openi.nlm.nih.gov/imgs/l51/314/2627265/2627265_kjr-9-291-g004.png

KNOW OUR MEDICAL PHYSICIST

Dr. Nirmal Kumar Painuly had his post-graduation in Physics from HNB Central University, Srinagar (erstwhile Garhwal university) in 1985, PG Dip. R.P. from Bombay university in 1986 and Ph.D. in Biomedical Physics from Dr. B.R. Ambedkar university, Agra (formerly Agra University) in 2000. He had second Master degree in Medical Radiation Physics from university of Wollongong, New South Wales (Australia) in 2003.

Dr. Painuly has more than 27 years of teaching and research experience in Radiotherapy and Nuclear Medicine in various capacities both in India and overseas.

Dr. Painuly served BRD Medical College, Gorakhpur as Lecturer from 1988 to 1992 and thereafter S.N. Medical College, Agra until 2001, after selection through public service commission to the position of assistant professor. He completed his Ph.D during this period and in 2001 moved to Australia to hone his research skills. During his stay in Australia, he got the opportunity to work with leading researchers and got involved in multi-institutional cum multinational collaborative research. It was during this collaboration that he got the opportunity to learn the modern tools i.e. Monte Carlo codes MCNP and Geant4.

Dr. Painuly’s research contributions are Multidisciplinary. He has published 43 research articles in peer reviewed journals and has contributed a chapter in a book on ‘Nuclear Cardiology’. He has presented many scientific papers/posters in various conferences/symposium and delivered quite a few invited lectures. Dr. Painuly has chaired number of scientific sessions in various conferences. He was runner up in “InSight Curie Prize Contest” organized by New South Wales/ACT chapter of the Australian College of Physical Scientists and Engineers in Medicine (ACPSEM) in 2003.

Dr. Painuly has been investigator in three research projects funded by DST, ICMR and AERB during 1996-2000. He was the part of an international collaboration between Department of Engineering Physics, university of Wollongong (New South Wales) and European Synchrotron Radiation Facility, Grenoble (France) on the development of 'Microbeam Radiotherapy' during 2003-2005.

Dr. Painuly was secretary of erstwhile UP-Delhi chapter of Association of Medical Physicists of India (currently known as Northern Chapter) during 2000-2001. He was the organizing Secretary of National conference of the Association of Medical Physicists of India (AMPICON 2006) held in Bhubaneswar. He has also organized the annual conference of the Northern Chapter of AMPI (AMPINCON 2014) at KGGMU, Lucknow. He was the member of the organizing committee of the National Conference of AROI 2015 held at KGGMU. At S.N. Medical College, Agra, he was part of the organizing team which organized many seminars and workshops under the banner of society of Nuclear Medicine of India. Dr. Painuly was coordinator for DNB examination of Nuclear Medicine during 1997-2000.

MOVERS AND SHAKERS

Dr. G. Sahani, SO "F", has been awarded Outstanding Performance / Special Contribution Award 2014 by Atomic Energy Regulatory Board, Mumbai in November 2015 for his significant contribution to various aspects of regulatory work. Congrats !!!

Dr. Omprakash Gurjar, Sr Medical Physicist, Roentgen Oncological Solutions Pvt. Ltd., Indore was awarded “Dr. M.S. Agrawal Young Investigator Award 2015” by Association of Medical Physicists of India at recently held AMPICON2015 at Thiruvananthapuram. Congrats!!!

Dr Suvendu Kumar Sahoo, Senior Medical Physicist & RSO, Deptt. of Radiotherapy, HCG Panda Curie Cancer Hospital, Cuttack, Odisha has been awarded Ph.D. degree in Physics by KIIT University, Bhubaneswar, Odisha in October, 2015. The title of his thesis was "Study of some Biomaterials by irradiating with a Modern Linear Accelerator".
Currently, Dr. Painuly is working as Professor of Radiological Physics in the department of Radiotherapy, King George Medical University, Lucknow. He is approved Ph.D. guide for King George Medical University, Lucknow, Bhilai Institute of Technology, Durg (C.S.), H.N.B. National University, Srinagar, KIIT Bhubaneswar and SRM University, Lucknow. Four PhDs have already been awarded to his students till date and currently three PhD scholars are registered with him. Dr. Painuly is also the course co-ordinator for B.Sc. (RT) degree since its inception in 2013. Recognizing the importance of the discipline, the university management has entrusted him with the task of development of quality education and research in Radiological Physics in King George Medical University, Lucknow, and to make it a reality, a formal process to create a department of Radiological Physics has already been initiated. Dr. Painuly is the founder member of College of Medical Physicists of India and life member of AMPI.

**KNOW OUR MEDICAL PHYSICIST**

Dr. Challapalli Srinivas, Professor of Medical Radiation Physics, Deptt. of Radiotherapy & Oncology, Kasturba Medical College (KMC), Mangalore was born at Vijayawada, Andhra Pradesh in the year 1966. After completion of his graduation in B.Sc. (Physics as main subject) in the year 1988, he acquired M. Sc. in Nuclear Physics (with Spectroscopy as main subject) in the year 1990 from Andhra University, Visakhapatnam. He underwent training in postgraduate diploma in Radiological Physics (Dip.R.P.) at Babha Atomic Research center in the year 1991. He joined as Lecturer in Medical Physics at Deptt. of Radiotherapy, KMC, Manipal in the year 1992 and subsequently established the radiotherapy treatment facility at Mangalore. He received Ph.D. from Manipal University in 2006 for his thesis entitled “Application of Bio-effect models to Radiotherapy of Carcinoma of Uterine Cervix”. He is the member of Faculty in Medical Radiation Physics for undergraduate (MBBS, BSc) and post graduate students (MD Radiotherapy & Radio-Diagnosis). He is extending support to hospital administration as an Internal Quality Auditor for ISO 9000:2001 & EMS (ISO 14001:2004) since 2004. He has written “Radiation Safety Manual” for Kasturba Medical College Hospitals in the year 2010. He has been appointed as Pre Ph.D Examiner (for Medical Radiation Physics) & Member Ph.D Registration Committee to Rajiv Gandhi University, Bangalore since 2011. He has been adjudged “Mentorship Radiological Safety Officer” by Indian Association for Radiation Protection during 2012. He is also the Course Coordinator for BSc (Medical Radiotherapy Technology) degree course (conducted by Manipal University) for Mangalore campus since 2013. Being life member of Association of Medical Physicists of India (AMPI), Association of Radiation Oncologists of India (AROI), Association of Radiotherapy Technologists of India (ARTTI) & Indian Association for Radiation Protection (IARP), he has received 4 times best paper awards for his scientific paper presentation in various annual conferences of AMPI, AROI & ARTTI. He has attended various international, national conferences, CMEs, workshops, seminars, presented scientific papers, delivered guest lectures in various academic platforms. He has published 12 papers in national and international journals. He served as Chairman of Karnataka Chapter-AMPI during 2009-2011 & elected as member of Editorial Board of Medical Physics Bulletin of Karnataka Chapter AMPI in the year 2015. He reviewed more than 10 scientific publications in Journal of Medical Physics & Journal of Cancer and Radiotherapy. He has conducted various academic events related to Medical Radiation Physics like national conference of Association of Medical Physicists of India (AMPICON) in the year 2012, Continual Medical Education programs on “Safety, Quality & Accuracy in Radiotherapy” in the years 2010 & 2011, “Radiation Safety Course” for Therapy technologists in the year 2012, Symposiums on Medical Physics & Radiation Safety (in the years 1997, 2002, 2010, 2015) in collaboration with Karnataka Chapter-AMPI at Mangalore. He has served as Secretary of AMPI during two consecutive periods 2011-13 & 2013-15. He played a major role in the development of dynamic website of AMPI. Conducting of AMPI elections through e-mode for the first time in the history of AMPI, leading AMPI member’s team to MCI, establishing of effective communications among AMPI members from AMPI office, conducting of all EC and general body meetings of AMPI smoothly and effectively, are some of his important contributions as secretary. Recently he visited Royal Hospital, Oman and Cho Ray Hospital, Vietnam as academic observer. He is Guide to Ph.D. students in Medical Radiation Physics under Manipal University. He also holds diploma in Karnatic Instrumental Music (Veena) from Andhra and Nagarjuna Universities and he has performed at various music concerts in All India Radio and in various national level music programs. He was credited as Best Student award from the Music College of “DwaramVenkataswamy Naidu Kalakhetram”, Vizag in the year 1991.

**MEDICAL PHYSICS FUN TIME**

Richa Sharma
Medical Physicist & RSO, Delhi State Cancer Institute, Delhi

![Medical Physics Fun Time](image)
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Medical Radiation Cartoon Contest

Medical Physics Chronicle, newsletter of Association of Medical Physicist of India Northern Chapter organises a Cartoon Contest on the subject of radiation in medicine and all its related aspects including profession, professional and policies.

The Contest is FREE and open for ALL

First Prize: Rs. 10,000/-
Second Prize: Rs. 7,000/-

1. A contestant may send one or multiple entries. Entries should be sent by email only. The entries may be in color or black & white and may be made in one or multiple frames.
2. The size of cartoon should be such that figure and words should be legible. However, inside cartoon there should NOT be any signature or name of the author(s) written.
3. One or more authors may collaborate in making the cartoon. All names of the winning entries would be published. However, the prize cheque will be sent in favour of the first author only.
4. Medical Physics Chronicle reserves all right regarding conduct, declaration and awards of the contest and prizes. Its decision will be final and binding. All entries will be properties of Medical Physics Chronicle and same should not be used by the author without prior approval of the editor, MPC.
5. The covering email should give undertaking that the creation is original.
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7. Kindly send entries to drpartikkumar@gmail.com by 31st May 2016. For any clarification kindly contact Editor, Medical Physics Chronicle at above e-mail.

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