

How technological innovations are changing medical practice

Convocation address delivered on 1st December, 2018 on the occasion of the 9th Convocation of Sri Venkateswara Institute of Medical Sciences, Tirupati

Honourable Minister for Health and Medical Education, Government of Andhra Pradesh, Honourable Director-cum-Vice Chancellor, Members of Governing Council, Academic Senate, Faculty and Staff of Sri Venkateswara Institute of Medical Sciences (SVIMS), Graduating students, Distinguished Guests, Ladies and Gentlemen,

My greetings to you all on the occasion, it is my great privilege and pleasure to address you at the 9th convocation function of this prestigious institute situated at the foothills of Lord Venkateswara and amidst eminent personalities and medical professionals. I am very delighted to know about the various strides that SVIMS has made since its inception and its services to the town of Tirupati and Andhra Pradesh. Under the able leadership of the present Director, I am sure these services will continue unabated.

At the outset, let me congratulate all the students who are graduating today. Dear graduating students, you are now entering a unique phase in your life, transiting from studentship to responsible citizens of the country. Please remember that you now belong to a fortunate few in the country, who had access to medical education. You should now awake to the realities of the country and world to be able to succeed in the competitive environment. You must learn to use your acquired knowledge to serve the society and create the intellectual wealth for you and for the organisations where you work. You must consider it as your bounden duty to strive for the welfare for the sick persons and to reduce the disparity in society and empower the disadvantaged section. Your profession is one of the noblest ones, caring for the health of humans – the rich and the poor, irrespective of race, religion or creed and nationality. It is one of the most respected professions in the society along with the teaching profession, to whom the sick and suffering look for hope. In a country where healthy and educated people live, the societal progress is automatically driven with assured quality of life. Unfortunately, health and education are the sectors in which the government's investment and importance are not

enough as it should be. Despite this, India is well known globally for its medical profession, thanks to several medical institutes such as SVIMS, who continue to produce quality graduates, with both professional competence and societal compassion. I am sure the students who are graduating today will imbibe these lifelong attributes in full measure.

I come from science education and research background and have been fortunate to be the Founder Director of two institutes of Indian Institute of Science Education and Research at Pune and now at Tirupati. My own research is in the area of how to make drugs out of the genetic materials deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). During my career, I have witnessed enormous growth in the area of biopharmaceuticals where macromolecules such as proteins, antibodies and now nucleic acids DNA and RNA are becoming drugs, as effective as widely known small molecules. With the human genome sequencing now available, most recent developments in antisense therapy have already led to three approved drugs based on DNA analogues. These can be used to address several diseases not amenable for therapy by small molecules. New approaches based on the stem-cell therapy and the emerging clustered regularly interspaced short palindromic repeats (CRISPR)/ CRISPR-associated (Cas) technology hold promise for new approaches for the treatment of many diseases for which either drugs do not exist or the present therapy is unsatisfactory. We are now witnessing unprecedented growth in the development of new technologies for both therapy and rapid and affordable diagnosis of diseases. This is possible because of medical, engineering and basic research scientists interfacing to create new materials and vistas for healthcare. In our country, it is important to increasingly fuse medical research with that in basic sciences and engineering. Unfortunately, both medicine and engineering have been taken out of university system, placing under All India Council for Technical Education (AICTE) and Indian Council of Medical Research (ICMR), which has seriously stunted the growth of such interdisciplinary research enterprise. Here, we talk of research from benchside to bedside, while

I found during my recent visit to the USA that research is actually opposite – bedside to benchside. Much of the research originates from observing patients not responding to certain treatments and then scientists investigating the reason for the same and going to their drawing board to find cure.

The advent of nanotechnology is making big strides in therapy and diagnostics and inventing new biomaterials for implants, eye surgery, etc. One of the biggest barriers for drugs is their poor cellular/tissue uptake and undesirable biodistribution leading to low efficacy and toxicity. Many nanoformulations are now overcoming these barriers and many drugs are being selectively targeted to reach desired tissues. The importance of nanoimmunotherapy is recognised by this year's Nobel Prize in two areas: physiology and medicine for cancer immunotherapy and in chemistry for phage display strategies resulting in developing antibody drugs. Finding effective cure for cancer through this approach holds great promise. Engineering virus particles to specifically interact with immune cells through nanointervention has great therapeutic potential when the challenges and barriers are overcome. In such a scenario, translational aspects become important and that's where basic scientists have to work closely with medical researchers. One can now design nanovehicles for drug delivery for combination drugs and to release them sequentially in a controlled fashion.

An area of great potential of modern research is in regenerative medicine. Regenerative medicine is about developing methods to regrow, repair or replace damaged or diseased cells, organs or tissues. It is achieved by the generation and use of therapeutic stem cells, tissue engineering and the production of artificial organs. Several exciting possibilities are on the horizon.

A tissue-engineered oesophagus could overcome limitations associated with oesophageal substitution. Tissue-engineered muscle: Despite the regenerative capacity of muscle, tissue volume is not restored after muscle loss, due to a loss of extracellular structural matrix. It should be possible to engineer a 'bioconstruct', comprising an extracellular matrix scaffold (decellularised muscle), muscle stem cells and muscle-resident cells. Such engineered tissues can address the growing need for tissues and organs in surgical reconstructions. Tissue and organ biology is very challenging to study in mammals. Advances in stem-cell culture have made it possible to derive *in vitro* three-dimensional tissues called organoids that capture some of the key multicellular, anatomical and even functional hallmarks of real organs

at the micrometre-to-millimetre scale. Organoids are already becoming amenable for real-life applications to cure several clinical conditions in both acute injuries and chronic diseases.

Scientists are developing several kinds of tissues and organs (from bladder to heart, blood vessels to skin, from nerve to ovary, etc.); unfortunately, only some of them have been implanted successfully in humans.

Every 30 seconds, a patient dies from diseases which could be treated with tissue replacement. Success in the tissue engineering and regenerative medicine could probably offer solution for children with congenital malformations, young soldiers disfigured in war and old people suffering from chronic invalidating diseases, which are burdening heavily on world's national economies.

Eve Harold, in her book — *Beyond Human: How Cutting-Edge Science Is Extending Our Lives*, says nanobots derived from nanotechnology can usher in an era of an ageless society. The concept of nanobots is an offshoot of converging technologies – marrying the concepts from physics, chemistry, engineering and artificial intelligence (AI) and drawing biological inspiration. This is leading toward the development of some of the most effective paradigms such as neural networks or evolutionary algorithms. A nanorobot can deliver cargo to payloads, sense, respond and build to perform tasks on a macro-scale. They are programmed and act autonomously. Termed as the silver bullet in medicine, the tiny robots may even conduct surgery and deliver drugs deep inside the body at the right location. While nanotechnology has great potential in preventing neurodegenerative diseases such as Alzheimer's disease and cancer, AI when spliced with nanorobots may supplement the gap in handling the immune system. They can usher in an adaptive immune system, as opposed to the reactive human immune system. AI program can learn on the go, becoming progressively better with the experience it gains. With such training, an AI program alongside nanobots could work in tandem to significantly improve the human body's response to diseases such as HIV, cancer and age-related degenerative diseases such as Parkinson's disease.

As with any new biotechnology, there are serious issues with linking AI with nanobots. AI program can target its host cells, leading to more damage. The AI program must be robust enough to handle changing scenarios in the host body, such as pregnancy, intake of other medications, withstand the magnetic fields and electrical forces during magnetic resonance imaging scan.

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Another area of great potential is application of data science and machine learning in medical practice. I am not sure how much of patient records are captured digitally, but India can be a rich source of such patient data. Keeping the secrecy and anonymity of patients, it is possible to extract a wealth of useful information from such data to generate the predictive knowledge about diseases useful in its identification and diagnosis. It also presents the challenge of finding ways to work with all the resulting data. That is where the idea of a biologist working with informational and computational scientists becomes important. Machine learning and AI are very good tools in increasing our understanding in the area of radiology, brain-based diseases such as depression and behavioral modifications and in personalised medicines and clinical trials. I have only highlighted some of the expected future developments in the field of medicine. There are very many exciting things that are possible in medical technology. I urge you all to always keep in touch with latest developments that are happening in your field to bring their benefits to patients. It is important for more medical people to get into research arena, but I do realise that the patient loads are so heavy in our hospitals that most doctors do not find time to devote to research.

Dear graduating students, you must realise that the noble values of caring and sharing of knowledge and sacrifice have prevented human society from degeneration and extinction. As inheritors of a vibrant and healthy society, you must cultivate an intense concern for human development, constantly expanding your knowledge, learning to collectively work in a team and forever be guided by higher ethical values, beyond the boundaries of narrow and partisan outlook. You must stretch beyond the limits of your abilities.

The world is moving so fast that even to be stationary we need to keep galloping; no one has patience, interest or time to know reasons for our failure. Each one of us has to selflessly contribute in appropriate and substantial

measures to raise the quality and outcome of our efforts by exemplary performance within our work environment. Dear graduating students, I am sure you will carry this message and acknowledge your *alma mater* forever in your life because it has made you what you are and what you will be in future. May you all be blessed with the wisdom, success and a true sense of fulfilment to reach your cherished goals and ideals.

Thanks and best wishes

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