1st Abdul Kalam Conference,
IITM,Chennai, July 2019

GLOBAL ALLIANCE FOR WELLNESS AND HEALTHCARE

Pre-Conference DraftReport of Working Group 5

The Kalam Conference Team

1st Abdul Kalam Conference
Working Group WG5 Report

A GLOBAL ALLIANCE FOR WELLNESS

Narayanan M. Komerath (Ed), Shivshankar Sastry, Saurabh Khakharia
and others for The Kalam Conference Team

June 22, 2019

Contents

List of Figures

Chapter 1

Introduction

1.1 State of Modern Medical Care:

Humanity has developed ways to alleviate sickness and pain, and delay death. The capabilities of medical science are truly awesome. However, so are their costs, which very few humans can afford, even if they can get access to them. Around the world, the accessibility of good medical care is a critical problem both in terms of physical access and financial access. Some people have access to private health insurance either individually or through employer-assisted groups. A common feature is that every year, the level of benefits go down, the so-called co-payment portion goes up, coverages are reduced, and the premium rises, much faster than inflation. On the other hand, some countries offer so-called socialized medicine. The quality of care, and the long waiting times for help, are often unacceptably poor. It is fair to say that the medical systems of many countries are dysfunctional from the patient's point of view. This, despite the obvious dedication and commitment of a majority of healthcare professionals.

Obstacles: On the other hand, most countries have a knowledge base of traditional medicine, above and beyond the local folk remedies learned in all families and communities. Efforts to integrate these traditional remedies with 'modern' government-certified medical practice is often suppressed by stringent punishments for practising medicine without a license. Licensed practitioners are forced to ignore traditional remedies because they are not certified by the appropriate authorities. Traditional medicine is often pooh-poohed as Witch Doctor remedies, even where it is not banned outright. In other places, there are high barriers separating the worlds of traditional

and "modern" medicine.

Opportunity: India is a nation where the relationship between these branches of medicine is much more complex, while the need for any medicine at all is very acute. This offers hope for a comprehensive global solution. The ancient body of knowledge called Ayur Veda (literally, knowledge-base of Life) is highly respected, and widely practised, with results that are absolutely undeniable in many cases. Practitioners of Modern Medicine, known in India as Allopathy or simply 'English remedy', argue that Ayurveda is based on empirical observations and remedies that are not synthesized from proper, statistically valid 'scientific' data. This claim requires examination from two angles. Firstly, 'English Medicine' also depends on empirical statistics. Consider the allowable A1C level for Type-2 diabetes patients. By metrics accepted in The West, over 80% of Indians are estimated to be diabetics. Is this true, or is it that the empirical database on which the criteria are based, are really applicable only to Caucasian populations? In the particular case of Type-2 diabetes, there are numerous folk remedies including a vegan diet, that achieve drastic reductions in A1C, much better than most Allopathic remedies, with few if any reported or observable side effects. On the other hand, there are also many more advertised miracle cures in the West, even more than ever-newer miracle drugs that do come with drastic side effects. Similar considerations may apply to the notion of Body Mass Index, when populations of active or sedentary carnivores living in climate-controlled communities is compared to those of herbivores living in sunny climes. Again on the other hand, when one is having a heart attack, it is not the time for slow-acting 'holistic' remedies; only prompt modern first aid followed by surgery may suffice to save lives, so that the holistic methods can be given time to act.

Modern Ayurvedic curricula in India teach respect for modern allopathic diagnostics. *Thus, India's growing number of Ayurvedic doctors are probably the best equipped in the world, to become Internal Medicine specialists as well as Family Physicians offering the full range of medical knowledge available anywhere.* Interestingly, qualified physicians from Ayurveda schools are now licensed in India to use and call for modern diagnostics, and prescribe allopathic remedies. As these physicians rise in numbers and experience, they are growing into a wave that will force Allopathic doctors to adapt or perish.

Meanwhile the traditional remedies in Kerala are rising in worldwide acceptance for their unique effectiveness against chronic pain - and possibly against other ailments that are considered to be chronic and incurable in the Allopathy knowledge base. The notion that this is somehow just based on pricing differentials, propagated by the term 'Medical Tourism' is largely nonsensical. Many very wealthy people from

other countries have reported coming to Kerala after exhausting efforts all over the world to get other treatment, money no object. They left India cured and pain-free. Yes, it is true that 'Medical Tourism' is also rising sharply as people come to know about the quality of care available in selected Indian institutions, and as medical authorities and health insurance companies in other nations gain confidence in the quality and reliability, enough to reach for the cost benefits.

How do we transform these developments into a Global alliance to revolutionize health care? The full spectrum from Wellness guidance to local care access to telemedicine come under this mandate. There are several inspiring models to draw upon.

1.2 Charter of Working Group 5

The evolving mission and charter of Working Group 5 is to develop a plan to provide top-quality medical care to evey Indian in every corner of India, at affordable cost. This is essential to encourage reverse migration to villagers. Going beyond, access to excellent medical care is an essential concern for anyone who has the financial resources to afford such care.

We will survey a small sampling of the literature on different aspects. This is followed by focused sections on each aspect. At this initial stage we will rely on some expert comments for perspective, while listing the sample of the literature. As the Group considers this knowledge and refines its knowledge, we expect that the ideas for revolutionary advances will evolve and gain wider and deeper understanding. Four specific aspects are considered below as reasons to bring this group together. These are (a) the dramatic technological opportunities of telemedicine, (b) the rising understanding and communication of the basis for Ayurvedic remedies in the literature and (c) The dramatic potential of Artificial Intelligence across the board, and (d) medical economics, for its obvious and pervasive importance.

Telemedicine is very much a growth area, with the quality of two-way communications and media improving rapidly. The present best practice appears to include local trained staff who are the contact interface between the patient and the specialist. Specialized equipment is installed starting with some items at the patient's home for routine monitoring, local clinics, district hospitals, national specialist centers, and global specialist centers. Transporting patients to hospitals is an obvious hurdle given poor road infrastructure and long and uncomfortable ambulance rides. Thus there is a pressing need for a huge number of rural emergency-care clinics.

Many practices in Ayurveda are being explained by their specialists, and make sense. An example is the research on the utility of cow urine: a remedy long in use, and subjected to much sneering by ignorant Modernists. It is shown that cow urine has excellent anti-biotic properties, so that the empirical knowledge base evolved over millennia is accurate in incorporating it into widely-available remedies.

Artificial Intelligence and Big Data technologies have great potential to incorporate and update the knowledge base on medicine, and specialize it down to local community level.

The topic of medical economics is vital to any improvement of the healthcare system. Clearly there is tension between the drug developers who must invest in research and certification efforts, and the patient who pays for them, either directly or via insurance premiums. Government-provided insurance certainly helps people access medical care, but at best the government can only try to control cost increases. Cost reduction must come from other avenues such as mass-market application combined with profit-margin controls, as well as opening up global competition.

Chapter 2

Modern Medicine

The following is from a surgeon who practises modern medicine.

" Modern medical care is good but it is not going anywhere fast, it is too expensive for the world and certainly for India and it will never ever cover the entire population. Modern "allopathy" or western medicine is very effective and definitely the best over a limited (50-60%) of health needs of a population. People hate this figure - but whichever way one cuts the cake modern medicine is not going to help 100% of people.

What are the areas where modern medicine excels?

1. Mechanical problems:
    - Blocked artery in the heart:we can unblock it
    - Hole in muscle causing hernia: We can seal it
    - Clot in brain endangering life: We can evacuate it
    - Broken bone may kill you or put you out of action for long: we can fix it quick and better than nature
    - Dirty lens in eye: We can replace it
    - Rusty painful joint: We can replace it
    - Abnormal blocked birth canal threatening mum and child: we can save both
    - No baby? Sperm not reaching egg: we can get the two to mate
    - Can't pee because of blocked prostate: we can core out the channel

- Stone in gall bladder, bile duct or kidney: we can extract/remove them

2. Infections:
   - We prevent killer infections Tetanus, Diphtheria, Polio, Whooping cough, Influenza, Hepatitis, Typhoid etc by vaccination
   - We kill infections using custom-designed anti-infection chemical medicines (anti-bacterial, anti-viral, anti-fungal, anti-protozoal)
3. Critical care/life saving:
   - Losing blood: transfusion. Coming soon: artificial blood
   - Can't breathe: unblock pipe, give oxygen, use artificial lung
   - Kidneys dying: dialysis/kidney transplant
   - Heart dying: drugs, mechanical support, artificial heart, heart transplant
   - Liver dying: Liver transplant
   - Short of hormones? Diabetic? We'll replace them
4. Quality of life:
   - Dietetics
   - Lifestyle advice

What modern medicine has done is:

- To make humans as a whole much more healthy than earlier
- To make humans live much longer than earlier
- To make humans much fatter than before
- To damage the environment in favour of human health and comfort

What modern medicine has done is to pull people back from death and cause people who would otherwise be dead to live.

2.1 What modern medicine has not done:

Humans continue to have a large number of niggling problems for which modern medicine has no cure. Most of these niggling issues are considered too minor to require attention by allopathic doctors. No research money goes into such conditions and since these conditions do not threaten life, modern medicine is not interested.

It is in these areas that traditional medicine scores. There are areas that involve lifestyle advice and dietary advice that modern medicine does not even recognize as valid but people do get relief from indigenous/alternative medical therapy. But allopathic science is too arrogant and self centered to accept that.

We fill the cities with highly educated specialists who cannot offer holistic treatment. The cardiologist fills his patient up with drugs that keep the patient alive but leave him with him all sorts other symptoms for which he has to seek treatment from other specialists who simply fill him up with more ineffective medicines. Many of these people either move away to alternative medicine or seek to do that but are scared. There is a definite role for alternative therapies in India because Indians live by indigenous beliefs and do not accept allopathic solutions easily.

We need a huge change..It will be painful. I hate to say it - but as I enter my 5th decade of medical practice I see the cocky addiction to allopathy alone as one limb of our mental colonization. Allopathy is good - but not complete and if we are scientists we must keep an open mind to what we cannot do and what have have not been doing. ”

For the successful use of Artificial Intelligence (AI), one needs a large pool of South Asian patients. Interestingly, this year for the first time the American College of Cardiology acknowledged that South-Asian ethnicity is by itself a risk factor for heart diseases. Yet, there are no current guidelines for primary prevention of heart diseases in South-Asians. One problem could be the Medicine teaching models in India. While India has just an amazing pool of patients, there is hardly any insistence on research and trials.

Chapter 3

Survey of the literature

Shankar Acharya [1] cited the shining example of the State of Tamil Nadu in providing public health services. He cited statistics showing that nearly 40 per cent of all children under three years have stunted growth while over half of married women (age 15-49) are anaemic. The incidence of communicable diseases such as dengue, diarrhoea, malaria and hepatitis, not to mention swine flu was rampant. Government spending on health was hardly 1 per cent of GDP. He cited papers by Monica Das Gupta et al. [2, 3] They noted that They note that a country's health system consists of three components:

1. Population-wide preventive services to reduce exposure to disease through sanitary and health regulations and monitoring and averting health threats
2. Clinical preventive services provided to individuals such as vaccination and screening
3. Medical services to care for and treat individuals with injuries and diseases.

The success of health advances in advanced nations has come from the first item, generally called 'environmental services'. Neglect of this sector in India can be traces to State level apathy and decisions on classifying workers. Tamil Nadu has been an exception, with well-organised public health services. They achieved the best results in full child immunisation coverage and the percentage of women receiving antenatal and postnatal care, resulting in reduced infant mortality. Disaster response has also been effective, such as after the 2004 Indian Ocean tsunami.

And all this has been accomplished despite being India's third most urbanised state (after Goa and Mizoram), being one of the least endowed with fresh water sources, being one of the main poultry producers (but no bird flu epidemic), and

with three international airports (but not an early hotspot for swine flu). This success can be traced to a separate Public Health Directorate since 1922, with trained staff and public health managers. Tamil Nadu has about 120 entomologists (contrasted with just a handful in most other states) who can contribute effectively to controlling vector-borne diseases. Tamil Nadu has a Public Health Act, which assigns responsibilities to different layers of government and agencies, sets standards of food hygiene, water quality et cetera and mandates regulation and inspection of agencies and establishments, including a broad authority to control any 'nuisance' that could threaten people's health. Fourth, there is a well-functioning professional public health cadre managing a team of non-medical specialists and lower-grade staff working solely on public health. This cadre has faster promotion avenues than medical cadre and enjoys considerable administrative responsibility and authority. The authors conclude that "Focusing on clinical services while neglecting services that reduce exposure to disease is like mopping up the floor continuously while leaving the tap running!"

The World Health Organization (WHO) [4] congratulated India in March 2016 for launching a vaccination campaign to immunize over 35 million children aged between 9 months and 15 years against measles, a major childhood danger, and congenital rubella syndrome (CRS), which causes irreversible birth defects. Measles is estimated to kill nearly 49,000 of the 2.5 million children infected every year. Rubella causes irreversibe vision and hearing loss in nearly 40,000 children each year. India has reduced measles deaths by 51% from an estimated 100,000 in the year 2000. This was done by increasing the reach of the first dose of measles vaccine, given at nine months from 56% in 2000 to 87% in 2015. In 2010 India introduced the second dose of measles vaccine to close the immunity gap and eliminate measles. Nearly 118 million children aged between 9 months and 10 years were vaccinated between 2010 and 2013. The plan was to cover 410 million children by 2018. India has already beaten smallpox, polio, maternal and neonatal tetanus and, very recently, yaws.

In 2018, India launched the Prime Minister's Health Insurance Scheme, known as the Ayushman Bharat Pradhan Mantri Jan Arogya Yojana. Literal translation would be *the Long-lived Indian: Prime Minister's People's Health Plan.* We will refer to this as AB for short.

Ayushman Bharat Pradhan Mantri Jan Arogya Yojana [5]. The authors summarize their conclusions:

1. Public spending on healthcare in India is amongst the lowest in the world at just over 1% of gross domestic product (GDP).
2. The Indian health system is characterised by substantial shortcomings relating

to workforce, infrastructure, and the quality and availability of services.

3. The Ayushman Bharat Pradhan Mantri Jan Arogya Yojana (AB-PMJAY), approved by the Indian government in March 2018, is an ambitious reform to the Indian health system that seeks to provide financial health protection for 500 million of the most vulnerable Indians.
4. We must halt the slide of the 5060 million Indians who fall into poverty annually as a result of medical-related expenditure (and much greater numbers worldwide).
5. There is a need for wide reforms across public and private providers of care if India is to meet its stated aims of providing universal health coverage (UHC) for its population.
6. The success of the program will rely on a reformed and adequately resourced public sector to lead implementation, delivery, and monitoring of the scheme.
7. While there are significant challenges facing the program, by providing the impetus for system-wide reform, the new AB-PMJAY presents the nation with a chance to tackle long-term and embedded shortcomings in governance, quality control, and stewardship and to accelerate Indias progress towards the stated goal of UHC provision.
8. Implementation and ongoing operation of the program need to be carefully monitored to ensure that it is meeting its aims in a sustainable manner and that negative unintended consequences are avoided.

3.1 Role of Technology and Innovation in Rural Healthcare in India

Life in villages is harder; citizens in villages are struggling for basic amenities like healthy food, clothes, sanitization, pure drinking water, toilets, basic education, electricity, transportation, medical facilities etc. The National Rural Health Mission Report shows that the majority of deaths occur due to preventable diseases such as diarrhea, measles and typhoid. The report estimated that 66% of rural Indians do not have access to critical medicines, and 31% of the population has to travel more than 30 kilometers to seek healthcare in rural India. Rural Health centers are critically short of trained health and medical personnel, 8% of the primary health care centers do not have doctors, 39% do not have lab technicians, 18% do not have a pharmacist.

On the other hand, the opportunities are huge. The Indian BoP healthcare market is estimated at around US $27 at Purchasing Power Parity, which is around 4 times to 6 times that amount at today's conversion rates. Each rural sub-center and primary health center is expected to serve 6000 and 36,000 people per year respectively. Nearly 1.75 million beds will be needed to reach 2 beds per 1000 people, and 700,000 doctors to reach the goal of 1 doctor per 1000 people. These needs a capital investment of around $80 billion. Currently the rural population spends 8 percent of its total expenditures on healthcare on average. Given that most have no access, or use very little, this means that those who must use significant healthcare assistance, are faced with unaffordable costs.

3.1.1 Rural Healthcare Challenges

Rural People Challenges are:

1. Affordability
2. Accessibility
3. Awareness
4. Quality of Healthcare Services

Organizational Challenges are:

1. Distribution and Reach
2. Recruiting skilled humanpower
3. Tackling social issues and local beliefs (self medication)
4. Creating awareness among rural consumers
5. Changing the mindset of rural people

3.1.2 Business Models

As seen in Figure 3.1, information technolgy is enabling new models in delivering rural healthcare. Advice from a doctor can be delivered via phone or videoconferencing. Healthcare Information Management Systems use ICT technologies to guide users about various good health practices, and the different steps that they should take, for the given disease or health problem. Initial business applications include what American author Thomas Friedman described as global collaboration with equal

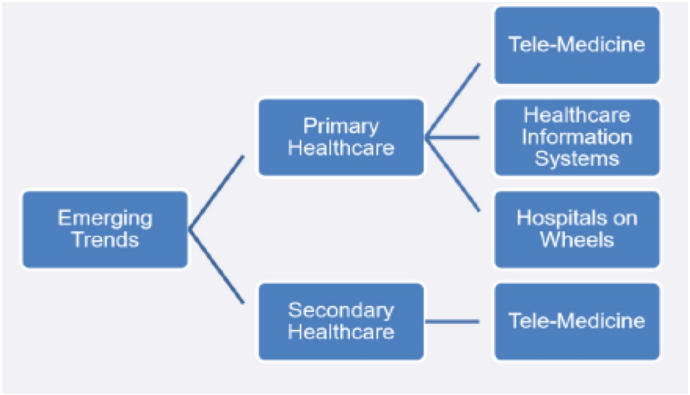

Figure. 3.1: Business Models for Telemedicine

power and tools: An Indian in Bangalore taking care of the office work of American doctors or reading the X-rays of German hospitals.

While this might have been the lucrative entry point of Indian IT companies into the global healthcare market, it only tests out a very small part of the spectrum of opportunities. The doctor or the health center taking the X-ray, might be one located at a remote village in India, with the same office work and diagnostic work being done with the same world-class facilities and experts.

The Ex-Gram Vani program provided cutting-edge mobile-hone and IVR solutions to connect with remote rural areas. The Safe Motherhood program in partnership with the White Ribbon Alliance sought to upgrade the quality of maternity healthcare in India. The tool helped to make women aware of their rights to demand good quality of care, to bring accountability by highlighting lapses in the health delivery process, and to increase the uptake if appropriate health services at the right avenues The healthcare program Ananya in Bihar, with the NGOs PATH and PCI, demanded greater accountability from the health delivery infrastructure. Through simple education ad discussion programs on the mobile phone, they made the marginalized communities aware of the best practices in healthcare and sanitation.

Communities in India are installing optic fiber links from community-level antennae/ broadband hubs to homes and businesses in villages. Online libraries and on-line edication allow access to knowledge.

3.1.3 Remote Diagnosis

The Truth On Call system provides answers via text messages (SMS) on mobile phones. It connects with physicians in the US and UK. Industry pays to ask the questions, and the physicians are paid for their responses. TruthOnCall provides critical input in real time, with answers from any of thousands of healthcare professionals. The AirStrip device provides remote patient monitoring via smarphones and tablets Live streams patient information from the hospital monitoring system to colinician's mobile devices. Information includes heart rate, respiratory rate and blood pressure.

3.1.4 Apollo Telemedicine

Apollos is the largest and oldest telemedicine network in India, founded in 1999 by Apollo hospitals, The first project was in Aragonda village, Andhra Pradesh, where a 50-bed hospital was connected to the Apollo multi-specialty hospital in Chennai. Videoconferencing tools were supplied by ISRO. One tele-consultation with a super-specialized doctor cost $11.2 to 16.7, or $50 if done with an overseas doctor.

Challenges encountered included changing the mindset of people towards telemedicine, winning the trust of village people, and standardizing the protocol of interaction between doctors and the telemedicine center. Patients were advised by doctors located 200 to 280 kilimeters away. The technology enabled telemedicine centers to scan and mail X-rays and other medical records, with the patient details transferred to the mulit-speciality hospital using desktop software.

By 2008 Apollos started to reach hospitals to deliver low-cost, high-quality care in Tier-2 city hospitals, suburban and rural areas. These Apollo Reach hospitals faced the challenge that doctors do not want to work in smaller cities. The Apollo model treats rich and poor alike, bubut revenue from high income people permits affordable healthcare for low income people. Health insurance covered RSBY hospital expenses up to Rs. 30,000 for a family of 5 people, in addition to a transportation charge upto a maximum of Rs 1000 including Rs. 100 per visit to the hospital or doctor.

E-Health Point Services India is owned by HealthPoint Services India (HSI) and started operations in 2009 in partnership with the Ashoka Foundation and Nandi Foundation in Punjab. They provided telemedicine, pharmacy and clean drinking water to around 10,000 people. By 2011, more than 80 EPH centers were operational in 7 districts of Punjab. Services were offered with a nominal fee of less than 1 US dollar equivalent. A subscription of around $1.53 per month supplied 20 liters clean

drinking water, decreasing water-borne diseases. Medicines were given by licensed pharmacies with a discount of up to 50% by direct procurement. Telemedicine consultation was done by HIS urban health center, including diagnosis by video-conferencing tools. Doctors were recruited locally to overcome language barriers and were specially trained for tele-consultations. The EPH has the facility to perform around 70 different tests, with devices such as a digital stethoscope, blood pressure monitoring machine and ECG, the average cost per test being around $1.

3.1.5 Piramal E-Swasthaya

This was established in 2010 as a social healthcare initiative of the Pharmaceutical company Piramal with Dean Nitin Nohria of Harvard Business School. They charge no consultation fee, only the cost of medicines. The revenue model was by medicine sales through the local health workers. This model appears to have started an experiment in Artificial Intelligence as a support tool. Their model is shown in Figure 3.2

Challenges included reluctance of patients to buy all prescribed medicines, or failure to complete the full course. Recruiting motivated health care workers who could take the system to the next level was a challenge. To meet these, the organization launched a pilot project with Rajasthan government funding to recruit women as government health workers.

General challenges facing rural healthcare professionals include problems of scarcity and distance. More time is spent on travel, with fewer face to face visits. Communicating with other providers and specialists is a problem, as is the limited access to medical knowledge and research work. There is a lack of networking and learning opportunities. Telemedicine technology offers opportunities to face these challenges. Emai, Skype and similar videoconferencing, and social media, facilitate communication, consultation and education. Community-based websites provide medical information, collaboration and bring people together. Mobile apps and web conferencing tools allow remote diagnosis and patient monitoring.

3.1.6 Conclusions

1. Telemedicine has emerged as a sustainable business to cater to the needs of rural people.
2. It is extremely helpful in primary and secondary healthcare;

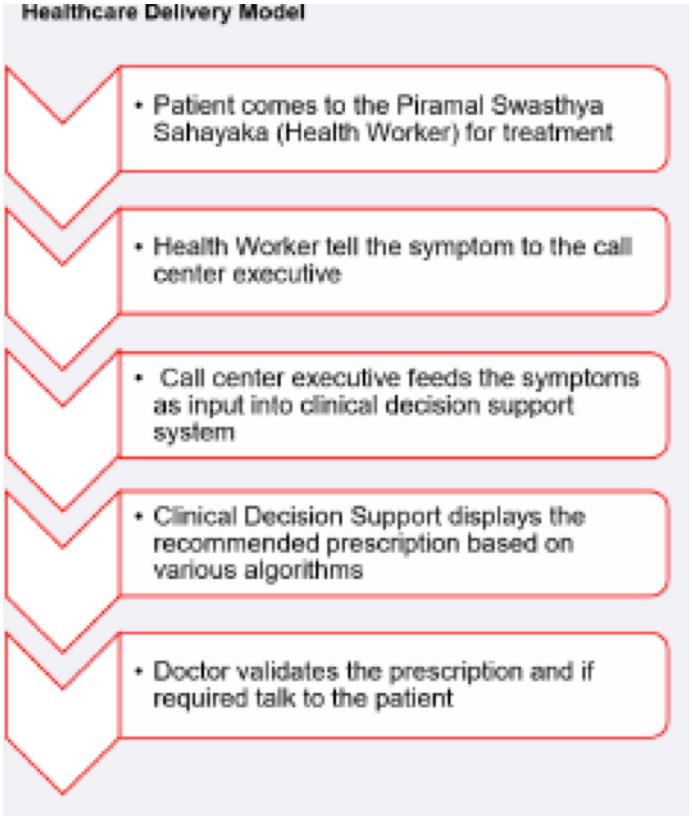

Figure. 3.2: Piramal E-Swasthaya Telemedicine Model. Courtesy Piramal Pvt. Ltd

3. It needs advancements to replicate the model for tertiary healthcare in rural areas
4. ICT has significantly reduced infrastructure and operating costs of healthcare delivery to rural areas.
5. Telemedicine has been used as a market development tool by companies, creating a new market to get an expert doctor without meeting him in person.
6. The emerging business models look promising but these are early days.
7. Treatment of poor people at a cheap and affordable price is a huge social capital created by these business models.

3.1.7 Some recommendations

1. Convert government hospitals to public-private partnerships to increase effectiveness and viability
2. Companies need to view telemedicine as a core rather than side activity
3. Need for more advanced health management tools such as Nokia Health Tools.
4. Healthcare information tools can improve preventive healthcare by creating awareness
5. It is important that big companies enter telemedicine.
6. It is also important for government to support rural telemedicine and help make it sustainable and reach everyone.

In 2017 India rolled out a national health policy [6] emphasizing preventive healthcare in a strategic partnership with private entities to make services affordable for all. Free essential drugs and diagnostic facilities are part of the policy. It lays a framework for screening and treatment of non-communicable diseases like cancer and diabetes, and discusses integrating the AYUSH system in education and wellness care through yoga. Digital tools are to be employed to improve efficiency and outcomes. A new National Health Care Standards Organisation was to be created, to formulate guidelines and protocols for healthcare. A separate empowered tribunal would resolove disputes and complaints. Family healtcare cards connected to the public health care facility would enable access to the patient's entire medical history. Metrics of quality would be applied periodically to all health institutions. Public expenditure on healthcare was to rise from 1.2% to 2.5% of GDP.

3.2 Ayurveda

Ashtikar [7] published a brief Exploratory Paper on Non-Conventional Sources of Energy in the Vedas. Oza [8] reviews the literature on the management of Fistula using Ayurveda and allopathy. Naharia [9] compare the Ayurvedic and allopathic perspective on diseaseas associated with Ahara (food; eating habits). He referred to the Vedic Rsis' beliefs in Energy from fire and the waves in the ocean, the winds, and the power of Soma, a variegated concept. More recent experiments describe measurable effects of being in the presence of the ritual fires of Agnihotra. The paper is indicative of attempts through the ages to study the reasons for observed effects. Ayurveda is often criticized by 'Modern' researchers for the apparently lack of Modern control studies, sample size determinations and extrapolation using modern statistics and Design of Experiments. What is missed in these arguments is the truly immense base of traditional knowledge passed on in temporal succession through untold ages. The empiricism underwent live iteration through the ages and through active debates between practitioners. Obviously the reputation of the Vaidyas (Literally, Learned Ones, or Those Who Know The Vedas, but referring to the equivalent of the modern Doctor), depended on the effectiveness of their cures, as spread by word of mouth and observation by neighbors - a facility that is rarely available in modern medicine beyond advertisements from pharmaceutical companies.

Kannan *et al* [10] describe Ayurveda in Kerala. Coffin *et al* [11] discuss the translational potential of Ayurveda Prakrti as concepts in Personalized Medicine. Patwardhan [12] discussed challenges and the way forward, in the research orientation in Ayurveda educational institutions. Katiyar [13] discusses pharmaceutics, manufacturing processes and drug delivery systems in Ayurveda. Kessler [14] reports on a nested diagnostic study of the reliability of Ayurvedic diagnosis for knee osteoarthritis patients, within a randomized control trial. Rioux and Howerter [15] discuss a pilot study of outcomes from a whole-systems Ayurvedic medicine and Yoga therapy treatment for obesity. Rastogi [16] writes about understanding cancer, expanding the horizon through applying the collective wisdom of Ayurveda and conventional medicine. Ram Singh [17] reports translational studies on fundamental principles of Ayurveda from the book to the bedside.

Chandra [18] describes Ayurvedic research for direct public benefit. Savirkar [19] provides critical comments on an article about allopathic, AYUSH and informal medicical practitioners in rural India. Rudrappa *et al* [20] wrote a book on Spine Care, focused on healthcare systems in India.

3.3 Telemedicine

One idea from Dr. K.V. Kumar, a cardiac researcher in the USA, is to develop a good cardiac CT reading facility (say in Delhi/Atlanta) and couple AI with, a new shear stress based predictive algorithm, as an example. Then one could have patients undergo a CT scan wherever they are located and read the CT from from the center and predict whether a patient will have heart attacks in the future via Telemedicine.

Kifle [21] defines Telemedicine as *a healthcare delivery mechanism where physicans and other medical personnel can examine patients remotely using Information and TeleCommunication Technologies (ICT). Telemedicine enables medical personnel working in remote areas to seamlessly transfer medical laboratory results to hospitals and clinics for diagnostics and data.* The implications are powerful, for people living in remote or displaced communities, enabling them to utilize the best in specialist care worldwide. As medical and communications technology advances along with communications infrastructure, the capabilities of telemedicine are increasing rapidly. The adoption profile of telemedicine is expected to follow an S-curve, with a gradual adoption at the start, a rapid rise, then settling into a slowly-growing, routine use profile.

Mugoh [22] describes a telemedicine system to promote self-management of blood pressure among patients. The need to go to a clinic to get blood pressure measured, makes it hard for patients to stay disciplined A mobile telemedicine system that allows patients to self-manage their BP was tested. The location was in Kenya. They used participatory research-design for the project.

Lage [23] *et al* describe a Quality of Service framework for telemedicine applications. Pliakas [24] describes a telemedicine service over a satellite network. This is a proposal for a system to be implemented in Greece, the Balkans and Southern Europe, and includes bidirectional satellite links. Five remote sites are proposed, 3 serving as trainers and two as trainees. The system is to allow real-time exchange of medical records, which include images and eaminations, allergies, medical history), along with real time tele-diagnosis by specialized medical doctors on remote sites. Tele diagnosis, coordination of medical and administrative processes, tele-assistance using videoconferencing, and reaching distant medical equipment, are also included. The forward link has speeds up to 45Mbps while the return upload from each site has up to 2Mbps per carrier. The DVC-RCS standard supports bi-directional broadbank connectivity via satellite, enabling fast Internet access, Intranet/VPN for secure connections multicase and real-time applications.

Mathur *et al* [25] reviewed the evolving role of telemedicine in health care delivery in India. They attribute the general inadequacy of healthcare, and the disparity between the rural and urban areas to a shortage of health care professionals and the lack of the necessary infrastructure in remote parts. They claim that telemedicine as a means of healthcare delivery has been tested applied at various levels all over the nation to address these deficiencies since Independence in 1947, and there is a growing record of successes. Initiatives have come from the Central and State governments as well as from private entities. They conclude that telemedicine is not yet a substitute for traditional healthcare, but can be used to overcome healtcare disparities in under-served areas. They classify telemedicine into two types. The first is Store-and-Forward or Asynchronous type, where there is exchange of pre-recorded data. The second is Real-time or Synchronous type where there is real-time exchange involving videoconferencing. Applications include disease diagnosis, triage, management and followup on treatment. Since the year 2000 the Government of India has been developing telemedicine intrastructure through the Department of Information Technology, Ministry of Communications and Information Technology, and the Indian Space Research Organisation, along with state governments, and technical/medical institutions. The North Eastern Space Applications Center (NESAC) started in 2004, had commissioned 25 out of the planned 72 telemedicine centers across the northeastern states of Sikkim, Nagaland, Arunachal Pradesh, Tripura, Mizoram, Assam and Meghalaya. The project sought to connect district level hospitals to other speciality tertiary care hospitals in and beyond the region. NESAC also set up Village Resource Centers (VRC) in all the northeastern states. These centers are to bring technology to the rural population, including telemedicine, tele-education, database creation and maintenance on agriculture, and weather. In Tripura, three referral hospitals and 17 nodal hospitals are interconnected with Internet speeds of 512kbps/ 2 Mbps. Between June 2005 and March 2013 the hospitals had treated over 30,000 patients by telemedicine. Effects are visible in improved statistics of health and education.

The Kerala Oncology Network was completed in 2001 by the Centre for Development of Advanced Computing and the Regional Cancer Center in TiruAnantapuram. This aims for early detection and treatment of cancer, along with pain management and followup services. A web-based electronic database of medical records is easily accessible to all the medical centers in the region. The project conducted online sharing and data transfers including histopathology slides, electronic medical records and radiology images between the nodal health centers and regional cancer center, facilitating remote followup of patients. This success is being scaled up across India to 25 regional cancer centers connected to 100 remote-site peripheral hospitals and

healthcare centers.

On the other hand, India lags far behind in deploying cancer medication. Only seven oncology drugs were introduced in India from 2010 to 2014, whereas nearly 50 claimed breakthrough therapies were rolled out globally. India has only 2,000 oncologists in India for over 10 million patients.

In the private sector the Apollo Telemedicine Networking Foundation (ATNF) is perhaps the best-known for reliability. Starting with India's first rural telemedicine Center that evolved into the world's first VSAT-enabled modern secondary care hospital at Aragonda village in Andhra Pradesh, by March 2000. This has served as a Case Study for the entire telemedicine industry. By 2015 Apollo had 125 peripheral centers in India and 10 overseas. Until May 2011, over 69,000 tele-consultations had been provided by ATNF through the telemedicine specialty centers at the tertiary care facilities. ATNF also leads the way in medical edication of health professionals and tele-consultations, to alleviate strokes, the third leading cause of mortality in India.

Being amenable to visual observation, dermatology is ideal for virtual medicine, in this case called Teledermatology.

The Sankar Netralaya and Aravind Eye Hospitals in Chennai have treated over 54000 patients by organizing temedicine camps across four Indian states. Teleopthalmology has been established in several projects.

The Narayan Hrdalaya (cardiac care facility) set up a pilot project at the District Hospital in Chamarajanagar, Karnataka in February 2002 with hardware and ICT support from ISRO and World Bank financial support besides the Karnataka Health System Development Project. Since then over 130 telemedicine centers have come up all over India, treating over 64,000 patients including 10,000 in coronary care units with tele-consultations.

Al Mamoon *et al* [26] discuss the issues, challenges and proposed solutions to those, for a Telemedicine Call Center based on VoIP (Voice Over the Internet Protocol). Moses *et al* [27] discuss how human health may be maintained on Mars in future. Thomas *et al* [28] discuss a ' Universal Plug'n'PEAKS' - towards easy deployment of multi-modal telemedicine.

Naegele *et al* [29] discuss the influence of compression and network impairments on the pcture quality in video transmissions. Kifle [21] discuss the interplay of cost and adoption of telemedicine in sub-Saharan Africam focusing on the specific case of tele-cardiology in Ethiopia. They cite how residents who can afford it, are driven to seek healthcare abroad because of the paucity of health care professionals and facilities

in their country. They explore how telemedicine can alleviate this situation. They cite the 'silent factors' that pose obstacles to the diffusion of telemedicine technology: it is often not the technology, but the economical and institutional dimensions that impede the exploitation of such a life-saving technology. At some level telemedicine implies labor substitution, which is a socioeconomic obstacle in impoverished areas where employment opportunities and skills are both scarce. On the other hand, Ethiopia has a ratio of one hospital bed per 4900 people, one physician per 38,000 people, 2.7 nurses per physician, and one health center per 222,850 people. Over 200,000 new cases of cardiac problems occur each year. An estimated 500,000 to 700,000 people with cardiac problems live in Ethiopia. These factors motivated investment in tele-cardiology as an urgent priority. The cost saving potential of telemedicine was identifed from reduced costs for servicing patients through

1. savings in time and travel for doctors and patients, fewer unnecessary referrals, and replacement of doctor resources with those of less medically trained personnel
2. cost savings from provision of better healthcare, generating cost reductions from early diagnosis and treatment.

Better quality and patient safety are cited as important other motivators for adopting telemedicine. Thus Quality, Access and Cost are the three important metrics for telemedicine. Telecardiology involves two different types of telemedicine: interaction between patient and physician, or between general practiotioner and specialist. Both of these can be done Synchronously through live interaction. In addition, store-and-forward telemedicine is used to transmit data in pre-recorded or Asynchronous telemedicine.

Tsoulkas and Pantelous [30] discussed embedding systems and controls terminology and conceptualization to model-based telemedicine - assisted home support. Lavariega *et al* [31] discuss monitoring and assisting maternity-infant care in rural areas. Parker *et al* [32] discussed the SNMMI and EANM Practice Guideline for Tele-Nuclear Medicine 2.0. Tiwari *et al* [33] assessed the performance of telemedicine for delivery of quality health care.

Isechi [34] describes an experiment with Internet-based telemedicine in the Amami rural islands. Elder *et al* [35] provide a user's guide for convegent points for conventional medicine and whole systems research.

Zaidi [36] discusses gender perspectives and quality of care in underdeveloped countries, dealing with disease, gender and contextuality.

The Deccan Chronicle [37] reported o the potential of 3D printing technology in

generating lost body parts with superior precision and lower cost than traditional methods. A prosthetic arm was reported by the Washington University in St. Louis at a projected cost of $200 versus the $6000 cost of traditional technology. The US startup Not Impossible Labs reported a prosthetic arm which cost only $100 to produce. In March 2017 a young woman received a 3D printed implant at the University of Utrecht in the Netherlands to replace much of her skull, which had been suffering from a chronic bone disorder. A British woman received a hip replacement using a 3D printed joint made from powdered titanium, with stem cells cultured to encourage new bone formation around the implant. Another man received a 3D printed pelvis to replace the half he had lost to bone cancer. 3D printed facial prosthetics and eyes are also in the works. A 'bionic ear' has been reported at Princeton University, for the present limited to experiments on bridging electronics with materials.

The Business Standard reported in 2018 [38] on Project Clean Street Food, which was to impart skills to 20,000 street vendors in the first phase, under the PMKVY, Pradhan Mantri Kaushal Vikas Yojana, or Prime Minister's Small Enterprise Plan. The project was under the Food Safety and Standards Authority of India (FSSAI) aimed to raise safety standards of foods sold on the streets of New Delhi. Training was to be imparted at 40 centers. This is the first phase to reach over 4 million street vendors across India. The 20,000 vendors would be trained, assessed and certified by seven training partners over four weeks at 40 training centres set up for the purpose across Delhi. This is under the Tourism and Hospitality Sector Skill Council (THSC), an affiliate of the National Skill Development Corporation, Ministry of Skill Development and Entrepreneurship. A Mobile App was launched to empower citizens to reach out to the food enforcement machinery for any concerns or suggestions.

3.4 Medical Economics: Recent National Initiatives in India

Shetty [39] reminesces that never has a farmer felt financially secure. Dependence on rain is a major factor. Farming contributes only 13.7% of GDP, but is responsible for 50% of employment. Thus alternative jobs are needed for farmers families. One possibility is the health services sector, worth $8 trillion, compared to Information Technology at 4.4 trillion, oil and technology at 2 trillion each.

The following is extracted from a discussion at an Economics forum. Public spending on healthcare in India is just over 1% of gross domestic product (GDP). The Ayushman

Bharat Pradhan Mantri Jan Arogya Yojana (AB-PMJAY) was approved by the Indian government in March 2018. It is an ambitious reform to the Indian health system that seeks to provide financial health protection for 500 million of the most vulnerable Indians and halt the slide of the 5060 million Indians who fall into poverty annually as a result of medical-related expenditure. The scheme, colloquially referred to as "Modicare after Indian Prime Minister Narendra Modi, aims to build on existing schemes to provide publicly funded health insurance cover of up to 500,000 Indian rupees (over US$7,000) per family per year to about 100 million families (500 million people, 40% of Indias population).

The scheme builds on the previous programs outlined above (for example, the National Health Mission still forms the basis of primary care under the new program) and has been designed to be implemented to either take over or operate alongside state-based programs, but has a broader remit in terms of the services covered and the amount of coverage to which each individual is entitled. The government has so far allocated 100 billion rupees (almost US$1.5 billion) to the program for 20182019 and 20192020. Currently, the country spends about US$64 per person on healthcare, two-thirds of which is privately financed by user fees. As such, current UHC initiatives in India centred on AB-PMJAY alongside state-based programs such as those in Andhra Pradesh, Telangana, Tamil Nadu, Karnataka, and Kerala represent, as a whole, one of the most ambitious ever health and, one could argue, poverty-alleviation programs ever launched.

Eligibility for the scheme is determined based on deprivation criteria measured in the 2011 Socio-Economic Caste Census. There is no limit to the number of family members covered, and benefits will eventually be India-wide (if all states and union territories sign up to the program). This means that a beneficiary will be allowed to take cashless benefits from any public or empanelled private hospital across the country. State health authorities will lead the implementation of the AB-PMJAY, and states are free to continue to provide existing programs alongside the national program or integrate them with the new scheme. States will also be able to choose their own operating model to either use the expenditure to pay a private insurance provider to cover services, provide services directly (as elected by Chandigarh and Andhra Pradesh, for example), or a mix of the two (as in Gujarat and Tamil Nadu). Expenditure under the program will also be shared between the central and state governments in a prespecified ratio depending on the legislative arrangements and relative wealth of the states, with the Indian government covering between 60%100% of expenditure.

The AB-PMJAY offers a unique opportunity to improve the health of hundreds of

millions of Indians and eliminate a major source of poverty afflicting the nation. There are, however, substantial challenges that need to be overcome to enable these benefits to be realised by the Indian population and ensure that the scheme makes a sustainable contribution to the progress of India towards UHC.

3.5 On Indian Medical Education

The following is excerpted from a post by an experienced physician, in an economics and education discussion related to legislation being debated in India's Lok Sabha.

> Homeopaths undergo a five and a half year, full time, undergraduate course in India. They are trained in every subject that a student of allopathy is taught except pharmacology. This includes anatomy, physiology, biochemistry, pathology, gynaecology, obstetrics and internal medicine. The students use the same textbooks, the syllabi for these subjects are the same, and the time allotted for these to be taught is also almost the same as the MBBS (Bachelor of Medicine, Bachelor of Surgery) syllabus.
>
> In universities where both MBBS and BHMS (Bachelor of Homeopathic Medicine and Surgery) courses are taught students may often share lecture halls for common lectures. The faculty is often the same! As in the MBBS course, the students must complete a rotational internship. This includes six months at a regular hospital.
>
> There are concerns that homeopaths may not be able to interpret modern investigations and diagnostic tests. These concerns are entirely unfounded. Homeopaths all over the country are using modern diagnostic techniques to assess outcomes of their treatment. Patients themselves are doing this! It is ludicrous to suggest that a homeopathy doctor or student is unable to interpret diagnostic test results because of an inherent and insurmountable lack of understanding.
>
> I have sat in rooms with various kinds of doctors, surgeons and paramedical personnel, in my undergraduate years, in my time as an MD-Homeopathy student, while reading for a post graduate degree at the University of Oxford, and in conferences in various parts of the world. I have sensed the scepticism in the room when I introduce myself many, many times.
>
> No one, however, has ever managed to arrive at the conclusion that one

> will simply not understand what is being taught or said because one is a homeopathic doctor. This seems to be the presumption being made by those opposed to the proposed bridge course. In the absence of details of the specific nature of this course, how is it being opposed, if not for this reason? When the training of both allopathic and homeopathic courses is so similar, one fails to understand the logic to this opposition.
>
> The most facile argument concerns the dual registration of homeopaths in another national register once they complete the bridge course. Apparently, this is neither permissible nor open. Im not sure what this means but maintaining a register of homeopaths who have completed the bridge course seems to be both possible and not a big deal.
>
> It is time that the opponents relax this perceived sanctity around the medical profession and become more sensitive to the healthcare needs of India. There are large parts of the country where no medical practitioner is present, and none are willing to go. This is despite changes in regulations like making rural internships compulsory and enforcing of bonds for graduates of government colleges, preventing their departure from the country. Homeopaths are well positioned to shoulder the disease burden of the nation. Only in India, because of the stellar training provided to homeopaths, is such a move even possible.
>
> If providing a bridge course can make them better equipped to handle at least some illnesses that they couldnt earlier and spread healthcare services to far flung areas of the country, what can possibly be the problem? If ignorance of the structure and scope of the training of a homeopath was the problem, i hope this has helped. If prejudice is the problem, the nation will do well to rise above it.

A counter argument is advanced against this:

> (Isn't this) again an ingenious way of dumbing down a science subject? If Ayush doctors want to practice allopathy why read alternate medicine in first place? Why does there have to be NEET (National Entrance Examination for adminission) for MBBS alone? If you think the private medical colleges are bad the Ayush colleges (both Govt & Pvt) can be significantly worse. If one wants healthcare taken to the periphery (remote areas) then why not train nurses, midwives & pharmacists with a bridge course - nurses & clinical pharmacists read significant amount of anatomy, physiology & clinical science.

A strong statement of support for National Medical Commission Bill follows, again quoting a very experienced surgeon. Again, the informality of such a discussion is preserved to retain the force of the points made.

> I have seen a great deal of hostility from my colleagues to the National Medical Commission bill of Indian 2017, which has not been tabled, let alone passed. But with due respects to my colleagues I allege that the vast majority have not actually read the text of the bill or what it seeks to replace in the old 1956 Indian Medical Council act.
>
> I received my first licence to practice "modern" "allopathic" medicine in India 40 years ago and it is certain that I have had more time to observe what medical practice means in India than the vast majority of doctors practising medicine in India today and I will use that perspective as the battering ram to voice my opinion.
>
> Let me first point out some salient changes in the proposed new act that I think are good. The first is the establishment of a National Medical Entrance Test which in my view can only be good for the country. Current practices in the allotment of medical seats are openly biased in favour of those who have money to pay for a seat. I know scores of people who, while being dedicated and talented. also got a seat only because they, or their parents could afford to pay insane amounts of money to buy that seat. A little publicized fact is that many doctors will not earn, in their entire career, the multiple crores of Rupees that were paid to get them a seat in an undergraduate or post-graduate medical course.
>
> The economics of such a choice may escape the casual observer, but some people get their children into medicine for the "honour and respect" that a medical degree brings to an otherwise sub-literate family, or for value in a marriage market that fetches a huge dowry. For those for whom money is not a problem, respect can be bought in India in the form of a medical degree. Others have enough family money to build a hospital; the cost of the medical degree is only a small fraction. One doctor I know pointed out that whether his new hospital succeeds or fails - the value of the property that the hospital is situated on would have increased ten or twenty times assuring him of guaranteed great wealth in future notwithstanding the medical services he is able, or unable to offer.
>
> There is a huge proliferation of medical colleges in India and most of them offer a "bypass route" for admission that involves the payment of huge

sums of money. Everyone blindly quotes statistics from the west about unfavourable "doctor-patient" ratios in India without once looking at the proverbial "elephant in the room" that every knows is there but pretends is not there. Medical education is too lucrative a business for anyone to bother about health care. From the time I got my medical degree 40 years ago, to this day, India is only creating "America ready" doctors in our 460-odd medical colleges. Our nation's brightest doctors, journalists, social workers and other scholars display a curious "split personality" when it comes to the way they view the Indian medical burden.

Everyone knows that India has the world's largest number of malnourished children; a very high number of maternal deaths of women with no access to obstetric care. Any thinking person should be able to figure out that the medical priority for India should be to create doctors and medical personnel who will provide the services that the vast majority of our population need. Yet we persist in building expensive medical institutions to create "America ready" Intensivists, Neurologists, transplant surgeons, Hepatologists, Gastroenterologists, Endocrinologists, specialists in robotic surgery, Interventional cardiologists, Interventional radiologists, rheumatologists and every speciality whose name will get underlined in red because my Facebook spell-check dictionary does not even know those names. None of these specialists - many of whom would have spent multiple crores in obtaining their qualifications, have any connection with what India really needs in large numbers in terms of health care.

And as regards the "elephant in the room" - that magical bogey, that excuse of excuses, - the "doctor /patient ratio", no specialist can sit in a village catering to women and children with diarrhoea or pneumonia. That specialist needs expensive machines and a large hospital - so the specialists sit in cities which have too many, too expensive, too specialized hospitals with not enough work to do, while the vast population in tier 2 and tier 3 cities, small towns and villages do not get the medical care they need. I ask, what is the Indian Medical Council Act of 1956 doing for India in 2018? The doctor population ratio in big cities is so high that when holiday season starts in December, or exam season in March-April - doctors sit in shiny hospital canteens, sipping tea, and asking each other anxiously "How's practice?" Of course practice is bad. Too many specialists and too many expensive services in cities. No one to do anything about the most common causes of disease and death in India.

One good move proposed by the new national medical commission act is to make all doctors pass a standard "licentiate" examination. Right now, if I have the money, I can send a student to Cuba, Ukraine or Russia to get a medical degree and he can return and practice here. An Indian doctor who tries to work abroad does not have it so easy. No more of that. Everyone will have to get his licence by passing a standard examination.

Another move that I see as positive in the proposed new act is to try and integrate indigenous medicine systems like Ayurveda, Siddha and Unani into the medical care environment without the cocky superiority complex that allopathy gives its practitioners. What modern "allopathy" or western medicine does, it does well, but there is a huge section of the population who are not addressed at all - who can and do find solutions in traditional medicine such as Ayurveda. Some colleagues of mine are up in arms, seeing a "threat" that Ayurveda doctors will now be able to do a "bridge course" and start doing what they are doing. To me it seems that these respected colleagues of mine have neither read the proposed act, nor do they have confidence in their own skills. The idea to combine the benefits of modern western medicine with that of indigenous systems is long overdue and essential.

I would probably have to write another article to point out where modern "allopathy" scores high marks for efficacy and where an infusion of skill from traditional medical systems is required - so I will stop here by reiterating that I think the proposed national medical commission act is a positive step forward.

Bibliography

[1] Shankar Acharya. Healthcare is terrible in india, but tamil nadu shines. Rediff.com, December 24 2009.

[2] Monica Das Gupta, Rajendra Shukla, T.V. Somanathan, and Datta. K.K. How to improve public health systems in india. Policy Research Working Paper 5140, World Bank, November 2009.

[3] Monica Das Gupta, B.R. Desikachari, T.V. Somanathan, and P. Padmanabhan. How to improve public health systems: the lessons from tamil nadu. Policy Research Working Paper 5073, World Bank, October 2009.

[4] Poonam Khetrapal Singh. India's measles-rubella vaccination campaign a big step towards reducing childhood mortality, addressing birth defects.

[5] Blake J Angell, Shankar Prinja, Anadi Gupt, Vivekanand Jha, and Stephen Jan. The ayushman bharat pradhan mantri jan arogya yojana and the path to universal health coverage in india: Overcoming the challenges of stewardship and governance. PLoS medicine, 16(3):e1002759, 2019.

[6] TNN. National health policy to focus on preventive healthcare.

[7] Madhukar Ashtikar. Non-conventional sources of energy in the vedas. Published by Dharam Hinduja International Centre of Indic Research, NAG Publishers, 11, A(UA), Jawahar Nagar, Delhi-110007, India, 1955.

[8] Bharat Kailash Oza. Ayurveda and modern management of fistula: A literary review. Journal of Drug Delivery and Therapeutics, 9(2-s):556–558, 2019.

[9] Ranjita Naharia and Mariya Husain. Ayurveda and modern perspective on diseases associated with ahara: A review. Journal of Drug Delivery and Therapeutics, 9(2):514–516, 2019.

[10] Srinivasan Kannan and Margret Frenz. Seeking health under palm trees: Ayurveda in kerala. Global public health, 14(3):351–361, 2019.

[11] J Douglas Coffin, Rammohan Rao, and Diana I Lurie. Translational potential of ayurveda prakriti: Concepts in the area of personalized medicine. In Translational Ayurveda, pages 21–32. Springer, 2019.

[12] Kishor Patwardhan, BS Prasad, Anam Aftab, Varsha Raghunath More, and Shriram S Savrikar. Research orientation in ayurveda educational institutions: Challenges and the way forward. Journal of Ayurveda and integrative medicine, 2019.

[13] Chandra Kant Katiyar. Ayurvedic pharmaceutics, manufacturing processes and novel drug delivery systems in ayurveda. In Translational Ayurveda, pages 33–52. Springer, 2019.

[14] Christian S Kessler, Antonio Morandi, Abhimanyu Kumar, Kartar S Dhiman, Shivenarain Gupta, Katja Icke, Carina Bühner, Elmar Stapelfeldt, Manfred Wischnewsky, Ludwig Kronpaß, et al. Reliability of ayurvedic diagnosis for knee osteoarthritis patients: A nested diagnostic study within a randomized controlled trial. The Journal of Alternative and Complementary Medicine, 2019.

[15] Jennifer Rioux and Amy Howerter. Outcomes from a whole-systems ayurvedic medicine and yoga therapy treatment for obesity pilot study. The Journal of Alternative and Complementary Medicine, 25(S1):S124–S137, 2019.

[16] Sanjeev Rastogi, Sen Pathak, and Ram Harsh Singh. Understanding cancer: Expanding the horizon through applying the collective wisdom of ayurveda and conventional medicine. In Translational Ayurveda, pages 103–122. Springer, 2019.

[17] Ram H Singh. Translational studies on fundamental principles of ayurveda from book to bedside. In Translational Ayurveda, pages 13–20. Springer, 2019.

[18] Shailaja Chandra. Ayurvedic research for direct public benefit. Journal of Ayurveda and integrative medicine, 10(1):1–3, 2019.

[19] Shriram S Savrikar. Critical comments on "allopathic, ayush and informal medical practitioners in rural india–a prescription for change". Journal of Ayurveda and integrative medicine, 10(1):72, 2019.

[20] Satish Rudrappa, Deepak Venkatesh Agarkhed, and Sushrut S Vaidya. Healthcare systems: India. In Quality Spine Care, pages 211–224. Springer, 2019.

[21] Mengistu Kifle, Victor WA Mbarika, and Pratim Datta. Interplay of cost and adoption of tele-medicine in sub-saharan africa: The case of tele-cardiology in ethiopia. Information Systems Frontiers, 8(3):211–223, 2006.

[22] James W Mugoh and Andrew M Kahonge. A mobile-phone tele-medicine system that promotes self-management of blood pressure among hypertensive patients in kirinyaga sub county. International Journal of Engineering Research and Applications, 5(4):47–52, 2015.

[23] AL Lage, Joberto SB Martins, J Oliveira, and W Cunha. A quality of service framework for tele-medicine applications. In WebMedia and LA-Web, 2004. Proceedings, pages 18–20. IEEE, 2004.

[24] Thomas Pliakas, Serafeim Dermeitzoglou, Christos Papachristos, and Artur Krukowski. A tele-medicine service over satellite network. Studies in health technology and informatics, 137:83, 2008.

[25] P Mathur, S Srivastava, A Lalchandani, and JL Mehta. Evolving role of telemedicine in health care delivery in india. Prim Health Care, 7(260):2167–1079, 2017.

[26] Ishtiak Al Mamoon, AK M Muzahidul Islam, and Sabariah Baharun. Voip based tele-medicine call center–issues, challenges and proposed solution. Jurnal Teknologi, 74(1), 2015.

[27] Robert W Moses, Dennis Bushnell, David R Komar, Sang Choi, Ronald Litchford, Franklin Chang-Diaz, and Mark Carter. Maintaining human health for humans-mars. In 2018 AIAA SPACE and Astronautics Forum and Exposition, page 5360, 2018.

[28] Janu Thomas, Spiegl Werner, Soutschek Stefan, Maier Andreas, and Steidl Stefan. Universal plug'n'peaks–towards easy deployment of multi-modal tele-medicine.

[29] Susanne Naegele-Jackson, Peter Holleczek, Thomas Rabenstein, Juergen Maiss, and M Sackmann. Influence of compression and network impairments on the picture quality of video transmissions in tele-medicine. In Proceedings of the 35th Annual Hawaii International Conference on System Sciences, pages 2060–2068. IEEE, 2002.

[30] Vasilis N Tsoulkas and Athanasios A Pantelous. The embedding of system's and control's terminology and conceptualization to model-based tele-medicine-assisted home support (tahos). In 2009 11th International Conference on Computer Modelling and Simulation, pages 538–543. IEEE, 2009.

[31] Juan C Lavariega, Gustavo A Córdova, Lorena G Gómez, and Alfonso Avila. Monitoring and assisting maternity-infant care in rural areas (mamicare). In E-Health and Telemedicine: Concepts, Methodologies, Tools, and Applications, pages 347–359. IGI Global, 2016.

[32] J Anthony Parker, Paul Christian, Hossein Jadvar, Bernhard Sattler, and Jerold W Wallis. The snmmi and eanm practice guideline for tele-nuclear medicine 2.0. Journal of nuclear medicine technology, 42(1):15–19, 2014.

[33] KA Tiwari, SG Prasad, M Sangma, P Krishnam Raju, AV Anjaneyulu, C Sridevi, V Karani, Nitin K Rao, and B Soma Raju. Tele-medicine: an assessment for delivery of quality healthcare. Health and Population-Perspectives and Issues National Institute of Health and Family Welfare, 31:82–188, 2008.

[34] Atsushi Isechi, Chiyomi Oda, Reiko Shinkura, Suminori Akiba, Hiromitsu Fujikawa, and Katsuyuki Yamazaki. Experiment of internet-based tele-medicine in amami rural islands. In 2004 International Symposium on Applications and the Internet Workshops. 2004 Workshops., pages 206–210. IEEE, 2004.

[35] Charles Elder, Nadine Ijaz, John Weeks, Jennifer Rioux, and Cheryl Ritenbaugh. Convergent points for conventional medicine and whole systems research: A user's guide. The Journal of Alternative and Complementary Medicine, 25(S1):S12–S16, 2019.

[36] S Akbar Zaidi. Gender perspectives and quality of care in underdeveloped countries: disease, gender and contextuality. Social Science & Medicine, 43(5):721–730, 1996.

[37] Deccan Chronicle. 3d printed body parts go mainstream.

[38] Anon. Health minister shri j p nadda launches project clean street food 20,000 roadside vendors to be skilled under pmkvy in the first phase, 2018.

[39] Devi Shetty. Served by indians: For india to be a services superpower, diversify beyond it to medical services served by indians: For india to be a services superpower, diversify beyond it to medical services. Times of India, Editorial, February 1 2018.