

Innovation for Early Diagnosis, Affordable Treatment- New Avenues

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ABSTRACT

Innovation in medical devices for early diagnosis of disease is essential for both doctor and patient. It helps doctor to plan vigorous and robust treatment & allows patients to gain a high success rate from treatment, higher quality of life, less stress for family care partners & longer time for treasuringthe present. Patients diagnosed early are also benefited fromongoing clinical trials. An ideal diagnosis procedure should be affordable without compromising with accuracy. We discuss importance of early diagnosis along with innovation in drug discovery, modern therapeutics approach and advancements in healthcare services that could revolutionize current medical system.

Key Words: Innovation, Early diagnosis, Quality life, Affordable treatment, Drug discovery, Medical devices, Digital health

INTRODUCTION

There are a minimum of a dozen advantages to get on an early and accurate diagnosis of pathology when symptoms are first noticed. These advantages end in a high success rate, higher quality of life, less stress for family care partners, longer time for treasuringthe present and increased time for future planning. Innovation in medical devices that would detect pathology at a really early stage is the need of hour; actually it's crucial, as research always leads to

vigorous & robust treatment options. Diagnosis should never be compromised with accuracy as accurate diagnosis is contingent upon an entire medical. It should even be noted that observers in early stages can still recall the order during which symptoms first appeared. The person also can participate in their own legal, financial, and long-term care planning and make their wishes known to family members or relatives. They might have the choice to prioritize how they spend their time—focusing on what matters most to them. It can prevent choices which may rather be made in ignorance, like moving distant from family and friends, or making legal or financial commitments which will be hard to stay because the disease progresses. Individuals diagnosed early in the disease process can make the most of early-stage support groups and learn tips and methods to well manage and deal with the symptoms. Those diagnosed early can benefit of clinical trials or advocate for more research and improved care and opportunities.

When we learn to associate the disease with people within the early stages, we understand they're still viable within the community. Families of the patient have more opportunities to find out about the disease, develop realistic expectations, and plan for his or her future together. Often, the method leads to reduced stress and lessened feelings of burden and regret later within the disease process. It also allows the person and family to point cognitive changes to the ailment instead of to their personal failings —preserving the person's self-esteem all through the disease process.

One bigger hurdle for medical sector is to provide affordable health care at each primary, secondary and tertiary level. Affordability is the only key to accessibility. Within the economic reality of a developing country, cheaper drugs and low-priced healthcare infrastructure models can work wonders. However, affordability isn't always that simple to implement; it requires creative & high divergent and intellectual thinking.

Innovation and New Frontiers for Early Diagnosis & Affordable Treatment:

To deliver affordability, we require innovation in discovering drugs, developing therapeutics and delivering healthcare. Innovation in health care is defined as providing “more for less” i.e. more value, better outcomes, greater convenience, access and simplicity; all for fewer cost, complexity, and time required by the patient and the health provider, in such a way that expands what's currently possible. Health care is an industry in need of innovation. Health plans,

providers, life sciences companies, and therefore the government face rising costs and inconsistent outcomes. They're working to realize the triple aim—improving care, improving health, and reducing spending. Our current health care system's performance are often defined by its rules, policies, regulations, enabling technologies, operating models, customs, and patient and provider preferences; together, these elements comprise the frontier of what's possible. They also function the constraints to what are often achieved. For much too long the health care industry's performance, despite attempts to spur progress, has remained at the sting of this frontier. The industry must break current constraints and expand the frontier to realize true breakthrough performance. Following are some new avenues that are most likely to achieve more for less in health care:

A. Next-generation sequencing (NGS):Recent advances in genome sequencing could direct to the improvement of demonstrative tests that may characterize in danger population where early mediations could spare downstream social insurance costs. Symptomatic tests additionally may assist clinicians with focusing on explicit prescriptions to patients who are probably going to react well to them, diminishing or killing the utilization of ineffectivemedicines^[1].

Human Genome Project finished sequencing in 2001, taking 15 years and costing around \$3 billion. From that point forward, propels in sequencing strategies have prompted exponential increments in the information yield for each sequencing run, from 84 kilobases of information to 1.8 terabases of information. Then, genome sequencing costs have dropped considerably to \$1000 for an entire exome succession till date^[2]. Genome testing can have vast applications in human population wellbeing, screening and distinguishing proof of in danger population where early mediation would be fruitful. Recognizing sub-populaces that may be progressively receptive to treatment could help get the correct medication to the correct patient at the perfect time. Current application of NGS includes identification of specific tumor receptors that can be indicative of genetic causes of disease. For example, a positive BRCA1/2 test in a breast cancer patient could indicate that the patient is at higher risk of recurrence and malignancies^[3]. Awareness of the increased risk may alter the patient's treatment plan. Further, it could prompt physicians to conduct genetic screening for at-risk relatives

B. 3D-printed devices: Manufacturers and suppliers could utilize 3D printing to make profoundly customized, minimal cost clinical innovation items that can be custom fitted to suit the physiological needs of individual patients^[4].

Instances of 3D-printed clinical advancements incorporate specifically designed 3D-printed prosthetics, burn victim's skin, organs, orthopedic and dental implants, and a variety of casts. It is to be noted that 3D-printed prosthetics, offer more refined, customizable and lower-cost options than the current standard of care^[5].

Another major example is Additive Manufacturing (AM) method empowered 3D-printing clinical gadgets. AM innovation gives the capacity to high customization and decreases waste and saves a huge cost. It works by piling materials as layer on layer, rather than producing something and cutting away the surplus. The commonly used airway splints for babies with tracheobronchomalacia are made in hours for \$10 per unit^[6].

C. Immunotherapy: A treatment with the capacity to considerably extend survival for cancer patients, without any side effects and related health care costs of traditionally used chemotherapy, but at a high treatment cost at times ranging even above \$250,000^[7]. Immunotherapy refers to classes of drug molecules that fortify the body's ability to produce an immune response. Immunotherapy could be of use in the treatment of cancer, inflammatory conditions, allergies, infectious diseases and some neurodegenerative diseases. Applications have been seen in oncology with a high success rate where therapies can offset how tumors suppress the immune system and as a substitute help the immune system to effectively attack tumor cells. Researchers and investigators are chiefly concerned in two classes of therapies: Checkpoint inhibitors including PD-1 and PDL-1 inhibitors, and Adoptive T-cell therapy, including CAR-T^[8,9].

Following are some commercially available immune-drugs:

- Avelumab (Bavencio®): It is a checkpoint inhibitor & targets the same PD-1/PD-L1 pathway; approved for patients with Merkel cell carcinoma, bladder cancer, kidney cancer^[10].
- Atezolizumab (Tecentriq®): It is a checkpoint inhibitor & targets PD-1/PD-L1 pathway; approved for patients with breast cancer, bladder cancer and lung cancer^[10]

- Aldesleukin (Proleukin®): It is a cytokine which targets IL-2/IL-2R pathway; approved for patients with melanoma and kidney cancer^[10]
- Cemiplimab (Libtayo®): It is a checkpoint inhibitor targeting PD-1/PD-L1 pathway; approved for patients with a specific type of skin cancer such as cutaneous squamous cell carcinoma^[10]
- Poly ICLC (Hiltonol®): It is an immune adjuvant used to target Toll-like receptor 3 (TLR3) pathway; approved for patients with squamous cell carcinoma^[10]

D. Artificial intelligence (AI): The capacity of a computer to think like and complete tasks performed by people with more prominent speed, precision and lower asset use can be described as Artificial Intelligence(AI)^[11].

Simulated intelligence can possibly improve the exactness, accuracy, and idealness of patient analysis, which could expand helpful achievement rates and lessening superfluous clinical mediations.

Some at present utilized AI in medicinal services: Artificial Intelligence-Based Drug Design and Discovery utilizes computational ways to deal with find, create, and investigate drugs and comparative organically dynamic atoms^[12]. There are two significant sorts of medication structure. The first is alluded to as ligand-based medication plan and the second, structure-based medication structure. One such case of structure-based medication configuration was endorsement of medication "Dorzolamid", a carbonic anhydrase inhibitor, which was affirmed in 1995. Some different medications that have been created utilizing AI device incorporates huge numbers of the atypical antipsychotics, Cimetidine, the prototypical H₂-receptor rival from which the later individuals from the class were created, Selective COX-2 inhibitor NSAIDs, Zanamivir, an antiviral medication and so forth^[1,13]

Watson Oncology is another AI arrangement that assists oncologists with staying aware of the field's quickly extending proof base. A coordinated effort of IBM and Memorial Sloan Kettering, Watson Oncology gives individualized treatment choices to patients dependent on their particular case subtleties and existing clinical proof. The innovation helps oncologists with the difficult undertaking of orchestrating the most recent exploration and best accessible data to improve persistent consideration^[14].

E. Point-of-care (POC) diagnostics: Allow for suitable, timely testing at the point of care (e.g., physician office, ambulance, home, or hospital), resulting in quicker and more unified patient care. Patients can utilize POC diagnostics in the home, physician office, ambulance or hospitals. Current extensively accessible home POC tests include pregnancy, blood glucose and HIV^[15]. Some medical device and diagnostic companies are also developing POC tests for tuberculosis, cancer and stroke markers, among others. POC diagnostics could help in prevention, early diagnosis, and management of chronic conditions^[16].

Reddy's lab, the Velocit pregnancy test kit, Mankind Pharmaceuticals Ltd, Prega news, ABON™ HIV 1/2/O Tri-Line Human Immunodeficiency Virus Rapid Test Device, DrAlere Determine™ HIV-1/2 SET are various popular products based on Point-of-care (POC) diagnostics. Another industrially accessible PoCT gadget for DNA testing is the Spartan RX™ stage which identifies changes in the CYP2C19 quality. These transformations influence decreased reaction to clopidogrel, an anti-platelet aggregation medication given to patients experiencing percutaneous coronary interventions (PCI), and can bring about unfriendly outcomes. PCIs are regularly performed earnestly, henceforth the likely advantages for quick PoCT to identify changes in the CYP2C19 quality and elective medication treatment with better results^[17]. Multiplexed point-of-care testing (xPOCT) is another more complex variety of point-of-care testing (POCT). While point-of-care testing is majorly quantification of one analyte from one in vitro (e.g., blood, plasma or urine) sample, multiplexed point-of-care testing is the concurrent on-site quantification of a variety of analytes from a single sample. Quidel's Triage system, CustomArray's ElectraSense® Reader are some multiplexed point-of-care testing kits that can analyze up to five analytes at a time^[18].

F. Virtual reality (VR): It is simulated environments that could speed up behavior change in patients in a way that is safer, more suitable, and more accessible. VR creates multisensory experiences using computer-generated images that appear on a headset.

Virtual reality can aid both patients and medical practitioners as:

Treatment of Post-traumatic stress disorder (PTSD): It is a very common condition among soldiers due to the various psychological traumas they faced during warfare. Also hospitals and clinics are using VR warfare simulations similar to conditions

in Afghanistan and Iraq and to aid veterans who are, in many ways, repeatedly reliving the traumatic proceedings they experienced. In a protected and restricted environment, the soldiers can be taught how to deal with instances that might otherwise trigger a behavior that could be destructive to themselves and others.

Training Medical Students: The virtual reality tool is also used to assist clinical team and students to train and acquire work skill faster. With this use of virtual reality in education, medical team and students can gain knowledge on how to conduct delicate surgical procedures. This can also aid trainees to increase their practice hours in a virtual setting, terminating the fear of risk on actual patients.

Therapy for Paraplegics: Patients and persons with conflicting physical abilities may have the opportunities to use VR tools to experience the thrills of a variety of environments without being restricted to their actual location. Markedly, VR headsets are being used to allow paraplegics to build back their brain functions and recover control of limbs.

G. Leveraging social media to improve patient experience: Tapping information from social media and online communities to present fitness care businesses the potential to tune client revel in and populace fitness developments in real-time^[19]. Just as shops are the usage of customer statistics to sell particular products, the health care industry is evolving its capability to apply information mining and predictive analytics to help improve populace health and the affected person experience. Social media may be a wealthy source of health care records that could be precious to patients, researchers, policymakers, and medical institution administrators. Social networks and online communities should play an crucial position in patron health management, serving as hubs where patients and caregivers can meet to invite questions, share statistics, and examine reviews with treatments and medications^[20]. Patient-generated content on digital platforms will illustrate the needs, wants, motivations, behaviors, and choice concerns of patients and caregivers. This statistics can provide a valuable supply of insights for providers and pharmaceutical companies searching for to apprehend how fine to reach, engage, and support people throughout the patient journey. Social media also can be used to tune consumers' experiences with the health care system. Research has focused on leveraging broad populace information such as looking for positive phrases on Twitter or other platforms, or using targeted disease groups to study

patient preferences, symptoms, responses to treatment, and other satisfactory-of-existence measures. The most not unusual examples of a few social platforms includes Google reviews, Twitter, You tube, Facebook etc. Anyone can get to recognize of the first-rate of services provided, fee and experiences of the human beings with the concerned health facility or clinician^[21].

H. Biosensors and trackers: Technology-enabled movement trackers, monitors, and sensors integrated into clothing, accessories, and gadgets that allow customers and clinicians to easily monitor health. In addition to observing exercise, nutrition and diet, and vital signs, these sensors and trackers could easily track changes inside one’s body -blood/hormone/protein levels, medication levels as well as device performance. Patients are more likely to adapt these sensing devices as they become compact and less invasive. Increased bio-sensing could improve patient participation, disease monitoring, medication adherence and eventually, health outcomes. The data collected can be used by clinicians, investigators to intercede earlier and more often, and by researchers to well understand treatment efficacy. Below given are some commercially available biosensors and trackers available in the market^[22].

Disease	Monitoring	Product Category	Commercial Product
Metabolic disorder ^[23]	Glucose Hydration	Wrist band/watch Ear appliance Patch Wrist band/watch	GlucoWatch G2 Biographer, Gluco Track, Symphony, Freestyle Libre, Dexcom Patches, LVL
Respiratory diseases ^[24]	Audio signal, heart rate, accelerations, Cardiac electrical activity (ECG)	Wrist band/watch Smart patch	LG Watch Urbane W150, Moto 360 2nd Generation, Savvy patch ECG sensor
Sleep or stress related disease ^[25,26,27]	Heart rate variability, Heart rate	Wrist watch/band Smart jewelry Patch	Airo Health’s anxiety tracker, Motivrin, Go2Sleep, Kenzen Patch, Vital Scout
Cardiovascular disease ^[28]	Heart rate, Pulse rate	Wrist watch/band	Omron HEM 6131
Fitness tracking ^[29,30]	Heart rate, Calories burned, activity level Heart rate, Heart rate variability, Body temperature	Smart jewelry Ear appliance	Ear-o-smart, Cosinuss’ One

Cognitive disorder ^[31]	GPS	Wrist band/watch	VegaGPSbracelet
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Table 1: Some commercially available biosensors and trackers available in the market

- I. Convenient care:** Retail clinics and urgent care centers that provide more convenient and lower-cost care to patients for a number of health issues.

Retail Clinics

Retail clinics provide walk-in services for patients. Instead of physicians, retail clinics are staffed by nurse practitioners (NPs) or physician assistants (PAs), and are intended to be affordable and efficient. Different location operators provide different services, but generally, retail clinics provide care for common illnesses and injuries, including a sore throat, cold and flu symptoms, allergies, minor cuts, burns, rashes and headaches. Some retail clinics may also perform immunizations, annual physicals and health screenings. The operating hours for retail clinics vary, but are generally open from 8 a.m to 8 p.m during the week^[32].

Urgent Care

Urgent care centers are a bit more advanced in clinical capabilities when compared to retail clinics, based on the staff and equipment available at an urgent care center. These centers are setup to assist patients with an illness or injury that does not appear to be life-threatening, but also can't wait until the next day, or for primary care doctor to see them. Urgent care centers have at least one board-certified doctor in-house to treat patients during business hours. Non-life-threatening conditions suited for urgent care clinic treatment include, but may not be limited to: accidents and falls, bleeding/cuts - not bleeding a lot but requiring stitches, breathing difficulties (i.e. mild to moderate asthma), diagnostic services, including X-rays and laboratory tests, eye irritation and redness, minor broken bones and fractures (i.e. fingers, toes) etc.^[33, 34]

- J. Telehealth/Telemedicine:** A boon in medical science, more suitable way for consumers to gain and improve self-care while substantially reducing clinic/hospital visits and travel time; may also prevent complications and emergency room (ER) visits.

Telemedicine can be defined as amalgamation of electronic information and telecommunications technologies to maintain long-distance clinical health care as well as patient and professional health-related education. Earliest published evidence of telemedicine dates back to first half 20th century when ECG was transmitted over telephone lines. From then to today, telemedicine has travelled a long way both in terms of healthcare delivery and technology. A very major role in it was played by ISRO and NASA. For instance, setting up of the National Telemedicine Taskforce by the Health Ministry of India, in 2005, lined the way for the accomplishment of various projects like the NeHA, ICMR-AROGYASREE and VRCs. Telemedicine can also help family physicians by giving them easy access to specialist doctors and aiding them in close monitoring of patients. Various types of telemedicine services like real-time and remote or self-monitoring, store and forward, provides a variety of educational, healthcare deliverance and management, disaster management and disease screening services all over the globe. Even though telemedicine cannot be a solution to all the problems, it can surely help decrease the burden of the healthcare system to a large extent^[35]. ISRO (Indian Space Research Organization) made a modest beginning in telemedicine in India with a Telemedicine Pilot Project in 2001, linking Chennai's Apollo Hospital with the Apollo Rural Hospital at Aragonda village in the Chittoor district of Andhra Pradesh. Initiatives taken by ISRO, Department of Information Technology (DIT), Ministry of External Affairs, Ministry of Health and Family Welfare and the state governments played a vital role in the development of telemedicine services in India^[36].

A few noteworthy examples of the successfully established telemedicine services in India include “Mammography Services” at Sri Ganga Ram Hospital, Delhi; “Oncology” at Regional Cancer Center, Trivandrum; “Surgical Services” at Sanjay Gandhi Postgraduate Institute of Medical Sciences, School of Telemedicine and Biomedical Informatics and “Telepsychiatry System” at Telemedicine Centre Postgraduate Institute of Medical Education & Research, PGIMER, Chandigarh.^[37,38, 39]

CONCLUSION

There is a huge scope of improvement, both in diagnosis accuracy and affordable treatment, to predict the clinical impact of identified pathologies as well as giving patients a quality life. Various new avenues either be it genome sequencing that could predict a probable future risk of disease or be it immunotherapy has almost zero side effects suffers lack of affordability. Development in the Information technology and Telecommunications is a must. These wireless technologies are the only solution to address problems of providing medical facilities to our country with population over a billion. Addressing these issues will not only help the community but will also pave the foundation of further new avenues in affordable medical technology.

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