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Reimagining the possible in the Indian healthcare ecosystem with emerging technologies

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Foreword

Healthcare is one of the fastest growing sectors in India and the Indian government has aggressive plans to develop India further into a global healthcare hub, leveraging its relatively lower priced treatment options. It presents a great opportunity for the growth of the entire health industry – medical devices, healthcare providers and pharmaceutical manufacturers.

The government has initiated a fundamental change in its role from being a care provider (hospitals) to also becoming an insurance provider, as is evident from the proposal in Union Budget 2018 of a health protection scheme of 5 lakh INR health insurance cover to 50 crore poor and vulnerable individuals, covering around 40% of the Indian population.

The gap between the required and current growth in healthcare infrastructure and care-providing staff in India cannot be addressed through an incremental and linear approach. Latest advancements in technology like artificial intelligence (AI), Internet of things (IoT) and blockchain can enable the healthcare industry to adopt disruptive technology-led service and business models, scale up for access and affordability, and take the winning leap to make India a global healthcare hub.

Technology adoption in healthcare is at a nascent stage in India. One of the first steps towards this transformation will be to use technology as the lever to break the silos and for tight coupling of data with providers and caregivers, and to encourage and enable an ecosystem of free data flow and interchange. Other steps will include adoption of IoT-enabled wearables to monitor health, AI-enabled predictive analytics to predict diseases, mobile and IoT-enabled technologies to shift from hospital-based care to technology-enabled home care, telemedicine and advanced imaging-enabled technologies to address availability of specialist doctors in remote and rural areas, and drone-enabled technologies to improve medicine availability. Sharing of health data will bring in privacy concerns which need to be addressed through greater focus and investments in cyber security.

In addition, we need to fund specialised domain research in medical fields like robotics-led remote surgeries, basic medicine and provisions to incentivise the participating resources for their time and effort to foster a culture of research and excellence.

And all this needs to be done by taking a leaf out of the successful private-public participation models in other countries and also other sectors in India to make the growth of technology-enabled healthcare more socially and economically inclusive and affordable.

Arnab Basu

Partner and Technology
Consulting Leader

Foreword

Healthcare in India has always posed big questions around accessibility and affordability for most of its population. On the one hand, it is largely financed through out-of-pocket payments and remains unaffordable for a large part of the population. On the other hand, access to the right doctors, facilities, treatment and medication in a timely manner is limited to a few metro cities and thus, large parts of the country lack this acess. As the population ages and more people begin to need medical and social care, this dual problem is poised to assume mammoth proportions in the next 20 years, unless we take significant measures to address it now with bold measures in policy and implementation.

On the policy side, the Indian government has made a bold commitment to achieve Universal Health Coverage (UHC) through Ayushman Bharat, which aims to provide affordable healthcare to the entire population and reduce their expenses on healthcare.

On the implementation side, improving healthcare infrastructure takes time and money. Fortunately, technologies have evolved and converged significantly over the last decade and shown promise to address these gaps in the Indian healthcare infrastructure. Rapid developments in mobile technologies, cloud computing, digital imaging, machine learning and 3D printing have paved the way for breakthroughs in the development and adoption of healthcare technologies – from telemedicine to nanotechnology, lab-grown 3D organs to Internet of medical things, and electronic health records to artificial intelligence.

Just as mobile technology helped India leapfrog its landline infrastructure problems and catapulted it into the information technology age in the 1990s, technology-enabled healthcare can provide cost-effective and scalable solutions to India's healthcare problems and make it a global healthcare destination. Digitally enhanced healthcare, speciality operating models and disruptive technology-led healthcare services are already making strides in patient satisfaction and provider revenues in western economies.

Globally, there are concerns around infringement of privacy of healthcare data and hacking into connected medical systems, but the significant benefits of cost reduction, improved access, and better and timely treatment are leading to increased adoption at both the healthcare provider and patient levels.

The key for Indian healthcare to taking a winning leap will be to reimagine the future with emerging technologies while finding a balance between:

1. Increasing care expectations of patients in a connected world and facelessness of technology-driven healthcare
2. Constrained budgets and rising costs of healthcare
3. Complexity of new technologies and their ease of deployment, integration and security

Abhijit Majumdar

Executive Director and

Technology Strategy Leader

State of healthcare in India

Healthcare in India is complex due to the multi-layered architecture of health system administration. There are various considerations for this multi-layered hospital administration architecture.

These include whether **it gets public** (Central or state government) or **private funding**, what **location** it covers (rural or urban), and what **demography** and **prevalent diseases** it covers.

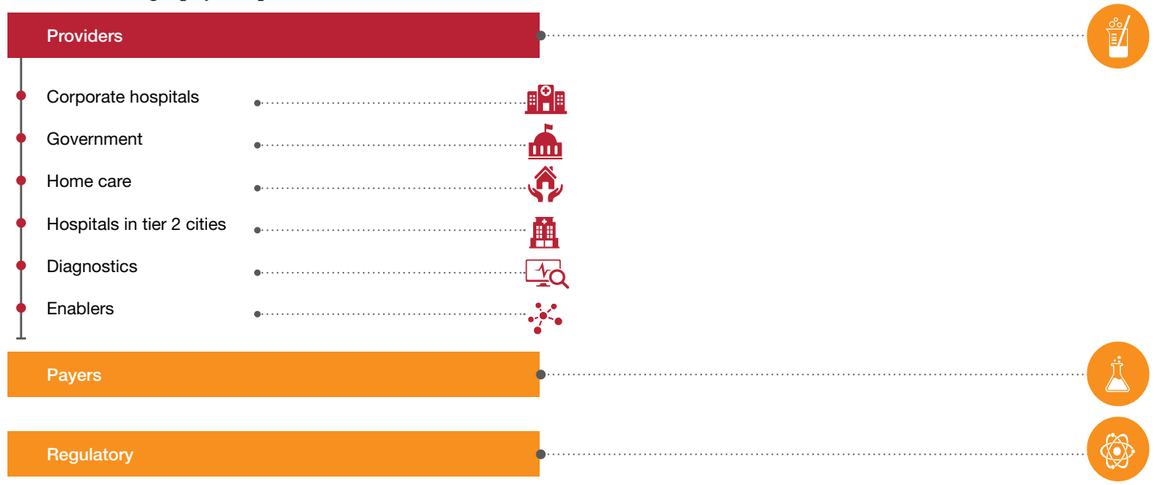


Figure 1: Healthcare provider ecosystem in India

Historically, healthcare delivery in independent India has been under the purview of the government. Although the government has secondary and tertiary care facilities, it is the **private sector that runs a majority of secondary, tertiary and quaternary care facilities**. Private facilities are also majorly concentrated in and around tier 1 and tier 2 cities.

Also, there is great disparity in the availability of skilled resources between rural areas and urban areas, and more treatments are taking place in private facilities as compared to public facilities in both urban and rural areas.

Split of population and doctors

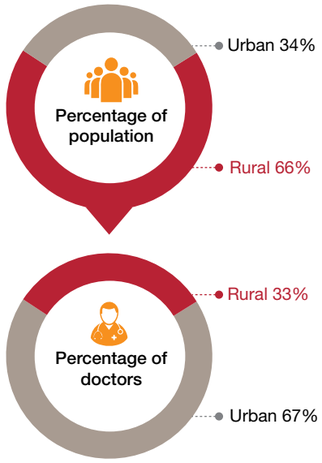


Figure 2: Split of population and doctors in India

Share of cases treated

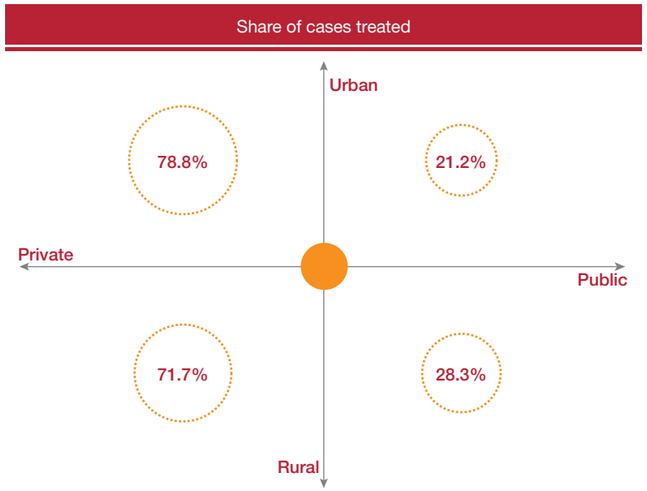


Figure 3: Share of cases treated in India

Source: PwC analysis, World Bank data (2017)

Indian healthcare has made substantial progress, especially in the last decade. The government is trying to improve public health delivery and huge ongoing investments are being made in infrastructure. **Between 2000 and 2014, there was a 370% increase in health expenditure.**[1]

Statistics for Indian healthcare providers ecosystem (rural)

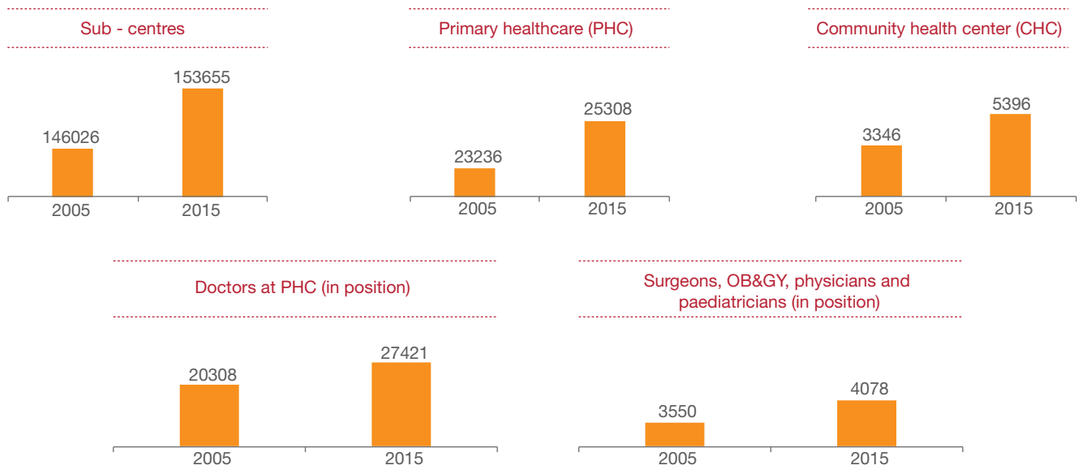


Figure 4: Change in spread of providers across the care delivery ecosystem in rural India between 2005 and 2015

Source: Health & Family Welfare Statistics in India, Ministry of Health and Family Welfare (MoHFW), 2015

[1] PwC analysis and World Bank data

There is an increasing emphasis from the government to reduce drug prices and make medicines more affordable—for example, some of the critical drugs for cancer treatment are now 86% cheaper, whereas prices of diabetes drugs are down by 42%.[2] Further, doctors are being encouraged to prescribe generic drugs instead as much as possible.

We are also observing tremendous efforts from the government to change its role in Indian healthcare from that of a provider to an insurer. With Union Budget 2017, the government has pushed to make **Aadhaar card a health identifier** for basic health services in the country. It was also a critical step in identifying the beneficiaries of social healthcare insurance programmes being rolled out by the government.

In **Union Budget 2018**, the government has given a further push to enhancing the healthcare system of the nation by launching the Ayushman Bharat, which will provide insurance cover to 10 crore families in India. This budget is also special because for the very first time, under the guidance of NITI Aayog, allocations to the tune of 3,073 crore INR have been set for creating a digital economy with emerging technologies like artificial intelligence (AI), the Internet of things (IOT), blockchain and 3D printing, which are necessary for building a modern technology landscape in healthcare delivery. If successfully implemented, this can reduce wait times and improve productivity greatly by minimising human intervention in electronic medical records (EMRs)/enterprise resource planning (ERP)/hospital information systems (HISs).

> ‘The government’s move to provide a coverage of up to 5 lakh INR to 10 crore poor families is the biggest scheme of its kind in the world and is in continuation with the trend of the government being a payer rather than a provider in the secondary and tertiary care space. The National Health Protection Scheme will provide much-needed protection to the most vulnerable section of our population and increase productivity due to lower disability-adjusted life years (DALYS) lost.
>
> The government has recognised the impact of medical inflation and increased the tax exemption for senior citizens from 60,000 to 1 lakh INR under section 80 DDB and medical insurance deduction under section 80 D from 30,000 to 50,000 INR. Also, the move to turn 1.5 lakh health sub-centres into wellness centres will help in the early detection of disease, reducing both mortality and morbidity. It will also help change the current focus from treatment to proactive prevention.’
>
> Dr. Rana Mehta
> Healthcare Sector Leader, PwC India

[2] Kapoor, R. (20 September 2017). A PPP approach to transform healthcare. The Hindu Business Line. Retrieved from https://www.thehindubusinessline.com/opinion/a-ppp-approach-to-transform-healthcare/article9866487.ece (last accessed on 28 February 2018)

The Ministry of Health and Family Welfare (MoHFW) is also running several e-governance initiatives for the digitisation of the healthcare sector in India, and has set up a division called e-Health India. e-Health adds two more goals to the triple aim of healthcare globally:

- Access
- Affordability
- Quality
- Lowering of disease burden
- Efficient monitoring of health entitlements to citizens

e-Health

e-Health initiatives by the MoHFW, Government of India

- **National eHealth Authority (NeHA)**

Envisioned as a regulatory and promotional organisation to strategise eHealth adoption and set the standards, policies and legal framework for the health sector. Additionally, NeHA is responsible for setting up electronic health exchanges for interoperability and devising a certification framework for EHR products.

- **Integrated Health Information Program (IHIP)**

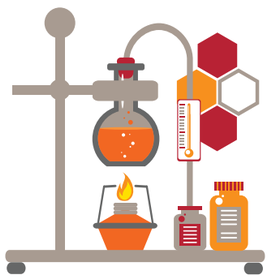
This programme intends to provide EHR to all the citizens of India and provide interoperability to existing EHR/EMRs on the Integrated Health Information Platform.

- **Electronic Health Record Standards for India**

EHR standards were first notified in September 2013 by the MoHFW and a revised version was later released on 31 December 2016 after taking feedback. The MoHFW has also made standards like Systematized Nomenclature of Medicine – Clinical Terms (SNOMED CT) available free for use in the country.

- **mHealth**

The government is working with organisations, both government and private, to provide intuitive and interactive modes of communication, treatment, data transmission, and retrieval to doctors/hospitals and patients using mobile apps and websites.



Despite the various initiatives undertaken by the government and private players, the Indian healthcare ecosystem faces numerous challenges:

- There is a **shortage of qualified doctors and nurses**. On the infrastructure front as well, there is a need for exponential growth.

World Health Organization (WHO) recommendations

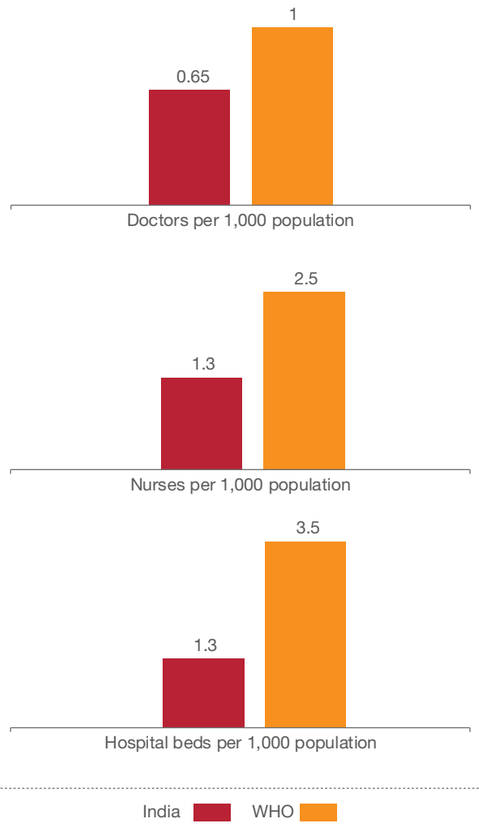


Figure 5: Comparison of key healthcare resources in India vis-a-vis WHO recommendations

Source: PwC analysis, NSS 71st Round, 2014

- Healthcare facilities are **not accessible uniformly** across India. In some places, patients might have to travel hundreds of kilometres to avail basic healthcare services.

- We don't have consistent quality in the healthcare sector across the nation—**less than 2% of hospitals in India are accredited.**[3] There are also a large number of informal players and unqualified individuals acting as doctors.

- **Government health expenditure is very low**—in fact, it is the lowest out of all BRICS countries. However, this should improve once Budget 2018 is implemented.

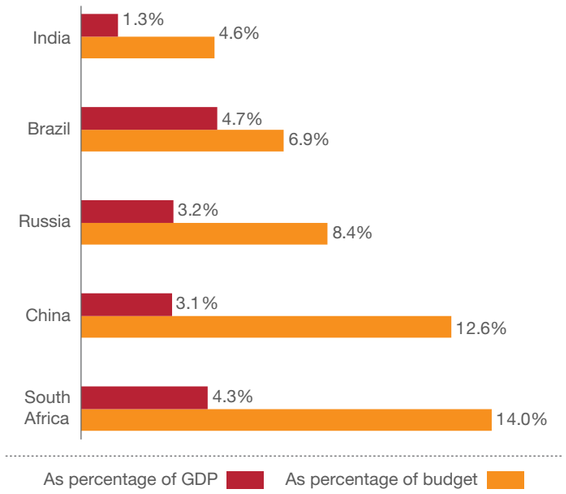


Figure 6: Comparison of Indian government healthcare expenditure vis-a-vis BRICS countries

Source: Lancet, World Bank

- **Private expenditure is very high in India**. It currently stands at around 70% whereas for the UK, this figure stands at 16.9%.

- There is low penetration of insurance in India. At **62.4%, out-of-pocket health expenditure** is a very high share of the total healthcare expenditure in India. In the UK and USA, this share stands at around 9.7% and 11% respectively.

- **The Indian healthcare system is reactive.** Patients don't act proactively and often visit a hospital only when the disease has reached an advanced stage. This can be attributed to lack of awareness about diseases, care and services available.

- Although government initiatives are in place, currently, they are not mobilised effectively to optimise healthcare delivery in India.

[3] PwC analysis, NABH (http://www.nabh.co/frmViewAccreditedHosp.aspx), Open Government Data (https://data.gov.in/catalog/number-government-hospitals-and-beds-rural-and-urban-areas) and Joint Commission International (https://www.jointcommissioninternational.org/about-jci/jci-accredited-organizations/?c=India)

These challenges require the healthcare industry to cater to a lot more patients. facilitated by the right push from the government in terms of providing insurance coverage to the masses, Healthcare should become more accessible and affordable, and the focus should shift from reactive to proactive diagnosis and treatment, and there should be greater collaboration between various healthcare stakeholders.

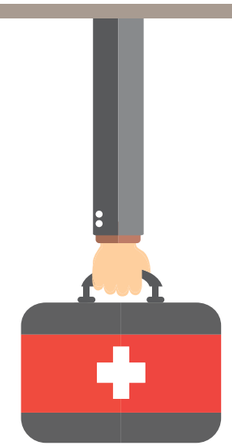
The healthcare industry needs to move beyond linear growth such as adding new hospitals and adding a fixed number of physicians every year, and instead look for ways to disrupt the current operating model.

Uberisation of the healthcare industry is required to radically change the way healthcare operates, and emerging technologies have the potential to positively impact the healthcare ecosystem.

Emerging technologies can take up many of the responsibilities currently performed by doctors, thus enabling doctors to spend more time on activities that require their expertise. Emerging technologies can also monitor patients on a regular basis and assist with the early diagnosis of serious conditions. This will enable patients and healthcare providers to proactively seek treatment.

Emerging technologies can ensure collaboration between healthcare providers with the right set of controls assigned to patients. Various aspects of Indian healthcare, such as treatment guidelines and protocols and ownership and sharing of patient records, need to be standardised. Most importantly, the costing of health services needs to be made uniform with the agreement of all stakeholders and implemented across the nation. Emerging technologies like blockchain look very promising in this regard. Sharing of patient data can be made as simple as sharing a key, without any hassles of managing availability or security of data. This will make it easier and faster for doctors to understand medical history and for insurance providers to validate and expedite the reimbursement process.

Disruptive technologies are shaping the future of healthcare



Innovations in healthcare

Technology is the best way to achieve the vision of a connected healthcare ecosystem. Medical devices in hospitals/clinics, mobile care applications, wearables and sensors are all different forms of technology that are transforming this ecosystem. These enable caregivers to perform their roles more easily by automating the logging-on mechanism, automating real-time updates of patient vitals and providing insights into early detection of diseases.

Technologies help to collect, store and share critical patient data. By adding an analytics layer to this, caregivers can provide a much better analysis of the condition and recommendations to the patient. AI can assist caregivers in the early detection of diseases based on certain triggers in vitals.

Even outside the hospitals, **wearables and smart sensors** can help track patient history or any threat to an individual, which may be beneficial, especially to those who are at a higher risk, such as those with diabetes or a history of heart attacks.

From simple fitness and heart rate monitors to **smart glasses and smart clothing**, there are several options for individuals to watch over their own health parameters in order to not only lead a healthy life but also get expert opinion by simply sharing these parameters with their caregivers.

Digitisation of patient health records and EMRs has been one of the crucial steps which made such a transformation possible. Several vendors are trying to digitise the ways we manage or share electronic records, payments, insurance, and document these aspects.

There have been various proofs of concept of blockchain applications in the healthcare industry that are theorised to bring together sharing of this information in a secure manner. All these use cases will enable **seamless access to historical and real-time patient data to authorised users**, eliminate the need for intermediaries, reduce costs, and save time.

Disruptive technologies in healthcare

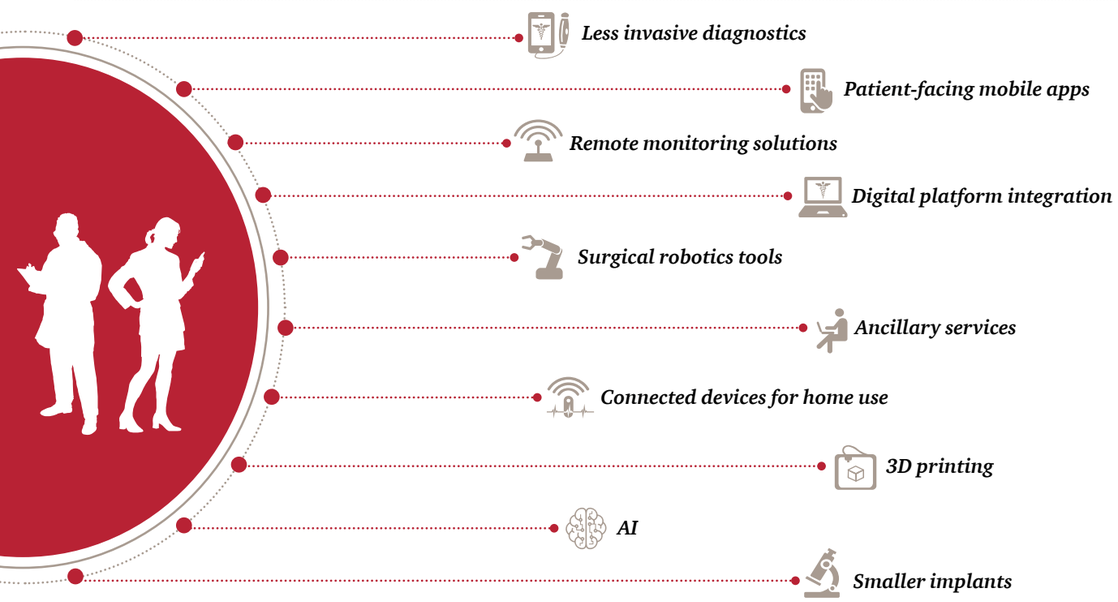


Figure 7: Disruptive technologies in healthcare

Source: PwC Health Research Institute clinician survey, 2015

Several other technologies are being used to empower healthcare providers with the tools to deliver better care or eliminate the current challenges. For example, **augmented reality (AR) and virtual reality (VR),** in addition to holograms are paving the way for precise surgeries with the help of 3D models of the patient which can be analysed in detailed by surgeons prior to performing the actual complex surgery.

AR is being used in medical education, where it has the potential to reduce the count of actual dissections, and greatly help in the study of human anatomy, histology and embryology. This is especially beneficial today when the need for doctors has vastly increased.

3D printing is also becoming popular in this industry due to its wide variety of applications. From precise casts to accurate replacement of bionic parts, it has found many uses in curing physical injuries. Bionic parts include not just accurate ears or teeth, but also tissues and organs made from the patient's own cells to reduce the risk of rejection of organ transplants.

Also, 3D printing of complex vascular organs and anatomical models has increased the accuracy of surgical process and training. Even in pharmaceutical processes, it is helping in personalised drug dosing, drug delivery and drug release profiles.

With the future of healthcare focused on personalised care, the **adoption of chatbots and AI assistants** in this field is beneficial as these help in reducing the workload of doctors and ensuring convenience for patients, in addition to helping in therapy and 24x7 support for patients across the globe.

Emerging technologies can be utilised to cater to the specific challenges faced in India:

- Provide real-time patient information and assist with symptom-based diagnosis which can save doctors' time and enable them to consult more patients.
- Provide consultations and conduct surgeries remotely, thus bringing healthcare to remote areas with no access to basic healthcare facilities.
- Enable the patient and healthcare providers to take proactive measures based on an analysis of vitals captured remotely using wearable medical devices.
- Provide critical home care with the same level of care and cleanliness that is provided in the ICU along with remote monitoring of a patient's vitals.
- Decentralise patient health records using blockchain technology to maintain a single source of truth and provide control to patients regarding who can access their records.

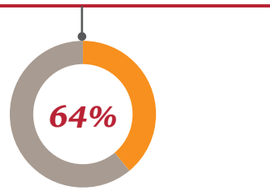
In this paper, we will look closely at applications of Artificial Intelligence (AI) and the Internet of Medical Things (IoMT), their adoption in India and challenges that the Indian healthcare ecosystem faces in terms of the adoption of these emerging technologies.

Relevant emerging technologies for the Indian healthcare ecosystem

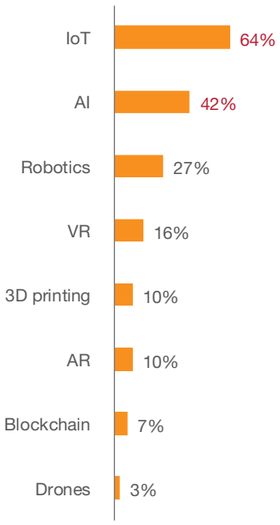
As per PwC's 2017 Global Digital IQ Survey, the Indian organisations surveyed seem to be making significant investments in AI, IoT and robotics. The investment focus is likely to shift to blockchain in the coming years.

PwC's Global Digital IQ Survey

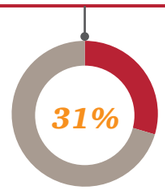
In India, investments are happening in IOT and AI:



of the Indian executives interviewed say they are investing in **IoT**



Globally, healthcare executives rate AI as most disruptive tech in the industry, followed by IoT:



of the global healthcare executives interviewed rate AI as the most disruptive tech in the industry

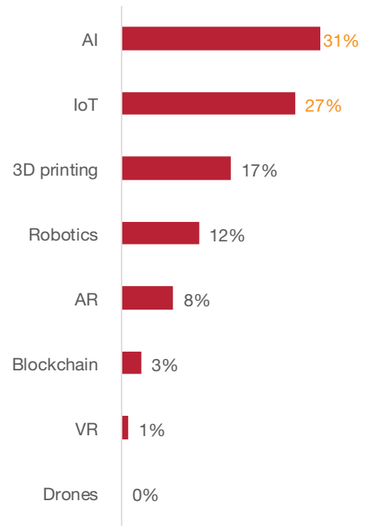


Figure 8: PwC's Global Digital IQ Survey

Source: PwC's Global Digital IQ Survey, February 2017

PwC's 2017 Global Digital IQ Survey

We've been conducting Digital IQ research since 2007, and 2017 marked our eighth survey of business and IT executives globally.

The 2017 edition was fielded September through November 2016 and included 2,216 respondents from 53 countries. Respondents were evenly divided between IT and business leaders. Reflective of the distribution of respondents globally, 62% work in organisations with revenues of 1 billion USD or greater and 38% have revenues between 500 million USD and 1 billion USD.

AI

Artificial Intelligence(AI) can be defined as the capability of devices to learn on their own without an explicit program and act on the information gathered cognitively. AI leaders are working tirelessly to enhance the applicability of AI in health sciences. There is a huge effort to put AI to good use at the very core of the healthcare industry, at the **point of care delivery.**

Some of the most remarkable developments are:

- Identifying patients at risk of developing a condition, deteriorating due to lifestyle, environmental, genomic, or other factors, utilising system dynamics driven pattern recognition. **PwC's Bodylogical™** uses machine learning algorithms to digitally represent the physiology of the human body, thereby enabling simulations to predict the likely progression of chronic diseases in the future based on choices made today. These simulations help hospitals, insurance providers, pharmaceutical providers, and researchers to better understand choices and therapeutics and their implications for patient's health outcomes and impact on associated costs.
- AI can also help clinicians take a comprehensive approach towards **disease management**, better coordinate care plans and help patients to better manage and comply with their treatment programmes. An application has been built by a **start-up in the US**, with these very objectives in mind. This application can not only identify the patient's face and the medication they're taking using a visual recognition system but also confirm ingestion.
- Clinical trials are traditionally time consuming. It might take more than a decade to create a drug and therefore huge investments to the tune of billions of dollars are sometimes necessary. AI is drastically expediting clinical trials from years to—in some cases—days, consequently leading to huge savings in expenses.
  Another start-up in the US discovered a potential candidate drug to reduce Ebola infectivity, cutting down months and years of analysis to a single day.
  With advances in AI, **tissue sample analysis**, which traditionally took a year of a pathologist's time, can now be performed in a single day. Since lower costs are incurred on drug discovery, in the long run, pharmaceuticals can be expected to pass on the benefits to the end user either voluntarily or by law, thus making healthcare accessible to more people.

PwC's Bodylogical

Bodylogical™ is a patent-pending scientific model that is bringing an entirely new level of precision to health and enabling organisations to double down on value. By simulating the interplay of actions and reactions inside each of our bodies, Bodylogical™ creates a deeper, more personal view into something not possible before: the unique requirements of our individual bodies when something changes to affect our health. Bodylogical™ helps organisations deliver on two sides of value simultaneously:
Improving health outcomes and lowering healthcare costs.

Pharmaceutical and life sciences organisations

can now create new and quantifiably more effective therapies faster, get therapies to the right people, and focus their investments on drugs and technologies that indicate the highest probability of success.

Population health managers and employers

can make better healthcare investments by knowing what interventions will quantifiably reduce chronic disease for specific, targeted populations – down to the individual level.

Devices from digital health providers

can now give consumers more power to do more with their health by providing more actionable and personally calibrated information.

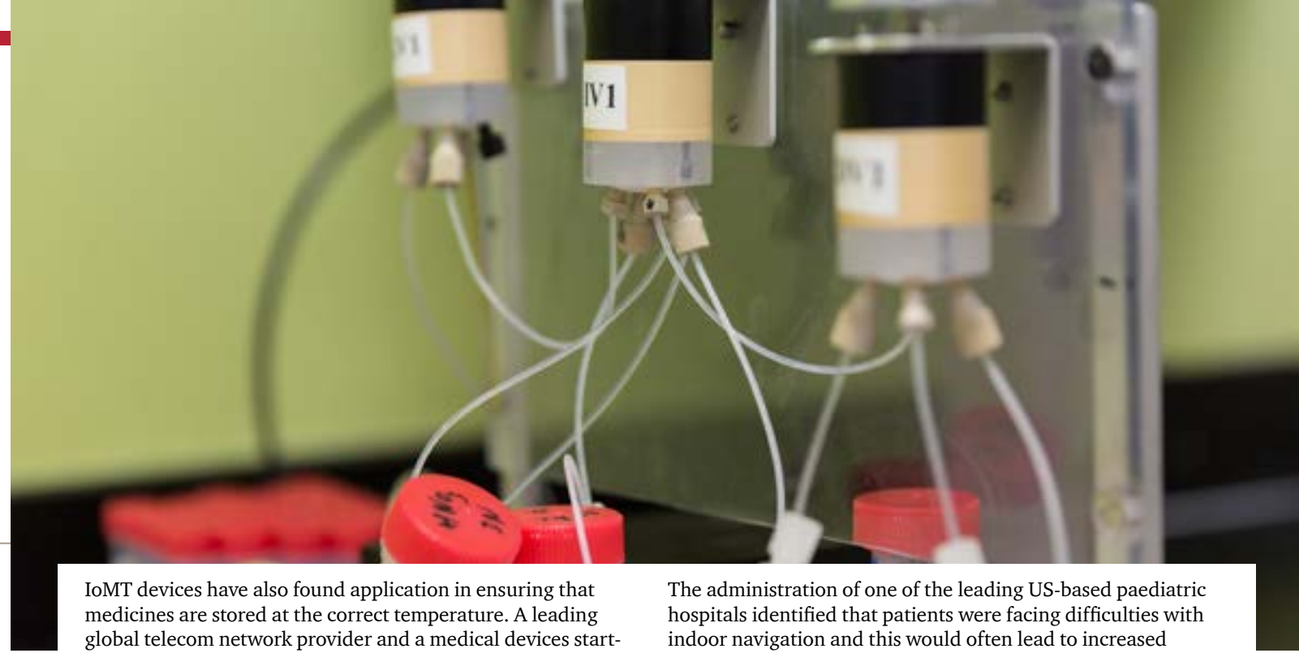
IoMT

Internet of Medical Things (IoMT) refers to the worldwide network of interconnected medical devices and applications. The healthcare sector stands to gain a lot from this technology as IoMT has found applications in clinical as well as non-clinical scenarios. On the clinical side, IoMT is being used to **monitor a patient's vitals** (temperature, blood oxygen saturation, blood pressure, respiration, ECG/EEG/EMG, etc.) and raise timely alarms. It is also being used for continuous monitoring of vitals and assisting physicians with intuitive dashboards instead of them manually operating ICU devices/ patient monitors to check for recent spikes in vitals or relying on information noted manually by nurses at regular intervals. IoMT and AI together have the potential to enhance the clinical decision-making process and change the reactive approach of healthcare delivery to a proactive approach.

On the non-clinical front, IoMT has found value in terms of **asset tracking,** tracking physicians' adherence to hygiene standards, connecting ambulances to the hospital information system, enhancing operational efficiency by tracking movements of people/assets in hospital premises, and assisting with real-time information on queues to suggest appointment rescheduling, etc.

A university hospital in the US was facing challenges in terms of locating IV pumps and nurses had to wait up to two hours before receiving a pump. Some nurses even resorted to hiding IV pumps, which led to an overall reduction of IV pump utilisation. The hospital administration implemented a **radio-frequency identification (RFID) based system** to quickly track IV pumps which **increased utilisation from 45% to 70%** and also reduced the waiting time from eight to twelve minutes.

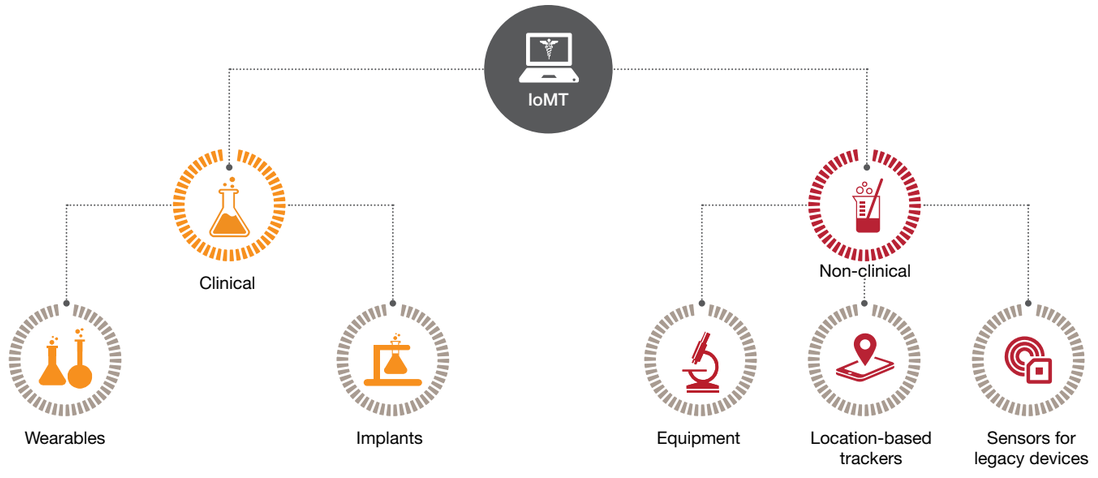
A leading medical centre in the US collaborated with a technology company to implement RFID-based hand hygiene compliance equipment. All **hand sanitiser dispensers were equipped to read RFID tags of physicians/staff** and the data was analysed to check for individual and overall hand hygiene compliance.



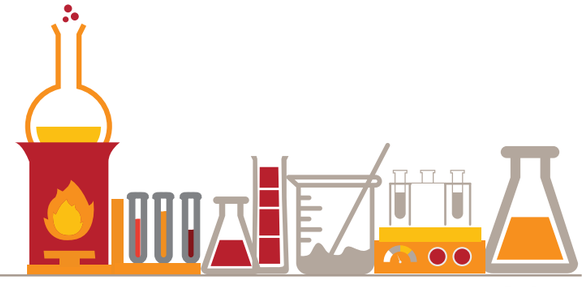
IoMT devices have also found application in ensuring that medicines are stored at the correct temperature. A leading global telecom network provider and a medical devices start-up collaborated to develop a **medicine packaging equipped with sensors to monitor temperature, light and movement,** and report the same via the former's global SIM as and when either is approaching a threshold. A healthcare start-up in the US has developed **smart wireless pill** bottles to track adherence by patients and report the same to physicians.

The administration of one of the leading US-based paediatric hospitals identified that patients were facing difficulties with indoor navigation and this would often lead to increased stress. The hospital created a mobile application which would utilise the location of a patient's family member and guide them from one point to another within the hospital. The application also allowed the hospital administration to update information such as faulty elevators so that people were not directed to these areas.

IoMT device categories



On the basis of their applications, IoMT devices can be split into two major types—clinical and non-clinical—which can be further classified into five device types.



Clinical

1. Wearables

They include biosensors for monitoring blood pressure, heart rhythm, respiratory rate, blood oxygen saturation, temperature, eye pressure, glucose level, brain waves, sleep metrics, etc. These can be used for monitoring inpatients and for remotely monitoring patients after they are discharged from hospitals or under home care.

2. Implants

They include ingestible or implantable sensors used for tumour detection, tracking genomic signals, drug tailoring and inflammation detection.

Non-clinical

1. Equipment

It includes bedside monitors, smarts beds, community kiosks, medication dispensers and medicine adherence trackers. These can be used in a hospital or for home care.

2. Location-based trackers

They include sensors or RFID tags used for tracking patient movement. The data is used to improve operational efficiency, track critical equipment and identify whether a patient has fallen and not recovered, etc.

3. Sensors for legacy devices

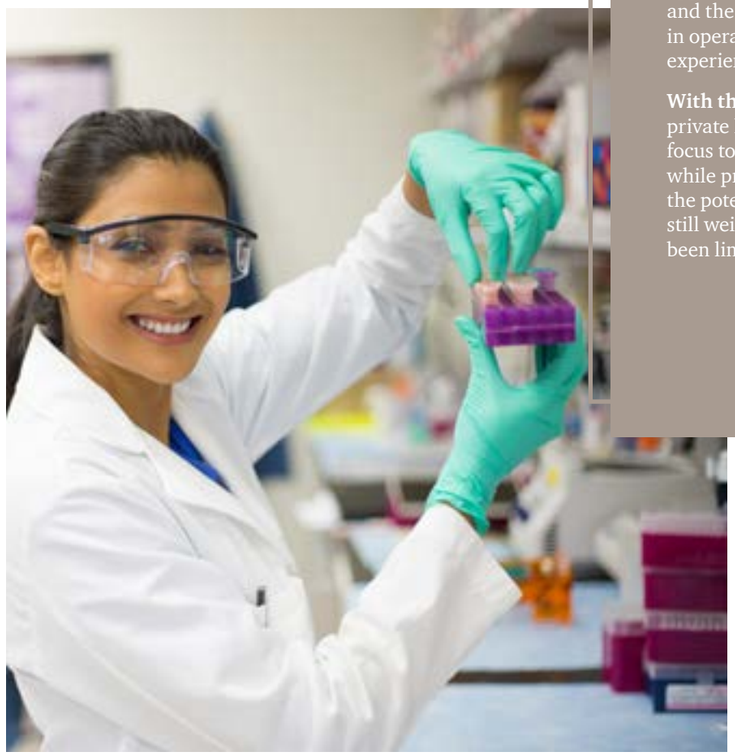
They include sensors that are used to simply transmit the data captured by legacy biomedical devices. These devices are costly and sometimes do not offer connectivity options. The sensors thus enhance their utilisation by connecting them to the enterprise applications.

PwC's Healthcare IT Survey 2018

In order to understand the adoption of AI and IoMT in the Indian healthcare ecosystem, the challenges being faced and expectations of the industry, **PwC interviewed senior executives from leading healthcare providers in India.**

The survey involved discussions on four topics:

1. Current technologies that are being adopted amongst healthcare providers in India
2. Adoption of AI and IoMT use cases by healthcare providers in India
3. Challenges for AI and IoMT adoption in the Indian healthcare ecosystem
4. Changes expected to drive adoption of AI and IoMT amongst healthcare providers in India



Survey question 1: Current technologies that are being adopted amongst healthcare providers in India

Technology adoption has been higher in private institutes as compared to public institutes. Most private healthcare providers, at least the ones in tier 1 and tier 2 cities, have adopted foundational technologies such as hospital information systems (HIS), enterprise resource planning (ERP) software, appointment booking software, RFID asset tracking and the integration of pharmacies with HIS to bring in operational efficiencies and provide good customer experience.

With the release of EHR standards for India, private healthcare providers have now shifted their focus to EHR adoption. As for emerging technologies, while private healthcare providers in India recognise the potential of these technologies, they are still weighing their options and the adoption has been limited.

Survey question 2: Adoption of AI and IoMT use cases by healthcare providers in India

There is a s**hared enthusiasm regarding the potential of AI and IoMT.** Most multi-specialty hospitals are **evaluating** AI, with some level of scepticism, by working with tech start-ups. Most large-scale hospitals have adopted IoMT in some shape or the other.

Adoption of AI and IoMT among Indian healthcare providers is **higher for driving care delivery and customer experience than improving operational excellence.** While IoMT has been used to collect and present patient vitals to assist physicians with real-time information, Indian healthcare providers can utilise emerging technologies to explore use cases such as asset tracking, identifying defects in assets and tracking patient waiting times to enhance queueing mechanisms in order to improve operational efficiency.

There is some level of confusion on **what AI is.** Further, AI is also associated with rule-based programmes being **marketed** as AI.

There are several use cases of emerging technologies being piloted across the **three pillars of healthcare delivery** in India. These technologies will help solve some of the biggest challenges in Indian healthcare.

Summary of currently implemented use cases of AI and IoMT in India

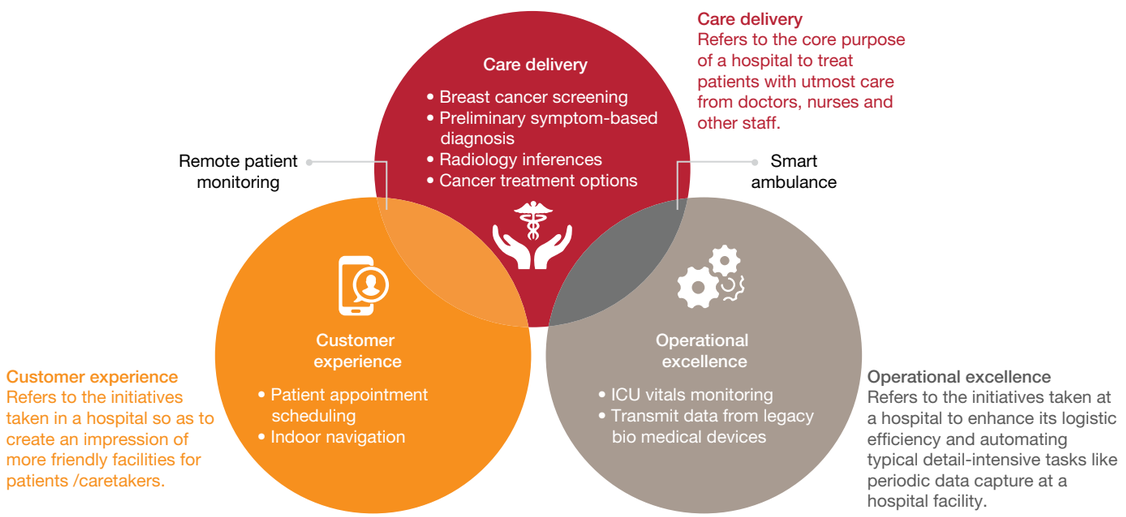


Figure 9: Summary of currently implemented use cases of AI and IoMT in India

Source: PwC's Healthcare IT Survey 2018

Care delivery

1. Breast cancer screening (AI)

In India, around 50% of women who are diagnosed with breast cancer die within half a decade. The fatality is alarmingly high specially when compared to developed countries or even China.[4] This severe situation can be changed if cancer is detected early.

There is a **lack of facilities and specialised radiographers.** The cost of screening is also very high, rendering it to be unaffordable for most of the population in India.

AI-based cancer screening software using machine intelligence over thermographic images has given rise to a l**ow-cost, easy to operate, portable solution** to detect breast cancer that too at a much earlier stage in comparison to traditional diagnostic methods, thus providing a great level of improvement in survival rates. Also, the screening method is **non-contact, painless and free of radiations,** making it easier for women of all age groups to undergo frequent screening.

2. Preliminary symptom-based diagnosis (AI)

The lack of healthcare infrastructure is one of the major challenges in the Indian healthcare ecosystem. A majority of physicians spend their time consulting patients about **not-very-complicated common diagnosis.** Patients also have to spend a great amount of time to travel to clinics/hospitals and then wait in queues to see a doctor.

Based on the symptoms a patient might be having and comparing them with a library of symptoms, **AI is helping physicians save time** for medical cases which might require immediate attention. This also makes the best of the physicians available to the larger population without any geographical barriers.

3. Radiology inferences (AI)

India is home to a quarter of tuberculosis cases across the world. This increases the disease burden of the nation. A lot of these cases are recorded in underserved rural areas, making detection and treatment difficult.

A leading hospital in Delhi-NCR, in association with the Government of Haryana, is involved in a project where a mobile van goes from village to village performing **digital chest x-rays to be processed later by AI.** The hospital is working with a machine learning company, which has an accuracy of around 85%.

The hospital claimed to have detected **244 positively diagnosed patients, out of the suspected 618,** within the first three months of running the initiative. This is remarkable progress towards the eradication of tuberculosis, considering that more than 10 people are saved from contracting this dreaded disease through sputum for each pulmonary tuberculosis diagnosis.

4. Cancer treatment options (AI)

As far as cancer treatment is concerned, there is no single solution for all sorts of variations found in diagnosis. For each new cancer case, physicians have to look for the best suited treatment plan; this is a very intensive process, and with a limited number of specialists available in India, this becomes a bigger challenge.

A leading hospital chain in India has created a system which can generate a detailed report in around less than thirty minutes. This report outlines the **most relevant treatment plan options for the patient** based on his/her cancer diagnosis and medical history. The platform uses advanced AI and covers around 60 different types of cancer.

This hospital also provides these reports for remotely located patients with an option to avail video consultation with an oncologist, further **breaking geographical barriers for cancer treatment.**

[4] Chakraberty, S. (24 April 2017). This startup uses AI to detect breast cancer from the cloud. Retrieved from https://www.techinasia.com/startup-patented-ai-tech-breast-cancer-screening (last accessed on 28 February 2018)

Care delivery and operational excellence

1. Smart ambulance (IoMT)

Previously, ambulances were used merely for transporting a patient and giving necessary care during transit. The lack of automated transmission of patients' vitals on a regular basis hindered analysis by senior physicians and also didn't provide enough information to the healthcare providers to prepare for the treatment by calling specialist doctors, arranging medical equipment, etc.

Some leading hospital chains in India have now implemented IoMT sensors in ambulances to track patients' vitals and share them in real time with the healthcare ecosystem so that physicians can analyse the vitals and make the necessary preparations for treatment before the patient reaches the hospital.

IoMT has thus helped improve operational efficiency and enabled healthcare providers to provide better care.

Operational excellence

1. ICU vitals monitoring (IoMT)

In an ICU, it is of utmost importance to record patient vitals on a regular basis and present them to physicians as and when they visit the patient. Generally, a nurse manually records patient vitals at regular intervals. However, this leads to risks of missing out on certain spikes in vitals in between the nurse's rounds. Along with nurses, physicians manually operate bedside patient monitors too.

A leading hospital in India has been running a pilot programme for the last two years on 10 ICU beds, whereby IoMT sensors attached to bedside patient monitors detect spikes in vitals on a continuous basis, trigger alarms when approaching a threshold and keep the data ready in the form of insightful dashboards for physician visits.

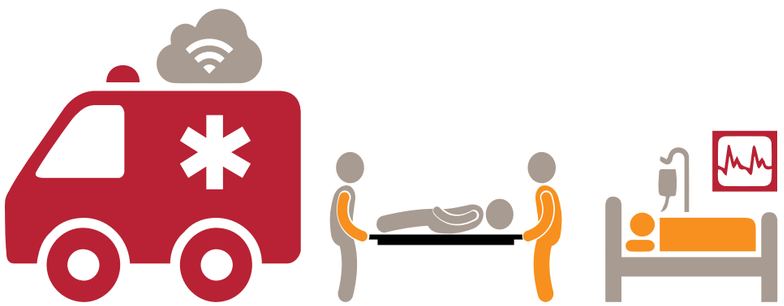
The dashboards generated using data captured through IoMT sensors not only provide an accurate analysis of the changes in vitals, but also save physicians the trouble of manually operating bedside patient monitors to see spikes in the last few hours.

2. Transmit data from legacy biomedical devices (IoMT)

Legacy biomedical devices are costly and do not offer flexibility in terms of connectivity. While some offer Wi-Fi, others only provide wired connections.

A leading hospital in India has utilised IoMT sensors to capture data from such legacy biomedical devices used in ICUs and share the same with a smart hub. Since the IoMT sensors are only used for transmitting data, the reliability of vital parameters transmitted is unquestionable.

The smart hubs provide insightful and configurable digital charts to physicians who now don't have to manually operate the biomedical devices to identify irregular patterns in vitals or rely on data captured manually by nurses at regular intervals. IoMT sensors also assist with automated alarms in case a threshold is reached. IoMT sensors thus assist in making legacy biomedical devices more user friendly.



Care delivery and customer experience

1. Remote monitoring (IoMT)

For some illnesses, it is preferable for patients to stay at home and receive the care that only their families can provide. However, it is also of utmost importance for patients to receive the necessary medical care and cleanliness that healthcare service providers offer.

Critical care at home is picking up in India with dozens of companies providing ICU facilities and critical care treatments at home. While the home provides a convenient environment for the patient and family members, the service provider ensures that the patient's vitals are continually recorded using IoMT devices; the vitals are then transmitted to physicians at their treating hospital.

Physicians thus have continuous access to the patient's vitals and can instruct the attending nurse at the patient's home to adjust the dosage, if required, basis the vitals reported remotely. Remote monitoring also assists in triggering automated alarms to physicians, ambulance service providers and patient's family members in cases of emergency.

Remote monitoring has also found application in rural areas where access to hospitals/clinics is limited. Physicians visit rural areas with mobile monitoring devices that either attach to a mobile to transmit data or transmit data to a mobile device through communication protocols such as Bluetooth Low Energy. Patient data is transmitted to physicians sitting miles away and, if needed, tele-consultations are arranged with specialists.

Customer experience

1. Patient appointment scheduling (AI)

Traditionally, patients used to make appointments with physicians by visiting clinic/hospital registration desks or by making a call, which would be processed by a receptionist. Human intelligence was used to match patient demands with physician supply. Today, with **multiple channels of interaction** between hospitals and patients (web/mobile apps/call/text messages), it's getting increasingly complicated to schedule patient visits.

Chatbots are helping hospitals schedule their patients better by analysing the data gathered at all points of interaction in combination with patient's medical history and past interaction data.

Chatbots also provide great opportunities to enhance and personalise the patient-caretaker experience.

2. Indoor navigation (IoMT)

It is not always easy to navigate from one point to another within a hospital and most of the time we have to seek directions from hospital staff.

A leading hospital in India has implemented IoMT-based location awareness technology. Patients have to download a **mobile application which connects to beacons** placed all across the hospital.

The beacons detect a patient's location and guide them from Point A to Point B by giving detailed turn-by-turn navigation. This same technology also has the potential of locating assets placed in the hospital.

Survey question 3: Challenges for AI and IoMT adoption in the Indian healthcare ecosystem

There are a number of barriers that are limiting the adoption of emerging technologies such as AI and IoMT in the Indian healthcare ecosystem.

Challenges for AI and IoMT adoption

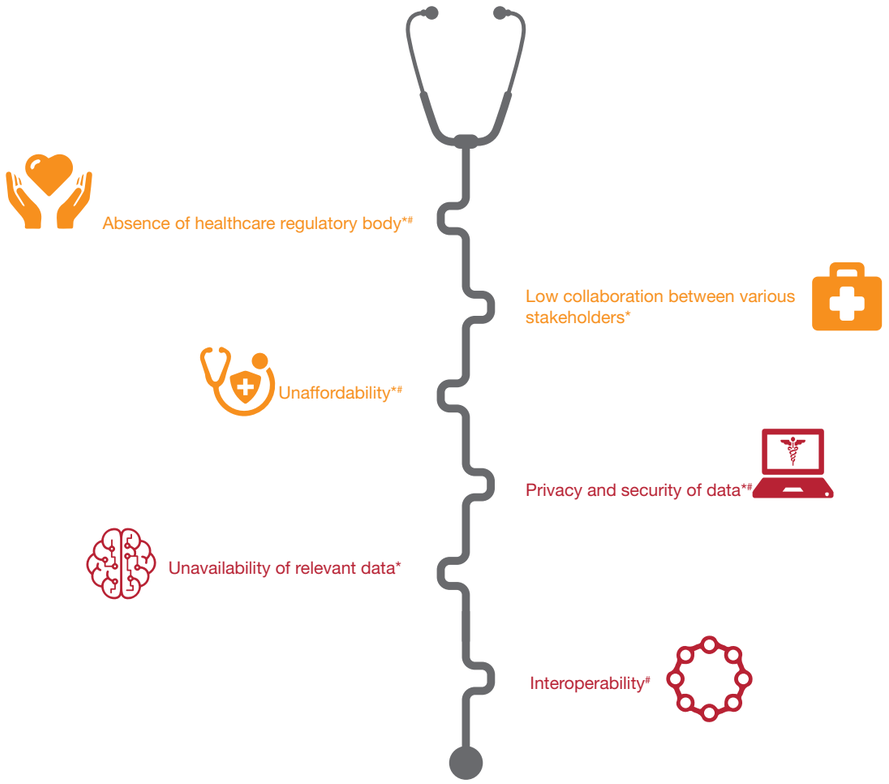


Figure 10: Challenges for AI and IoMT adoption in the Indian healthcare ecosystem

Source: PwC's Healthcare IT Survey 2018

• *Absence of a healthcare regulatory body*

There is no healthcare regulatory body in India. In the absence of adequate regulations, there is concern among healthcare providers regarding the reliability of medical devices and thus practitioners prefer to use traditional medical devices. **Although the Medical Devices Rules, 2017, became effective on 1 January 2018, their effectiveness is yet to be seen.**

• *Low collaboration between various stakeholders*

Although the Government of India has set up standards for sharing statistics among healthcare providers, the **sharing of clinical data between healthcare stakeholders still seems a farfetched goal in India.** In some cases, the sharing of information within the same entity is not seamless as some big hospital chains in India are using different HISs across different locations.

• *Unaffordability*

While there are some big players in the AI and IoMT space that provide quality solutions and reliability in terms of their longevity, their solutions are not well-priced.

Oncology consultations using world-renowned AI software can cost tens of thousands of rupees, whereas in-person consultations with leading oncologists can be sought by paying a small percentage of that amount.

While IoMT sensors, **actuators, etc., are not very costly,** IoMT solutions provided by big players and IoMT platforms cannot be afforded by most healthcare providers in India. In order to avoid heavy costs, some of these healthcare providers have experimented by developing use cases and getting them **implemented by smaller technology partners** instead of procuring solutions from big players in the emerging technology space.

Medical Device Rules, 2017

The MoHFW notified the Medical Devices Rules, 2017, on 31 January 2017. The new rules have been framed in conformity with the Global Harmonisation Task Force (GHTF) framework and conform to the best international practices. Only 15 categories of medical devices are, at present, regulated as drugs. This indicates that the current regulatory practices in India are not fully equipped to meet the requirements of the medical devices sector in the country. The new rules seek to remove regulatory bottlenecks with regard to the Make in India initiative and facilitate ease of doing business while ensuring better availability of better medical devices for patient care and safety.

Medical devices are to be categorised into four classes based on associated risks. Manufacturers of medical devices will be required to meet risk proportionate regulatory requirements that have been specified in the rules and are based on best international practices.

Class A, low risk	Class B, low to moderate risk
• Manufacturing licences will be granted without prior audit of a manufacturing site, based on self-certification • Post-approval audit for conformance with QMS • Licenced by state licensing Authorities	• Licensed by state licensing authorities

Class C, moderate to high risk	Class D, high risk
• Licensed by central licensing authorities	• Licensed by central licensing authorities

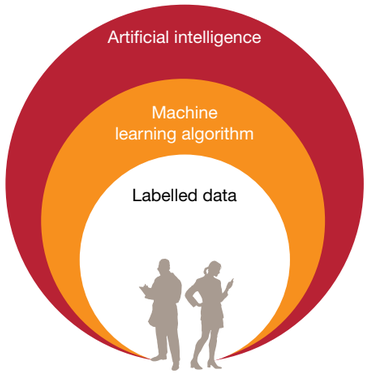
- A system of 'third party conformity assessment and certification' through notified bodies is envisaged. The notified bodies will be accredited by the **National Accreditation Board for Certification Bodies (NABCB).**
- Quality management system (QMS) will need to be aligned with **ISO 13485.**
- Imported medical devices will continue to be regulated by the Central Drugs Standard Control Organization (CDSCO).
- **New devices will also be regulated by CDSCO.**
- No requirement for the periodic renewal of licences.
- Manufacturing and import licences will remain valid till they are suspended or cancelled or surrendered.
- **The entire licensing application process is to be processed through an online electronic platform with predefined timelines fo most activities.**

- ***Privacy and security of data***

Based on our interactions with CxOs of leading healthcare providers, it was identified that privacy and security of healthcare data is a major concern in the absence of adequate laws. Many medical devices in the healthcare ecosystem run on public networks and there are no regulations for ensuring secure management of such data. **There is concern and confusion regarding legal aspects tracking patient location.**

India needs stronger regulations in the form of the **Healthcare Data Privacy and Security Act (HDPSA)**, which is being drafted by the Union Health Ministry. Hopefully, this will address the concerns of the industry and provide a clear path to the adoption of emerging technologies.

- ***Unavailability of relevant data***



To develop highly accurate AI predictions, a gigantic amount of labelled data* is required to train the underlying models. Further, this data needs to have parameters similar to the one for which it needs to make predictions.

The lack of India-specific clinical data was a shared concern from the CxO community. Further, the cost of collecting and testing this data (e.g. collecting genome data) is enormous.

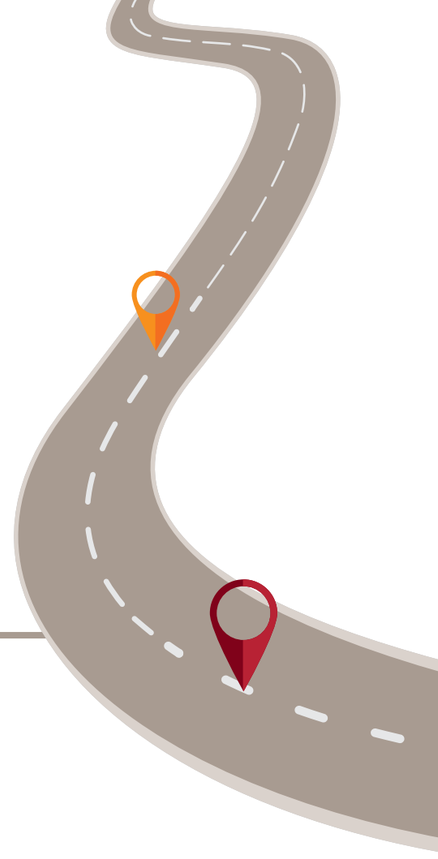
* Data with known outcomes for input parameters

IoMT solutions available in the market are mostly proprietary targeted solutions that are developed to tailor a particular client's requirement, with an emphasis on reducing the cost and not with an intent of **sharing information with external players in the future.** Therefore, most of the current implementations use different protocols which result in the lack of standardisation of communication protocols. This leads to interoperability issues between various IoMT devices/ solutions available in the market.

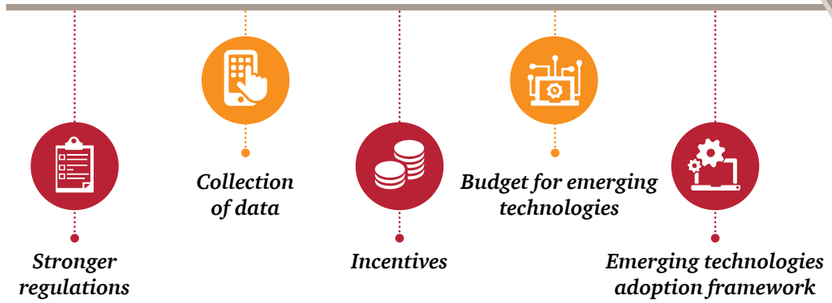
Survey question 4: Changes expected to drive adoption of AI and IoMT amongst healthcare providers in India

Collective efforts by the government and industry stakeholders are necessary in order to increase the adoption of emerging technologies such as AI and IoMT. Stronger and clearer regulations are expected from the HDPSA. Public and private institutes should collaboratively work towards collecting and sharing India-specific patient data so that emerging technologies can be utilised to their full potential. The **government should incentivise the adoption of emerging technologies.**

Road ahead



What steps can be taken to drive adoption of AI and IoMT by healthcare providers in India?



Stronger regulations

Currently, there is no healthcare regulatory body in India. Data privacy and security is a concern in the absence of the HDPSA, which is still being drafted by the Union Health Ministry. Further, the effectiveness of the Medical Devices Rules, 2017, is yet to be seen.

The government needs to form a legal framework which should be imposed stringently but with a caveat that laws should be formed in a participative manner, taking industry perspective in consideration along with accommodations for geographical conditions, resource availability and public-private partnership administration model.

Collection of data

Despite the enormous costs related to the collection and testing of clinical data such as genome data, some start-ups have started collecting India-specific data and plan on extrapolating it for it to become relevant for AI. Once a significant amount of relevant data is available, **a team of physicians, IT staff and data scientists** will have to collectively develop algorithms for AI software.

Sharing of clinical data and discussions among various stakeholders should be promoted in order to collaboratively draw insights from the captured data. **Emerging technologies such as blockchain can play a big role in achieving this goal.**

'We are seeing the emergence of non-profit organisations like Ramesh Nimmagadda Cancer Foundation (RNCF) that has created a software platform called OncoCollect which is being used by organisations spread across India. OncoCollect can be used to collect, collaborate (AWS cloud based) and analyse patient data.' – JP Dwivedi, CIO, Rajiv Gandhi Cancer Institute and Research Centre

Incentives

The typical carrot-and-stick approach might not work. Industry leaders who were interviewed by us agreed that we need to consider the models adopted in the Western world for the digital transformation of healthcare. However, models like Meaningful Use 1 (MU1) and Meaningful Use 2 (MU2) applicable in the US **can't be used as they are in India.** At the same time, most of the leaders agreed that **physicians spearheading the adoption of emerging technologies need to be incentivised appropriately.**

Budget for emerging technologies

Similar to the allocation of funds by the Government of India in Union Budget 2018 towards emerging technologies, Indian healthcare providers should also set aside a budget for the adoption of focused use cases of emerging technologies across the three pillars – **care delivery, customer experience and operational excellence.**

Emerging technologies adoption framework

Once healthcare players decide to embark on the journey of adopting emerging technologies, PwC recommends a systematic approach towards understanding the challenges that need to be tackled or innovations that need to be brought in, defining use cases for emerging technologies, understanding the internal and external factors related to the use case, designing a holistic solution by considering the current state of IT, deciding on insourcing vs outsourcing, selecting the right set of partners, deploying the use case, and operating and monitoring it on a regular basis.

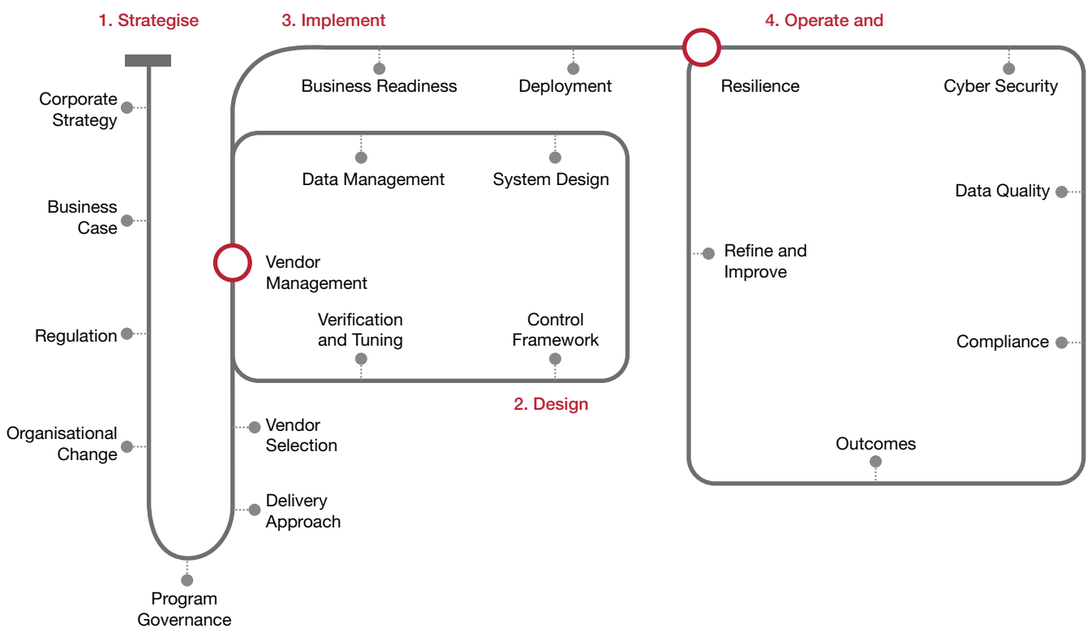


Figure 11: PwC's framework for emerging technologies adoption

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Notes

Notes

About BCC&I

The Bengal Chamber of Commerce and Industry, India's oldest institution of its kind, traces its origins to 1833. The Chamber has played a pioneering role as a helmsman, steering the evolution of Commerce and Industry in India. The Chamber reviewed and commented upon some of the most critical legislations in the country.

The Bengal Chamber has managed to remain both young and relevant simply because it is quick to recognise and value the only constant in time – change.

In healthcare

In keeping with this practice, the Chamber has pioneered a number of initiatives and programmes in new directions in the past which have brought cutting-edge offerings in healthcare services to the common man and included lectures on health issues by leading and iconic personalities in health like doctors, entrepreneurs and policymakers.

The Health Committee also organises an annual Health Quiz, which has made a niche for itself in the corporate community of the city.

The Bengal Chamber's Health Committee has been playing an important role in addressing the critical aspects in the field of healthcare in the state and has been catalytic in bringing about significant corporate consciousness in healthcare management. It has organised health expos, panel discussions, and lectures on health issues by leading and iconic personalities in health from the fraternities of doctors, entrepreneurs and policymakers. The Chamber's National Health Debate, which has been addressed by national and international personalities, also deserves a special mention. The Committee also organises a quiz on health and lifestyle to create awareness on healthy living. The Committee's activities also include a B2B Meet with IT companies to discuss the latest offerings relevant to the healthcare sector, a Medico Legal Workshop involving doctors, lawyers and hospital administrators to learn and share the experiences on medico-legal issues and guidelines, a Blood Donation Camp, a Seminar on Deceased Organ Donation as a gesture of our responsibility to society. The Committee also celebrates Doctor's Day in a unique way by organising a panel Discussion and quiz with doctors.

Technology

The Chamber has a vibrant IT Committee comprising all leading developers, consultants and corporates. The focus has always been to communicate and create a bridge between technology users and developers on how applications can make enterprise planning and manufacturing processes simpler, faster and less complicated – achieving all this at a lower cost. Most importantly, as a catalyst, service provider, initiator of sector-specific activities, facilitator of business and spokesperson for the state government, the Chamber envisions itself to be the most valued partner of our members in promoting and facilitating sustainable growth.

Our signature programme is Business IT Conclave, the eighth edition of which was held on 24 May 2017 on 'Bridging Automation and Society'. The presentations shared by speakers, photographs, and YouTube links of videos are available on our website: http://www.bengalchamber.com/events-gallery-business-it-conclave.html The archive of earlier editions is also available here. The Conclave brings together stakeholders of IT to discuss, brainstorm, and share best practices of the latest happenings in the realm of technology.

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About PwC's Healthcare practice

PwC India's Healthcare team offers Advisory services in the healthcare sector covering multiple domains such as strategy, business planning, market scan, commercial due diligence, feasibility study, operations improvement, cost reduction, health IT, digital and technology, internal audit and PPPs.

The Healthcare Advisory team of 30 members combines over 40 years of operational experience in setting up and managing hospitals, and over 120 years of healthcare consulting experience. This enables the team to deliver granular strategy and market and operational insights of the highest quality. The team works with leading healthcare providers, medical technology providers, central and state governments, diagnostic players, insurance providers and private equity players on projects both in India and overseas.

Our Social Sector Advisory Services, a division within the GRID practice, also works with several government (national and state) departments, IFIs, private players in the social sector on health and nutrition, education and skill development, livelihood, governance, local community development based in urban and rural areas, and women and child development. All these sectors and sub-sectors are multi-dimensional in nature and are intricately interconnected through various aspects including grassroots community development.

About PwC

At PwC, our purpose is to build trust in society and solve important problems. We're a network of firms in 158 countries with more than 2,36,000 people who are committed to delivering quality in assurance, advisory and tax services. Find out more and tell us what matters to you by visiting us at www.pwc.com

In India, PwC has offices in these cities: Ahmedabad, Bengaluru, Chennai, Delhi NCR, Hyderabad, Kolkata, Mumbai and Pune. For more information about PwC India's service offerings, visit www.pwc.com/in

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