एसटीपीआई
STPI

STPINEXT
INITIATIVES

ARTIFICIAL INTELLIGENCE IN HEALTHCARE SECTOR

STPI KnowledgeUp Series

October 2022

Key message

Shri Alkesh Kumar Sharma

Secretary

Ministry of Electronics and Information Technology

Government of India is encouraging maximum adoption of technology in all work spheres, whether it is the internal workings of the Government itself or extending services to citizenry, industry & start-ups. The Government has been proactively introducing AI initiatives, schemes and policies in healthcare. Deployment of AI across the entire healthcare sector will create a new class of healthcare facilities. With Government's backing, transformations are faster & long lasting.

AI & its applications are increasing rapidly across the globe and India is not lagging behind. AI-based solutions are booming in the Indian health-tech space making healthcare services more accessible, affordable & effective. The number of healthcare systems pursuing automation and AI to enhance competitiveness as well as their prospects are increasing exponentially.

The 'AI in Healthcare' Knowledge Report is well-contemplated and it gives valuable insights. It outlines the active role AI can play at every step of the healthcare value chain. It will help us prepare for a transforming landscape, assist in guiding AI investments within healthcare.

The Report will be useful for start-ups, industry, academia & all stakeholders working in Health sector. I compliment the team of STPI for preparing the report and extend my best wishes.

Message

Shri Bhuvnesh Kumar

Additional Secretary

Ministry of Electronics and Information Technology

The power of technology in making execution better & faster is a time-tested fact. The 1st Industrial Revolution between 18th – 19th century was marked by the introduction of machines in factories for mass-production. The 2nd witnessed emergence of new forms of energy and communications during 19th – 20th century. The 3rd one in 20th century is called the 'Digital Revolution' which saw emergence of nuclear energy, electronics, telecommunications, and, most importantly, computers and the internet. Currently we are living in the 4th Industrial Revolution referred to as Industry 4.0 in which emerging technologies like AI, IoT, blockchain, quantum computing etc. are doing things which were not imagined before.

AI is not only one of the most powerful emerging technologies but also the most fascinating one. As name indicates, AI includes 'intelligence' which is the key differentiator between Humans & machines. In that sense, AI is the pinnacle of technological prowess.

Effective use of AI in Medical & Healthcare, particularly in a developing, diverse & huge country like India, can be a game-changer in many ways. It can make services accessible in remote areas, affordable to the underprivileged and more effective to the existing users.

The 'AI in Healthcare' Knowledge Report by STPI shall prove to be a very valuable resource for enabling a cost-effective and quality healthcare system in the nation.

Foreword

Shri Arvind Kumar

Director General

Software Technology
Parks of India

Developed economies have flourished on innovation and IPRs. One of their key strengths is the unison in which the innovators (i.e. industry, start-ups and entrepreneurs) and the policy makers (i.e. Government) work. Any policy, framework or agency that is endorsed by the Government, drives confidence amongst general public. People look up to Government bodies for validation.

When it comes to innovation using emerging technologies, STPI, with its state-of-the-art infrastructure, networking with government, industry & academia and comprehensive & superior mentor pool, is uniquely placed. It provides the best of both worlds – trust of the government and connect from the industry & academia.

AI is the foremost emerging technology today and, as I foresee, in the next 3 years, there won't be device without AI of some sort. AI will help in tackling one of the biggest problems that plague Indian healthcare – misdiagnosis, low doctor-patient ratio, affordability, inadequately trained staff and be immensely useful in bringing down the costs of medical treatment. The publication of 'AI in Healthcare' report is a result of intensive consultation and market research conducted by Praxian Global Private Limited with the support of STPI. It comes at a more opportune time when the startup ecosystem in India is entering the next phase and AI is going to be a major enabler across sectors. The report brings a comprehensive understanding of how healthcare sector in India has evolved in the last decade, role AI is expected to play in healthcare value chain, opportunity & market size for AI in healthcare globally & within India and insights from Startup Ecosystem.

I extend my regards to various government departments & agencies, industry leaders, experts and entrepreneurs for their valuable inputs towards preparation of this report. The 'AI in Healthcare' report shall be a very valuable resource to understand the potential of AI, opportunities in global market, enablers in place and would catalyze development of 'Made-in-India' AI products & solutions with global appeal.

Executive summary

Healthcare in India 	• **Healthcare in India has improved a lot in last decade,** increased life expectancy and decreasing disease burden are positive achievements of Indian healthcare system • Ageing population with increasing burden of obese & diabetic population is driving need for greater number of both in-hospital and out of hospital interventions • Total expenditure on healthcare as % of GDP has largely remained stagnant, however healthcare has become more affordable with **increased coverage of insurance, primarily driven by government sponsored health insurance schemes which has ~800 M eligible beneficiaries**
Role of AI 	• **Key challenges** of Indian healthcare are **Low doctor-patient ratio, skewed distribution of expertise, affordability, inadequately trained staff and delayed detection and diagnostic errors**, Artificial Intelligence (AI) in healthcare can resolve majority of these challenges
Global Landscape 	• The **market** for **AI in healthcare globally** is estimated at **US$ 15 B** and estimated to grow at **CAGR of ~37% till 2030**. The market includes software, hardware and services • Global funding for AI in healthcare has grown at a **CAGR of ~54%** between 2016 to 2021 • In India, the investment in AI in healthcare is gaining dominance and it stood at **US$ 1.1 B** in **2021**
Start-up ecosystem 	• **Key challenges** as quoted by most of the start-ups are **funding, data for training, validation of models, and market access.** • Central and State Governments have been proactively coming up with new initiatives, schemes and policies for AI in healthcare • As an incubator, **STPI offers** a number of value-added services for start-ups, including **infrastructure, mentorship, funding & investment, support and facilitation in developing IPR** • Academic institution like **IIT, IIM are also having their incubation centers** to support AI in healthcare. Private players like GE Healthcare, Microsoft, HealthStart, and Prime venture partners are also providing incubation services for start-ups • Going forward, to **increase adoption** not only in India but to have **'made-in-India' AI solutions get adopted in global markets,** work on a policy which is aligned with evolving global frameworks for use of AI in healthcare • **India can better utilize the potential of AI** and help scale **it by enabling better access to data, encouraging AI R&D, emphasizing on privacy & security**

Current status of healthcare in India

While health and healthcare outcomes have rapidly improved over last 5-10 years, a lot of challenges still exist

1 Improved life expectancy (4month increase per year)

- *Life expectancy at birth has **increased from 66.2** in FY09 to **69.6** in FY19*
- *Survival to age 65 for males has **increased from 64% to 69%** & **70% to 75%** for females between FY09 – 19*

2 40% reduction in overall disease burden

- *DALY rates **declined** by ~60% for **communicable diseases** & and ~18% for **injuries** between FY09 – 19*
- *DALY rates **increased** by ~15% **for Non-communicable** diseases*

DALY: Disability-Adjusted Life Years Lost
One DALY is one lost year of healthy life

3 Increasing age profile & rise of chronic ailments

- *By FY 25P, 30+ age group will have **additional ~135 M population***
- *People living longer and have multiple chronic ailments*

4 Healthcare has become more affordable

- ***~10% coverage by retail and group insurance***
- *Government sponsored health insurance scheme with eligible beneficiaries of ~80 Cr*

Verified beneficiaries: ~31 Cr (~17 Cr e-card issued and rest in Central Government Health Scheme (CGHS) and ESIS (Employee State Insurance Scheme)

5 Estimated growth in hospital beds (FY15-20)

- ***169 K** additional beds in **private hospitals** (4% CAGR)*
- ***121 K in public hospitals** (4% CAGR)*

6 Growth in installed base of medical equipment

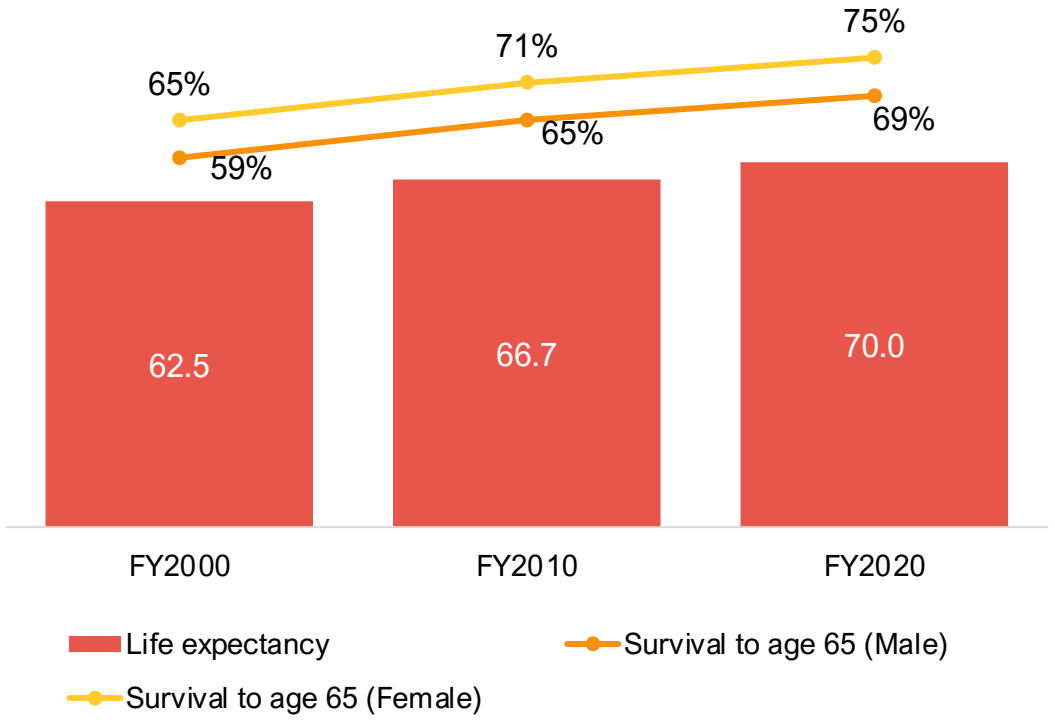
- *Annual average units of medical equipment added (FY 15 – 20) to the installed base (IB) in FY 20:*
  - ***Computed Tomography (CT): ~650***
  - ***Magnetic Resonance (MR): ~400***
  - ***Cardiac Catheterization Labs: ~250***
  - ***Positron Emission Tomography-Computed Tomography (PET-CT): ~50***

Note(s): Includes digital health-tech platforms only (start-ups performing clinical tests etc. are not included); Others include start-ups in home healthcare, medical tourism, emergency response, financial services & personal health management
Source(s): PGA Labs analysis

Improved life expectancy and decreasing disease burden, in terms of communicable disease and injuries are positive achievements of Indian healthcare

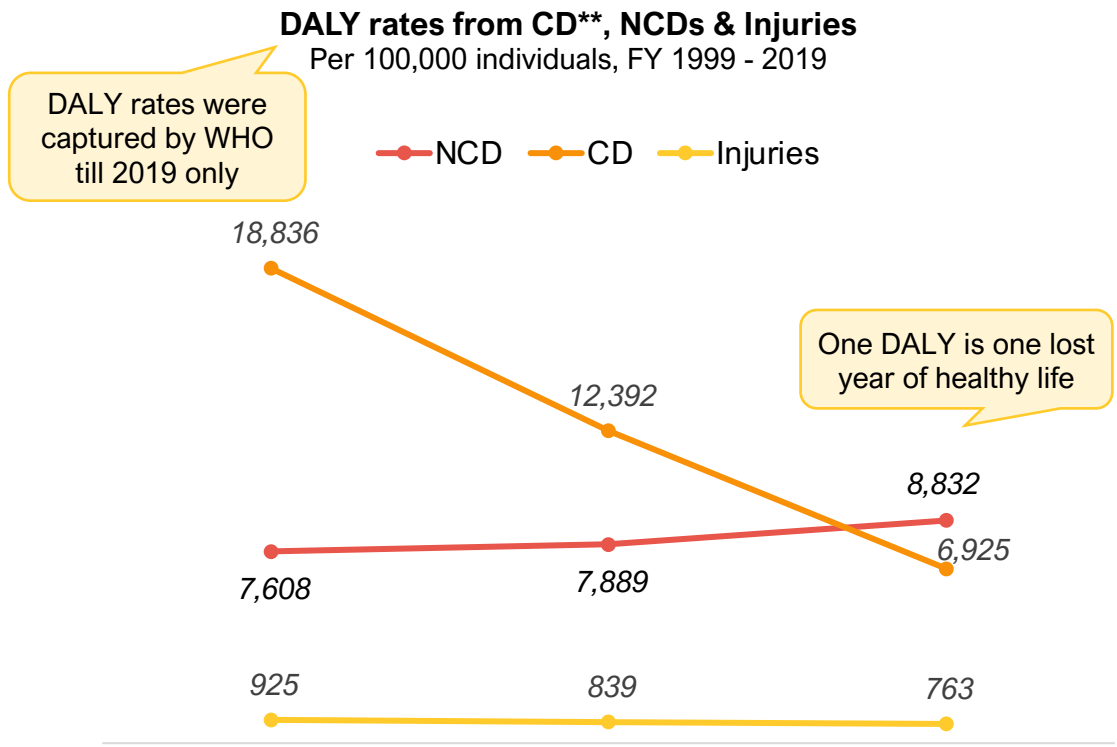
Constant increase in Life expectancy at birth and survival rate to 65 years for India

Life expectancy at birth for India
In age years, FY 2000 - 2020



Consistent decline in Disability-Adjusted Life Year Lost (DALY) for India over years across causes of deaths

DALY rates from CD, NCDs & Injuries**
Per 100,000 individuals, FY 1999 - 2019



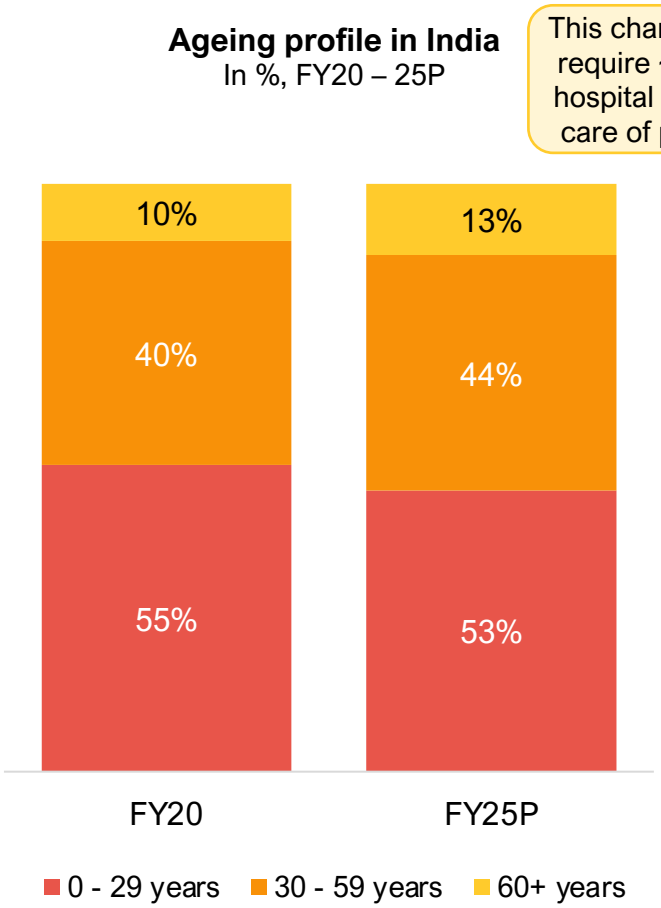
DALY (in L)		FY1999	FY2009	FY2019
NCD	Cancer	526	544	**678**
	Diabetes	1,042	1,170	**1,460**
	Cardiovascular	3,407	3,556	**3,979**

Note: *DALY: Disability-Adjusted Life Years Lost (DALYs) per 100,000 individuals from all causes; **CD: Communicable, Neonatal, maternal and nutritional disease, NCD: non-communicable disease
Source(s): United Nations Population Division, World Bank, PGA Labs analysis

Ageing population with increasing burden of obese & diabetic population (non-communicable diseases) is driving need for hospital interventions

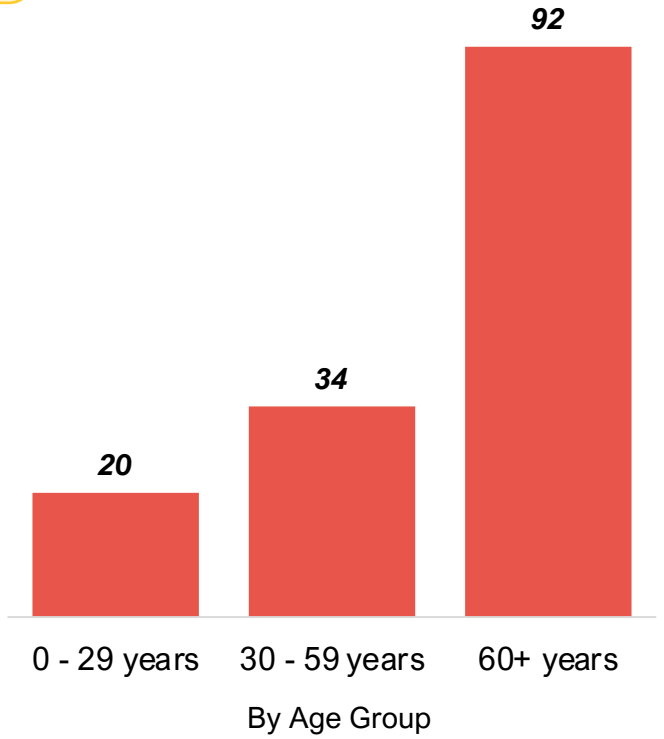
By FY25P, there will be additional ~135 M population in 30+ age group

Ageing profile in India
In %, FY20 – 25P



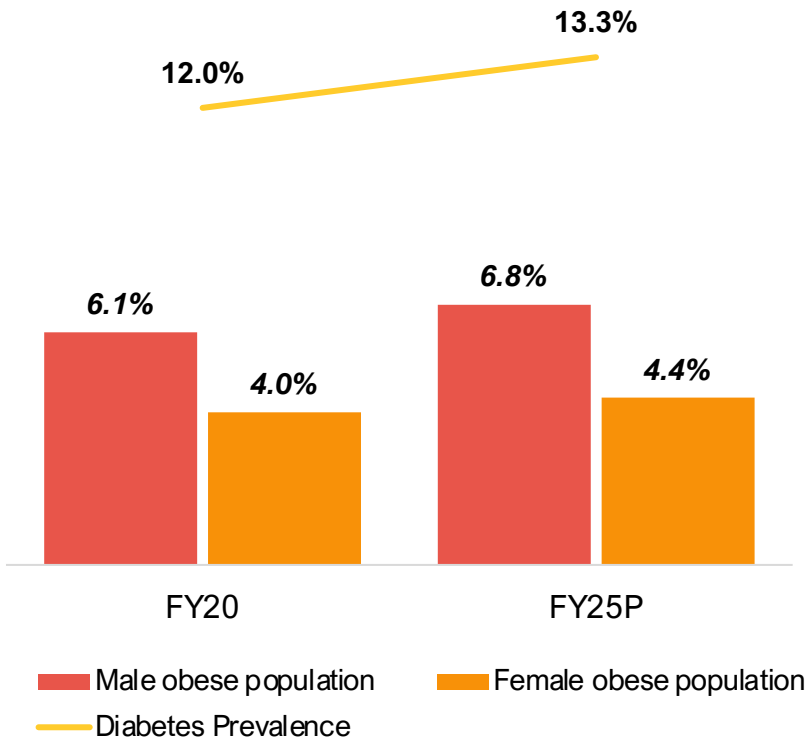
Hospitalization rate is 3x among 60+ years population vs. < 60 years

Annual Cases of hospitalization
In # per 1000 population, FY20



Lifestyle changes are leading to increasing incidences of diabetes and obese population

Obese Population and Diabetes Prevalence
In %, FY20 - 25P



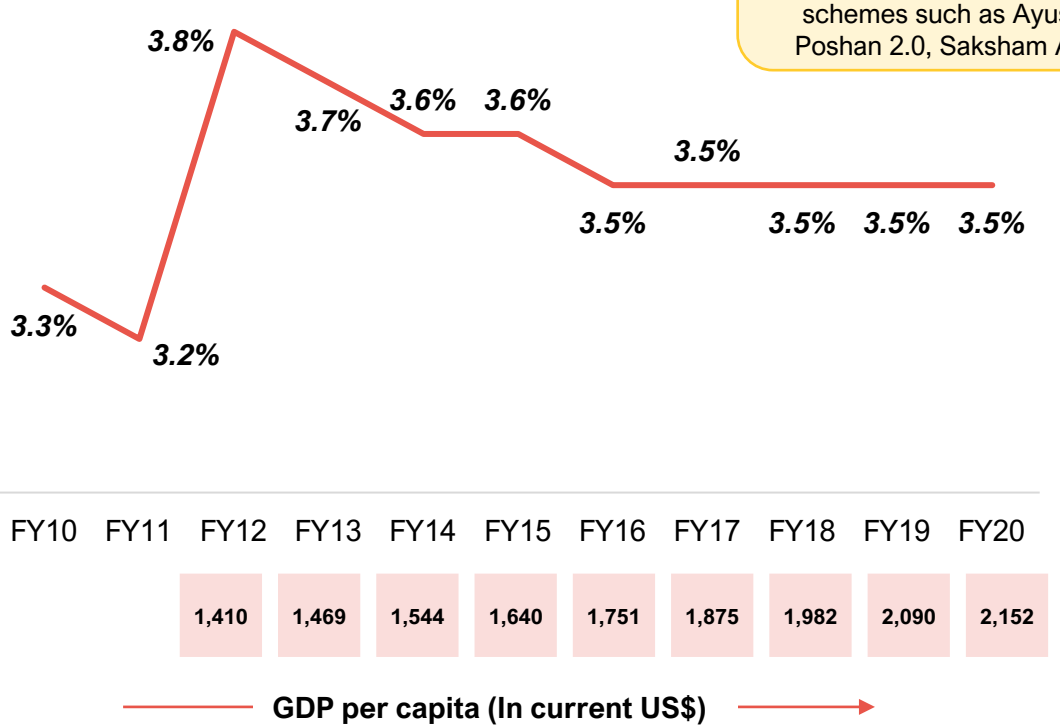
Note NCD: Non-communicable disease
Source(s): MoHFW, Euromonitor, Praxis knowledge base, Secondary sources, PGA Labs analysis

Total expenditure on healthcare as % of GDP has largely remained stagnant, however healthcare has become more affordable

Expenditure on health has remained ~ 3.5% of GDP; But increase in GDP per capita has provided a comfortable cushion to absorb increase in health spending per capita

Health exp % of GDP
FY 10 - 20

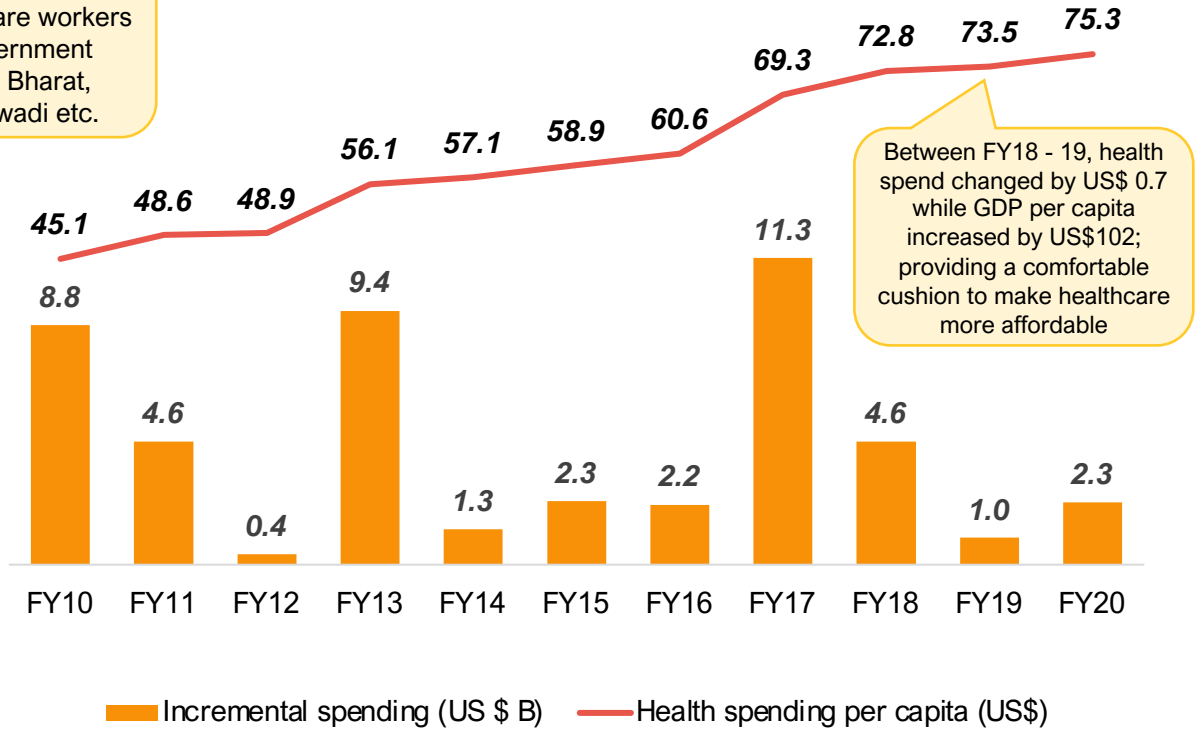
Government healthcare expenditure includes spends on medical devices & consumables, wages of healthcare workers in the public sectors, on government schemes such as Ayushman Bharat, Poshan 2.0, Saksham Anganwadi etc.



Spend on health per capita has increased ~ 6% year on year in real terms

Profile of Health expenditure in India
FY 10 - 20

Between FY18 - 19, health spend changed by US$ 0.7 while GDP per capita increased by US$102; providing a comfortable cushion to make healthcare more affordable

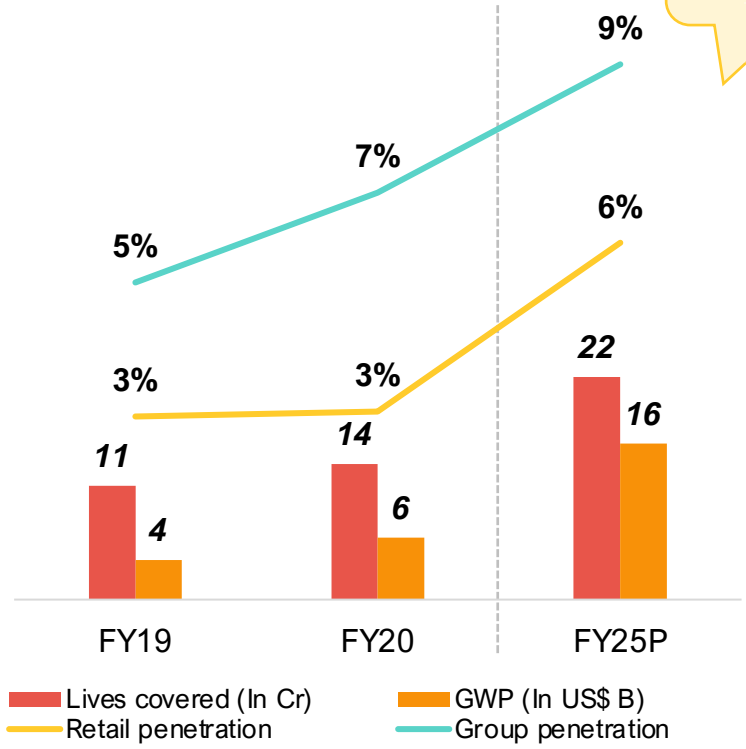


Source(s): WHO Global Health expenditure database, PGA Labs analysis

Penetration of health insurance has increased significantly, primarily driven by government sponsored health insurance schemes

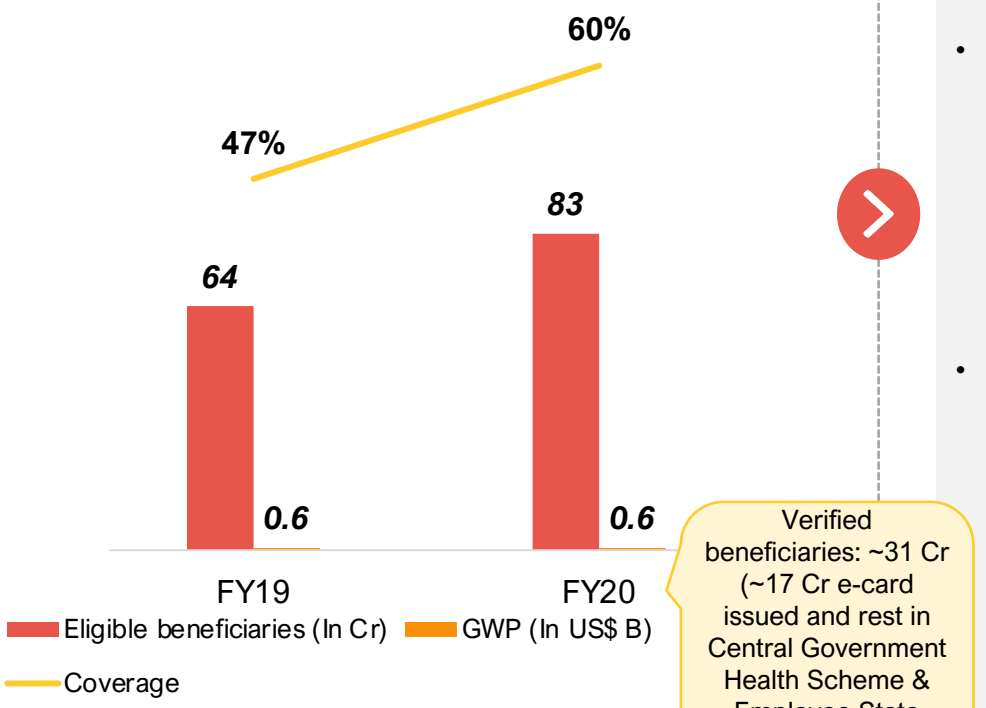
Retail and group health insurance is likely to only reach ~15% penetration by FY25

Retail and group health insurance penetration in India
FY19 – 25P



Government health insurance is likely to increase, extending coverage to the uncovered families

Government health insurance coverage in India
FY19 – 20



Key takeaways

- Around 10% of the population – 14 crore individuals – are covered through **private voluntary health insurance**
- The Ayushman Bharat Yojana, State Government extension schemes, CGHS & ESIS provide comprehensive hospitalization cover to the **bottom 60% of the population**
- GoI contemplating to expand PMJAY to cover remaining 30% of the population i.e. the '**missing middle**' who are currently devoid of health insurance. While this would make healthcare more affordable, hospital economics would get adversely impacted

Note(s): Coverage refers to total eligible lives covered under that scheme divided by total population, government health insurance includes PMJAY, State insurances, Central Government Health Scheme & Employees state insurance scheme
Source(s): Analyst reports, NITI Aayog report, Secondary research, PGA Labs analysis

* Gross Written Premium (GWP) is in US$ billion

Where does AI come in?

Challenges which AI and digital technology are trying to bridge: diagnostic issues and reach, skill resources and human capital, affordability etc.

Challenges in Indian Healthcare

Low doctor-patient ratio	Geographically skewed distribution of expertise	Affordability	Inadequately trained staff	Delayed detections and diagnostic errors
• 0.76 doctors and 2.09 nurses per 1,000 people (as compared to World Health organization recommendations of 1 doctor and 2.5 nurses per 1,000 population respectively)	• Clinical expertise is concentrated in larger urban while disease prevalence is not much different across Tiers of urban cities and rural areas	• Healthcare is largely paid out of pocket by individuals, whose size of pocket is small • India household savings of ~ INR 33K per year as OOP expense is insufficient across some common cases of hospitalization	• Large workforce for health which are not well trained or not up-to-date on skill and knowledge in their areas of operations	• In healthcare delivery, early detection of diseases is a challenge • Preliminary treatment and initial diagnosis

"We are dealing with the problem of shortage of pathologists, especially in Tier-II/III cities. When it comes to microscopy, it is difficult for a pathologist to work around the clock to identify and report with accuracy. This is where AI comes in."

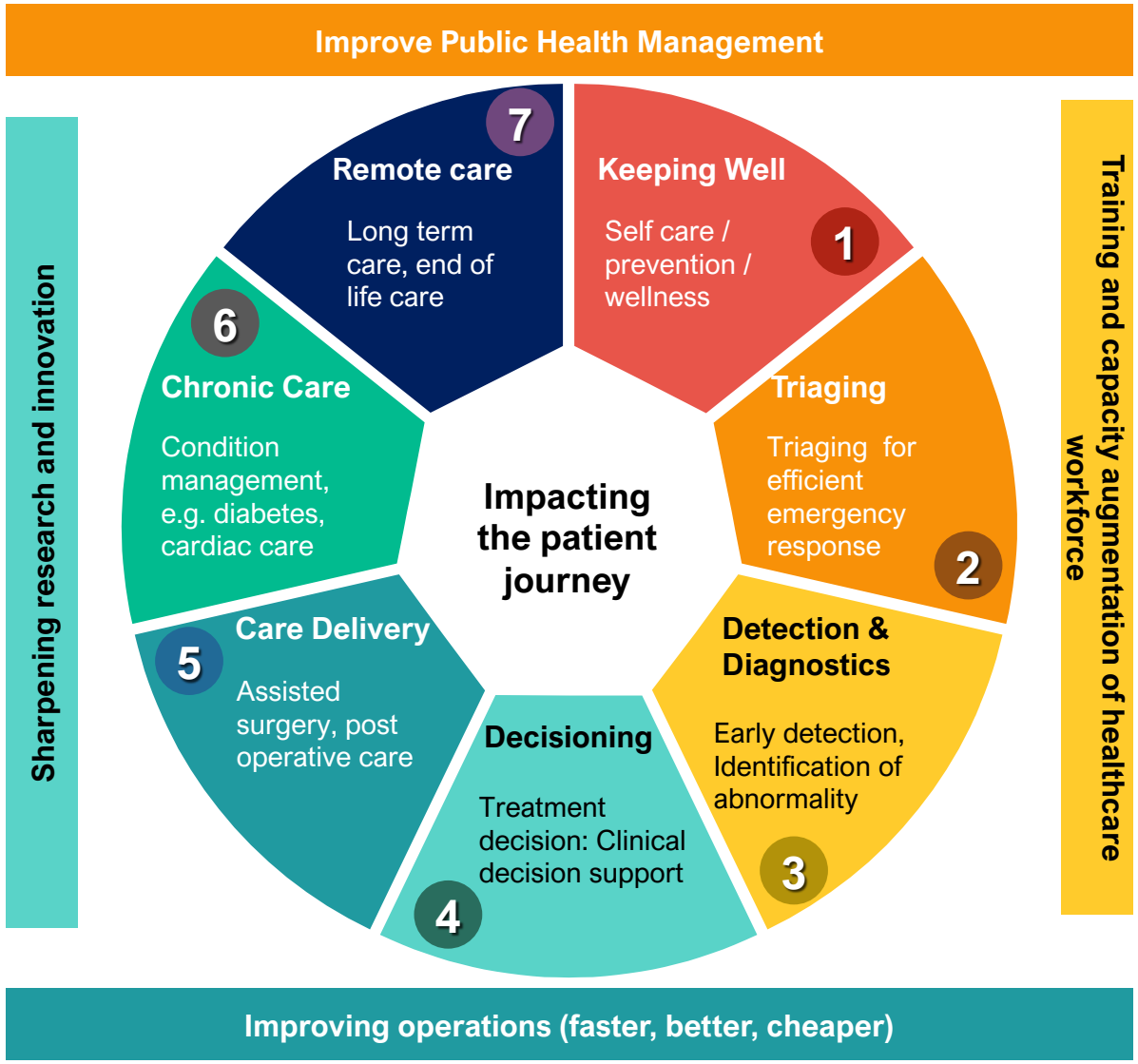
- SigTuple

"Radiologist to general population ratio is 1:1,00,000 in India. There is a huge backlog of imaging that needs to be assessed by doctors – which leads to late diagnosis and diseases spreading and becoming dangerous; hence AI in radiology is very important."

- Niramai

Source(s): ai4Bharat, Secondary research, Primary discussions, PGA Labs analysis

AI in healthcare has an active role at every step of the healthcare value chain; different types of AI include vision, conversational, sense and decision AI



Types of AI

Vision AI
Extracts intelligence from images, videos or documents

Conversational AI
Automates conversations and provides information in an instant

Sense AI
Deduces human emotions from various forms of communications

Decision AI
Automates processes with accurate decision-making capabilities by analyzing retrieved data

Source(s): NASSCOM, Secondary research, PGA Labs analysis

AI is addressing the challenges faced in healthcare and has the potential to help people keep well, make care accessible, improve quality and make care cheaper

Challenge	Some use cases
• High cost for hospital-based care • Delivering care at convenience of home	• Smart care @ Home • Tracking and monitoring solutions • Smart wearables

Challenge	Some use cases
• Increased longevity and chronic ailments requiring care at home	• Tracking and monitoring solutions • Smart wearables & sensors • Smart exercising

Challenge	Some use cases
• Personalized health management at scale • Avoiding hospitalizations by managing chronic care	• Continuous glucose monitoring and insulin dose adjustment • Quantification of stress levels for effective management

Challenge	Some use cases
• Staff shortage • High patient load	• Real time case prioritization (e.g., Covid) • Risk based stratification – risk of complications, possibility of cardiac arrests

Challenge	Some use cases
• Limited availability of skilled personnel • Varying level of surgical skill sets and standards of care	• Virtual reality-based solution to teach surgeons new procedures and determine their level of competency • Systems to support post surgery rehabilitation • Assistance in treatment planning through decision support systems

Challenge	Some use cases
• Access to expertise beyond urban areas • Turnaround times	• Medical Image Analysis (Pathological & Radiological) • Critical illness diagnostics • Genome analysis for personalized medicines

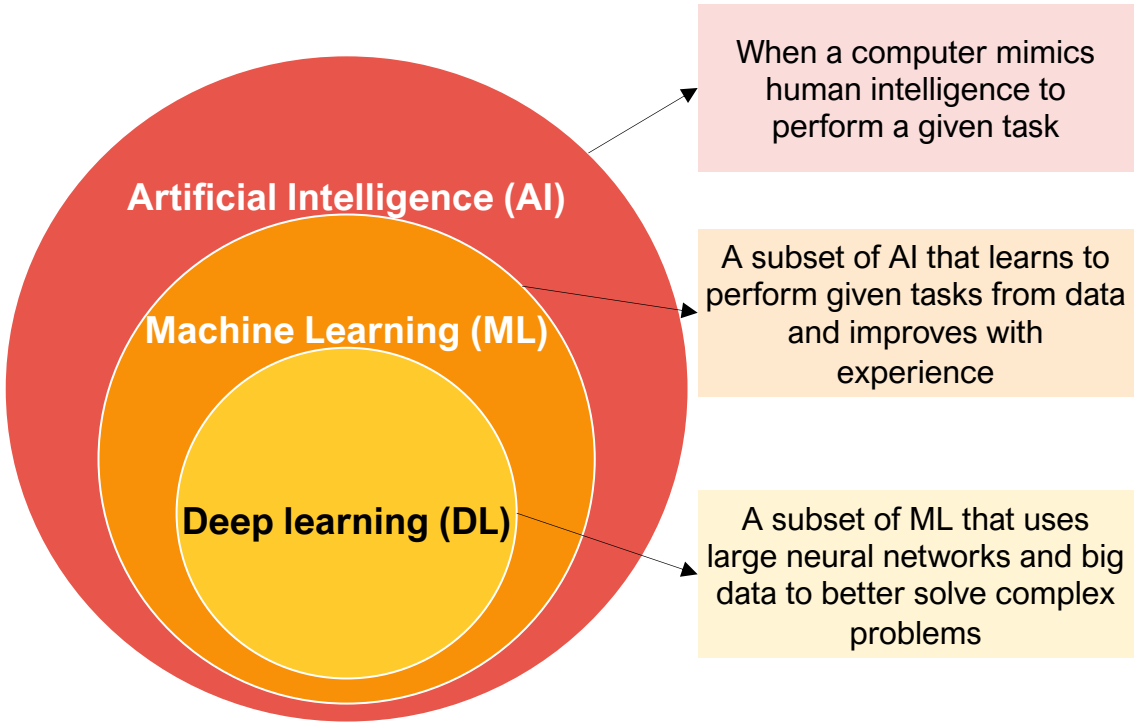
Challenge	Some use cases
• Skewed distribution of doctors towards urban areas • Quality of doctors	• Clinical decision support systems for primary care and advanced care such as oncology

Source(s): Secondary research, PGA Labs analysis

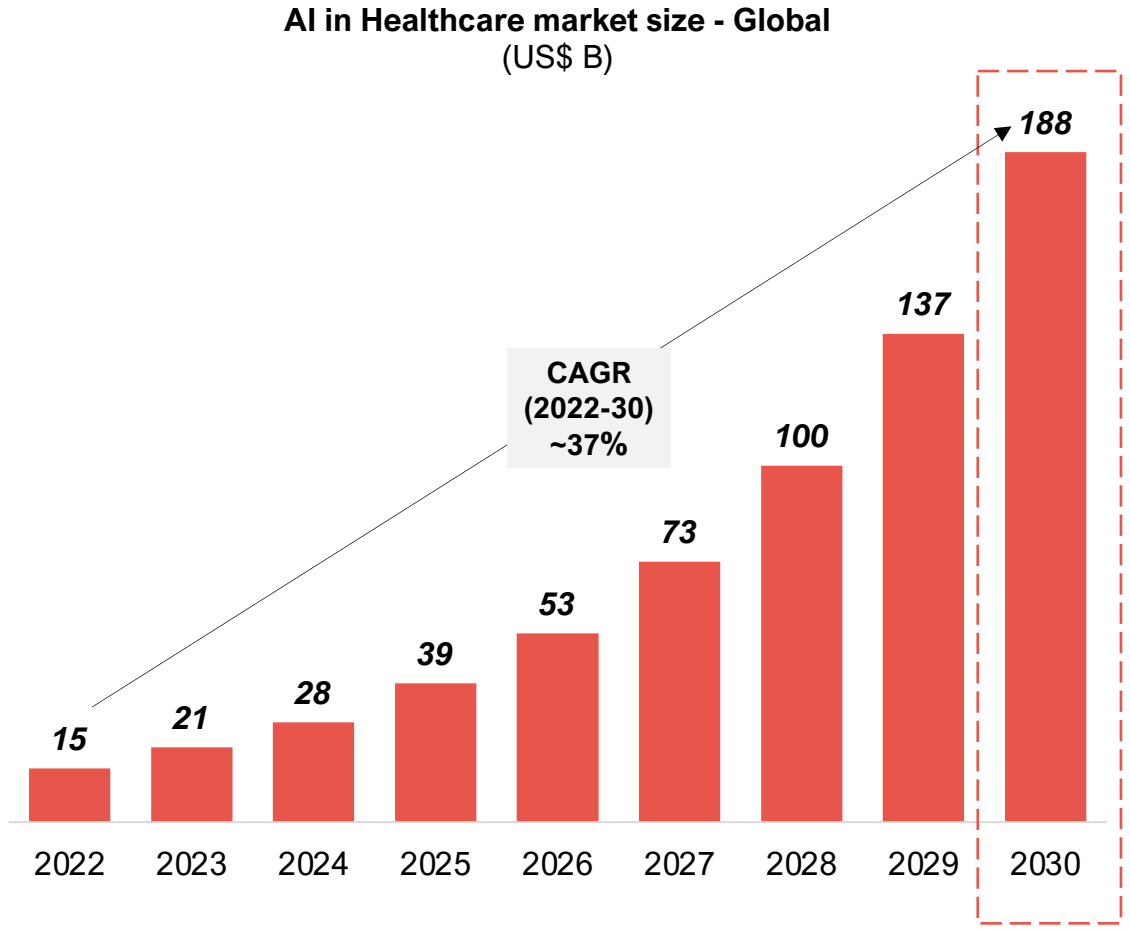
AI landscape – Global

Global market for AI in healthcare is slated to grow at a CAGR of ~37% from 2022 to 2030, to a value of ~US$ 188 B

Globally multiple applications are emerging which use AI / ML / DL to make healthcare better



The market size of AI in the global healthcare market stand at US$ 15 B in 2022

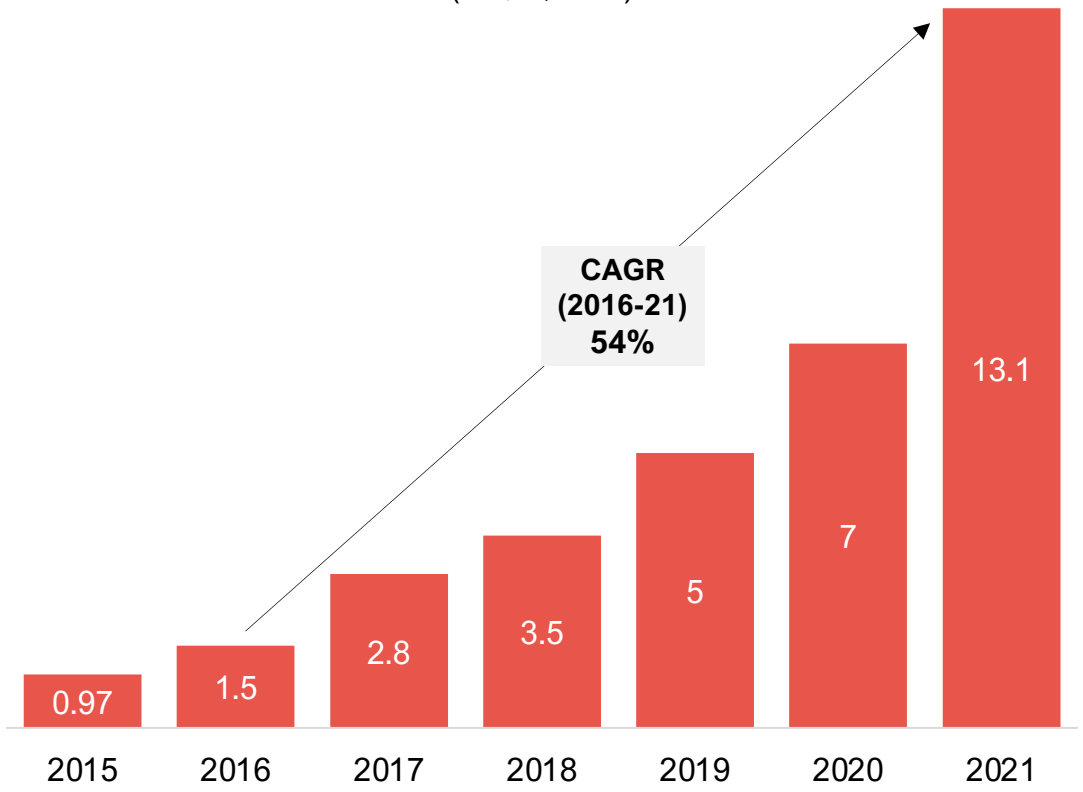


Source(s): European Parliamentary Research Service, Globe Newswire, PGA Labs analysis

Global funding for AI in healthcare has grown at a CAGR of ~54% between 2016 and 2021

Global funding for AI in Healthcare stood at ~US$ 13B in 2021; it has grown at a CAGR of ~54% between 2016 and 2021

Global funding growth for AI in healthcare
(US$ B, 2021)



USA leads the total funding for AI in healthcare, followed by China and UK

Total funding by countries
(US$ B, till date)

	Total funding	# funding rounds
USA	26.9	~1,830
China	4.4	~260
UK	1.7	~200
Israel	1.3	~120
India	1.1	~270
Canada	1.1	~130
France	0.9	~90
Switzerland	0.6	~50

Source(s): Secondary research, PGA Labs analysis

Global landscape [1/2]: Top 20 focus areas across the areas of impact, by investment in 2021

Area of impact	Focus area	Investment 2021 (US$ M)	Total Investment (US$ B)	Total number of companies	Recently funded top companies
Detection & Diagnostics	Research, development and drug discovery	~1,100	~4.9	~310	XtalPi, Exscientia, INTERVENN
	Cancer Diagnostic Tests	~755	~6.2	~195	freenome, PathAI, GRAIL
	Therapeutics research and innovation	~590	~3.4	~90	ma2e, HiFiBiO Therapeutics, freenome
	Ultrasound Imaging Devices	~280	~1.8	~120	EXO, Butterfly Network, EchoNous
	Healthcare IT – Ultrasound	~220	~0.4	~20	clarius, EXO, 深至科技公司
	Drug discovery and innovations (disease-linked proteins)	~210	~0.4	~10	SEISMIC Therapeutic, INTERLINE Therapeutics, FRONTIER MEDICINES
Keeping well	Smart Home – Gym Equipment	~570	~1	~30	ZONFIC, TEMPO, TONAL
Decisioning	Research and innovation – life sciences	~470	~24.3	~3,360	immunai, arbor, SYNTHEGO
	Data Analysis Platforms (Genomic)	~420	~3.8	~470	Insilico Medicine, Benchling, HUMAN LONGEVITY, INC.
	Research and innovation – cloud platforms for discovery	~340	~1.7	~103	DNAnexus, Insilico Medicine, arrakis Therapeutics

Source(s): Secondary research, PGA Labs analysis

Global landscape [2/2]: Top 20 focus areas across the areas of impact, by investment in 2021

Area of Impact	Focus area	Investment 2021 (US$ M)	Total Investment (US$ B)	Total number of companies	Top companies funded by value
Decisioning	Healthcare IT - Suite	~410	~2	~1,000	Olive, XISOFT 熙软, Ringmaster
	Clinical research and innovation – data analytics platform	~240	~1.5	~265	iCarbonX, 新合生物 NeoCura, NantHealth
	Biotechnology research and innovation	~230	~12.4	~420	deep genomics, SHINE Health. Illuminated., CARIS LIFE SCIENCES
	Analysis Software (Genomics Sequencing)	~220	~3.1	~530	Element BIOSCIENCES, HUMAN LONGEVITY, INC., deep genomics
	Clinical decision support - Business Intelligence Solutions	~220	~1.3	~470	AXTRIA, komodo HEALTH, PROSPECTION
	Research and innovation – Molecular modeling software	~210	~0.5	~110	ENTOS, 望石智慧, Enveda BIOSCIENCES
	Clinical decision support - Healthcare IT	~195	~0.3	~100	PROSPECTION, MDisrupt, AXTRIA
Care Delivery	Health Management Solutions	~420	~2.6	~420	ginger, workrise, lark
	Robot-assisted Surgery	~300	~4.6	~180	CMR SURGICAL, EDGE MEDICAL 精锋医疗, memic
	Accelerating clinical trials and health management	~195	~1.2	~220	Reify HEALTH, TrialSpark, evidation

Source(s): Secondary research, PGA Labs analysis

Global unicorns [1/2]: United States of America has been the leading producer of unicorns leveraging AI in the healthcare domain

Area of impact	Company	Country	Year founded	Short description	Funding (US$ M)	
					Amount	# rounds
Keeping well	spring health	USA	2016	AI based employee assistance program for mental wellbeing	~300	7
	workrise	USA	2015	Employee wellness tracking and management platform	~750	3
	TONAL	USA	2015	AI-based digital full body motion analysis and training	~450	4
	verily	USA	2015	AI-based suite solutions for health management	~2,500	3
Triaging	iodine	USA	2010	AI-based documentation solution for efficient and quick response time	*Undisclosed*	2
	LinkDoc Care Data · Care Life	China	2014	Provider of oncology-focused medical records & data solutions for quick and effective response	~260	5
Remote care	innovaccer	USA	2014	Cloud & AI-based telehealth solutions	~380	7
	k health	USA	2016	Online healthcare services platform	~280	10
Decisioning	Olive	USA	2012	Clinical decision support with intelligent automation	~900	8
	MODERNIZING MEDICINE	USA	2010	Clinical, financial and operational software solutions	~330	10
Care delivery	mindmaze	Switzerland	2012	VR-based solution provider for neuro-rehabilitation	~225	7
	ORCAM	Israel	2010	Provider of AI devices for visually impaired	~90	3

Source(s): Secondary research, PGA Labs analysis

Global unicorns [2/2]: Most global unicorns impact the decision-making

Area of impact	Company	Country	Year founded	Short description	Funding (US$ M)	
					Amount	# rounds
Detection & Diagnostics	DentalMonitoring	France	2013	Dental monitoring technology to detect tooth movements	~200	3
	XtalPi	China	2014	Developer of tool to predict crystal structure of drug	~785	6
	Benevolent AI	UK	2013	Sharpening research and innovation: AI-based computational drug discovery platform	~280	4
	iCarbonX	China	2015	Health management and drug development bioinformatic platforms for sharpening research & innovations	~370	5
Decisioning	HealthCare.com	USA	2006	Online insurance comparison platform for health insurances	~210	9
	immunai	USA	2018	ML-based clinical decision support for immune system	~300	3
	TrialSpark	USA	2014	Accelerating clinical trials and health management for clinical decision support	~250	3
	komodo HEALTH	USA	2014	Cloud-based business data analytics platform for life sciences companies	~330	6
	AXTRIA INGENIOUS INSIGHTS	USA	2010	Online sales and marketing management tool and big data analytics for life sciences industries	~210	7
	依图 | YITU	China	2012	Provider of AI based decision intelligence platform for multiple sectors	~385	11

Source(s): Secondary research, PGA Labs analysis

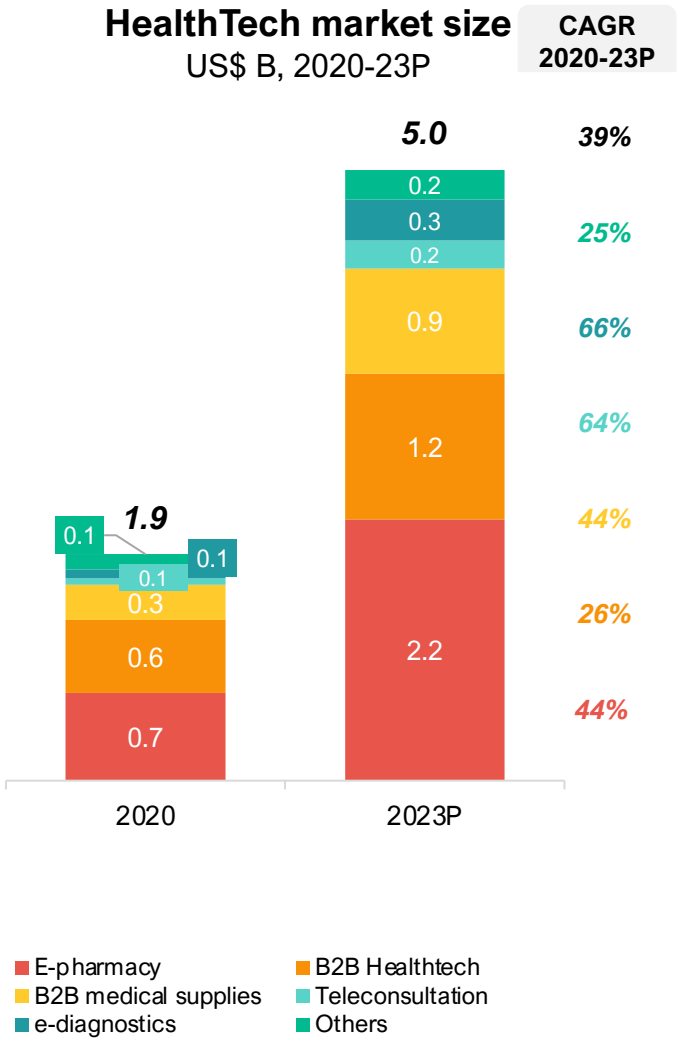
AI in China: Medical imaging is one of the most common application of AI in healthcare industry in China

Areas of impact	Company	Location	Year founded	Overview	Funding (US$ M)	
					Amount	# rounds
Detection & Diagnostics	XtalPi	Shenzhen	2014	Sharpening drug research and discovery with innovative tools	~785	6
	iCarbonX 碳云智能	Shenzhen	2015	Health management and drug development bioinformatic platforms for sharpening research	~370	5
	Insilico Medicine	Hong Kong	2014	Drug discovery and biomarker development bioinformatic platforms for sharpening research	~310	8
	数坤科技 SHUKUN	Chaoyang	2017	Artificial intelligence based diagnostic system for coronary heart disease	~300	7
	InferVision	Beijing	2016	AI-based medical imaging and clinical diagnosis solutions	~210	7
Decisioning	平安科技 PING AN TECHNOLOGY	Shanghai	2015	Self-adaptive AI model & multi-source data for disease prediction	~400	1
	依图 | YITU	Xuhui	2012	Provider of AI based decision intelligence platform for multiple sectors	~385	11
Triaging	LinkDoc Care Data · Care Life	Haidian	2014	Provider of oncology-focused medical records & data solutions for quick & effective response	~260	5
	森亿智能 SYNYI·AI	Pudong	2016	AI-based medical data management and mining platform for effective emergency response	~200	7
Care Delivery	EDGE MEDICAL 精锋医疗	Longgang	2017	Developer of robots-based surgery for doctors	~310	4

Source(s): Secondary research, PGA Labs analysis

AI landscape – India

Although at a nascent stage, the HealthTech market in India is expected to grow at a CAGR of ~39% up to ~US$ 5B by 2023



HealthTech landscape

- E-pharmacy: PharmEasy, TATA 1mg, netmeds, Apollo 24|7, Flipkart Health+
- EHR / EMR and HIS: DocEngage, 21st Century Informatics, Akhil Systems Pvt. Ltd., docon, Binary Spectrum, URPLEDOCS, HealthPlix
- DeepTech diagnostics: MEDGENOME, strand, XCODE, NuGenomics, SIGTUPLE, OncoStem, qure.ai, CYCLOPS, CELLIX, Niramai
- Healthcare IT & analytics: pharmarack, ENDORUSH, ATTUNE, BuddhiMed Technologies, Synapsica, Predible, innovaccer, CitiusTech, CARESTACK, tricog, AXTRIA
- Telemedicine: Critinext, INTELEICU, TELERAD PROVIDERS, Prognosys, Teleradiology Solutions, MyHealthcare
- B2B medical supplies: medikabazaar, ColMed, Dr Store.in, ZEPNUR
- Online Teleconsultation: lybrate, MediBuddy, TATA HEALTH, CLINIKK, doc prime, mfine
- e-Diagnostics: Healthians, KlinicApp, Thyrocare, MedPlusLab.com
- Online Home healthcare: PORTEA, care24, CallHealth, HealthCare at HOME
- Emergency / medical tourism: MUrgency, DIAL 4242, STANPLUS, plan my MEDICAL TRIP.com, MEDMINKS
- Financial services: primechain, HealthFin, thynk blynk, LetsMD, affordplan, carecover, ARTIVATIC.AI, ABI HEALTH
- Health and wellness: cure.fit, PregBuddy, tinystep, DRIEFCASE, brün health, skin, HealthifyMe, wysa, BLUESEMI, dozee

Platforms leveraging Artificial Intelligence

Note(s): Includes digital health-tech platforms only (start-ups performing clinical tests etc. are not included); Others include Startups in Home healthcare, medical tourism, emergency response, financial services & personal health management

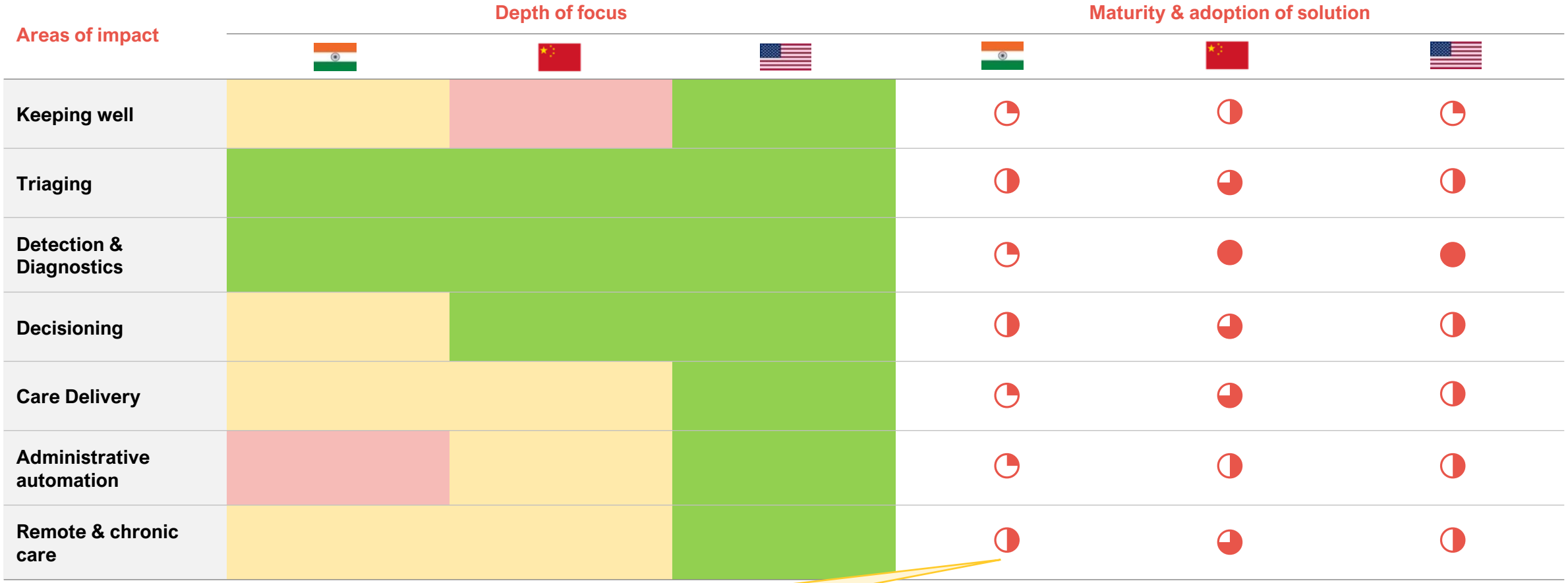
Source(s): PGA Labs analysis

AI in healthcare is a rising trend in the Indian health-tech landscape

Area of impact	Company	City	Year founded	Overview	Funding (US$ M)	
					Amount	# rounds
Triaging	qure.ai	Mumbai	2016	Deep learning technology for automated interpretation of radiology exams	~20	4
	tricog	Bengaluru	2014	Cloud-connected device for interpretation and analysis of ECG reports	~17	6
Detection & Diagnostics	Niramai	Bengaluru	2016	Developer of AI-based early-stage breast cancer screening devices	~14	6
	SIGTUPLE	Bengaluru	2015	AI-based healthcare diagnostic solution	~45	8
	CELLIX	Hyderabad	2014	Innovative drug design & development of therapeutics	~17	7
Decisioning	HealthPlix your diabetes companion	Bengaluru	2014	Clinical decision support via AI and cloud-based electronic medical record management solutions	~24	8
	Synapsica BETTER RADIOLOGY	New Delhi	2018	Decision support by developing AI-enabled radiology tools for workflow and practice management	~5	3
Care delivery	BLUESEMI	Hyderabad	2017	Provider of a IoT solutions to manage healthcare	~70	2
	dozee	Bengaluru	2015	AI-based contactless remote patient monitoring and early warning system	~18	8
Remote Care	wysa	Bengaluru	2015	AI-based chatbot & evidence-based cognitive-behavioral techniques for managing mental health	~10	5

Source(s): Secondary research, PGA Labs analysis

Triaging, detection and diagnostics are the high focus and high impact areas for AI in healthcare across countries



India has **high potential** in all the areas of AI application. The AI maturity level reveals that the latent value from the use of AI is waiting to be unlocked. All sectors are looking to scale-up their ongoing AI initiatives. Focus is on cost efficiencies and business growth opportunities with the use of AI.

According to NASSCOM's Adoption Index report, among healthcare companies, 55% have well defined AI strategy, 70% have active Proof of Concept (PoC) or defined use cases, 67% focus on cost optimization with AI, 62% leverage AI in product / service development, 70% allocate <10% of IT budget to AI projects.

Note(s): NPTEL-National Programme on Technology Enhanced Learning
Source(s): Centre for Security and Emerging Technologies, NASSCOM Adoption Index report, Primary conversations, Secondary research, PGA Labs analysis

National Education Policy 2020 is a step in the right direction – it will eventually put India at par with the fast-moving world in terms of AI education and R&D

In India, the National Education Policy of 2020 places special emphasis on the inclusion of AI in education

	India	China	US
AI in Education	◑	●	◕

- In accordance with the **National Education Policy** 2020, AI has been made a part of Class IX curriculum – the policy places special emphasis on AI.
- The **NPTEL platform** offers ~10 certificate courses on AI. In 2021, there were ~15,000 AI/ML graduates in the country.
- Most top schools – including **IITs, IIMs, NIT** etc. – have started including AI in their curricula.

- Since 2018, the Chinese government has approved **340+ universities to offer an AI major**, and at least **34 universities** have launched their **own AI institutes**.
- The government has mandated AI education in the **high school curricula** and for AI companies to **partner with schools** and universities to train students

- The US has been experimenting with AI education curricula and **industry partnership initiatives**, although in a piecemeal way that varies by state and places a heavier emphasis on computer science education
- **200+ AI/ML courses** are available across universities, including the top Ivy League universities.

In the past decade, ~5K AI patents have been filed in India; in the same time period, China filed ~390K patents

	India	China	US
Research & Development	◔	●	◕

Patents – Processing & Growth

- In India, patents have grown at **~41% CAGR**. However, the total AI patents in India are **75x lower** than in China.
- Organizations have a limited focus on AI patents and research with majority of AI patents being filed **by research or academic institutes.**

- Patent processing in India is **~33% longer** than in US/ China.
- Long lead time for patent processing - an average Indian patent examiner sees **3x more** applications.

- In the past decade, China has filed **~390K patents** in the field of AI, accounting for **~75%** of the global total, and the US has filed **~280K**.
- On the other hand, **~5K AI patents** have been filed in India in the same time period.

Level of maturity: ○ None ◔ Low ◑ Medium ◕ High ● Very high

Source(s): NASSCOM, RNAip, World Intellectual Property Organization, Secondary research, PGA Labs analysis

Initiatives to support AI in healthcare in India

Apart from funding, most founders cite data availability for training and validation and market access as the top areas where start-ups need support

What start-ups look for	Degree of requirement	Challenges	Description	Support available
Infrastructure	◕	• Limited access to labs • Restricted access to advance equipment	• Limited access to advanced equipment, labs and machinery to run pilot tests/ soft-launches • Difficulty in finding proper infrastructure to house the entire team, and for day-to-day operations	◕
Mentorship	◑	• Appropriate guidance • Academic collaboration • Need for professional networking	• Contacting the right people to guide at the right time is difficult • Collaboration with academia for nascent start-ups is a challenge – it is difficult to contact professors	◑
Funding	●	• Liquid assets/ cash • Under/ over-valuation of the actual value of the start-up	• Early-stage seed funding is not enough to sustain operations for longer periods • Difficult to get funding with proof of concept • Difficulty in getting line of credit for working capital requirements	◔
Data for training, validation of models	●	• Access to relevant data • Hurdles in procuring data • Addressing privacy and data sharing concerns • On field trails and validation	• Large, good-quality datasets are needed to train and test AI systems • Access and support for field validation of AI models	◔
Market access	●	• Tough navigation through regulatory framework • Initial deployment	• Start-ups get stuck at the 'ethical clearance' required to obtain data – 'ethical committee' meets once in 3 months to take decisions • Support is needed for testing & deployment – pilot programs and certifications are required for validation in the market	◔
Marketing	◑	• Timely and relevant marketing expertise • Need for stringent IP rights	• Insufficient knowledge and assistance with different marketing channels • High costs related to filing for patents	◑

Source(s): Primary conversations, PGA Labs analysis

○ None ◔ Low ◑ Medium ◕ High ● Very high

Key Insights from Government Initiatives

Dr. Harpreet Singh

Scientist and Head,
Division of Biomedical Informatics, Indian Council of Medical Research (ICMR)

> In India AI ecosystem for health can be a paradigm changer for public health. It is expanding with more applications from predictive image analysis.
>
> Among the significant challenges for developing a translational AI ecosystem for health worldwide includes (i) structured data generation and (ii) responsible data sharing. In addition, developing accessible and interoperable data systems is required by implementing standard terminology.
>
> Recently, ICMR signed an MoU with IISc to develop gold-standard thematic datasets through multi-institutional collaboration. These highly curated datasets will help researchers develop better AI algorithms/applications and a platform for the comparative evaluation of applications.

Note(s): ABDM- Ayushman Bharat Digital Mission; C-DAC-Centre for Development of Advanced Computing; NRCeS-National Resource Centre for EHR Standards

Government initiatives [1/2]: Central and State Governments have been proactively coming up with new initiatives, schemes and policies for AI in healthcare

2008 — **Cognitive Science Research Initiative**

Provides funding to promote cutting edge research around different components of cognitive science, including artificial intelligence

2012 — **Biotechnology Ignition Grant Scheme**

Enables innovators to establish and validate proof of concept (POC) for high-risk, potentially high-impact technological ideas in order to eventually commercialize or implement them

2014 — **Centre for AI & Robotics, DRDO**

For research and development in AI, robotics, command and control, networking, information and communication security

2015 — **National eHealth Authority (NeHA)**

An authority responsible for the development of an integrated health information system in India, using technologies such as artificial intelligence

2016 — **Health Data Privacy & Security Act**

A collaboration between Ministry of Health & Family Welfare & National Law School of India University, which deals with issues of confidentiality, privacy, ownership of health data

2017 — **Task Force on AI for India's Economic Transformation**

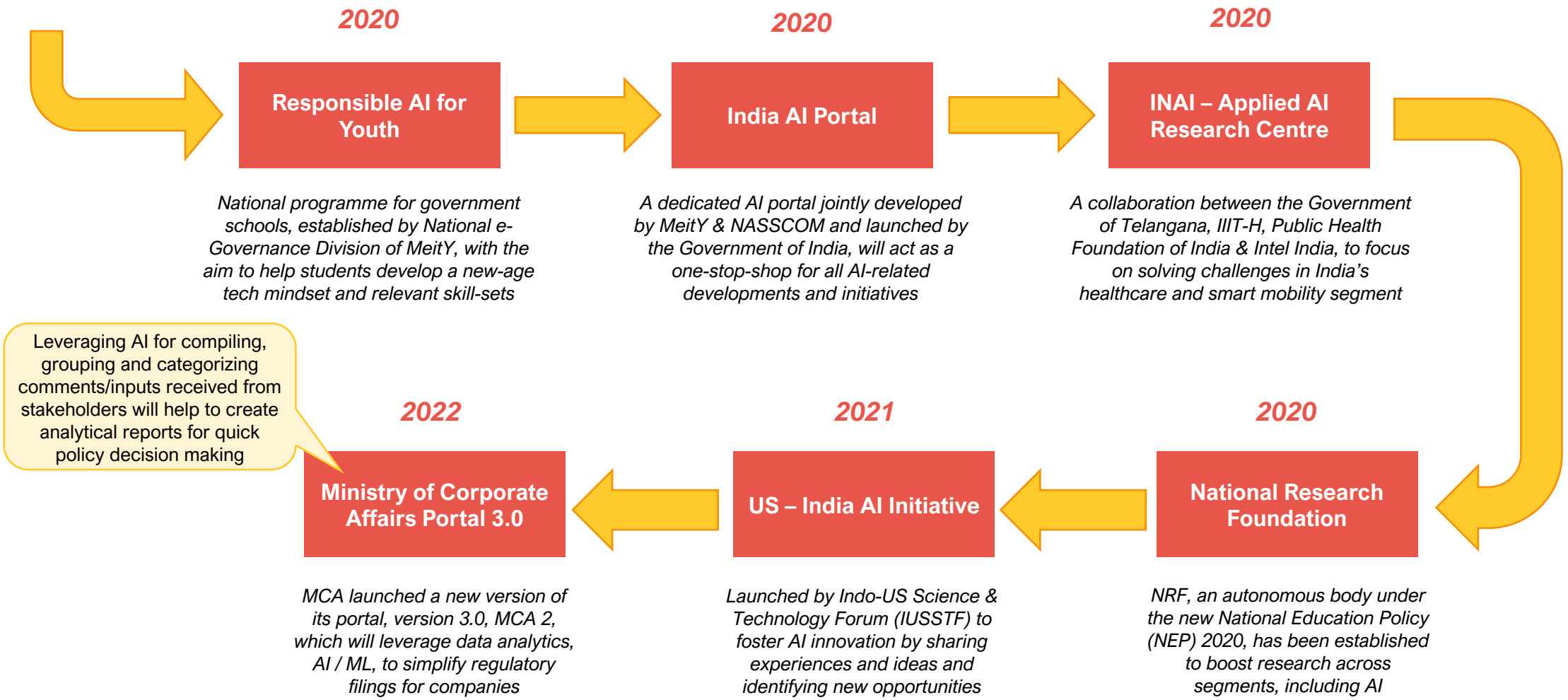
Set-up by the Ministry of Commerce & Industry to explore possibilities to leverage AI for development across various fields

2017 — **Centre of Excellence for Data Science and AI**

A collaboration between the Government of Karnataka & NASSCOM (CoE-DS&AI), for the development of data science and AI across the country

Source(s): The Centre for Internet & Society, India AI, Secondary research, PGA Labs analysis

Government initiatives [2/2]: Most recent initiatives include - MCA 3.0, US-India Artificial Intelligence Initiative, Applied AI Research Centre – among others



Note(s): MeitY: Ministry of Electronics & Information Technology, IIIT-H: International Institute of Information Technology, Hyderabad
Source(s): The Centre for Internet & Society, India AI, Secondary research, PGA Labs analysis

Centres of Entrepreneurship (CoEs) and the Next Generation Incubation Scheme (NGIS) are the flagship offerings for start-ups and entrepreneurs by STPI

CoE	Location	Technology area
Electropreneur Park	New Delhi	Electronics Systems Design & Manufacturing
IoT OPENLAB / STPINEXT INITIATIVES	Bengaluru	Internet of Things
Electropreneur Park	Bhubaneswar	Electronics Systems Design & Manufacturing
VARCoE	Bhubaneswar	Virtual & Augmented Reality
FinBlue	Chennai	Financial Technology
NEURON	Mohali	AI/ Data analytics, Internet of Things
MOTICN	Pune	Autonomous Connected Electric & Shared Mobility
IMAGE	Hyderabad	Gaming, Animation, VFX, Computer Vision, AI
apiary	Gurugram	Blockchain

CoE	Location	Technology area
MedTech	Lucknow	Medical Technology
OCTANE	Guwahati	Internet of Things in Agriculture
OCTANE	Shillong	Animation
OCTANE	Imphal	Emerging technology (Augmented/ Virtual Reality)
OCTANE	Itanagar	Geographic Information System
OCTANE	Aizwal	Gaming Technology
OCTANE	Kohima	Graphic Designing
OCTANE	Gangtok	Healthcare Technology
OCTANE	Agartala	Data Analytics
asal	Akola	Internet of Things in Agriculture
KALPATARU	Visakhapatnam	Industry 4.0

Next Generation Incubation Scheme (NGIS)

NGIS has a budgetary outlay of **INR 95 Cr** for a period of 3 years. It targets to incentivize start-ups with a seed-fund of up to **INR 25 L**.

Centres of Entrepreneurship (CoEs) are technology incubators which have been established by STPI for building India's leadership across the spectrum of technologies throughout the country, in a collaborative manner.

A CoE is facility where the **highest standards and best practices** in terms of infrastructure, technology, leadership, mentoring, training, research & development is made available for specific focus areas.

250+ start-ups are being incubated the STPI CoEs.

- NGIS is a futuristic and comprehensive incubation scheme entrusted by the Ministry of Electronics & Information Technology to STPI for implementation. It promotes and supports innovative start-ups working **towards software product development** (including embedded electronics) through a synergized pan-India approach
- Under NGIS, **240+ start-ups** are being supported at various STPI Centers throughout the country. NGIS Centres have been set-up in **12 Tier-II cities across India** – Agartala, Bhilai, Bhopal, Bhubaneswar, Dehradun, Guwahati, Jaipur, Lucknow, Prayagraj, Mohali, Patna & Vijaywada

Note(s): COE-Centre of Entrepreneurship
Source(s): STPI, Secondary research, PGA Labs analysis

STPI offerings: As an incubator, STPI offers a number of value-added services for start-ups, including infrastructure, mentorship, funding & investment etc.

Infrastructure

- Ready to work 'Plug & Play' space
- Health Informatics Lab/ IoT Lab
- Year-around operational workspace
- Testing and validation facility

Facilities include fully air-conditioned incubation spaces, uninterrupted power supply, 24x7 security, workstations, cubicles, conference halls, internet bandwidth etc.

Monitoring

- Monitoring and guiding through dedicated portfolio managers and start-up support executives
- Reviewing and monitoring the progress and performance periodically
- Taking necessary actions as and when required

Marketing

- End-to-end marketing plans to attract visibility
- Marketing knowledge sessions, road shows, networking events, social media outreach
- Partnerships with key international promotional agencies for cross border collaboration

Mentorship

- Needs-based mentoring sessions on legal, compliance, branding, cybersecurity, tech
- Transformation from idea level to Prototype level, Prototype level to MVP (Minimum Viable Product) level, MVP level to GTM level, and graduating the start-ups into full-fledged company status
- Networking with other players in the ecosystem

Intellectual Property Rights

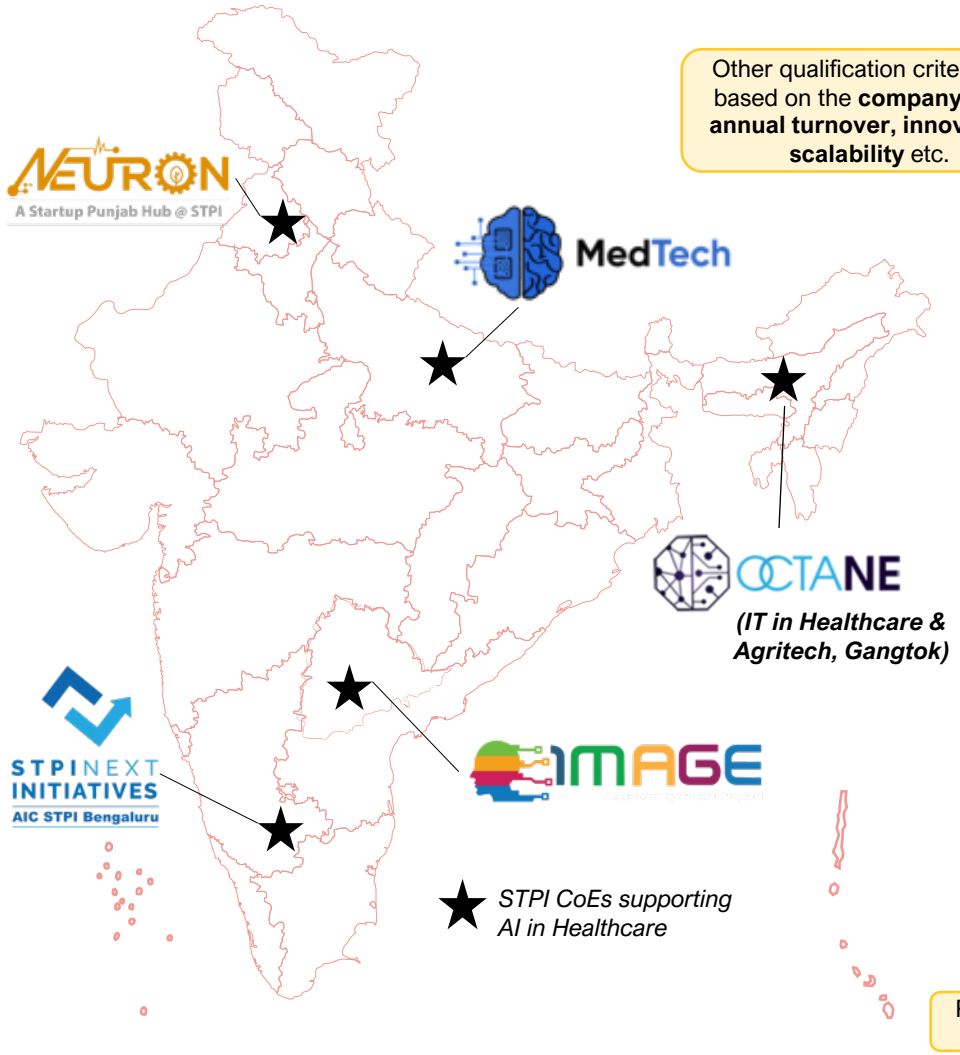
- MoU with NRDC for filing Intellectual Property Rights
- Patenting (drafting & filing), Trademark, Copyright and other related legal or statutory support

Funding & Investment

- Support in raising funds by leveraging connections with potential customers
- Networking with HNI individuals, VCs, Corporates as per size of start-ups
- Grants, equity, debt

Source(s): MedTech STPI, Primary conversations, Secondary research, PGA Labs analysis

5 STPI CoEs are supporting AI in Healthcare start-ups from all over India; some of those being incubated have been mapped below (illustrative)



Other qualification criteria are based on the **company type, annual turnover, innovation, scalability** etc.

Qualifying Categories for Incubation for Start-ups at these 5 CoEs

- Medical Electronics
- Health Informatics
- Health-Tech
- Internet-of-Things

	Start-up	Inception	Focus area	Location
Triaging	Grainpad	2017	Software-as-a-medical device - health informatics chatbot	New Delhi
Triaging	Sunfox Technologies	2016	Detection of cardiac diseases through portable ECG device	Dehradun, Uttarakhand
Detection & Diagnostics	Detrocel Healthcare	2020	Diagnostic solutions for respiratory abnormalities and genetic disorders	Lucknow, UP
Detection & Diagnostics	Datalyca Technologies	2020	Radiology AI - Computer vision for sports and healthcare & MRI scans	Bengaluru, Karnataka
Detection & Diagnostics	Primary HealthTech	2018	Point of care technologies for early diagnosis of non-communicable diseases	Guwahati, Assam
Detection & Diagnostics	Codelogic Consultancy	2014	Software & diagnostics and diabetic retinopathy detection	Gwalior, MP
Care Delivery	Cerebralx Innovation Hub	2019	Neurotech – developing thought-powered devices for communication & interaction	Mohali, Punjab
Care Delivery	Julien Innovations	2017	Analytics automation, conversational BOTs and speech technologies	Hyderabad, Telangana
Care Delivery	Glovatrix	2021	Wearable technology for communication for speech & hearing impaired	Pune, Maharashtra
Remote Care	Manodayam	2020	Voice marker-based mental health and other condition detection	New Delhi

Disclaimer: *This map doesn't purport to be the political map of India. It represents the location of STPI CoEs*
Note(s): The list of start-ups mentioned here in not exhaustive; UP-Uttar Pradesh; MP-Madhya Pradesh; CoE-Centre of Entrepreneurship
Source(s): STPI, Primary discussions, Secondary research, PGA Labs analysis

HTIC by IIT Madras is one of the top incubation programs provided by an academic institution in healthcare and med-tech

Incubation programs by some top academic institutions in India

Incubation program	Offered by	Year	Distinguishing features
Healthcare Technology Innovation Centre	IIT Madras	2011	• 25+ start-up incubatees • Multidisciplinary research center • Developing & deploying affordable healthcare tech with 20+ institutions
CIIE.CO BUILT AT IIMA	IIM Ahmedabad	2002	• 68+ start-up incubatees • Aarohan Ventures – backs social start-ups in education & healthcare
PHG TBI Indian Institute of Public Health Gandhinagar	Indian Institute of Public Health, Gandhinagar	2008	• 24+ start-up incubatees • Fab, Microbiology & Molecular Lab • Health assessment center for validation at host institute
SINE	IIT Bombay & CitiusTech	2004	• 43+ start-up incubatees-21 MedTech • Up to 3 years incubation support to start-ups
FITT	IIT Delhi	2000	• 45+ start-up incubatees-10 MedTech • Recognized as a Scientific and Industrial Research Organization
INCUBATION & INNOVATION	IIT Kanpur	2000	• 100+ start-up incbatees-33 MedTech • Manages government-funded programs across domains like NIDHI EIR, TIDE 2.0, BIRAC's BIG etc.
IIT Mandi CATALYST	IIT Mandi	2016	• 11+ start-up incubatees • Plan to disburse ~INR 35 Cr through various programs over next 3 years

Incubation programs by some top private players in India

Incubation program	Offered by	Year	Distinguishing features
Edison ACCELERATOR	GE Healthcare, India	2019	• 17+ start-up incubatees • ~INR 7.5L equity-free cash grant • Support in customer discovery and product validation
SOCIAL alpha	Microsoft & Social Alpha	2016	• 110+ start-up incubatees - 18 MedTech • Pfizer INDOvation – for start-ups working in digital healthcare or oncology
HealthStart	HealthStart India Private Limited	2015	• 20+ start-up incubatees • Global expansion partnerships • Recruitment & HR support
villgro possible.	Villgro Innovations Foundation	2001	• 84+ start-up incubatees-18 MedTech • Measure the impact entrepreneurs create through globally accepted SDG and IRIS metrics

Enablers

#startupindia

DEPARTMENT OF BIOTECHNOLOGY
Ministry of Science & Technology
Government of India

ATAL INNOVATION MISSION

birac Ignite Innovate Incubate

विज्ञान एवं प्रौद्योगिकी मंत्रालय
MINISTRY OF SCIENCE AND TECHNOLOGY
सत्यमेव जयते

These institutions, along with State governments, are responsible for the implementation of most of the government schemes pertaining to innovation and incubation at the academic institutions and other public forums in India

Note(s): IIM: Indian Institute of Management; IIT: Indian Institute of Technology; SDG: Sustainable Development Goals; IRIS: Integrated Risk Information System
Source(s): MedTech STPI, Primary conversations, PGA Labs analysis

As the AI landscape matures, appropriate policy measures would be needed to manage and mitigate risks associated with the use of AI and related technologies

Parameters	Potential Causes	Mitigation measures
AI errors & accuracy	• Noise & artefacts in AI's clinical inputs • Data shift between training and real-world • Unexpected variations in clinical environment	• Comprehensive multi-center evaluation studies to identify instabilities • Traceable and dynamic solutions that improve with time
Use of medical AI tools	• Proliferation of easily accessible online AI solutions • Limited involvement of clinicians and citizens in developments • Lack of awareness and literacy	• Better regulation and information on emerging Ai tech • New literacy programs and future integration of AI in education and training • Extensive usability tests for algorithms
Balance & diversity in medical AI	• Biased and imbalanced datasets • Lack of diversity and inter-disciplinarity in development • Disparities in access to quality equipment and tech	• Systematic AI training with representative datasets • Promotion of more diversity and inclusion in the field • Interdisciplinary approaches involving social scientists
Transparency	• Lack of understanding and trust in AI decisioning • Limited uptake of AI tools in clinical practice • Difficulties to reproduce and evaluate algorithms	• Documenting all the model's key information • Including traceability as prerequisites for certification
Privacy and security	• Risk of harmful and potentially fatal cyberattacks • Risk of personal data re-purposing and data being shared and used without consent	• Legislative approach for de-centralized privacy-preserving medical AI • Continuous research to protect algorithms
Accountable AI	• Lack of ethical and legal governance • Legal gaps in current regulations and difficulties in defining the roles and responsibilities	• Establishment of regulatory agencies dedicated to medical AI • Unified regulatory frameworks
Implementation in real-world healthcare	• Limited data quality, structure and interoperability • Potential alterations of physician-patient relationships • Lack of clinical and technical integration	• Building data standards and data interoperability • Defining standard operation procedures • Establishing new guidelines and care models

Source(s): Secondary research, PGA Labs analysis

Going forward, to increase adoption not only in India but to have 'made-in-India' AI solutions get adopted in global markets, work on a policy which is aligned with evolving global frameworks for use of AI in healthcare

Principles for responsible management and adoption of AI in the future include measures to ensure safety & reliability, equality, inclusivity etc.

Principles for responsible management & adoption		
	Safety & reliability	• AI system needs to be **monitored** through its lifecycle • Risks to all stakeholders should be minimized • Appropriate **grievance redressal**, **care,** and **compensation structures** should be in place
	Equality	• AI systems must treat individuals under the **same circumstances** relevant to the decision equally
	Inclusivity & Non-discrimination	• AI systems should not deny opportunity to a qualified person based on their identity (religion, race, caste, sex, descent, place of birth, etc) • Prevention of **unfair exclusion** of citizens from services guaranteed by the state
	Privacy & Security	• **Maintenance of privacy and security** of data of individuals or entities used for training the system • Access should be provided only to those authorized with sufficient safeguards
	Transparency	• Deployment should be **fair, honest, impartial** and should guarantee accountability • **Recording** the design and functioning of systems for external scrutiny and audit
	Accountability	• Stakeholders should conduct **risk and impact assessments** to evaluate the direct and indirect potential impact of AI systems on end-users • They should set up an **auditing process** to oversee adherence to principles
	Positive human value	• AI should promote positive human values and not disturb in any way **social harmony** in community relationships

Going forward, a clear policy framework for AI in Healthcare in India will be vital

"Before 2014, 'start-up' was just a buzzword. Now, it is an exciting time for new start-ups to emerge. Going forward, the government should increase the budget allocated for assisting start-ups and funding infusion is needed for capital requirements."

- Grainpad

"There is a positive change in the Indian landscape with respect to digital heath adoption. Government is the only body that institute country-wide changes. It should now focus on increasing investments at a faster speed and laying down a clear policy framework pertaining to AI in healthcare."

- Tricog

"Government's intervention in digitalizing different sectors is bringing up new opportunities. Programs or policies at the national level, encouraging senior experienced personnel from big MNCs to assist and guide start-ups is required. Industrial mentorship is absolutely vital."

- Primary HealthTech

Source(s): NITI Aayog, Primary conversations, Secondary research, PGA Labs analysis

Key Insights from Government Initiatives

Dr. Praveen Gedam

Additional Chief Executive Officer,
National Health Authority

> Ayushman Bharat Digital Mission aims to support the integrated digital health infrastructure of the country. It will bridge the gap between different stakeholders of the healthcare ecosystem through digital highways.
>
> ABDM is not a health data compiler. It facilitates exchange of data between two entities with the consent of data principals; it does not create a central data repository of health records.
>
> ABDM follows the standards recommended by NRCeS at C-DAC, Pune which provides the knowledge base for developing, implementing and using Electronic Health Records (EHR) standards in India. We will be pushing the ecosystem towards data standardization.
>
> ABDM's open architecture has been put in place to ensure that innovations flourish amongst start-ups as well as government and private entities. We will be organizing events like hackathons etc. to continue encouraging innovations in this space.

Note(s): ABDM- Ayushman Bharat Digital Mission; C-DAC-Centre for Development of Advanced Computing; NRCeS-National Resource Centre for EHR Standards

India can better utilize the potential of AI and help scale it by enabling better access to data, encouraging AI R&D, emphasizing on privacy & security etc.

Formulating a multi-stakeholder plan for AI

Enabling access to data

By encouraging an Open Data system and ensuring that this data meets the standards set in terms of interoperability, privacy and safety

Encouraging AI research & development

Pushing for AI adoption by businesses and the public sector

Setting up a dedicated regulatory framework to oversee AI in India

Design standards and appropriate certification system for health systems driven by AI

Equipping existing and future labor forces with the skill sets to successfully adopt AI

Regulatory and data sandbox for the health sector

A regulatory sandbox is a controlled environment with relaxed regulations that allow the product to be tested thoroughly before it is launched to the public

Liability framework & pragmatic future planning

Close monitoring towards harmonized implementation of Electronic Health Record (EHR) policy

Emphasize Privacy and Security

A key step towards ensuring privacy and security is for India is to enact and effectively enforce a comprehensive privacy legislation

Continuous monitoring and research into impact of AI on the human

Note(s): R&D-Research & Development
Source(s): The Centre for Internet & Society, India AI, Secondary research, PGA Labs analysis

Key Insights from Government Initiatives

Shri Abhishek Singh

MD & CEO,
Digital India Corporation,

President & CEO,
NeGD,

CEO, MyGov,
Ministry of Electronics and Information Technology

AI enabled tools are being used in various Government departments like Agriculture, Education, Health. MyGov Helpdesk is an AI enabled chatbot that provides information about Covid19, vaccination services as also access to Digilocker documents. UMANG is implementing AI Chatbot that will also have a Voice Bot in multiple languages.

Digital India has addressed many challenges pertaining to incomplete and non-standard datasets, and Open Government Data Portal 2.0 is now being rolled out. National Data Governance Policy Framework is being finalized after public consultation and inputs from all stakeholders on draft policy. India Data Management Office will help build capacity and will enable a framework for access to anonymized non-personal datasets for startups and researchers to build applications in agriculture, health, education, rural development, skilling.

Bharatnet is helping connect all villages including sub centers and primary health centers. Ayushman Bharat Health Mission is helping build Health registries and basic framework that will enable electronic health records and telemedicine. Success of Co-Win is an example of how robust, scalable systems with simple UI/UX can be adopted quickly enabling digital transformation in healthcare sector. eSanjeevani is now scaled to handle more than 30 million tele-consultations and is designed to scale up to handle many more. Private health service providers can build systems/apps on top of national health stack layer. Governments approach of building public digital infrastructure with basic building blocks also ensures equity in the whole system and also gives choice to citizens to opt for a government service or a private service.

Tech adoption in government should be based on creating value. Blockchain based applications can be used in land records, land registration, supply chain of medicine supplies, managing academic credentials. With 5G coming, IoT will play a big role in utility maintenance and compliances like meter readings for water bills, maintain AI enabled irrigation system, predictive analysis on rainfall, soil moisture data, vehicle monitoring and smart mobility. Metaverse can potentially be used in medical education for surgeries and, training and skilling in sectors like automobiles.

Technologies in AI: Emerging use of allied technologies in healthcare

Web 3.0 restores the ownership of data with the user by providing privacy and security

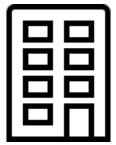
What is Web3?

3rd generation of Web

Web3.0 or Web3 uses decentralized blockchain networks to enable better personalization and faster user experiences.

Ownership of data

Web3 enables users to own their data, identity, content, algorithms and will participate in the market by owning cryptocurrencies and NFTs etc



Free from intermediaries

Web3 will help users interact with each other without any interference by intermediaries. It removes servers, platforms and authorities as the key participation in data flow.

Features of Web3

Data ownership

In web 2.0, the data generated by users was stored with larger corporations like Facebook, etc. But with web3 features, end-user will have full ownership of data and data transferred through network will be fully encrypted

Interoperability

With the help of decentralized network, applications can be easily run across different devices (TV, Laptop, smart phone). Easy for developers to build on web3 infrastructure

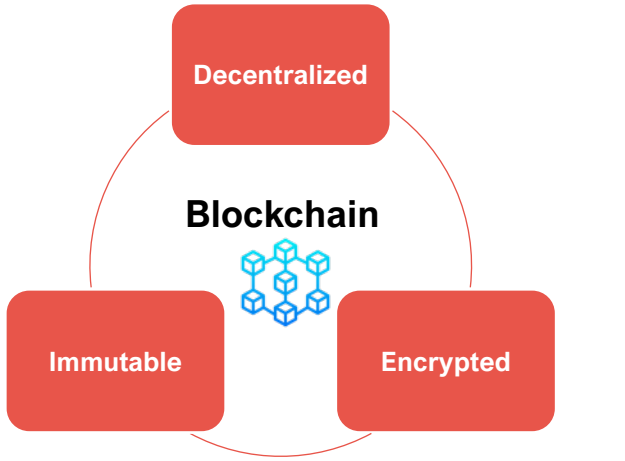
Permissionless

Blockchain network used will be free from any central authority. It will enable access to individuals who are discriminated against because of their gender, wealth, or geography etc as anyone can join the blockchain by creating an address

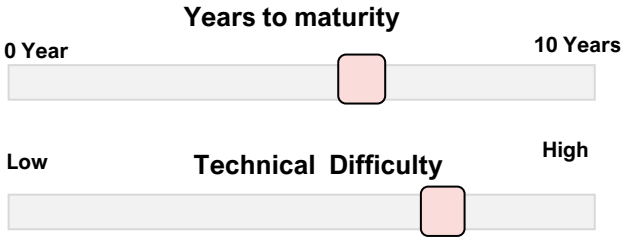
Web 3.0's decentralized business model revolves around handing over to users the ownership of their data and putting the community first. The base healthcare application for Web 3.0 is remaking **electronic health records** (EHRs) - transferring EHRs from siloed, centralized software to interoperable, patient-owned, immutable records

Source(s): 101blockchains.com, ethereum.org, PGA Labs analysis

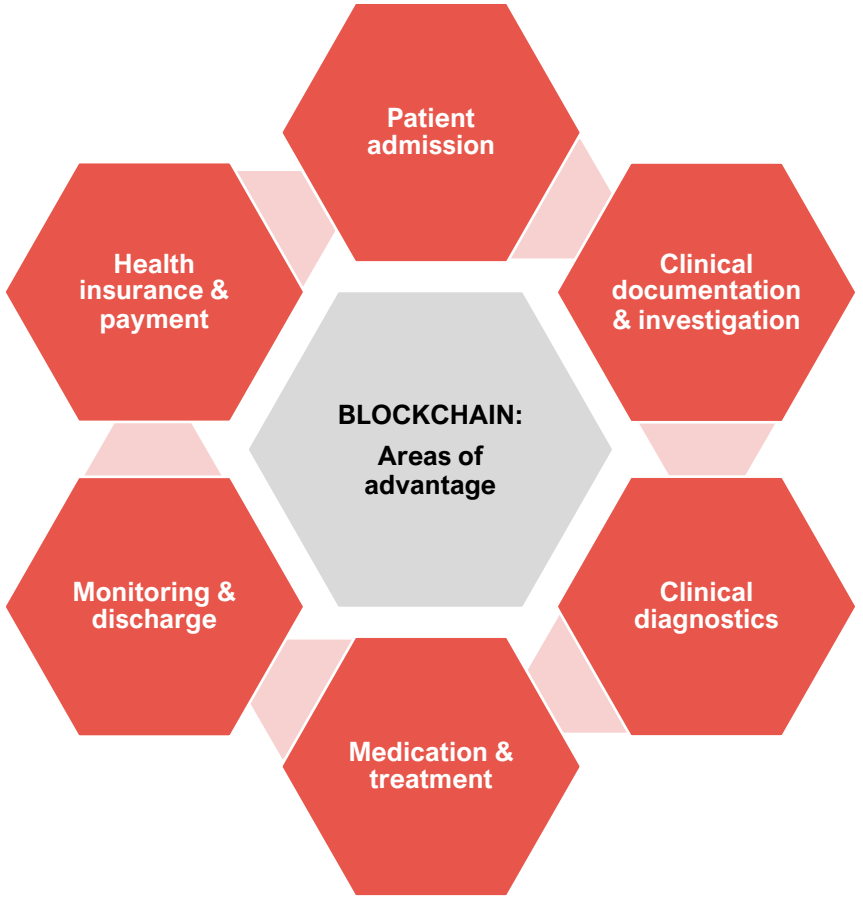
Blockchain has multiple use cases throughout a person's healthcare lifecycle, ranging from registration and profiling to health insurance management



Blockchain is a distributed, shared and immutable digital ledger that keeps a record of all transactions that take place across a peer-to-peer network



Use Cases for Healthcare Lifecyle	
Citizen registration	• Blockchain can form the single source of truth for citizen records, and can be integrated to provide citizen information to any other database • This can be integrated with government health coverage schemes, etc., to create a truly interconnected system
Health profiling	• Personalized health profile for each citizen, with data security and information control • Centralized mapping and maintenance of confidential records
Medication tracking	• Prevention of counterfeit and black-market medicine sales across the ecosystem by establishing a digital system to validate seller licenses • Maintaining drug inventory, medication profiles; tracking prices and authorized sellers
Provider care	• Citizens will be able to view the availability of health services in their neighborhood based on their requirements • Aggregate-level data repository will bring together the ecosystem of providers
Health insurance management	• Citizens will be able to manage their private as well as public health insurance scheme claims and will benefit from blockchain-enabled seamless and cashless claim processing

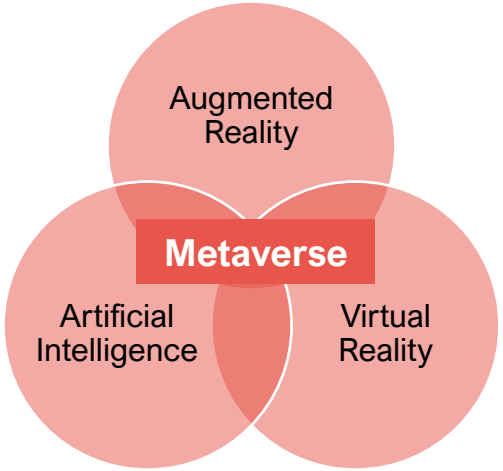


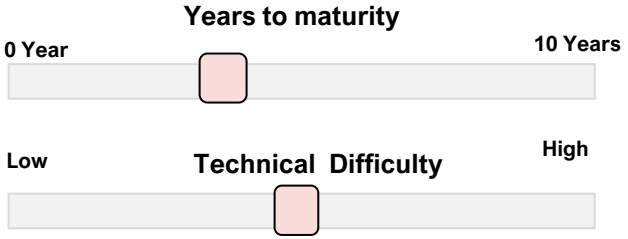
Note(s): Years to maturity and technical difficulty are based on the global market scenario
Source(s): PwC, Secondary research, Primary conversations, PGA Labs analysis

Metaverse's potential in healthcare includes creating digital twins, data security via Blockchain, medical education and training etc.

What is Metaverse?

Metaverse involves the convergence of three major technological trends - artificial intelligence (AI), augmented reality (AR), virtual reality (VR), and ever-increasing connectivity (5G networks etc.) to create online environments that are more immersive, experiential and interactive than what we have today





1 Telepresence

- Telemedicine consultations, particularly through VR, would imply that patients will no longer be **limited to being treated** by particular clinicians **due to their physical location**
- Environments would be **personalized to individual patients**

2 Virtual hospitals/ Surgical operations

- Metaverse can enable a **virtual reality hospital environment**, accessed through a headset, where treatments will at first be focused on counseling and physiotherapy services
- Metaverse for surgeries, will give a 3D view of the patient's body and **realistic interaction between doctor-patient**

3 Digital twins

- A digital twin is a **virtual model, or simulation**, of any object, process, or system, generated using real-world data, for the purpose of learning more about its real-world counterpart
- In the case of the metaverse, the digital twin could be of the **patient themself**

4 Data security

- Metaverse will be used for the **management and security of our highly valuable health data**. It has the potential to bring upon better care & increased transparency in payment and administration
- On a blockchain, everyone can own their records in a personal file – this will be 'unhackable'

5 Medical Education & Training

- Metaverse would be able to produce an **augmented reality space** to examine the anatomy of a human body in a laboratory setting
- AR gives medical students **hands-on learning** like blood clot removal etc., while VR allows them to **virtually enter the human body**

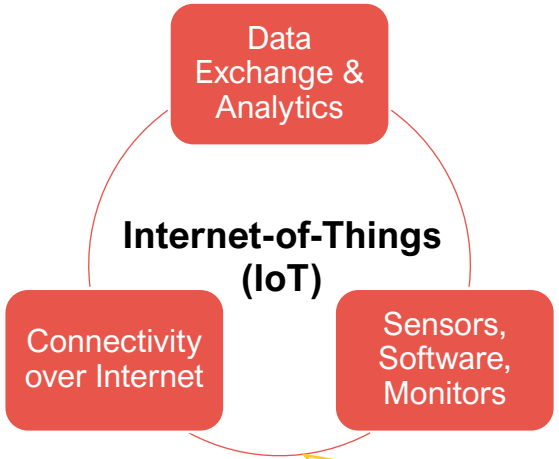
6 Mental Health

- Metaverse can be used for the **treatment of various brain issues** such as PTSD, hallucinations, anxiety disorders etc.
- It has an **interactive nature** and provides an arena for online therapy, improves access to therapy for disabled people, and renders a life-like experience

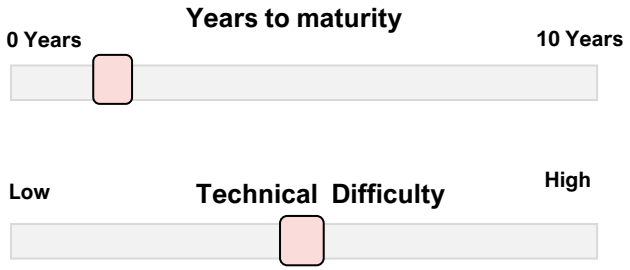
With a click of a button, owners will be able to give consent to any clinician anywhere in the world to review their records

Note(s): Years to maturity and technical difficulty are based on the global market scenario
Source(s): Forbes, ET Health, InformationWeek, Secondary research, Primary discussions, PGA Labs analysis

Internet-of-things (IoT) has enabled a phenomenon where physical objects can share and collect data with minimal human intervention



The Internet of Things (IoT) describes the network of physical objects—"things"—that are embedded with **sensors, software, and other technologies** for the purpose of **connecting and exchanging data** with other devices and systems **over the internet**



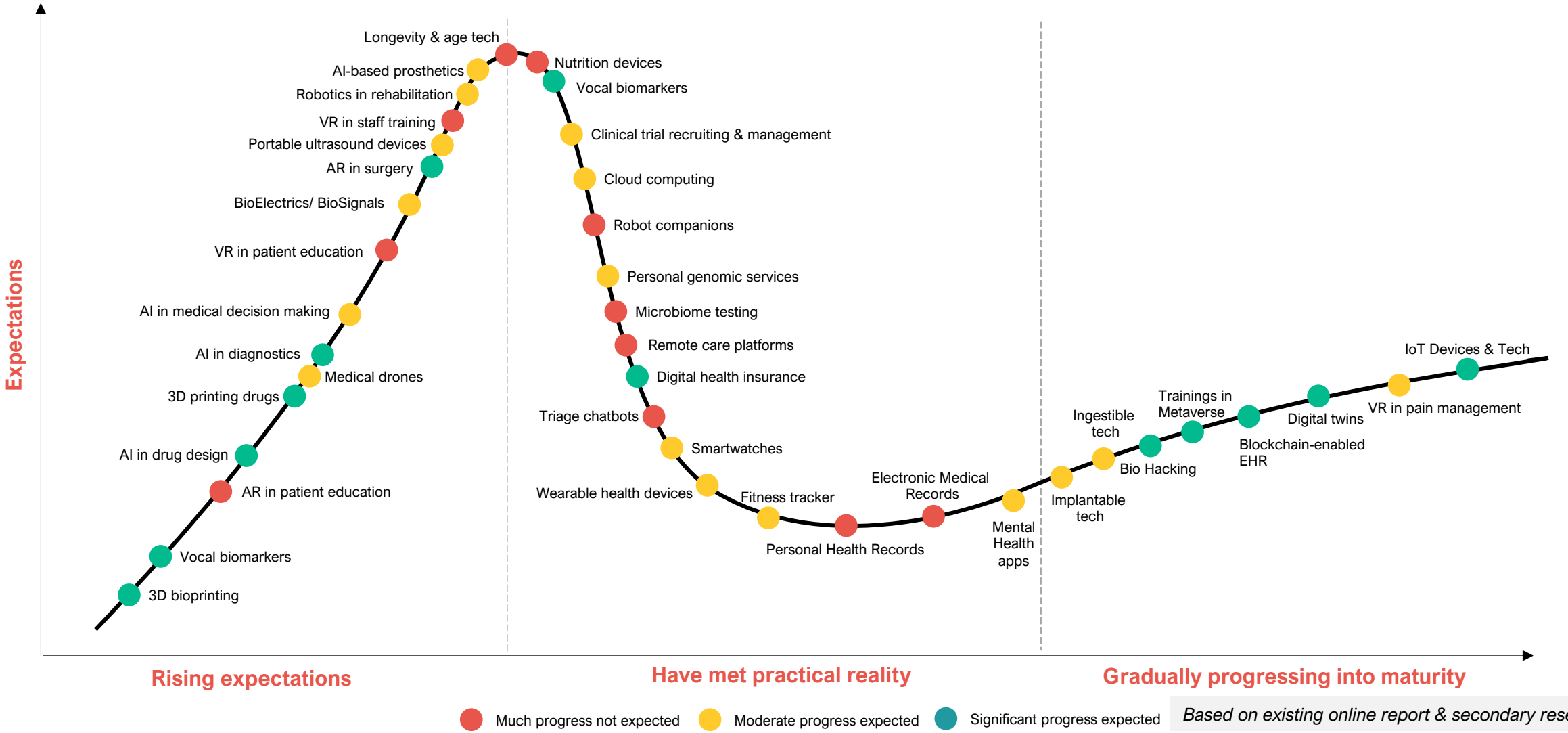
How does IoT work?

	IoT for Patients	IoT for Physicians	IoT for Hospitals	IoT for Insurance
IoT use cases	• Devices in the form of wearables like fitness bands and other wirelessly connected devices like blood pressure and heart rate monitoring cuffs, glucometer etc. give patients access to **personalized attention** • IoT has changed people's lives, especially elderly patients, by enabling **constant tracking of health conditions**	• Physicians can **keep track of patients' health** more effectively. They can track patients' adherence to treatment plans or any need for immediate medical attention. • IoT enables healthcare professionals to be more watchful and **connect with the patients proactively.** Data collected from IoT devices can help physicians identify the best treatment process	• IoT devices tagged with sensors are used for tracking **real time location of medical equipment** like wheelchairs, defibrillators, nebulizers, oxygen pumps and other monitoring equipment. • **Deployment of medical staff** at different locations can also be analyzed real time • IoT-enabled hygiene monitoring devices help in **preventing patients from getting infected**	• Insurance companies can leverage data captured through health monitoring devices for their **underwriting and claims operations** • In the light of IoT-captured **data-driven decisions in all operation processes**, customers will have adequate visibility into underlying thought behind every decision made and process outcomes.

IoT devices also help in asset management like pharmacy inventory control, and environmental monitoring

Note(s): Years to maturity and technical difficulty are based on the global market scenario
Source(s): Wipro, Oracle, Primary conversations, PGA Labs analysis

Global Digital Healthcare: Metaverse, IoT & Blockchain solutions in healthcare are gradually progressing into reality, will take 3-5 years to mature



Based on existing online report & secondary research

Note(s): AR: Augmented Reality; VR: Virtual Reality
Source(s): MedicalFuturist, Healthcare.Digital

Select case studies

Indian start-ups [1/2]: Niramai & SigTuple are working on software-based imaging and on democratizing microscopy respectively, by leveraging AI

Niramai

Founded
2016

Geographical Presence
India, USA, Europe

Founder

Geetha Manjunath
Founder & CEO

- 25+ years in IT & innovation
- Ex - Xerox Research India, Hewlett Packard India

Investors

AXILOR, DI Dream Incubator, ankur capital, pi Ventures, BEENEXT

Niramai has **27 granted patents** across different countries, with 11 of them granted in the US and 11 of them in India.

Overview	• NIRAMAI has developed a **novel software-based medical device to detect breast cancer** at a much earlier stage than traditional methods or self-examination • Radiation free imaging method, non-touch, not painful and works for women of all ages • Low cost, accurate, automated, portable cancer screening tool that can be operated in any clinic or from home
Offerings	• **Thermalytix:** A computer aided breast cancer detection system powered by AI • **XraySetu:** An AI-driven X-ray analysis for COVID interpretation via Whatsapp • **Niramai FeverTest:** Simple screening for COVID symptoms

SigTuple

Founded
2015

Geographical Presence
India, USA

Leadership

Tathago Dastidar
Founder & CEO

- 21+ years in tech & software
- Ex- Tribune Digital, American Express

Ashes Ganguly
Chief Technology Officer

- 20+ years in healthcare
- Ex – GE Healthcare, Abbott Labs, Samsung Healthcare

Investors

TRIFECTA CAPITAL, Accel, Microsoft Accelerator, chiratae VENTURES

SigTuple has **19 patents** granted in the US & India

Overview	• SigTuple **democratizes microscopy** by automating it through advanced AI and robotics • AI-assisted digital microscopy, enabled through the cloud, provides a smart alternative to the current process • Use of robotics and AI to **digitize any biological sample** on a glass slide to enable AI aided remote review
Offerings	• **AI100:** An in-vitro diagnostic device which is designed to automate manual microscopy using robotics and AI • **Shonit:** An AI application to analyze blood cell morphology • **Shrava:** An AI application to analyze and pre-classify multiple elements in urine sediment

Source(s): Company websites, Primary conversations, PGA Labs analysis

Indian start-ups [2/2]: Qure.ai & Tricog are working on automated radiology interpretation & virtual cardiology services respectively, by leveraging AI

qure.ai

Founded
2016

Geographical Presence
India, USA, UK (~50 countries)

Leadership

Prashant Warier
Co-founder & CEO
- 19+ years in AI & deep learning, data science
- Ex-Imagna, Fractal Analytics

Chiranjiv Singh
Chief Commercial Officer
- 21+ years in healthcare & marketing
- Ex-GE Healthcare, Adidas

Investors

novo holdings, MSD, HEALTH QUAD, fractal, SEQUOIA

Overview	• Qure.ai leverages **deep learning technology** to provide **automated interpretation of radiology exams** like X-rays, CTs and ultrasounds scans for time and resource-strapped medical imaging professionals - enabling faster diagnosis and speed to treatment
Offerings	• **qXR:** AI for chest X-ray interpretation • **qER:** AI for neurocritical care – detects abnormalities in brain • **qCT-Lung:** AI for lung nodule detection & analysis • **qVH:** AI for ultrasound imaging (cardiovascular diseases) • **qMSK:** AI for musculoskeletal x-rays • **qTrack:** Lung health management platform • **qRemote:** AI-enabled telehealth solution

tricog

Founded
2014

Geographical Presence
India, Singapore, China, Malaysia (~14 countries)

Leadership

Charit Bhograj
Founder & CEO
- 23+ years as a Cardiologist
- Ex- Vikram Hospital, Fortis Hospitals

Zainul Charbiwala
Founder & CTO
- 17+ years in energy efficiency, ML, healthcare
- Ex-IBM India, Qualcomm

Investors

UTEC, DI Dream Incubator, SG, ICP INVENTUS CAPITAL PARTNERS, BLUME

Overview	• Tricog leverages its deep medical and technology expertise, to provide **virtual cardiology services** to remote clinics • AI data store exhibits 200+ cardiac conditions, which significantly enhances the detection of rare cardiac disorders • **Predictive healthcare analytics** backed by highly experienced medical team
Offerings	• **InstaECG:** Tricog's flagship product, a cloud-connected device that makes the interpretation and analysis of an ECG report quick and easy • **InstaEcho:** Helps in quick and accurate echocardiogram diagnosis, and hence helps in reducing the treatment time and saving critical lives

Note(s): Information for Qure.ai has been taken directly from their website
Source(s): Company websites, Primary conversations, PGA Labs analysis

Sources of input: N = 26 interviews conducted with senior government officials, management of STPI and other private companies, hospitals and start-ups

Government Officials (N = 11)

Designation	Location
Director General, STPI	New Delhi
MD & CEO, Digital India Corporation, President & CEO, NeGD	New Delhi
Chief Data Officer, ICMR	New Delhi
Additional CEO, NHA	New Delhi
COO, AIC STPI Bengaluru	Bengaluru, Karnataka
COO, MedTech	Lucknow, Uttar Pradesh
Director, STPI	Hyderabad, Telangana
Additional Director, STPI	Hyderabad, Telangana
Additional Director, STPI	Bengaluru, Karnataka
Additional Director, STPI	Noida, Uttar Pradesh
Deputy Director, STPI	Hyderabad, Telangana

Supporting secondary sources

Financial reports / Industry reports	• Nasscom • Tracxn • NITI Aayog
News articles, press releases	• Health-tech industry players
Industry coverage	
PGA Labs proprietary data	

Expert Interviews (N = 15)

Company	Designation
Niramai	Director
SigTuple	Director – Robotics
Medanta Hospital	Group CIO
Tricog	SVP – International Business
CloudPhysician	Co-founder
Cerebralx	Founder & CEO
Datalyca	Founder
EPAM	Consultant – Data Analytics
Primary HealthTech	Founder
Grainpad	CEO & MD
Dectrocel	Co-founder
Manodayam	Director
BotsInRed Tech	Founder
Codelogic	Director
Wayu Health	Co-founder & CTO

Note(s): COO: Chief Operating Officer; CIO: Chief Investment Officer; SVP: Senior Vice President; CTO: Chief Technology Officer

Transmittal Disclaimer

- This report has been prepared for Software Technology Parks of India (STPI) by Praxis Global Alliance (which is the trade name of Praxian Global Private Limited referred as “Praxis” hereunder) with the intent to showcase the capability and disseminate learnings to start-ups, industry, policy makers & potential partners/associates
- Nothing contained in this report should be construed as definitive predictions or forecasts. Any use of the information provided herein by the reader shall be at the sole risk of the reader and STPI or its associates shall not be liable for any unintended or adverse effect or outcome from the use of such information by the reader.
- STPI does not have any duty to update or supplement any information in this document. STPI or its knowledge partner shall not be responsible for any business or commercial loss sustained by any person who relies on any information provided therein.
- Any and all logos of companies used in the information provided herein have been published for information purposes only and STPI or its associates do not hold any and all liability in connection therewith.
- Any information provided herein is only for informational purposes and readers are advised to perform an independent analysis of the same before making any decision based on such information. The information does not constitute any business advice or guidance and is to be construed as a general summary based upon the publicly available information and its interpretation using internal resources. For this material, different sources of information (which may be primary sources, publicly available information and relevant information available internally) may have been relied upon
- The ownership of this report lies with STPI and this report can be referred to by the readers on the internet but should be referenced to STPI if reused or adapted in any form, medium and on any forum.
- The frameworks, approaches, tools, analysis and opinions are solely Praxis’s intellectual property and are a combination of collection of best data it could find publicly, and Praxis team’s own experiences and observations.

About STPI

Software Technology Parks of India (STPI) is a premier S&T organization under Ministry of Electronics and Information Technology (MeitY) engaged in promoting IT/ITES Industry, innovation, R&D, start-ups, product/IP creation in the field of emerging technologies like IoT, Blockchain, Artificial Intelligence (AI), Machine Learning (ML), Computer Vision, Robotics, Robotics Process Automation (RPA), Augmented & Virtual Reality, Animation & Visual effect, Data Science & Analytics for various domains like Gaming, FinTech, Agritech, MedTech, Autonomous Connected Electric & Shared(ACES) Mobility, ESDM, Cyber Security, Industry 4.0, Drone, Efficiency Augmentation, etc.

Since its inception in 1991, STPI has been working towards equitable and inclusive IT-led growth pan-India which in turn has helped promoting Software exports, Science, Technology & Innovation (STI) and Software product development. With 11 jurisdictional directorates and 62 centres, STPI has expanded its presence pan-India to support IT/ITeS Industry. Working closely with all stakeholders, STPI has played a key role in transforming the country as the preferred IT destination.

About AIC STPINEXT INITIATIVES

AIC STPINEXT INITIATIVES, a Special Purpose Vehicle set up by STPI, is aligned with STPI's vision to promote and grow the culture of innovation leading to successful startups & entrepreneurs. AIC STPINEXT INITIATIVES acts as the nodal agency and common implementation vehicle for various startup and entrepreneurship activities at STPI.

To download the report, scan the below QR code

*'**STPI KnowledgeUp Series**' aims at building up awareness, knowledge and information stack to all relevant stakeholders of the Technology Ecosystem. The reports in the series are being published with focus on a sector, domain, technology, adoption, government policy and initiatives etc. Each report captures trends & its analysis, current status, growth enablers & inhibitors, gaps & opportunities etc. Thus, it aims to be a pragmatic report for start-ups, corporates, policy-makers, state/central government departments, funding agencies/investors, academia, research institutes and other ecosystem players.*

Knowledge Partner

PRAXIS
GLOBAL ALLIANCE