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DISPARITY TO PARITY

Advancing Quality, Affordability, and Accessibility in Tier 2 & 3+ India through Technology

White Paper

OCTOBER, 2024

Foreword

Deepak Sood
Secretary General,
ASSOCHAM

The Indian diagnostics industry has started gravitating towards the centerstage in healthcare delivery system for preventive & prescriptive applications and implications. It has also been witnessing a constant flux of competitive technological supremacy be it conventional and time-tested clinical pathology or high-tech-centric AI or genomics. An inevitable tectonic paradigm shift will certainly impact the futuristic diagnostics and vision by CY30. Its sustainability and growth are quite promising and assuring due to the country's growing healthcare sector, driven by attractive margins and incremental growth potential. With a market size of approximately US$ 15B in FY24, the industry is expected to grow at a CAGR of 14% over the next five years. Key drivers of this growth include changing demographics, increasing urbanization, improving test penetration, favorable government policies, and rising health awareness.

However, the industry is characterized by high fragmentation, with over 132K labs, mostly concentrated in tier 1 and 2 cities. This highly fragmented sub-sector encounters multiple existing and potential challenges in terms of infrastructure, skilled human resources, and patient awareness or preventive health literacy in tier 2+ cities. Nevertheless, it also offers significant opportunities for technology-driven solutions to address these challenges and enhance the quality, affordability, availability, and accessibility of gamut of laboratory and other diagnostic services.

The white paper assumes significance because of the ever-mounting disease burden and looming threat of epidemics, pandemics, health security, and demographic dividend imperatives. The good thing is that the healthcare industry stakeholders are gearing up and driving the last mile transformation while navigating the complexities of modern medicine and emerging 'threatening health challenges'. This comprehensive paper also delves into the vital role of enhancing diagnostics outreach, exploring the transformative impact of genomics on the industry. It provides insightful and thought-provoking diagnostic market statistics for CY28-30 while recommending and implying the need for an in-depth study of consumer behavior and attitude toward preventive healthcare. Furthermore, the paper examines the future of wellness centers in tier 2 and 3 cities and last-mile connectivity, highlighting opportunities for growth and innovation.

Through this white paper, we aim to catalyze outcome-centric deliberations, foster collaborations, and drive progress in the diagnostics sector. We hope that the insights and perspectives shared here will inspire stakeholders to collaborate towards a healthier future for all.

Foreword

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The Indian diagnostics industry has emerged as a preferred play in India's growing healthcare sector, driven by attractive margins and huge headroom for growth. The domestic diagnostics industry in FY24 is ~US$ 15B and is expected to grow at a CAGR of ~14% over the next five years. This growth will be primarily driven by changing demographics, increasing urbanization, improving test penetration, favorable government policies, and rising health awareness.

The diagnostics industry is characterized by a high degree of fragmentation with over ~132K labs of which ~65% is concentrated in tier 1 and 2 cities. Of the US$ 15B market, tier 1 and 2 cities account for more than 50% market share. The fragmentation of laboratories in tier 2+ cities presents challenges in terms of infrastructure, talent, and patient awareness. However, this fragmentation also offers significant opportunities for technology-driven solutions to address these challenges and improve the quality and accessibility of laboratory services.

This white paper analyzes the current state of the diagnostics market and how the key technological trends can bridge the gap in tier 2+ cities. These include a) AI and big data analytics in diagnostics b) Smart laboratories, c) Specialized testing technologies d) Genetic testing and bioinformatics e) PoC and rapid diagnostics, f) Telemedicine services, g) Smart wearables and mHealth, h) Mobile diagnostics

This white paper aims to assess and quantify the influence of these technological trends on the tier 2+ diagnostics market in the foreseeable future.

We, at Praxis Global Alliance, hope you will find the white paper informative and look forward to continuing the discussion. We hope that this paper will give you an insight into the underlying success factors to ride this wave of growth in the Indian diagnostics industry.

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Glossary of terms

	Acronym	Description
Industry related	ABPMJAY	Ayushman Bharat Pradhan Mantri Jan Arogya Yojana
	AI	Artificial Intelligence
	AKI	Acute Kidney Injury
	ASP	ASP
	B&I	Biochemistry & Immunoassay
	CAPEX	Capital Expenditure
	CGHS	Central Government Health Scheme
	CHC	Community Health Center
	CT scan	Computed Tomography scan
	DH	District Hospital
	EHR	Electronic Health Record
	EMR	Electronic Medical Record
	GDP	Gross Domestic Product
	GH	Government Hospital
	GHE	Government Healthcare Expenditure
	GL	Government Lab
	HAQ	Healthcare Access and Quality
	HbA1c	Haemoglobin A1c
	HMIS	Health Management Information System
	HWC	Health and Wellness Centers
	IoT	Internet of Things
	IPD	Inpatient Department
	LPH	Large Private Hospital (>300 beds)
	M&A	Mergers And Acquisitions
	MI	Medical Institutions
	MoHFW	Ministry of Health and Family Welfare
	MPH	Medium Private Hospital (100–300 beds)
	MRI	Magnetic Resonance Imaging
	NABL	National Accreditation Board for Testing and Calibration Laboratories
	NCD	Non-communicable Diseases
	NCL	National Chain Lab

Glossary of terms

	Acronym	Description
Industry related	NH	Nursing Home
	NHM	National Health Mission
	OPD	Outpatient Department
	PHC	Primary Healthcare Center
	PoC	Point of Care
	PPP	Purchasing Power Parity
	PPP	Public-Private Partnership
	QC	Quality Control
	RCL	Regional Chain Lab
	SAHI	Standalone Health Insurance
	SAL	Standalone Labs
	Sample	1 sample can be used to perform multiple tests
	SDH	Sub-District Hospital
	SPH	Small Private Hospital (<100 beds)
	TA	Therapeutic Area
	TCCC	Tertiary Cancer Care Centers
	Tier 1	All urban cities with more than 4M population
	Tier 2	All urban cities with 1-4M population
	Tier 3+	All urban cities with less than 1M population
	IVD	In-vitro Diagnostics
	WHO	World Health Organization
Units	CAGR	Compounded Annual Growth Rate
	CY	Calendar Year (From 1st January to 31st December)
	FY	Fiscal Year (From 1st April to 31st March)
	INR	Indian Rupee
	K	Thousand
	M	Million
	B	Billion
	US$	United States Dollar
	Kg	Kilograms

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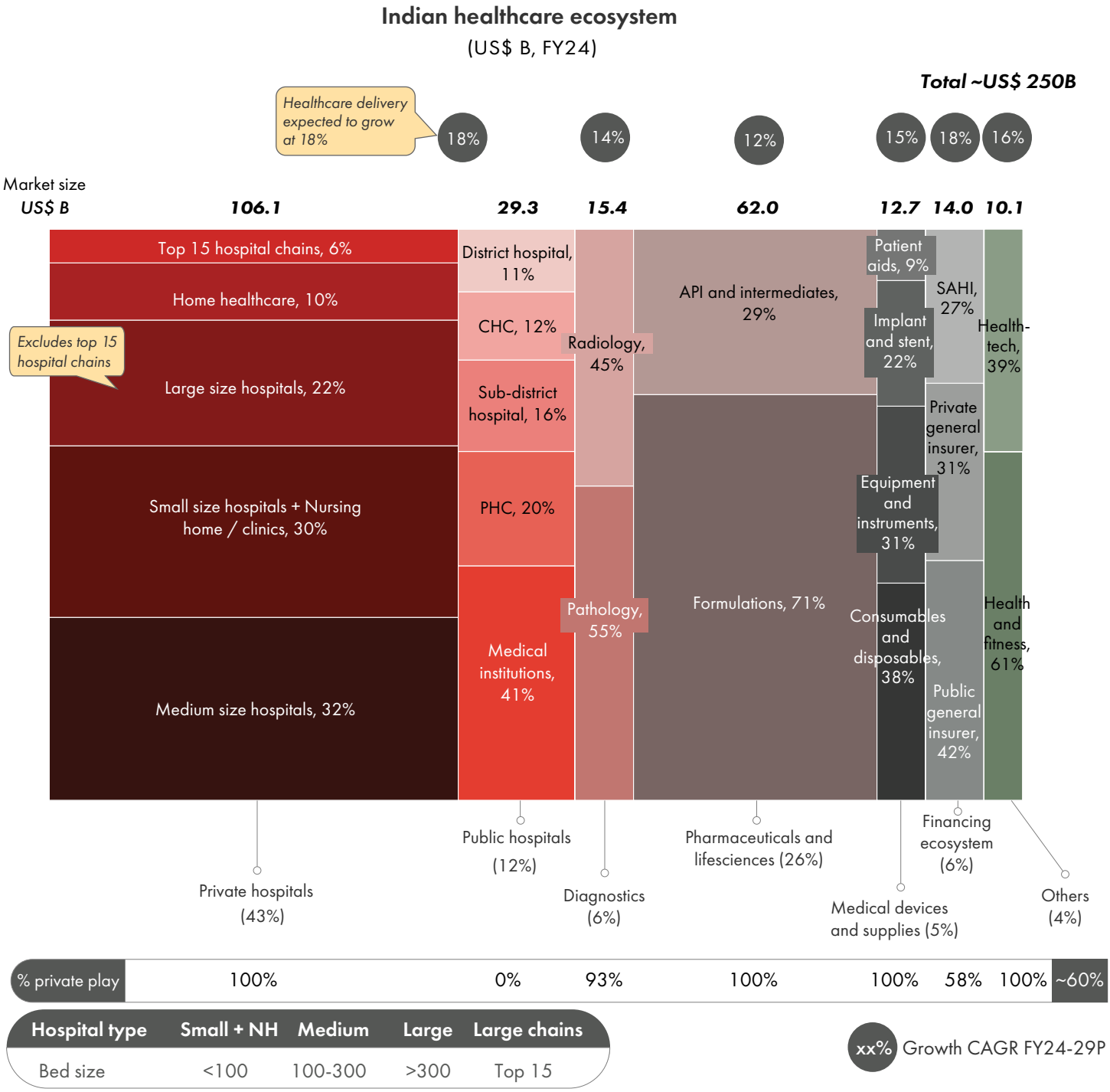
INDIAN HEALTHCARE ECOSYSTEM

1.0 INDIAN HEALTHCARE ECOSYSTEM

The Indian healthcare ecosystem is on the brink of a significant transformation, driven by rapid growth and innovation. As a US$ 250B market in FY24, it encompasses a diverse range of healthcare services, including healthcare delivery, diagnostics, medical devices, pharmaceuticals, financing, and health-tech. The sector is evolving with increasing investments in digital health, telemedicine, and personalized care, aiming to meet the rising demand for accessible and high-quality healthcare across the country. This dynamic landscape is poised to reshape the health-care ecosystem, making it more efficient, affordable, and patient-centric.

Exhibit 1.1

Indian healthcare ecosystem



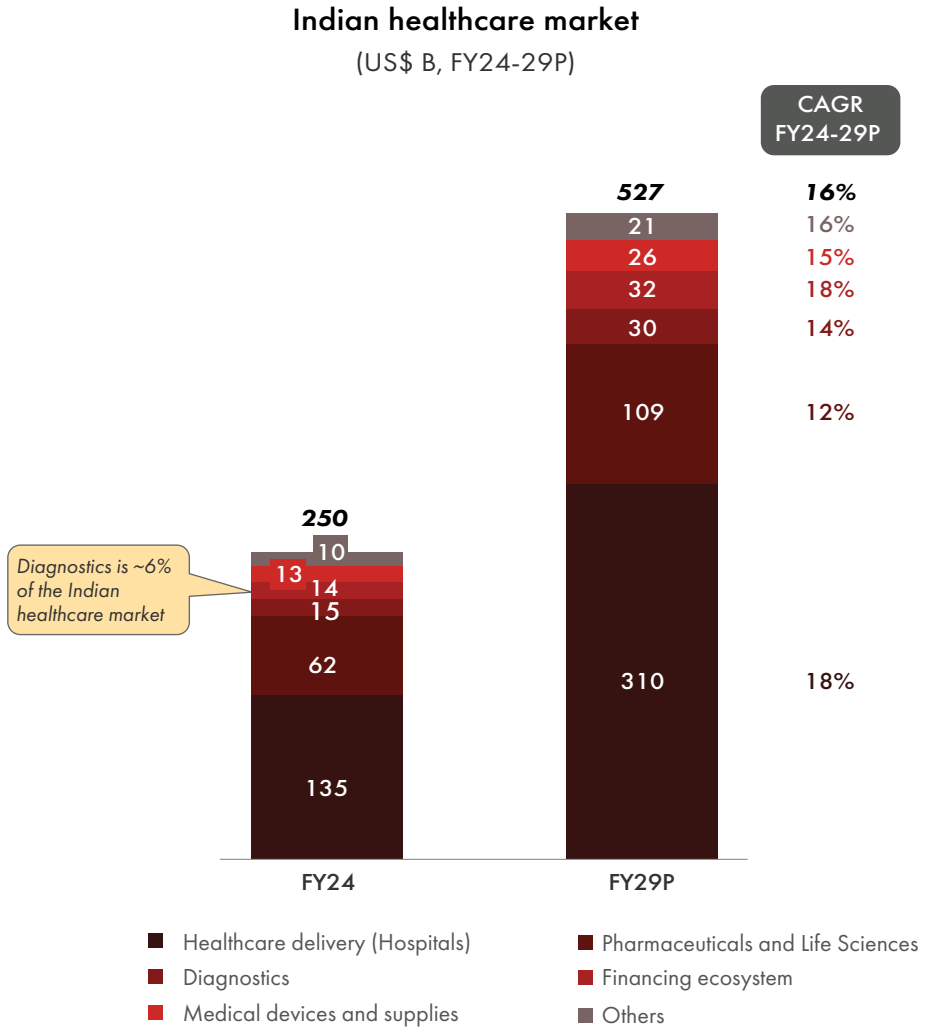
Note(s): SAHI focus solely on health insurance products – Aditya Birla Health Insurance, Care Health Insurance, ManipalCigna Health Insurance, Niva Bupa Health Insurance, Star Health and Allied Insurance; The market for Health-tech includes telemedicine, personal health management products & services, remote diagnostic devices and healthcare IT; The market for Health & fitness includes both the fitness trackers and health & wellness coaching segments

1.1 Healthcare market dynamics and growth projections

Looking ahead, the ecosystem is projected to reach around US$ 527B by FY29, growing at a CAGR of 16%. Diagnostics, in particular, is expected to grow at a CAGR of 14%, reaching US$ 25B by FY29. This growth is fuelled by an increase in life expectancy, a growing middle class, and higher private insurance penetration.

Exhibit 1.1.1

India healthcare market dynamics and growth projections



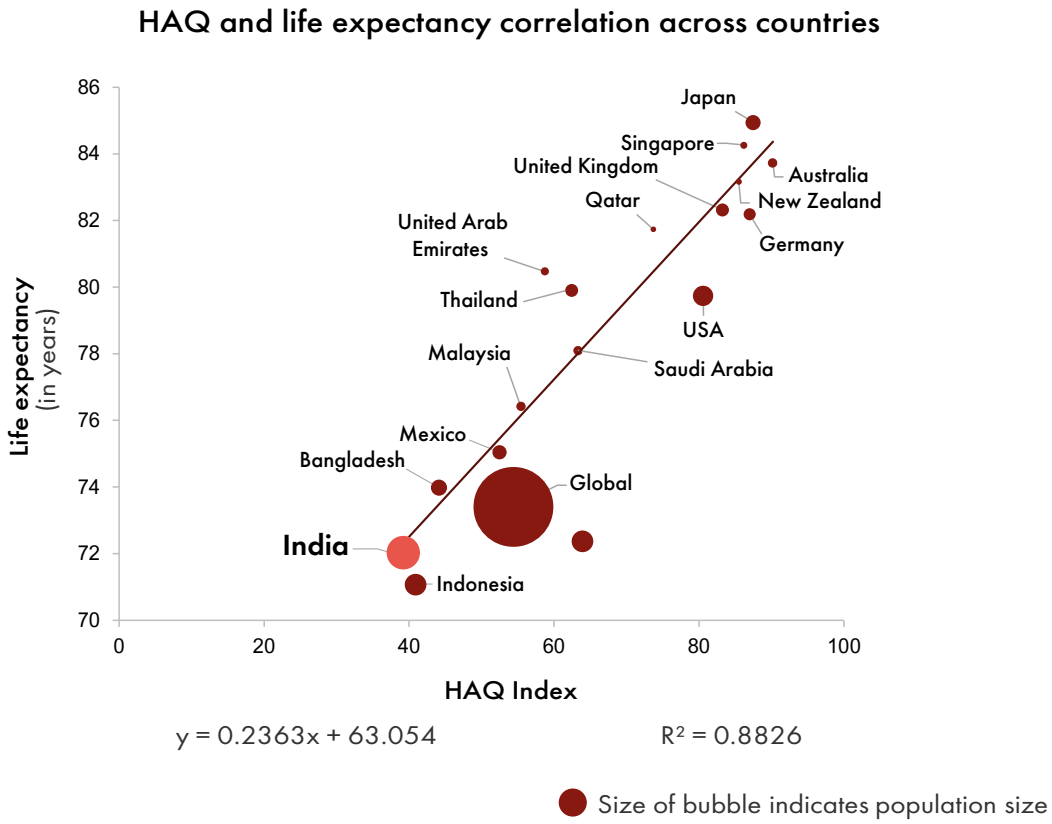
Note(s): Others include health & fitness and health-tech

1.2 Healthcare access and quality comparison

India's healthcare system faces significant challenges, as evidenced by its low ranking in the Healthcare Access and Quality (HAQ) index. This index measures the extent to which people are healthy and have access to services necessary to maintain good health including health outcomes, health systems, illness, risk factors, and mortality rates. There is a direct correlation between a country's HAQ index and its average life expectancy, with nations like Japan and Australia leading the rankings.

Exhibit 1.2

HAQ and life expectancy correlation across countries

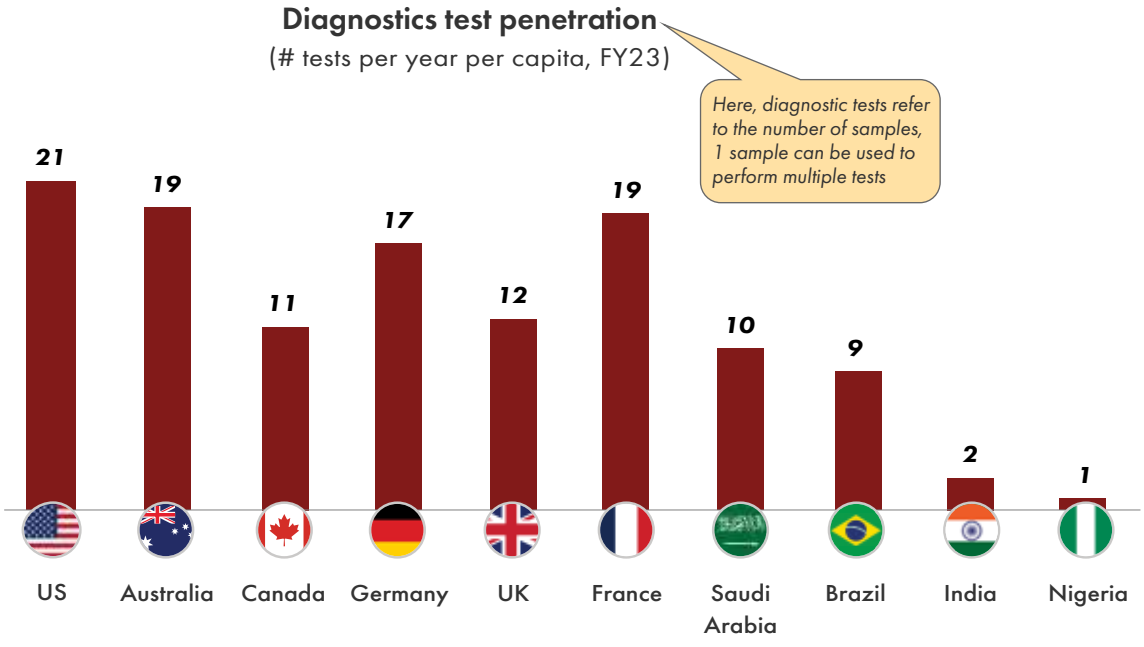


1.3 Diagnostics test penetration and comparison

India's diagnostics infrastructure is significantly underdeveloped, with only 2 tests per million people. This low penetration rate highlights a substantial growth opportunity and underscores the need to expand diagnostic services, particularly in underserved areas, to improve early disease detection and overall health outcomes.

Exhibit 1.1.1

Diagnostics test penetration



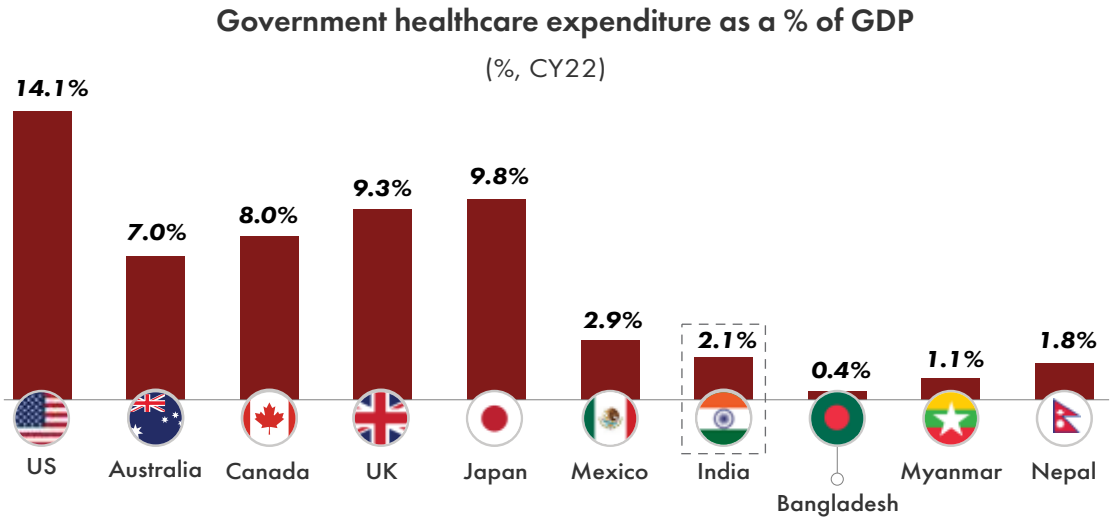
1.4 Government Healthcare Expenditure (GHE)

GHE in India is currently underpenetrated but is expected to grow rapidly in the future, driven by increasing demand for services and the need to improve healthcare accessibility and quality across the country.

India's GHE is low, at just 2.1% of GDP in CY22, significantly below that of other countries. However, it is on an upward trajectory, with expectations to reach around 3.2% of GDP by FY33.

Exhibit 1.4

GHE as a % of GDP



Note(s): Data on government healthcare expenditure as a % of GDP of Bangladesh and Myanmar are of FY21 and that of India is for FY23, Government health spent as percentage of GDP is without PPP conversion; GPD per capita, PPP is for calendar year

02

DIAGNOSTICS SECTOR IN INDIA

2.0 DIAGNOSTICS SECTOR IN INDIA

The diagnostics sector plays a crucial role in healthcare by providing tools and services to identify, monitor, and manage various medical conditions. The diagnostics sector is a dynamic and essential component of modern healthcare, playing a pivotal role in disease prevention, early detection, and effective management. The Indian diagnostics market is ~US$ 15B, as of FY24.

The diagnostics sector can be broadly divided into two main segments: pathology and radiology. Each segment focuses on different aspects of diagnostic testing and plays a crucial role in identifying and diagnosing various medical conditions.

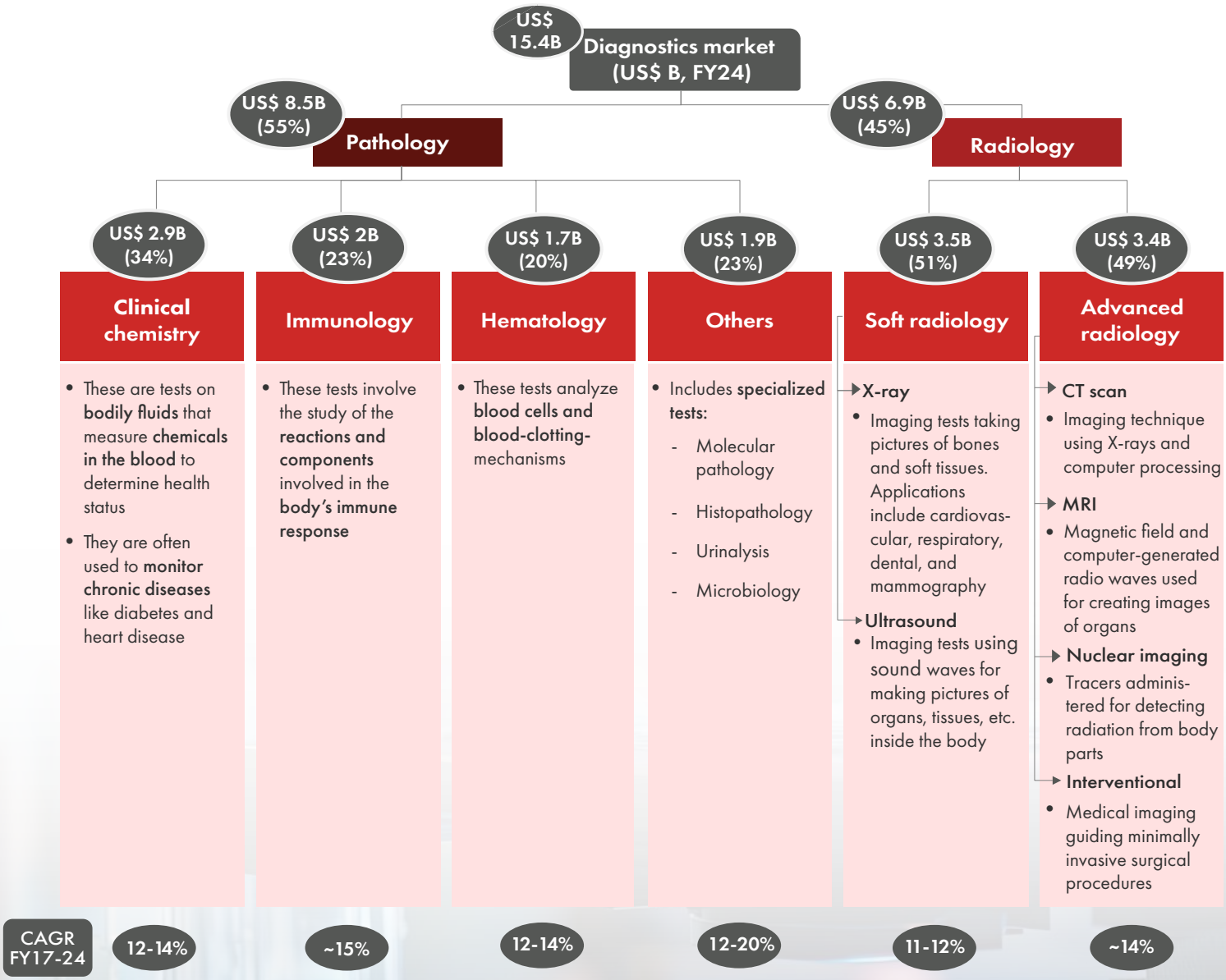
2.1 Pathology and radiology opportunity in India

Pathology, a cornerstone of the diagnostics industry, involves the examination of tissues, cells, and body fluids to diagnose diseases. With a market value of US$ 8.5B, it constitutes 55% of the diagnostics market. Clinical chemistry, as depicted in Exhibit 2.1.1, holds the largest market share within pathology. Other essential tests include hematology, immunoassay, molecular pathology, histopathology, urinalysis, and surgical pathology.

Radiology, another critical component of diagnostics, employs medical imaging techniques to diagnose and treat diseases and injuries. Radiology encompasses various imaging modalities that enable healthcare professionals to visualize internal body structures. Valued at US$ 6.9B, radiology accounts for 45% of the diagnostics market. The radiology market can be categorized into soft radiology (X-ray and ultrasound) and advanced radiology (CT scan, MRI, nuclear imaging, and interventional radiology).

Exhibit 2.1.1

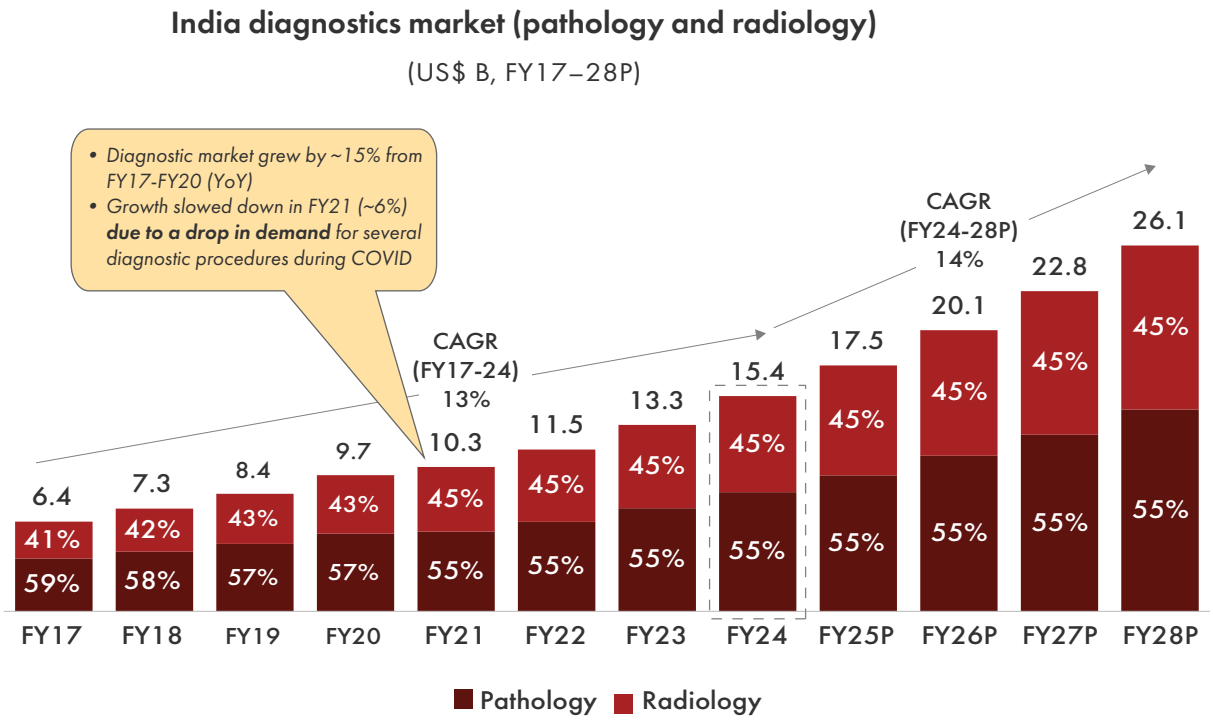
Diagnostics opportunity in India



Within this market, the ASP in pathology is projected to remain constant at US$ 3.7 across the period of FY24-28, with a marginal drop in FY27. Concurrently, the number of tests per capita in pathology is expected to grow from 1.6 to 2.6. Similarly, radiology is anticipated to experience an increase in ASP from US$ 11.3 in FY24 to US$ 12.7 by FY28 with the number of scans per capita in radiology expected to grow from 0.37 to 0.54. These projections reflect the ongoing growth in the diagnostics market, driven by factors such as increasing awareness of preventive healthcare and technological advancements.

Exhibit 2.1.2

Diagnostics opportunity in India from FY17-28 by segment



%YoY growth rate		15%	15%	16%	6%	12%	15%	15%	14%	14%	14%	14%
Pathology	# samples per capita	0.77	0.87	0.98	1.11	1.26	1.42	1.60	1.81	2.05	2.31	2.61
	ASP (US$)	4.1	4.0	4.0	3.6	3.6	3.6	3.7	3.7	3.7	3.6	3.7
Radiology	# scans per capita	0.19	0.21	0.24	0.27	0.30	0.33	0.37	0.41	0.45	0.49	0.54
	ASP (US$)	10.0	10.4	10.9	11.3	11.1	11.0	11.3	11.6	12.0	12.3	12.7

Low — High

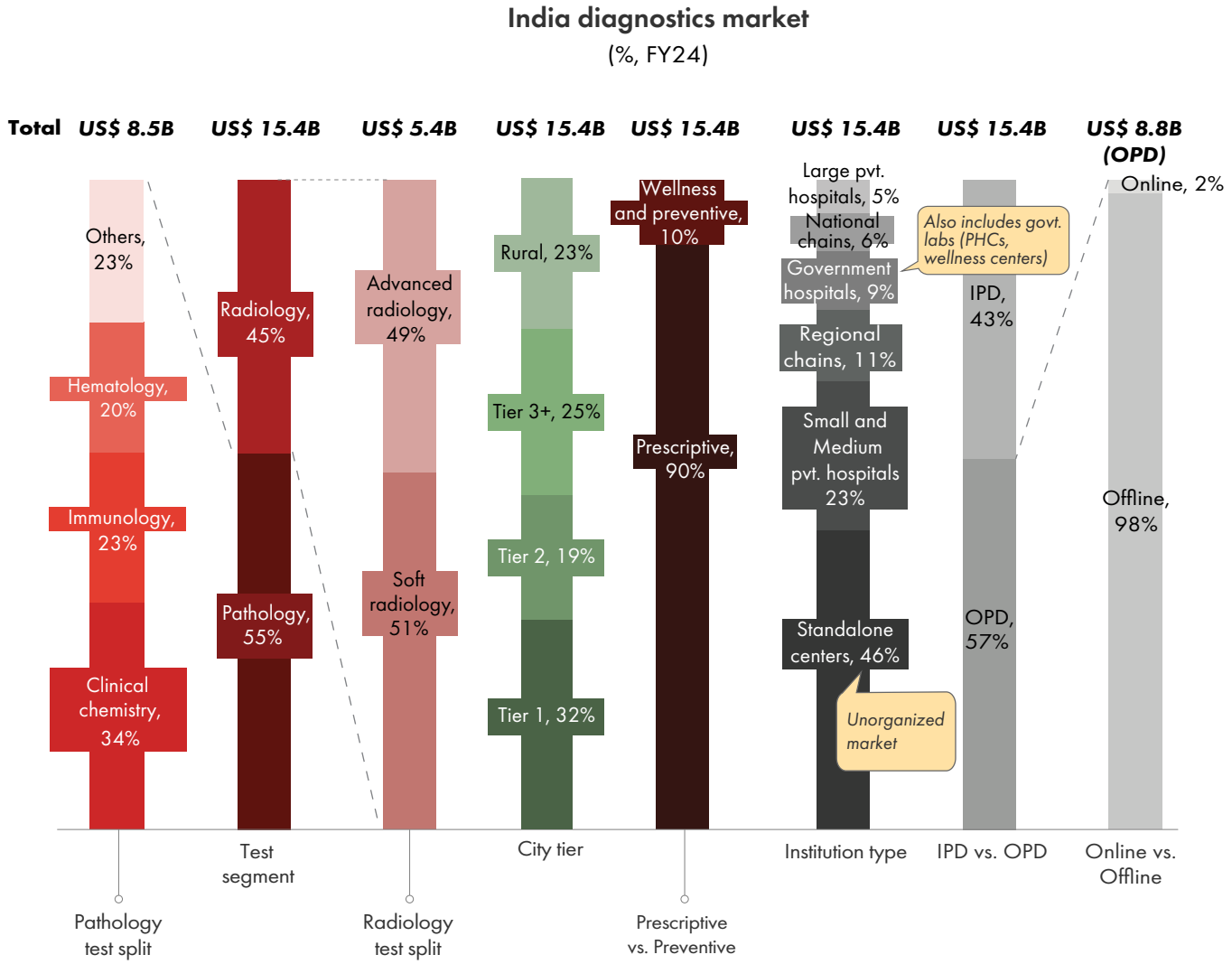
2.2 Diagnostics market segmentation

The Indian diagnostics market is highly fragmented, with a diverse range of players including standalone centers, regional chains, national chains, and hospital-based labs. While the market is primarily dominated by prescriptive diagnostic services, there is an increasing demand for preventive and wellness solutions.

Despite the growing popularity of online diagnostics, the majority of services are still delivered offline. OPD diagnostics remain the primary focus, although IPD diagnostics also play a significant role. This segmentation, combined with the fragmented market structure, presents opportunities and challenges for players in the Indian diagnostics industry.

Exhibit 2.2

Diagnostics market in India by test segment, city tier, institution type, patient mix, and channel mix



Note(s): Private and Government labs' split is estimated at 75:25, and for market estimation price of tests are assumed at market prices instead of subsidized rates

The fragmentation of diagnostic labs in India stems from several systemic and operational challenges, leading to a fragmented market with many small standalone facilities.

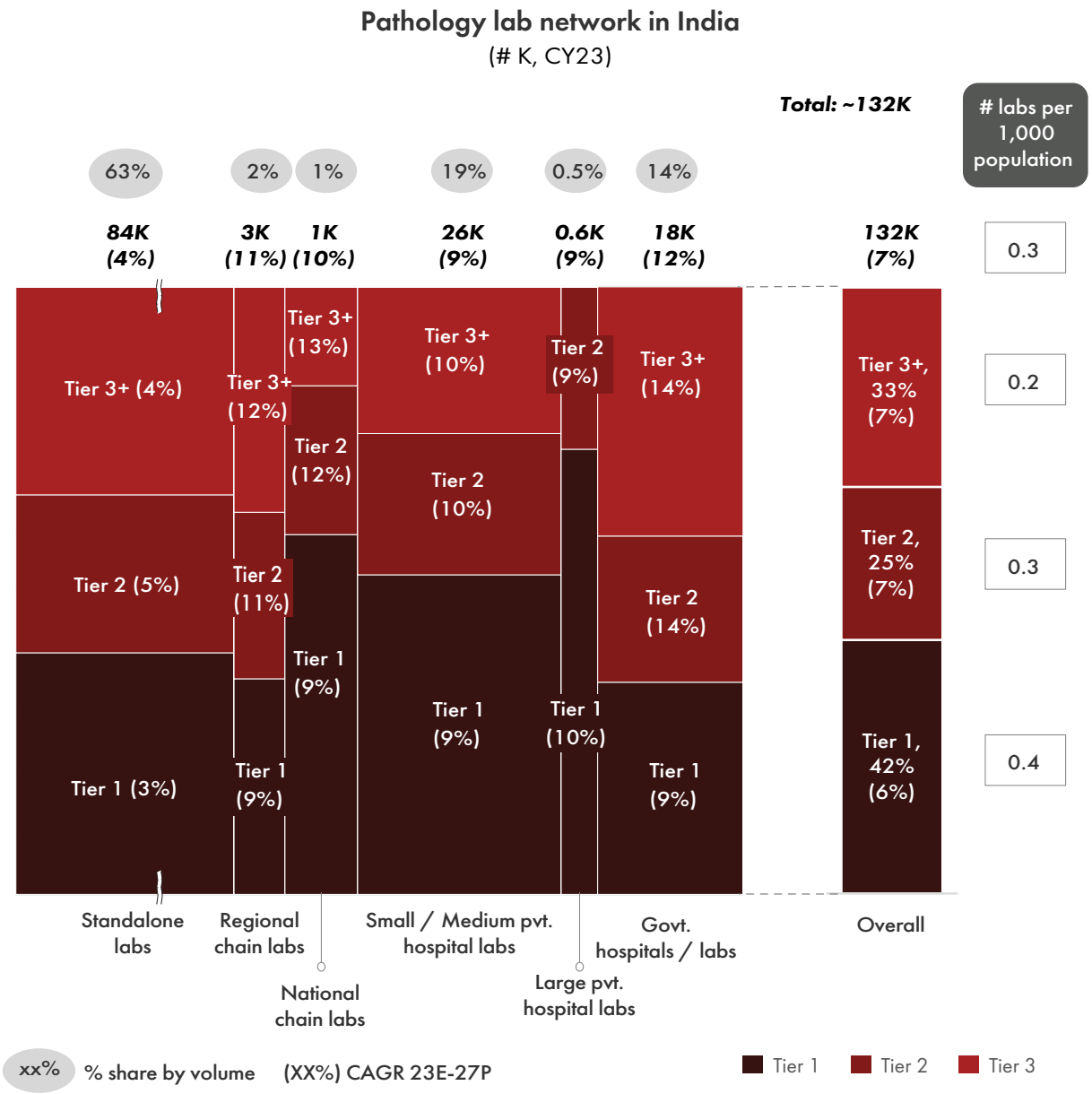
- **High entry barriers:** Expensive technology and regulatory compliance prevent many labs from scaling
- **Lack of standardization:** Inconsistent quality standards and varied testing protocols across labs contribute to fragmentation
- **Geographical dispersion:** A vast and diverse geography results in numerous localized diagnostic centers
- **Limited access to capital:** Small labs struggle to invest in advanced equipment and expansion
- **Local trust:** Patients often prefer familiar and local labs over larger chains
- **Regulatory challenges:** Complex state-specific regulations hinder standardization and consolidation
- **Fragmented healthcare ecosystem:** Poor integration with hospitals and clinics reinforces a fragmented market

2.2.1 Distribution of pathology and radiology labs across city tiers

Tier 1 and 2 cities account for over 65% of India's pathology and radiology network, revealing a significant concentration of diagnostic facilities in urban areas. This distribution underscores the disparity in access to diagnostic services, with these cities having much higher lab densities than others. To address this imbalance, the government is working to expand pathology and radiology centers in tier 3+ and rural areas, aiming to improve healthcare accessibility and affordability across the country. Most labs are standalone facilities, followed by those in small to medium private hospitals, while national chain labs and large private hospital labs hold the smallest shares.

Exhibit 2.2.1

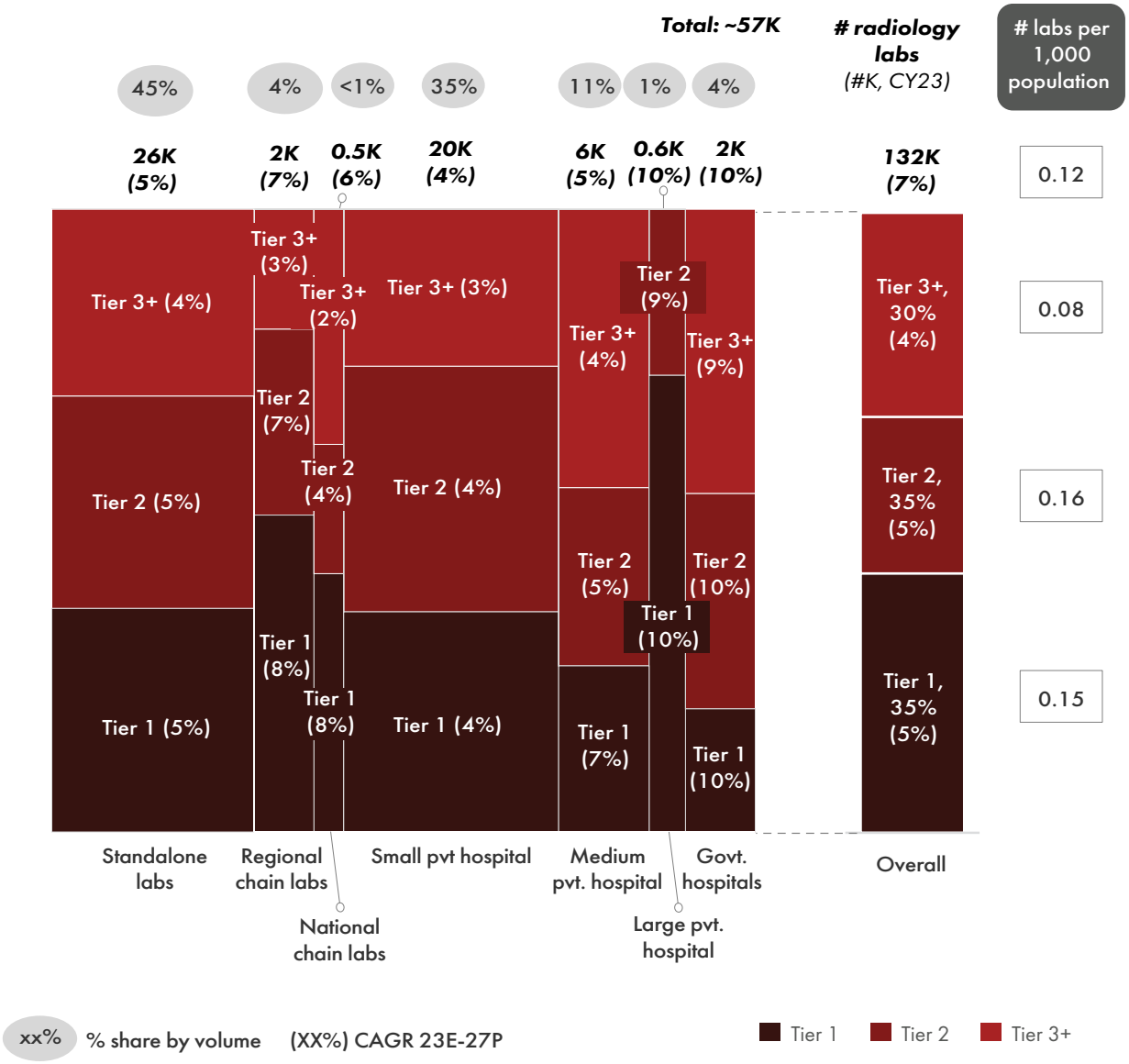
Distribution of pathology and radiology labs across city tiers



Notes(s): Government Hospitals include PPP

Radiology lab network in India

(#K, CY23)



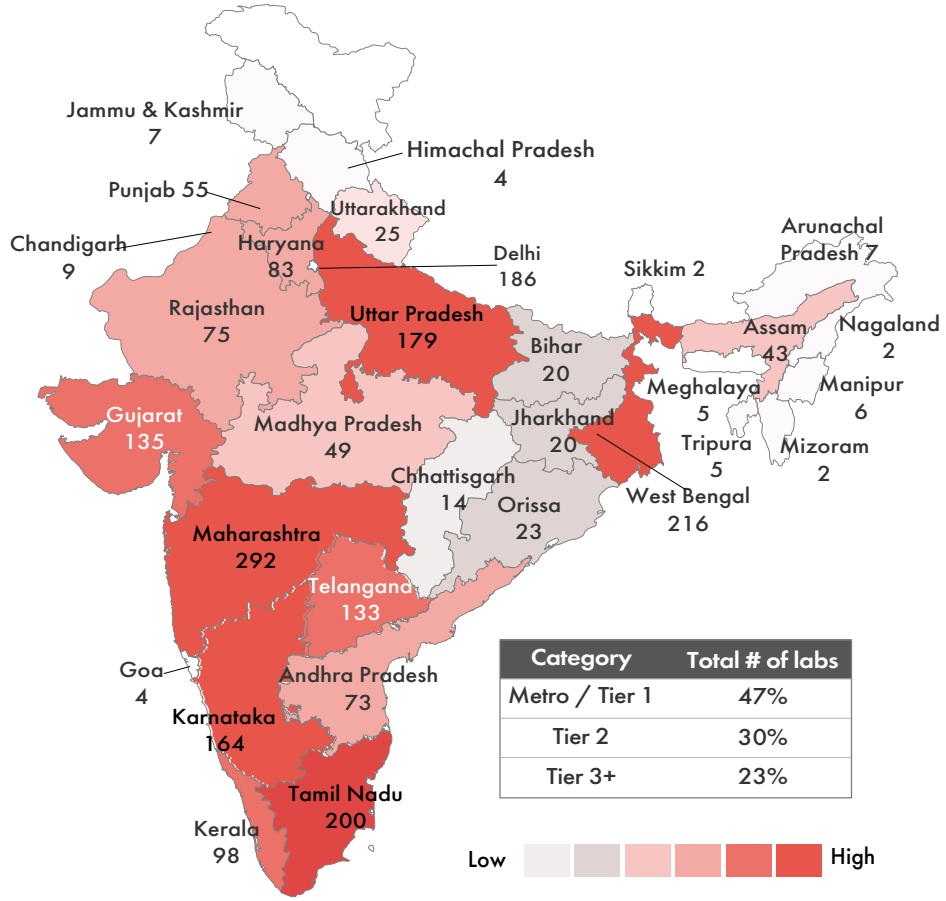
Notes(s): Government Hospitals include PPP

In India, only 1% of laboratories are NABL certified which raises concerns about the quality and reliability of diagnostic services. NABL certification ensures that a laboratory adheres to government of India accepted standards for quality and competence, which is crucial for accurate diagnostics and effective treatments.

Without such accreditation, there is a higher risk of inaccurate test results, which can lead to misdiagnosis and inappropriate treatment, ultimately affecting patient outcomes. Strengthening the accreditation process and encouraging more labs to seek NABL certification can improve the overall quality of healthcare services in India.

Exhibit 2.2

NABL accredited labs footprint across India



Category	Total # of labs
Metro / Tier 1	47%
Tier 2	30%
Tier 3+	23%

The establishment of quality diagnostic laboratories is essential in addressing the growing healthcare needs of India, particularly with the rising burden of non-communicable diseases (NCDs) and the increasing demand for accurate public health data. With NCDs on the rise, accurate and timely diagnostics are crucial for effective disease management, while public health emergencies, such as infectious outbreaks, require reliable diagnostic data to manage and control their spread. Furthermore, as patients become more informed, they expect higher standards of diagnostic services. However, the path to building quality labs is fraught with challenges, including high costs, limited access to skilled personnel, and infrastructural constraints, especially in underserved regions. These hurdles make it difficult to ensure consistent and accurate diagnostic services across the country.

Exhibit 2.2.3

Need for quality labs in tier 2+ cities and challenges associated with developing them

Need assessment	
Increasing burden of NCDs	The **growing prevalence of NCDs** necessitates accurate and timely diagnostics for **effective disease management**
Public health management	Managing public health issues like **infectious disease outbreaks (e.g., COVID-19, etc)** requires **reliable diagnostic data** collected over large span of time
Rising patient expectations	With **increasing health awareness,** patients are demanding more **accurate and comprehensive diagnostic services,** making more informed decisions

Challenges	
High costs and limited resources	Ensuring the **availability of resources** such as **skilled personnel** and advanced equipment is challenging, especially in remote or underserved areas
Regulatory and bureaucratic hurdles	The process of **obtaining and renewing NABL accreditation** can be **complex and time-consuming,** deterring labs from pursuing certification
Infrastructure and logistical challenges	Logistics, such as the **transport of samples** and **timely delivery of results,** can be problematic, particularly in **regions with poor infrastructure**

2.2.2 Distribution of pathology and radiology equipment across city tiers

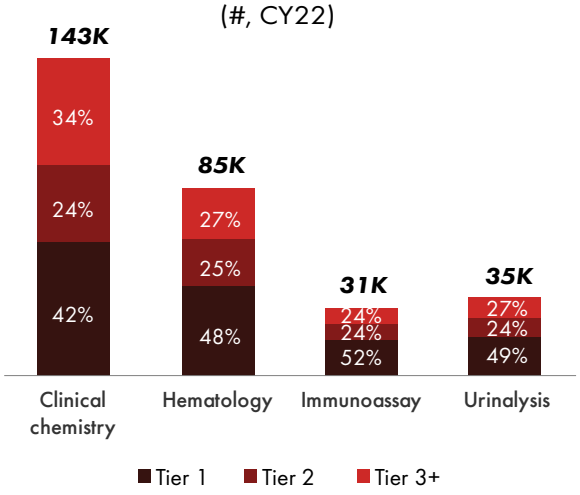
Tier 1 cities dominate the pathology equipment market, holding a 46% share, driven by their larger populations and higher healthcare spending. Clinical chemistry equipment is most prevalent in tier 1 cities, with 0.46 units per 1,000 people, more than double the 0.20 units per 1,000 seen in tier 3+ cities. This highlights the significant disparities in healthcare infrastructure and resource availability across city tiers. Additionally, radiology equipment penetration is lower in tier 3 cities compared to tier 1 and 2, with X-ray imaging equipment more prevalent in tier 1 at 0.22 units per 1,000 people versus 0.21 units in tier 3+ cities, underscoring the challenges of providing comprehensive radiological services in rural areas. A snapshot of these penetration levels is depicted in the exhibit below.

Exhibit 2.2.4

Distribution of installed base of pathology and radiology medical equipment across city tiers

Distribution of installed base of pathology medical equipment across city tiers

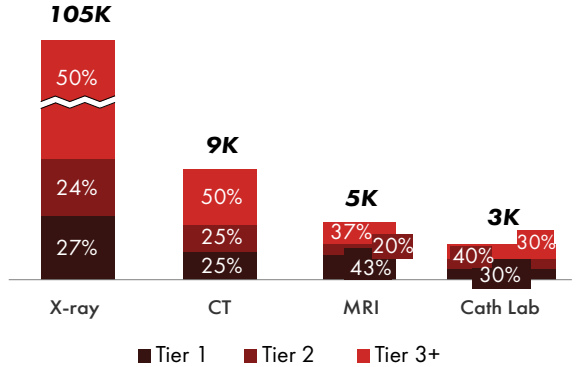
(#, CY22)



Penetration per '000 population	**Overall urban**	0.29	0.17	0.06	0.07
	Tier 1	0.46	0.31	0.12	0.13
	Tier 2	0.31	0.19	0.07	0.08
	Tier 3+	0.20	0.09	0.03	0.04

Distribution of installed base of radiology medical equipment across city tiers

(#, CY23)



Penetration per '000 population	**Overall urban**	0.22	0.02	0.01	0.01
	Tier 1	0.22	0.02	0.02	0.01
	Tier 2	0.23	0.02	0.01	0.01
	Tier 3+	0.21	0.02	0.01	0.005

Note(s): In radiology, data for CY23 is as of Oct'23

The rollout of advanced diagnostics technology in underserved areas faces multiple challenges that limit access to quality healthcare. From logistical and supply chain issues to funding constraints and infrastructure gaps, these barriers hinder the effective deployment and use of diagnostic tools in rural and remote locations.

- **Logistics challenges:** Transportation infrastructure limitations in rural areas make it difficult to install and maintain equipment, while a shortage of specialized technicians further complicates operations in remote locations
- **Supply chain issues:** Higher shipping and delivery costs to remote areas, delays in obtaining equipment and parts, and complexities in inventory management for specialized equipment create significant supply chain challenges
- **Funding limitations:** Lower patient volumes in rural areas reduce the return on investment, while limited access to capital and competing priorities strain healthcare budgets
- **Workforce shortages:** A lack of radiologists and specialized technicians in rural areas limits the ability to provide advanced diagnostic services
- **Infrastructure issues:** Unreliable power supply and poor connectivity hinder the effective use of advanced diagnostic equipment
- **Regulatory challenges:** Complex regulatory and licensing requirements create additional hurdles for rural healthcare facilities

2.3 Emerging themes

The healthcare and diagnostics landscape is rapidly evolving, driven by trends in patient behavior, clinical needs, competition, business models, and technology. Patients now prefer convenient, reliable services, with a growing focus on preventive care and self-testing. Clinically, personalized medicine, specialized tests, and earlier cancer detection are gaining importance. Increased competition from allied industries and public investment is reshaping the market, while asset-light business models and remote diagnostics expand access. Technological advancements are enhancing customer experience and operational efficiency. These themes highlight the ongoing transformation in diagnostics.

Growth driver	Brief description
Digital transformation	• **Integration of AI, machine learning, and big data analytics** in diagnostic processes for more accurate and faster diagnoses • Increased usage of modern technologies such as **advanced imaging techniques,** wearable devices, and **digital pathology platforms**
Supply chain optimization	• Streamlining diagnostic processes through **automation, robotics, and improved logistics** • **Focused on reducing turnaround times, minimizing errors,** and optimizing resource allocation in diagnostic labs
New clinical developments	• **Addressing newly identified diseases,** evolving pathogens, and complex health conditions • **Development of novel diagnostic tests for rare diseases,** and rapid tests for emerging infectious diseases
Tier 2/3+ market growth	• Expansion of diagnostic services to smaller cities and rural areas • **Development of portable, cost-effective diagnostic solutions,** and telemedicine platforms to **reach underserved populations**
Industry consolidation	• M&A among diagnostic companies to expand **service offerings, geographical reach, and technological capabilities** • **Reshaping the competitive landscape** of the medical diagnostics industry
Innovative business models	• Business models are introduced with an **aim to improve accessibility and affordability of diagnostic services** • A**pproaches include D2C testing, subscription-based diagnostic services,** and partnerships between diagnostic and healthcare providers
Economies of scale	• **Large-scale diagnostic operations** leveraging advanced technologies and **automated systems to reduce costs and improve efficiency** • Leading **growth of centralized diagnostic laboratories** serving multiple healthcare facilities
Patient-centric services	• Shift towards **patient-focused diagnostic services,** including **home-based testing, non-invasive sampling methods,** and rapid result delivery • Focused on **encouraging proactive health management** and improving overall patient experience
Regulatory changes	• Changes in policies, **reimbursement models, and regulatory frameworks** improving the development and adoption of diagnostic technologies • **Standardized diagnostic practices** and ensure quality control across the industry

03

SMART TECHNOLOGIES BRIDGING THE DISPARITY GAP

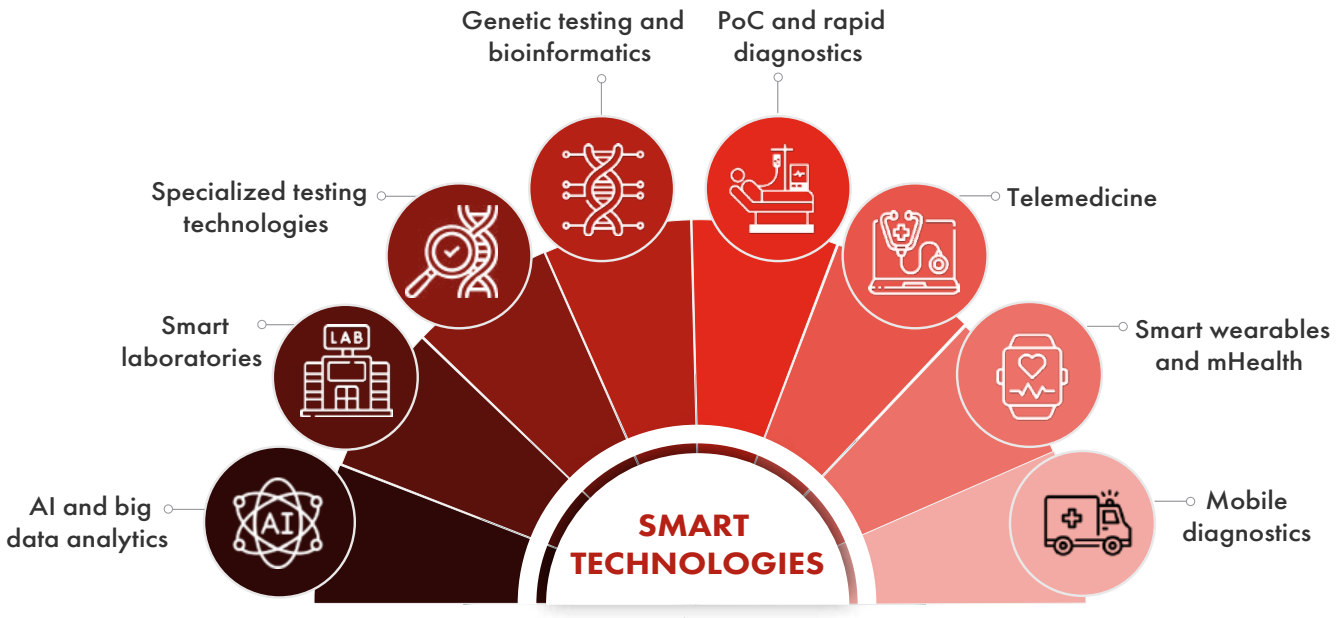
3.0 SMART TECHNOLOGIES BRIDGING THE DISPARITY GAP

The diagnostics industry is undergoing a major transformation, with emerging technologies set to redefine its future. In tier 2+ cities, these innovations will bridge the healthcare gap, offering accessible, accurate, and timely diagnostics. As these technologies take hold, they will elevate the standard of care and democratize healthcare, reaching even the most underserved communities.

1. **AI and big data analytics in diagnostics:** AI and big data analytics are revolutionizing medical diagnostics. These technologies enhance accuracy, efficiency, and personalization in disease detection and prediction. By enabling more precise care and earlier interventions, they are transforming healthcare delivery and improving patient outcomes.
2. **Smart laboratories:** Smart labs leverage IoT for real-time, automated data collection and monitoring, ensuring precision in diagnostics. Blockchain secures data integrity and transparency, safeguarding patient information. Together, they streamline operations, enhance security, and improve diagnostic accuracy, driving better patient outcomes.
3. **Specialized testing technologies:** Advanced testing technologies like microfluidics PoC, liquid biopsy, and multiplex assays are revolutionizing healthcare by improving diagnostics, treatment, and patient outcomes while advancing personalized medicine.
4. **Genetic testing and bioinformatics:** Genetic testing analyzes DNA to identify genetic variations, while bioinformatics processes and interprets this data. Together, they enable accurate diagnosis, risk assessment, and personalized treatment based on a patient's genetic profile.
5. **PoC and rapid diagnostics:** PoC and rapid diagnostics are revolutionizing healthcare by providing immediate, patient-centric testing that leads to faster clinical decisions. Adopters will lead in delivering timely, life-saving interventions.
6. **Telemedicine services:** Telemedicine is expanding diagnostic access by breaking geographical barriers, offering inclusive, continuous care through virtual consultations, remote diagnostics, and patient monitoring.
7. **Smart wearables and mHealth:** Smart wearables and mHealth platforms are empowering individuals with convenient, precise health monitoring at home, offering accessible, user-friendly solutions that cater to preventive care and wellness.
8. **Mobile diagnostics:** Mobile diagnostics brings healthcare to remote areas with portable, on-the-go testing, reducing the need for clinic visits. Prioritizing mobile solutions will bridge healthcare gaps and reach underserved populations.

Exhibit 3.1

Diagnostics industry will ride on the new waves of technologies



3.1 Modern technology integration across the diagnostics value chain

The pathology sector is undergoing a significant digital transformation, leveraging cutting-edge technologies across its entire value chain. The following exhibit illustrates the integration of IoT, AI, big data analytics, smart wearables, mobile diagnostics, specialized testing technologies, genetic testing, bioinformatics, blockchain, and telemedicine throughout the pathology testing value chain. From sample acquisition to quality control, these innovations are enhancing efficiency, accuracy, and patient care. The adoption of these technologies promises to revolutionize traditional pathology processes, enabling real-time tracking, automated analysis, predictive insights, and secure data management, ultimately leading to more precise diagnostics and personalized treatment strategies.

Exhibit 3.1.1

Value addition of smart technologies across the pathology value chain

Sample acquisition	Preparation and processing	Analysis and interpretation	Reporting	Quality control
IoT Real-time sample tracking Automated alerts for sample collection points	**AI and big data analytics** Predictive sample preparation optimization Automated reagent and resource allocation	**AI and big data analytics** Pathology slide analysis for anomaly detection Predictive diagnostics from real-time data	**AI and big data analytics** Automated lab reports Predictive insights integrated reports	**AI and big data analytics** Real-time process monitoring Error detection in lab processes
Smart wearables and mHealth Continuous health data transmission to labs Automated sample requests	**Specialized testing technologies** High-precision sample preparation for complex tests	**Specialized testing technologies** Advanced molecular diagnostics	**Blockchain** Secured report sharing Transparent audit trails	**Blockchain** Secure audit trails for all QC processes Transparent tracking of equipment maintenance
Mobile diagnostics Mobile units for sample collection On-demand home sample collection	**Genetic testing and bioinformatics** Automated DNA/RNA extraction systems Bioinformatics platforms guiding sample preparation	**Genetic testing and bioinformatics** Identifying disease markers Personalized treatment-based genetic profiles Gene expression profiling	**Telemedicine** Instant sharing of lab results Virtual consultations to review and discuss reports Integration with patient's EHRs	**IoT** Continuous equipment performance monitoring Automated calibration reminders and adjustments Real-time alerts for deviations
PoC and rapid diagnostics On-site immediate testing Real time sampling	**IoT** Continuous monitoring Automated equipment adjustments			

The medical imaging sector is experiencing a technological paradigm shift. Advanced digital solutions including AI, blockchain, IoT and telemedicine are being integrated throughout the imaging workflow - from acquisition and analysis to reporting and quality control. These innovations promise to revolutionize traditional processes, enhancing diagnostic accuracy, operational efficiency, and data security. By enabling remote collaboration, automated analysis, and real-time monitoring, these technologies are poised to significantly improve both healthcare delivery and patient outcomes in the field of medical imaging.

Exhibit 3.1.2

Value addition of smart technologies across the radiology value chain

Image acquisition and pre-processing	Image analysis and interpretation	Reporting and interpretation	Quality control
AI and big data analytics To enhance image acquisition by reducing noise and optimizing quality Automated image optimization Noise and artifact reduction Segmentation of key features	**AI and big data analytics** To detect anomalies in images and highlight patterns to accelerate analysis Automated anomaly detection High-risk area identification Predictive diagnostic insights	**AI and big data analytics** To generate automated reports by interpreting image data for initial findings Automated report generation Structured report suggestions	**AI and big data analytics** To continuously monitor and enhance image quality, ensuring consistent outcomes Continuous image monitoring Quality trend analysis Automated quality reviews
Blockchain and IoT Secure data collection from imaging devices to ensure the integrity of images Secure image transmission Real-time device monitoring	**PoC and rapid testing** AI-integrated PoC tools to offer immediate interpretation in critical care scenarios Bedside imaging diagnostics AI-enhanced rapid interpretation	**Blockchain and IoT** To securely transfers image data and reports between multiple stakeholders Secure report sharing Report process logging	**Blockchain and IoT** Can track and verify each step in the diagnostic process Device performance tracking Tamper-proof image records IoT-based equipment monitoring
Smart wearables and mHealth To provide preliminary imaging data or transfer patient-related data Continuous patient monitoring Vital-sign driven imaging		**Telemedicine** Remote consultations for interpreting radiology reports Remote result explanation Patient-doctor discussions	
Mobile diagnostics Mobile imaging units for image acquisition in remote areas Portable imaging deployment PoC imaging			

3.2 AI and big data analytics

3.2.1 AI in diagnostics

AI is poised to revolutionize medical diagnostics in tier 3+ cities by improving access to high-quality healthcare services. Through advanced applications in medical imaging analysis, digital pathology, and predictive diagnostics, AI can enhance diagnostic accuracy, even in regions with limited medical expertise. These technologies can reduce turnaround times for critical tests and provide timely, accurate insights, leading to better patient outcomes. Emerging startups in India are harnessing AI to process vast amounts of medical data, making it possible to deliver precise diagnostics to remote areas where such capabilities were previously unavailable.

3.2.1a AI in pathology

AI is revolutionizing pathology in India, impacting both primary areas like hematology, biochemistry, and immunoassay, as well as specialized fields such as histopathology and molecular pathology. AI-driven solutions enhance microscopy image quality, automate tasks, reduce turnaround times, and lower manpower costs, significantly improving efficiency and accuracy in diagnostics.

This impact is particularly transformative in tier 2+ cities, where AI enables faster and more reliable diagnoses, even in regions with limited medical expertise. By reducing dependence on specialized pathologists, AI makes high-quality pathology services more accessible, leading to timely treatment and better patient outcomes.

Exhibit 3.2.1

Use cases of AI in pathology across primary and secondary modalities

Primary modalities

Modality	Therapeutic area	Solutions	Impact	Providers
Hematology	• Infectious diseases • General diagnostics	• Detecting and **quantifying parasites** in blood smear slides	• Parasite quantification in blood smear within **20–30 minutes** • Enhanced accuracy and **efficiency in differential counts** • Reduced manual **counting errors** • Reduced time needed for image analysis	Motic DIGITAL PATHOLOGY
		• **Automating specimen handling** to speed up pathogen detection and colony identification		CELLAVISION
		• Enhanced **quality of microscopy images**		ThermoFisher SCIENTIFIC Nikon
Biochemistry and Immunoassay	• General diagnostics • Cardiology • Endocrinology	• Enhancing **test accuracy and speed,** ensuring **calibration,** and predicting maintenance needs before failure	• **Improved accuracy** and reduced TAT • **Increased consistency** of results • **Reduced equipment downtime** and **lower maintenance costs**	Abbott techcyte
Urinalysis and urine cytology	• General diagnostics • Oncology	• Enhancing **sediment detection accuracy** and auto-identifying atypical cells for review	• **Reduced repetitions** with improved accuracy • **Faster TAT** and **higher throughput**	TRANSASIA No.1 Diagnostic Company in India techcyte

Specialized modalities

Modality	Therapeutic area	Solutions	Impact	Providers
Histo-pathology	• Oncology • Infectious diseases • Pulmonology	• AI-driven platforms **automate IHC quantification** and enhance cancer detection and grading	• **80%–90%** potential savings in diagnostic time • **Higher diagnostic accuracy** • Enhanced workflow efficiency • **Precise biomarker measurement** for personalized treatment and improved diagnosis reproducibility	PROSCIA mindpeak VISIOPHARM
		• Detecting **infectious agents in biopsy slides** and specimens		DeePathology.ai
Molecular pathology	• Oncology • Genetic disorders	• Identifying **genetic variants** and conducting comprehensive genomic profiling for biopsies	• **Reduced TAT** and **improved accuracy** of genetic variant detection and disease characterization • **Personalized treatment** through genetic markers and disease profiles	SOPHiA GENETICS illumina
	• Oncology	• Identifying and **validating new biomarkers**		illumina
	• Multi-specialty	• **Advanced 3D visualization** of biological structures		ThermoFisher SCIENTIFIC
Microbiology	• Infectious diseases	• **Automating specimen processing** and imaging to detect and identify microbial growth	• Significantly **lower TAT** • **Reduced labor costs** • Improved accuracy and **consistency of culture and gram analyses** • Enhanced **precision** and speed of **colony selection**	BD Copan CLEVER CULTURE SYSTEMS techcyte

3.2.1b AI in radiology

The impact of AI in radiology is particularly evident in two key areas: image acquisition & pre-processing, and image analysis & interpretation. These AI-driven solutions offer a range of improvements, enhancing efficiency and accuracy in radiological diagnostics. Industry leaders such as Philips, Siemens Healthineers, and Synapse Enterprise Imaging are at the forefront of implementing AI technologies to transform radiological practices. The exhibit below provides a comprehensive overview of AI applications in radiology, illustrating its transformative potential in the field.

AI in radiology can significantly enhance diagnostic capabilities in tier 2+ cities. By automating routine tasks, improving image quality, and providing more accurate interpretations, AI can help address the challenges posed by limited medical expertise and infrastructure in these regions. This will lead to faster and more reliable diagnoses, enabling timely treatment and improved patient outcomes.

Exhibit 3.2.2

Use case of AI in radiology across image acquisition and pre-processing and image analysis and interpretation

Image acquisition and pre-processing

Solutions	Impact	Providers
• Accurately **recognizing and extracting organ region images,** regardless of shape deviations and image conditions	• **Enhanced accuracy** by consistently identifying organ regions • **Reduced time taken** and radiologist workload	SYNAPSE Enterprise Imaging
• Speed engine **maximizing imaging speed while preserving crucial details** across imaging types	• Up to **3x higher** imaging speed • Reduced exam time and **increased throughput** • Up to **65% higher** image resolution	PHILIPS
• **Automate positioning, orientation, and protocols** for streamlined, consistent imaging across setups	• **20+ hours** of annual imaging workload savings per machine • **Accurate collimation positioning** without manual adjustments	SIEMENS Healthineers, AGFA RADIOLOGX SOLUTIONS, GE HealthCare
• **Optimize radiation and contrast agent doses** based on patient factors and exam type, with precise injection timing	• **Improved image quality** for bariatric patients • **Dose reductions** between **30%–70%**	AGFA RADIOLOGX SOLUTIONS, Guerbet, PHILIPS
• **Automatically compensate for patient motion,** adapt to diverse anatomies, and **streamline positioning for faster, higher-quality imaging**	• Up to **30% faster** patient positioning • **Reduced need for repeat scans** due to patient motion • High-quality imaging with c**onsistent fat saturation**	SIEMENS Healthineers

Image analysis and interpretation

Solutions	Impact	Providers
• **Improves early cancer detection, automates lesion analysis,** and intelligent segmentation for efficient workflows	• **Up to 99% sensitivity** without increasing false positives, **~70% higher** positive predictive value than visual thermography interpretation • **40–50%** potential workload reduction • **30–35%** reduction in reading time • **20–30% higher** accuracy than traditional mammography	qure.ai, InferVision, SIEMENS Healthineers, aidence, Volpara, Quibim, SCREENPOINT Medical, Nanamai
• **Accurately detect abnormalities** and prioritize worklists to expedite critical readings	• **97–99%** accuracy rate, **30–35% reduction** in reading time for normal cases, and 10–15% for all cases	vuno, Lunit
• **Enhance contrast and sharpness,** reduce noise and artifacts, and **apply advanced reconstruction techniques** for superior image quality	• Complete denoising in **25%** of the original scan duration • Up to **50% reduction** in scan times • Up to **60% improvement** in SNR and sharpness	Canon, PHILIPS, MEDICVision, GE HealthCare, AGFA RADIOLOGX SOLUTIONS
• **Advanced early detection**, automated lesion analysis, and intelligent segmentation for **efficient diagnostics**	• Improved detection and **reduced intra and inter-rater variability with ~40%** faster radiological reading	icometrix
• **Automatically removing extraneous information** to reveal 3D fetal face quickly	• Enhanced accuracy • Increased efficiency for sonographers	PHILIPS

3.2.2 Big data analytics in diagnostics

Big data analytics is transforming healthcare by leveraging vast amounts of data to improve public health and patient care. By analyzing data from various sources, predictive modeling enables early disease detection, machine learning optimizes diagnostic processes. These advancements ultimately improve outcomes for both individuals and populations.

Exhibit 3.2.3

Use cases and applications of big data analytics

Use case	Description	Impact	Providers
Predictive analytics for disease outbreaks	• **Combines data** from EHRs, **social media, and environmental factors** to predict disease outbreaks • **Enables public health agencies** to monitor and **respond to emerging health threats in real-time**	• **Faster response** to potential epidemics • **Improved resource allocation** for public health initiatives • **Reduced spread** of infectious diseases • **Cost savings** in healthcare systems	bluedot, ENLITIC, IBM, Google Health, METABIOTA
Early detection and risk assessment	• Uses machine learning algorithms to **analyze medical imaging and patient history for early disease markers** • Identifies **high-risk patients,** allowing for **early interventions** and preventive treatments	• **Improved patient outcomes** through earlier interventions • **Reduced healthcare costs** by preventing disease progression • More **personalized** and **targeted** preventive care • **Increased efficiency** in screening processes	Wellsource, CORE HEALTH, Aarca Research, Milliman
Optimization of diagnostic processes	• **Streamlines diagnostic procedures** by analyzing data flow **to reduce delays and improve test accuracy** • Uses predictive models to optimize the allocation of diagnostic equipment and staff	• **Reduced waiting times** for diagnostic procedures • **Improved accuracy** of diagnoses • More **efficient** use of medical resources and personnel • Enhanced **patient satisfaction**	FIND, Quest Diagnostics, OptiDx
Personalized medicine and treatment planning	• **Analyzes genetic data,** patient history, and treatment outcomes to recommend personalized treatment plans • Incorporates **real-time monitoring data** to adjust treatments	• More **effective** and **tailored** treatments • **Reduced adverse** drug **reactions** • **Improved** patient **outcomes** • **Potential cost savings** through optimized treatment selection	AMGEN, abbvie, Agilent, illumina

3.3 Smart laboratories

In smart labs, blockchain, and IoT are revolutionizing diagnostics by enhancing data security, interoperability, and real-time monitoring. Blockchain ensures the integrity and privacy of lab-generated patient data, while IoT devices enable automation, continuous monitoring of lab equipment, and immediate data transmission. Together, they streamline lab processes, improve diagnostic accuracy, and support personalized treatment, positioning smart labs at the forefront of healthcare innovation.

3.3.1 Blockchain in smart laboratories

Blockchain's decentralized architecture holds immense potential for transforming smart laboratories in tier 2+ cities. The benefits seen in EHR demonstrate the possibilities blockchain brings to lab operations. By enabling secure, interoperable data management, blockchain ensures accurate and tamper-proof lab results, accessible to healthcare providers even in remote areas. Additionally, blockchain can optimize supply chain management within labs, ensuring timely and efficient delivery of critical reagents and equipment, thus enhancing the overall performance of smart laboratories in underserved regions.

Exhibit 3.3.1

Benefits of blockchain in diagnostics

Parameters	Description
Accuracy	• Enables the **creation of a unified health IT infrastructure** by connecting disparate networks, ensuring **data integrity across different systems** • **Immutable and time-stamped records reduce the risk of errors** and prevent unauthorized alterations, providing a reliable medical information
Access	• **Multiple providers can access patient record,** eliminating the need for redundant tests and procedures • Patients have **greater control over their health data** empowering them to make informed decisions about their healthcare
Efficiency	• **Streamlines the claim processing process** by allowing payers to access relevant information **quickly and accurately,** reducing administrative burden • **Simplifies credentialing process** for diagnostics providers, **reducing administrative overhead and enabling providers** to focus on delivering care
Decentralization	• Provides an **alternative to centralized health information exchanges, reducing the risk of data breaches** and ensuring privacy of patient data • Creates a more resilient and robust system, reducing the risk of data loss or corruption by **distributing information across multiple nodes**
Decentralization	• **Logs documents and payment requests** immutably thus providing a detailed and accurate record of patient care • Enhanced traceability **enables effective tracking and management of infectious diseases** through contact tracing, improving public health outcomes

3.3.2 IoT in smart laboratories

The integration of IoT technology in smart laboratories is revolutionizing diagnostics by enabling continuous, real-time monitoring of lab equipment and data. In tier 2+ cities, where healthcare infrastructure is limited, IoT automates lab processes, reducing the need for manual intervention and skilled manpower. It enhances diagnostic accuracy by automating data collection, enabling remote monitoring, and facilitating centralized oversight of lab operations. This ensures timely equipment maintenance, improved diagnostic quality, and faster turnaround times, making IoT crucial for streamlining lab efficiency and improving patient outcomes in underserved regions.

Exhibit 3.3.2

Use cases of blockchain and IoT in a smart lab

	Use case	Description	Impact	Providers
Blockchain	**Interoperability between healthcare systems**	• Facilitates **interoperability** between different healthcare providers and diagnostic centers, enabling seamless sharing of medical records and diagnostic data across institutions	• **Improves** data exchange between systems • **Reduces data duplication** and inconsistencies • Ensures **continuity of care** across institutions	HEALTH CHAIN, medanta, CallHealth, zebra MEDICAL VISION
Blockchain	**Secured health records**	• **Secure storage and sharing** of medical imaging data and test results for pathology tests and radiology scans like X-rays, MRIs, and CT-scan, ensuring authorized access and data integrity	• **Strengthens** data security and privacy • Provides an **immutable audit trail** of records • **Reduces risks** of data breaches	MY HEALTH MY DATA, HEALTH CHAIN, CureMetrix
Blockchain	**Efficient supply chain management**	• Enhances **transparency and traceability** in the supply chain of diagnostic equipment and reagents • Ensures components used in tests are authentic and sourced from reliable suppliers	• Reduces **risks of counterfeit** and substandard goods • **Streamlines logistics** and distribution processes • Enables **real-time monitoring** of shipments	PharmaSecure, tracelink NETWORK FOR GREATER GOOD, savi
IoT	**Devices for physicians**	• IoT devices equipped with AI algorithms **enhance accuracy and efficiency in interpreting diagnostic images** • Helps physicians identify the best treatment process	• Improves **efficiency in treatment** decision-making • **Streamlines communication** between patients and providers	Niramai, MIND BOWSER, CureMetrix
IoT	**Lab automation**	• Enables **lab instruments to be connected** to a network, allowing **centralized monitoring** and real-time QC • Allows for remote monitoring of equipment for **predicting maintenance needs** • Tracks and manages **energy consumption** of equipment	• Enhances **operational efficiency** through centralized monitoring • Optimizes energy consumption for **cost savings** • Enables **predictive maintenance** to minimize downtime	Dr Lal PathLabs, Thyrocare, Forus Health, Neuberg DIAGNOSTICS

3.4 Specialized testing technologies

Specialized testing technologies are reshaping the future of diagnostics by improving speed, accuracy, and personalization in patient care. These advanced tools are essential for early disease detection, precision medicine, and more effective treatment decisions, making them critical to enhancing healthcare outcomes. In tier 2+ cities, where healthcare infrastructure is often limited, these innovations are particularly valuable, bringing advanced diagnostics to underserved regions and enabling timely interventions. While several technologies are driving this transformation, a few stand out for their profound impact: microfluidics PoC, liquid biopsy, and multiplex assays.

Microfluidics PoC tests, projected to grow at a CAGR of 13%, enable early disease detection by analyzing biomarkers and genetic material with high sensitivity and specificity. Their portable, miniaturized design reduces sample and reagent use while enhancing ease of use, making them ideal for resource-limited settings like tier 2+ cities, where access to advanced labs is scarce.

Liquid biopsy, expected to grow at a CAGR of 22%, offers a non-invasive alternative to traditional biopsies, enabling early cancer detection through the analysis of circulating cells and cDNA in blood samples. This test provides real-time molecular profiling, offering precision diagnostics without the need for invasive procedures, making it a practical solution in areas with limited healthcare infrastructure.

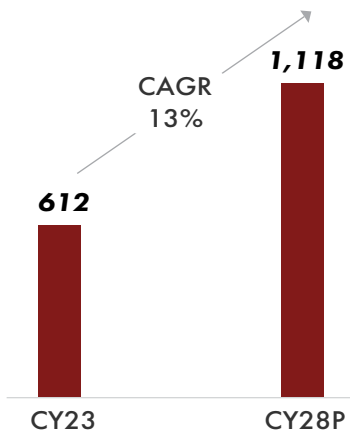
Multiplex assays, with a CAGR of 12%, streamline the diagnosis of complex diseases by simultaneously analyzing multiple analytes in a single sample, allowing for rapid, cost-effective assessments. This technology supports personalized medicine by delivering comprehensive disease profiling, crucial for addressing the rising burden of chronic conditions in tier 2+ cities.

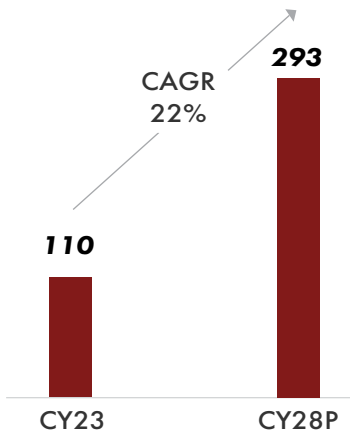
Together, these specialized testing technologies not only represent the forefront of diagnostic innovation but also serve as critical tools for bridging the healthcare gap in underserved regions. By improving accuracy, accessibility, and patient outcomes, they are helping transform healthcare delivery in tier 2+ cities and beyond.

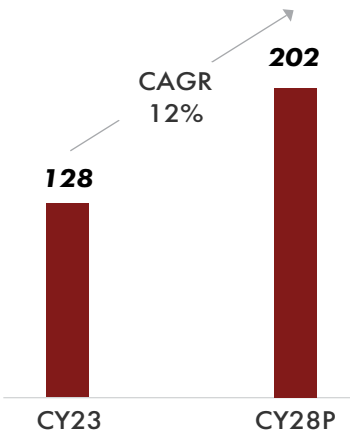
Exhibit 3.4

Market size of different testing technologies

Microfluidics PoC test (Clinical chemistry)	Liquid biopsy test (Molecular pathology)	Multiplex assays (Molecular pathology)
Microfluidics PoC test market (US$ M, CY23–28P)	**Liquid biopsy test market** (US$ M, CY23–28P)	**Multiplex assays market** (US$ M, CY23-28P)







	Microfluidics PoC test (Clinical chemistry)	Liquid biopsy test (Molecular pathology)	Multiplex assays (Molecular pathology)
Clinical needs	• Enables the **early detection of diseases** by allowing the analysis of biomarkers, genetic material, etc.	• **Early detection of cancer** by analyzing circulating tumor cells (CTCs) and cell-free DNA (cfDNA) in blood samples	• Simultaneous detection and quantification of **multiple biomarkers in a single test** for comprehensive disease profiling and personalized medicine
Benefits	• **Offers high sensitivity** and **specificity**, allowing for the detection of low concentrations of analytes • Devices are often **miniaturized and portable,** providing benefits such as reduced sample and reagent consumption	• **Offers a non-invasive and convenient alternative** to traditional tissue biopsies • Provides **real-time molecular profiling of tumors**	• Enables **efficient and cost-effective analysis** of complex diseases by measuring multiple analytes in one sample • Facilitates **rapid diagnosis and treatment decisions** by providing a holistic view of a patient's health status
Players	ACHIRA, ShanMukha, IDEX, Trusted Solutions, Improving Lives, BIO-RAD, riken labs	4baseCare, SPRINT DIAGNOSTICS, strand, MEDGENOME, Dr Lal PathLabs	DNA Labs India, biotech India, BIO-RAD, illumina, ThermoFisher SCIENTIFIC

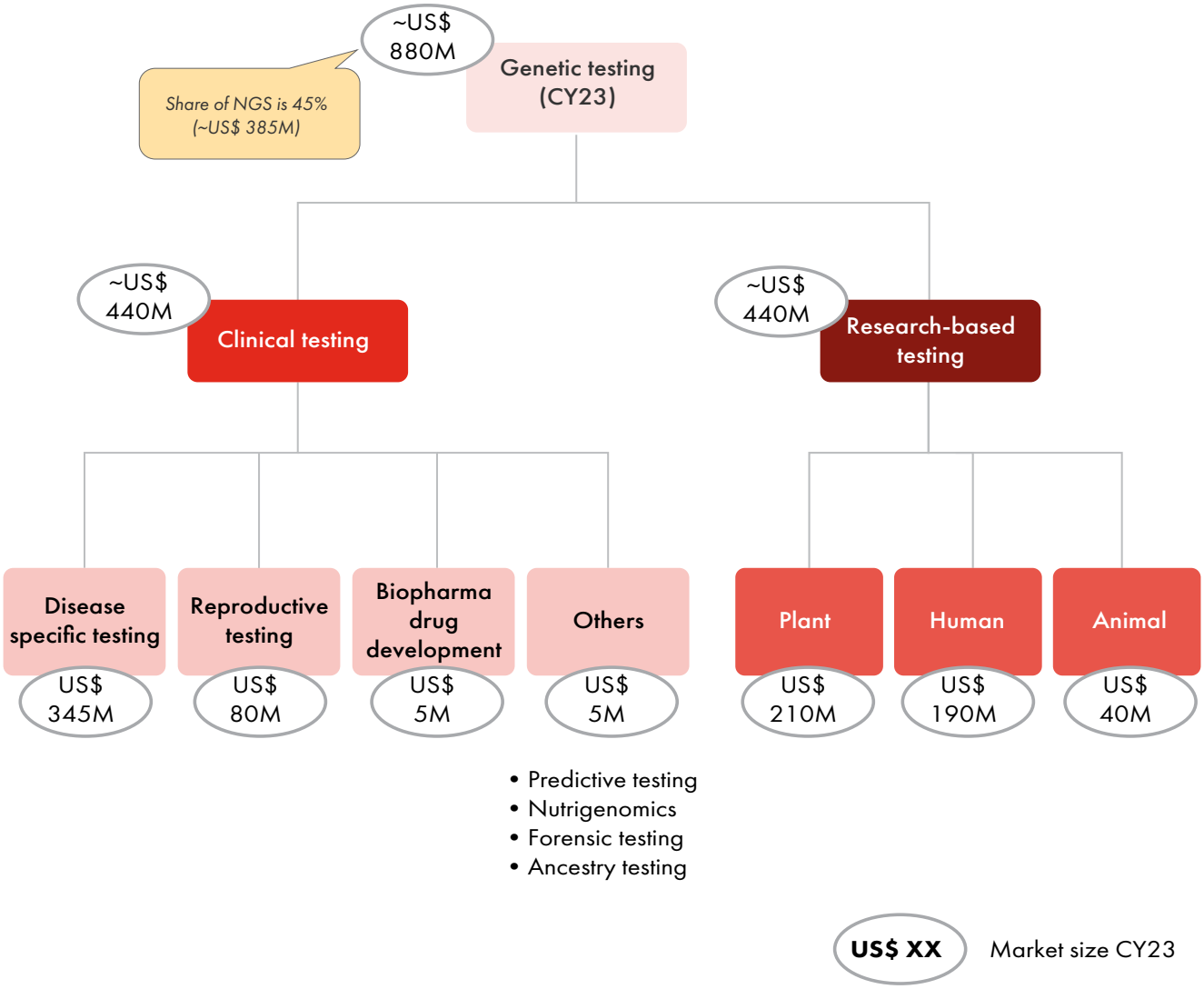
3.5 Genetic testing and bioinformatics

3.5.1 Genetic testing

Genetic testing across the world is rapidly gaining popularity, offering a wealth of information about an individual's genetic makeup, and empowering individuals to make informed decisions about their health and well-being. The genetic testing market in India is experiencing robust growth across both segments of clinical testing and research testing.

Exhibit 3.5.1

Genetic testing market in India



Genetic testing has evolved into a powerful tool with diverse applications across clinical and research fields, offering significant advancements in healthcare, biotechnology, and scientific understanding. This evolution in the clinical domain plays a critical role in reproductive health, disease-specific diagnostics, and biopharma drug development.

Exhibit 3.5.2

Diverse range of tests offered in genetic clinical testing

	Genetic clinical testing			
	Disease-specific testing	**Reproductive testing**	**Biopharma drug development**	**Predictive / Presymptomatic testing**
Objective	• Identify individuals with increased risk due to family history or other risk factors • Confirm a **suspected genetic diagnosis / disease** • Guide treatment and **management of chronic illnesses**	• Identify carrier status for genetic disorders from parents • Diagnose potential conditions in fetuses / new-born babies	• Includes biomarker discovery, clinical, and preclinical testing • Discovering and developing **therapeutic products** such as vaccines, biologics, and biosimilars • **Quality control of raw materials** and drugs during manufacturing • Incorporation of **personalized medicine for tailored treatments based on individual genetic profiles**	• Enable **informed decision-making** for future healthcare management • Assess the risk of developing a **specific genetic disorder** • Allow for **early intervention** and **develop prevention strategies**
Key sub-types / examples	• Infectious and symptomatic, like **COVID-19, TB** • **Oncology testing** • Rare disorders / geneticdisease testing • Disease management / routine checks	• New-born screening • Carrier testing • Prenatal (invasive & non-invasive)	• Vaccine development • Gene-drug pair testing • **Precision medicine** • Panel testing for drug efficacy and allergens • Companion diagnostics • **Gene therapy, cell therapy, and CAR-T cell therapy**	• Monogenic testing • Multigene panel testing • Cancer screening • **Targeted screenings** and treatments • **Immunizations (vaccination)** • Other chronic disease screening
Typical target segments	• Symptomatic individuals • Individuals with illness (disease management)	• Married couples • Embryo / fetus • New-born babies	• **Pharma / biopharma companies / CROs** • Drug trial candidates • Patients undergoing **experimental or personalized therapy**	• General population • Individuals at risk of hereditary diseases
Customer type	B2C & B2G	B2C	B2C & B2B	B2C & B2G
Key players	TEXAS ONCOLOGY, EXACT SCIENCES, MEDGENOME, 4baseCare	Counsyl, Apollo Centre for Fetal Medicine, genea, MEDGENOME	Biocon, BHARAT BIOTECH, ARUP LABORATORIES, gencove, incite health, SERUM INSTITUTE OF INDIA	eurofins, color, mapmygenome, MEDGENOME

Research-based genetic testing spans a variety of applications across agriculture, human health, and animal studies. In agriculture, it focuses on improving crop quality, identifying pathogens, and enhancing food safety. Human-specific testing explores genetic diversity, disease genetics, and pathogen evolution. Animal testing supports conservation, breeding programs, and disease management. Each type serves diverse industries contributing to advancements in the field.

Exhibit 3.5.3

Diverse range of tests offered in genetic research-based testing

	Genetic research-based testing		
	Agri genetic testing	**Human specific testing**	**Animal genetic testing (incl. livestock, pets, etc.)**
Objective	• Analyze genetic diversity within species and populations • Enhance the quality, yield, and nutritional value of crops through targeted breeding and selection and testing for different pathogens affecting crops • Validate the origin and composition of food products, prevent fraud, and identify potential foodborne pathogens	• **Evolutionary studies** - Genetic variations across populations to understand evolutionary processes • **Disease genetics** - Identify genetic variants associated with various diseases and conditions • **Population genomics** - Large-scale studies of human populations to elucidate genetic diversity • **Pathogen testing** - Study genomes of viruses and microbial epidemiology	• Analyze genetic diversity within species and populations to assess conservation needs, identify endangered species, and support breeding programs • Identify genetic markers associated with diseases, identify optimal breeding practices for desired traits, and test for different pathogens affecting cattle
Key sub-types / examples	• Population genomic testing • Marker-assisted selection testing • Genotyping and DNA fingerprinting • Microbial / Disease specific testing	• Ancient nuclear DNA (nDNA) analysis • Evolutionary Developmental biology (Evo-Devo) • Genome-wide Association Studies (GWAS) • Polygenic risk score analysis • Viral genomics for understanding viral evolution	• Population genomic testing • Disease-specific testing • Wildlife forensics • Animal behavioral analysis
Typical target segments	• Agricultural / Botanical institutions • Plant breeders • Seed companies • Food manufacturers • Govt. bodies and regulatory bodies	• Archaeological and anthropological institutions • Research institutes • Government health agencies • National genome projects and biobanks	• Animal breeders / owners • Veterinary institutions • Conservationists and wildlife agencies • Law agencies (Forest and wildlife) • Govt. bodies
Customer type	B2C, B2B & B2G	B2B & B2G	B2C, B2B & B2G
Key players	NEOGEN, CIBUS, Terviva, Dovetail Genomics	Max Planck Institute for Evolutionary Anthropology, MAMR, ICMR Indian Council of Medical Research	Animal Genetics It's all in the DNA, zoetis, COOKS VENTURE, Optimal Selection

3.5.2 Bioinformatics

Bioinformatics is a critical field that leverages computational methods to analyze and interpret biological data. By organizing and analyzing vast datasets from genomics, proteomics, and clinical sources, bioinformatics enables researchers to identify meaningful patterns that can inform disease diagnosis, treatment responses, and personalized medicine. This interdisciplinary field plays a pivotal role in understanding gene and protein functions, predicting disease mechanisms, and accelerating drug discovery, ultimately advancing medical research and improving patient outcomes.

Exhibit 3.5.4

Use cases and applications of bioinformatics

Use case	Description	Impact	Providers
Data analysis	• **Organizes large biological datasets** from genomics, proteomics, and clinical sources • **Detects patterns in data** to enhance disease diagnosis, treatment, and personalized medicine	• Enables faster and more accurate diagnosis • Facilitates **personalized treatment plans** • **Improves patient outcomes** through targeted therapies • Reduces **healthcare costs** by optimizing treatment strategies	illumina, ThermoFisher SCIENTIFIC, QIAGEN, SevenBridges, MEDGENOME, Ocimum Biosolutions, DNAnexus
Gene protein function	• **Predicts gene and protein roles** to understand disease mechanisms • **Identifies biomarkers for diagnostics** and therapy targets	• **Accelerates drug discovery** process • Enhances **understanding of disease pathways** • Enables the **development of targeted therapies**	Genedata, Bioconductor, MOLECULAR HEALTH, strand, UniProt, ArrayGen, eurofins
Evolutionary studies	• **Analyzes genomes across species** to trace evolution and disease-linked mutations • **Provides insights into pathogen evolution** for vaccine development and treatments	• **Improves vaccine efficacy** • Enhances **outbreak prediction** and management • Facilitates **understanding of disease origins** and progression • **Aids in conservation efforts** and biodiversity studies	Geneious, DNASTAR, QIAGEN, Partek, GOLDEN HELIX
Drug discovery	• **Simulates drug interactions** to predict efficacy and side effects • **Speeds up drug discovery** by screening molecular databases	• **Reduces time and cost** of drug development • **Increases success rate** of clinical trials • **Enables repurposing of existing drugs** for new indications	Schrödinger, CERTARA, DASSAULT SYSTEMES, SRC
Pharmaco-genomics	• **Analyzes genetic profiles** to predict drug response and potential adverse effects	• **Enables personalized drug** prescriptions • **Reduces adverse drug** reactions • Optimizes drug dosing	Myriad genetics, admera health, OneOme

Bioinformatics is at the forefront of personalized medicine, enabling precision healthcare through the analysis of genomic data. By leveraging computational methods, researchers can identify genetic variations that influence disease susceptibility and treatment response. This personalized approach offers the potential for more effective therapies, reduced side effects, and improved patient outcomes.

Exhibit 3.5.5

Application of bioinformatics in personalized medicine

1 Study design

- Consider bioinformatics **resources** and tools that will be required for data analysis and interpretation
- Plan for data **quality** control

2 Genome sample

- Ensure **sample quality** and **integrity**
- Obtain informed consent from patients and **adhere to guidelines**

3 Genome analysis

- Utilize bioinformatics tools for **quality control** variant calling and annotation
- Ensure **data format** compatibility

4 Data acquisition

- Implement robust data management practices
- Standardize data formats and metadata

5 Statistical analysis

- Employ appropriate **statistical methods** for genomic data
- **Validate findings** through rigorous testing

6 Biomarkers identification

- Leverage bioinformatics tools for biomarker **prioritization**
- Consider functional relevance and **clinical utility**

7 Pathway analysis

- Utilize network analysis and systems **biology approaches**
- Employ computational methods for **drug repurposing**

8 Therapy identification and treatment

- Develop **personalized treatment plans**
- Continuously **monitor treatment response** and adjust therapy

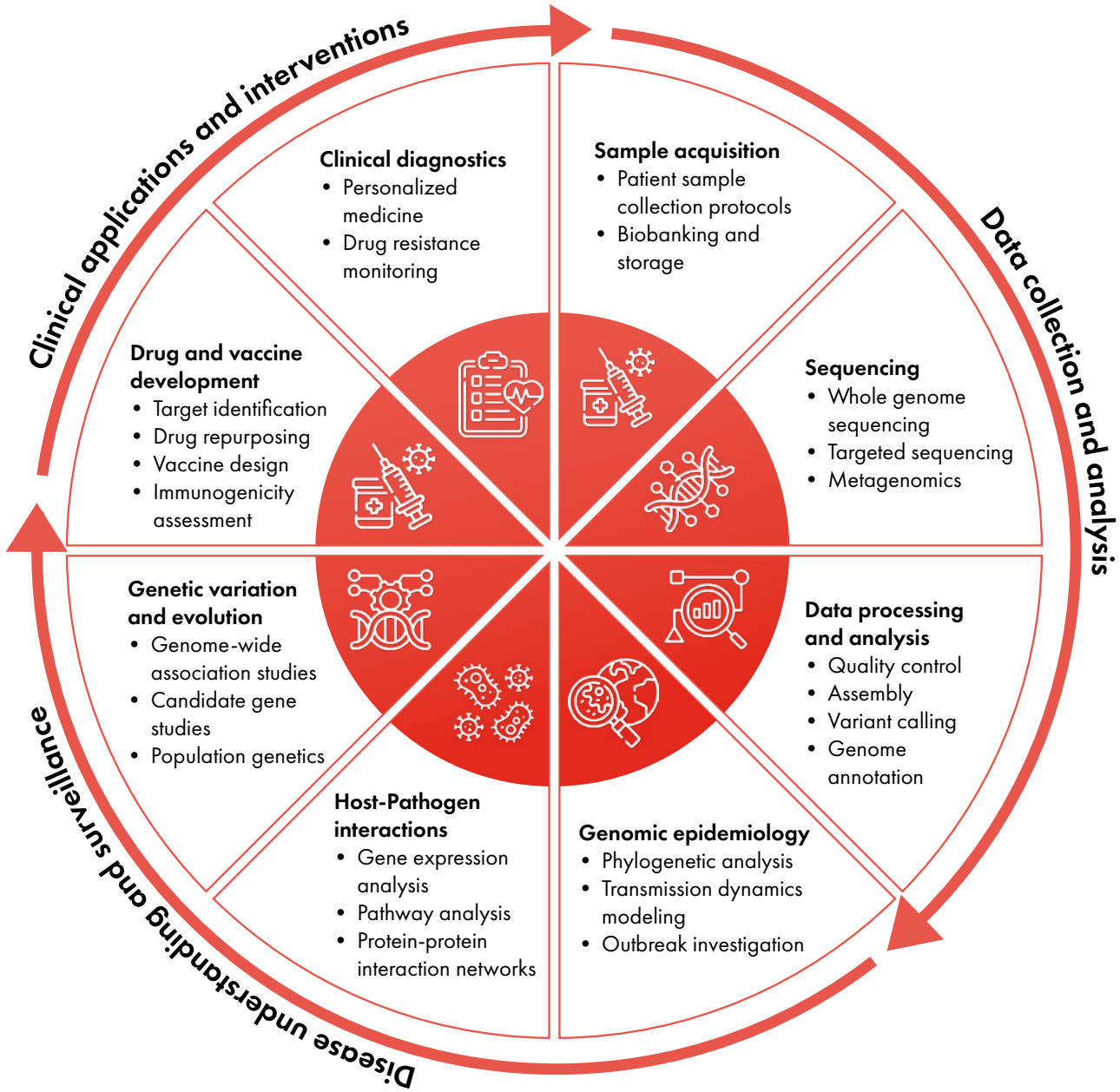
3.5.3 Leveraging bioinformatics and genetic testing in infectious disease control

Bioinformatics offers a powerful approach to combating infectious diseases. By analyzing genomic data, researchers can gain insights into disease transmission, evolution, and pathogenesis. This information is crucial for developing effective diagnostic tests, vaccines, and therapeutic strategies.

The framework outlined in the exhibit presents eight key steps, categorized into three segments, that guide the application of bioinformatics in infectious disease research. From sample acquisition and sequencing to clinical diagnostics and interventions, these steps provide a comprehensive approach to harnessing the power of genomic data for combating infectious diseases.

Exhibit 3.5.6

Utilizing bioinformatics and genetic testing in combating infectious diseases



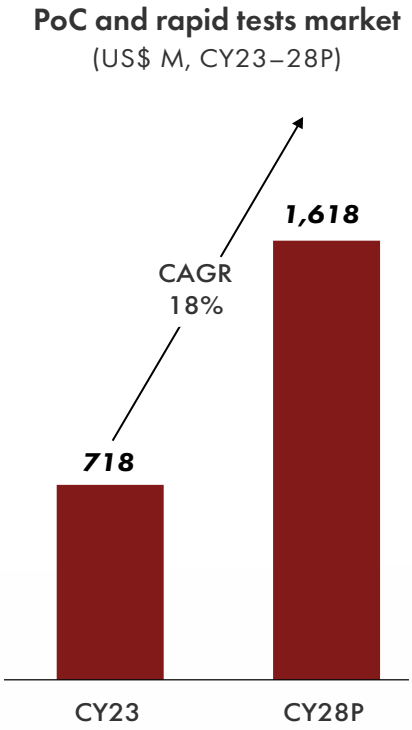
3.6 PoC and rapid diagnostics

Point of Care (PoC) testing has evolved significantly, expanding beyond traditional tools like thermometers and pregnancy tests to encompass modern devices such as portable blood analyzers and rapid infectious disease detectors. These advancements offer faster, more accurate results, enabling immediate decision-making and improved patient outcomes. As technology continues to advance, PoC testing is poised to play a pivotal role in delivering personalized and accessible healthcare.

With a current market size of US$ 718M, this sector is projected to grow at a CAGR of 18% from CY23-28, reaching a market size of US$ 1,618M by the end of the forecast period. This growth is driven by the market's recognition of the value offered by these tests in terms of speed and convenience.

Exhibit 3.6.1

PoC and rapid diagnostics market in India



Expanding the reach of PoC and rapid diagnostics to tier 2 and 3 cities is crucial for enhancing healthcare access and outcomes in these underserved regions. By offering faster diagnosis and treatment, these technologies can address the challenges posed by limited healthcare infrastructure and lengthy turnaround times for traditional laboratory tests. The increased awareness of these testing options, fostered by the pandemic, presents a prime opportunity for healthcare providers to expand their service offerings and improve patient care. Prioritizing the adoption of PoC and rapid diagnostics in tier 2 and 3 cities is essential to ensure equitable access to quality healthcare.

Exhibit 3.6.2

Key drivers for adoption of PoC and rapid diagnostics

Parameter	City tier			Description
	Metro / Tier 1	Tier 2	Tier 3	
TAT	●	◕	◕	• Enables **instant / quick diagnosis** and administration of treatment plan
Affordability	◕	●	●	• Many of these tests are **relatively affordable,** which is a crucial factor in a country like India where **out-of-pocket healthcare** expenses can be high
Accuracy	◑	◕	◕	• **Satisfactory accuracy levels** achieved as per doctors w.r.t. the time taken • Favorable trade-off between speed and accuracy for PoC test for several use cases
Testing urgency	◔	◑	◕	• PoC diagnostics help GPs / specialists / hospitals get **better first-hand information** • Very useful in times of emergency
Accessibility	◔	◕	●	• Integrating PoC tests enhances accessibility, **providing timely diagnostics** at the community level and reducing the need for patients to travel to **central labs or hospitals**
Awareness	◕	◔	○	• Increasing **patient awareness** translating to doctors / hospitals **incorporating PoC and rapid tests** in their portfolio

In India, rapid testing and PoC diagnostics are gaining widespread acceptance due to their ability to deliver quick and reliable results. These technologies are particularly valuable in tier 3+ and remote areas, where access to centralized laboratories is limited. The rise of infectious diseases, such as COVID-19, has further accelerated their adoption, enabling timely decision-making and treatment. Government initiatives and increasing awareness of early diagnosis among the population have also contributed to their widespread use across the country.

Exhibit 3.6.3

Companies offering effective PoC and rapid diagnostics solutions

Company	Product	Launch year	Solution	Impact
molbio	Truenat	2018	• Delivers **rapid, accurate** diagnostics for **infectious diseases like tuberculosis, COVID-19**, etc.	• **Endorsed by WHO** for rapid molecular assays
Mylab Discovery solutions	PathoDetect	2022	• India's **first indigenously** developed real-time **PCR** test kits for rapid and **accurate detection of COVID-19** and other infectious diseases	• **Increased testing capacity** during the pandemic • **~65% reduction** in TAT
ACHIRA	ACIX 100	2016	• Based on a **microfluidic platform** for rapid diagnosis of **chronic conditions like thyroid** • The infectious diseases category is under development	• **~50% reduction** in test price • **~30 mins** TAT
HealthCube	HealthCube XL	2019	• **Multi-parameter diagnostic device** offering on-the-spot testing for various health parameters such as **blood glucose, lipid profile, ECG**, etc.	• **Instant test results** • **0.5M** lives touched across **4** continents and **22** states
SIEMENS Healthineers	Stratus CS Acute Care Diagnostic System	2015	• Obtain lab-quality **comprehensive assessments** from a **single sample, analyzed** in a single run on a compact, versatile instrument	• **~15 minutes TAT** for first result and **~5 minutes** for each subsequent results

3.7 Telemedicine market in India

Telemedicine has the potential to transform the medical diagnostics industry by enabling remote consultations and real-time patient monitoring. This technology will enhance the accessibility, particularly in tier 2+ and underserved areas, while also reducing healthcare costs.

Telemedicine market in India is expected to grow rapidly in the coming years. This expansion is driven by several key factors, including technological advancements, rising healthcare costs, and increased public awareness and acceptance of telemedicine services. By leveraging advanced technologies, telemedicine enables remote access to diagnostic services, breaking down geographical barriers and expanding access to specialized expertise. From teleconsultation and remote patient monitoring to telepathology and teleradiology, telemedicine offers a diverse range of applications that are transforming the diagnostic process. Through telemedicine, patients can receive timely and accurate diagnoses, even in remote or underserved areas, while diagnostics providers can improve efficiency, enhance collaboration, and reduce costs.

As telemedicine continues to evolve, it is expected to play an increasingly important role in medical diagnostics, driving innovation, improving patient outcomes, and enhancing the overall quality of healthcare by addressing challenges such as access to care, efficiency, and costs, ultimately transforming the way we diagnose and treat patients.

Exhibit 3.7.1

Use cases of telemedicine and companies providing telemedicine solutions

Use case	Description	Impact	Key providers
Tele-consultation	• Enables **remote consultations** on diagnostic results with doctors via video or audio calls • Facilitates remote **discussions on treatment options** and further testing needs • Allows for follow-ups and second opinions **without in-person visits** • Particularly crucial for **patients in remote areas**	• Increases **access to specialized diagnostic** interpretations for rural populations • **Reduces travel costs** and time for patients by **30-40%** • **Speeds up the treatment process** with timely consultations • **Decreases hospital workload** through remote follow-ups and second opinions	practo, TATA 1mg, MediBuddy, Apollo, CallHealth, mfine
Remote patient monitoring	• Enables providers to **manage acute and chronic conditions via at-home medical devices** • Facilitates at-home diagnostic **screenings for chronic diseases** • Allows patients to **directly share test results** with healthcare providers	• Improves **early detection** and **management of chronic conditions** • **Reduces hospital visits,** increasing patient convenience • Enables **continuous monitoring,** improving long-term outcomes • Expands care access in remote and underserved regions	dozee, Cardiotrack, Medtronic, LedTel, Beato, Janitri, ULTRAHUMAN, INNACCEL
Tele-pathology	• Enables remote diagnosis using **high-resolution digital images of pathology slides** • Allows pathologists to review samples remotely, **avoiding transport of physical slides** • Commonly used for **telebiopsy**, particularly in **cancer diagnosis** • Helps connect remote facilities with larger centers for expert opinions	• **Reduces time to diagnosis by up to 30%,** particularly in cancer cases • **Reduces logistical issues** of transporting physical slides • **Facilitates collaboration** among pathologists and oncologists, **improving diagnostic accuracy** • Increases access to expert opinions in underserved areas • **Improves treatment timelines** with immediate remote consultations	OptraScan, PROSCIA, mindpeak, VISIOPHARM Proscia DP system integrated with Mindpeak and Visiopharm AI
Tele-radiology	• Enables **remote interpretation of medical images** (e.g., X-rays, CT scans, MRIs) using digital imaging technology • Allows radiologists to review images from remote locations, **avoiding transportation of physical films** • Widely **used for emergency radiology, second opinions,** and consultations between specialists • Facilitates **collaboration among radiologists, clinicians, and other healthcare professionals**	• **Improves access to specialized radiology expertise** in remote or underserved areas • **Reduces TAT** benefitting increasingly in emergency cases • Facilitates timely consultations and second opinions • **Reduces workload** by better distribution of radiology interpretation from teleradiologists across the world	Teleradiology Solutions, Qure.ai, NightHawk Radiology, 4medica, RADEVER, 5C, VISTARAD, RADISKY

3.8 Smart wearables and mHealth

A paradigm shift is underway as today's generation embraces preventive healthcare. Driven by a growing awareness of health and wellness, individuals are increasingly prioritizing proactive measures to prevent diseases. Regular screenings, vaccinations, and adopting healthier lifestyles are becoming integral parts of their healthcare routines. This shift towards preventive care not only improves overall well-being but also alleviates the burden on healthcare systems by reducing the need for extensive medical treatments.

The preventive health sector is being transformed by cutting-edge technology. Leading this change are intelligent wearable devices and digital wellness apps, which are rapidly becoming essential tools in the modern health-conscious lifestyle. These technologies provide individuals with accessible, at-home diagnostic options, allowing residents in remote locations to perform basic health tests without the need for nearby medical facilities.

Combined with personalized insights and monitoring through mobile apps, these tools enable early detection and continuous health tracking. This empowers people in underserved regions to take charge of their health, leading to improved outcomes and more efficient healthcare delivery.

The smart wearables and mHealth market has seen substantial growth in recent years and is expected to maintain this upward trend. Several key factors, such as rising health awareness, convenience, and accessibility, have driven this expansion.

Exhibit 3.8.1

Key drivers for smart wearables and mHealth market in India

Rising health awareness	People are **becoming more proactive about monitoring their health parameters** there by increasing the demand for self-testing devices
Convenience, accessibility & affordability	Self-testing and wellness devices provide the **convenience of monitoring** health without the need to visit a healthcare facility
Rise of lifestyle diseases	The increasing prevalence of **lifestyle-related diseases** such as **diabetes** and **hypertension** has driven a **significant surge** in the demand for **self-testing devices**
Technological advancements	**Advancements** in sensors, data connectivity, and mobile applications have enhanced the **overall user experience**
Urbanization and middle-class expansion	**Urbanization** and the **expansion of the middle-class population** have resulted in increased disposable income

Several Indian startups are making significant strides in tech-enabled solutions for diabetes, weight management, and overall health. These innovations are particularly beneficial in tier 2+ areas, where healthcare infrastructure is limited. By utilizing digital platforms, these companies provide essential health services directly to remote communities, enabling early detection and management of chronic conditions.

Exhibit 3.8.2

Companies providing smart wearables and mHealth solutions

Company	Launch year	Solution	Impact
Beato	2018	• **Smart diabetes management** with glucose monitoring and personalized	• Reduction of HbA1c by **2.2% in 3 months**
HealthifyMe	2012	• AI-driven app for **diet, fitness, and personalized health coaching**	• Decline in lifestyle diseases for **80%** of pro users • **15% drop** in users' **blood glucose** levels
cult.fit	2016	• Fitness classes, mental health, nutrition, and wellness services	• **6 kg average weight loss** in 3 months • **90%** have seen a **rise in energy** and **stamina** • **92%** improved sleep cycles
WITHINGS	2008	• **Health tracking** by integrating powerful health scans in **connected watches** and scales	• Detected **2M signs** of atrial fibrillation indicating **heart stroke risks** • Determined risks of conditions such as **type 2 diabetes** by recording **85M nights**
fitbit	2007	• Offers wearable devices for **tracking health metrics,** helping users **improve their fitness and overall well-being**	• **Daily steps increased** by more than **2k steps** • **Improved blood pressure,** BMI, weight loss, and other body measurements

The health management and wellness sectors have emerged as attractive opportunities for startups, with numerous companies venturing into various sub-segments to offer innovative, integrated solutions. These startups are bridging different aspects of health and wellness, creating a unique blend of services. A selection of startups operating across multiple segments is highlighted below.

Exhibit 3.8.3

Health management and wellness segment landscape

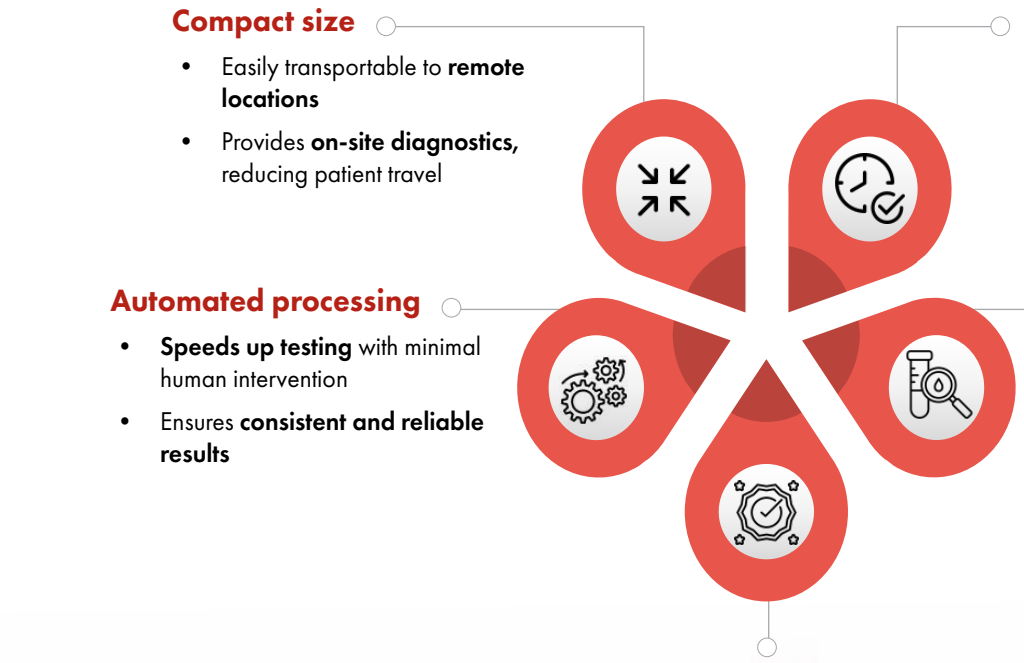
3.9 Mobile diagnostics

Mobile diagnostics are revolutionizing healthcare, particularly in tier 3+ areas where access to traditional clinical settings is limited. These portable, lab-quality testing devices bring advanced diagnostics directly to underserved communities, enabling healthcare professionals to conduct essential tests on-site.

By delivering rapid, accurate results in real-time, mobile diagnostics eliminate the need for patients to travel long distances to metro / tier 1 centers for testing. This not only enhances timely care but also improves health outcomes by facilitating early diagnosis and treatment. In tier 3+ regions, where healthcare resources are often scarce, mobile diagnostics plays a crucial role in bridging the gap in healthcare accessibility, ensuring that even remote populations receive high-quality diagnostic services.

Exhibit 3.9.1

Key features of mobile diagnostics



Mobile diagnostics are experiencing rapid growth due to a confluence of factors. The increasing demand from an aging population, coupled with advancements in portable medical devices and telecommunications infrastructure, has made these services more accessible and convenient. Rising awareness of preventive healthcare and the benefits of early disease detection further drive demand. Additionally, the cost-effectiveness of mobile diagnostics and government support have played crucial roles in expanding their availability and utilization.

Exhibit 3.9.2

Key growth drivers for mobile diagnostics

Increasing NCDs	• **The economic burden of NCDs** on India is anticipated to be ~US$ 3.6T between CY12-30 • **63% of deaths in India** are because of chronic diseases which are preventable
Technological advancements	• Development of highly capable and quality **portable medical devices for a wide range of diagnostic tests** • Improvement in **telecommunication and public** infrastructure leading to overcoming **logistical challenges**
Increasing awareness	• Convenient access to health screening help **identify potential health problems early on,** thus making better treatment plans
Affordability	• **Early diagnosis of diseases** leads to **reduced treatment costs** • Accessing mobile diagnosis **reduces travel expenses for patients**
Government support	• Under the NHM, **GoI provides financial and technical support** to states/UTs for MMUs • Each MMU is supported per 10 lakh population **capped at 5 MMUs per district serving 60 patients per day per MMU**

Mobile diagnostics brings advanced medical testing directly to patients, particularly in underserved areas. This innovative approach addresses accessibility and efficiency challenges in healthcare diagnostics. Companies offer various solutions, from automated vans to portable devices, covering a range of medical tests. By leveraging technology, mobile diagnostics improves the speed and convenience of testing, potentially leading to better healthcare outcomes. The following case studies illustrate its transformative potential in healthcare diagnostics.

Exhibit 3.9.3

Companies providing mobile diagnostics solutions

JITM Skills Pvt. Ltd.	• Manufactures **automated mobile testing vans (>15)** accredited with NABL and ICMR • Can test up to **4K samples daily** with a **24 hours TAT** with **a very low need for human intervention**
sainCe	• Offers **non-dilated diabetic eye tests, glaucoma tests, bone density scans, ultrasound** directly to patients' locations • All diagnostic reports are integrated into the EMR to ensure continuity of care
AGAPPE	• Launched **Demo on Wheels** bringing diagnostic tools, including **semi-automatic and automatic analyzers,** directly to laboratories • Aims to empower rural India by **delivering cost-effective, quality healthcare solutions** nationwide
Accuster... Expert in Vitro Diagnostics	• Offers **36 blood tests** over **2-wheeler** particularly useful for underserved areas, with a **TAT of ~5-10 minutes** • Advanced features include **built-in satellite control,** with high quality **(USA-FDA approved)**

04

ACHIEVING PROCUREMENT EFFICIENCIES THROUGH SCALE

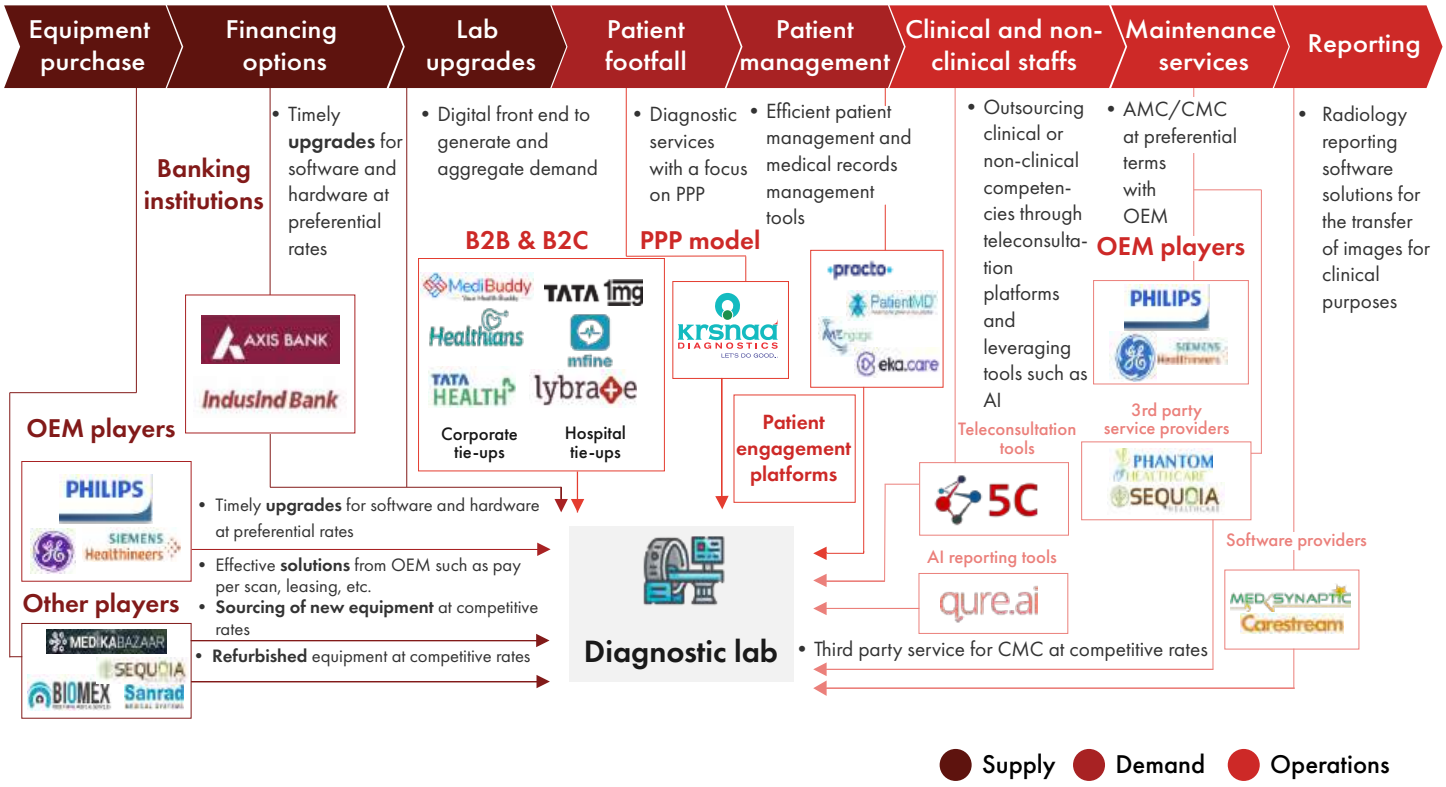
4.0 ACHIEVING PROCUREMENT EFFICIENCIES THROUGH SCALE

Exhibit 4.1 illustrates that the diagnostics market consists of multiple players in the value chain. On the supply side, economies of scale allow diagnostic labs to procure high-quality equipment at lower prices, get favorable financing terms, and utilize their high bargaining power. On the demand side, scale allows labs to access channels that increase their patient footfall and patient management solutions. On the operations side, economies of scale allow for lower operating costs, better negotiations, and access to digital solutions.

In tier 2+ cities, economies of scale can significantly drive operating leverage for diagnostic labs.

Exhibit 4.1

Leveraging scale to achieve procurement efficiencies



Drivers							
Procures high quality equipment from OEMs at lower prices	Easier and favourable financing terms enabling cheaper funding	Utilize their high bargaining power to command preferred rates	Access to a wider base via B2B/ B2C channel and PPP models allowing higher footfall	Deploying efficient patient management solutions allows cost reduction and enhanced patient experience	Outsourcing allow for lower employee cost for scaled players	Can negotiate better terms for maintenance services	Can deploy digital solutions for reporting applications

05

GOVERNMENT INITIATIVES

5.0 GOVERNMENT INITIATIVES

5.1 Key government initiatives supporting the diagnostics sector

The Indian government has launched several comprehensive healthcare schemes to enhance access to quality medical services. These initiatives, including the National Digital Health Mission's e-reports and Ayushman Bharat Yojana's diagnostic coverage, are transforming the diagnostics industry. The emphasis on improving healthcare infrastructure, fostering public-private partnerships, and encouraging domestic manufacturing is likely to boost affordability, accessibility, and technological advancement in diagnostic services across India.

Exhibit 5.1

Key government initiatives promoting the diagnostics industry in India

Ayushman Bharat Digital Mission (ABDM)	• Aim to enhance the digital healthcare space via **e-reports, tele-consultation, e-pharmacy solutions**, etc. • Provides access to both public and private health services, ensures **transparency** in **pricing of services** and **accountability** for the health services being rendered
Ayushman Bharat Yojana (PMJAY)	• Provides **free healthcare** services to more than **40% of the population** offering a health cover of INR 5L • The scheme covers medicines, diagnostic expenses, medical treatment, and pre-hospitalization costs • **~355M** e-cards issued and **~70M** admissions made across the country
Central Government Health Scheme (CGHS)	• Provides comprehensive health care facilities for **central government officials** and **pensioners** in 80+ cities • Currently, 1.5M pensioners are cardholders, with **4.3M beneficiaries** across **460+ CGHS units** • OPD and IPD services across specialties, with **cashless treatment** being offered at AIIMS, PGIMER, etc.
PM Atma Nirbhar Swasth Bharat Yojana (PMASBY)	• Provision of support for **~18K** rural HWCs and establishing **~11K** urban HWCs • Strengthening of the National Centre for Disease Control **(NCDC)** • Setting up of **Integrated Public Health Labs** in all districts across 11 focus states
Public Private Partnership (PPP) under NHM	• Ensures that the existing medical infrastructure and resources are leveraged through optimum utilization, at an affordable cost to the end user • Provides expertise and services to the private sector (accounting for 81% of doctors in India) in public health facilities
National Medical Devices Policy (NMDP)	• Aims to **reduce import dependence** and boost domestic production of medical devices to **increase affordability** and **availability** of devices / consumables for healthcare providers and patients • Seeks investment from PE/VCs as well as encouraging PPP
Foreign Direct Investment (FDI) regime	• Permits up to **100% FDI** under the automatic route in the hospitals segment and medical device manufacturing • Foreign investors do not require approvals from the GoI for investment in these areas
Production Linked Incentive (PLI) scheme	• Financial incentive to boost domestic manufacturing and attract large investments in pharmaceuticals and medical devices segments such as **cancer care** devices, **pathology, radiology, imaging devices,** etc.

5.2 Integration of diagnostics services in wellness centers

India has ~199K wellness centers in FY22, many of which suffer from inadequate services and poor quality. Basic utilities like electricity and water supply are critically lacking in states such as Bihar, Jharkhand, and the Andaman and Nicobar Islands. While only ~4% of Indian PHCs operate without these essentials, the situation is particularly severe in the mentioned states. These shortcomings severely affect services like operating hours, emergency response, diagnostics, sanitation, and overall patient care, impacting both patients and healthcare workers.

The lack of basic utilities has worsened working conditions for healthcare staff, contributing to challenges in maintaining an adequate workforce. Other factors like financial constraints and limited career opportunities also result in low retention rates. Addressing these key issues can help rural healthcare systems retain skilled workers and provide consistent, high-quality services.

Integrating diagnostic services into SCs, PHCs, and CHCs is crucial for improving healthcare in India. The following recommendations highlight five key areas to enhance diagnostic capabilities in underserved regions. By focusing on these strategies, the government can strengthen primary care facilities, enabling timely disease detection and better public health outcomes.

Exhibit 5.2

Key recommendations for the government to improve the condition at wellness centers

Recommendation	Description
Infrastructure development	• Equip PHCs and CHCs with X-rays, ultrasounds, and lab facilities; deploy **mobile diagnostic units to serve remote SCs** • Develop **essential infrastructure like reliable water supply** and **electricity** to support the effective operation of these centers
Digital health integration	• Implement **telemedicine platforms** to connect SCs with PHCs and CHCs for remote diagnostics and expert consultations • Introduce **EHRs across all centers** to ensure **seamless data sharing and patient tracking**
Workforce training	• Provide **ongoing training for healthcare workers** on diagnostic equipment use and result interpretation • Establish **certification and continuous education programs** focused on the latest diagnostic technologies
Public-Private Partnerships (PPP)	• Partner with private companies to **supply and maintain diagnostic equipment** in PHCs and CHCs • Collaborate with private entities to **deploy and operate mobile diagnostic units** in remote regions
Preventive care and community engagement	• Conduct **regular health camps** and diagnostic screenings at SCs and PHCs to **promote early detection** • Run **community awareness programs** on the importance of **preventive diagnostics** and regular health check-ups

5.3 Digital Personal Data Protection Act, 2023

The Digital Personal Data Protection Act, 2023, has introduced new challenges for diagnostic centers of all sizes, requiring them to adapt to stricter data privacy and security regulations. As these centers navigate the evolving landscape, they face unique hurdles depending on their scale and scope of operations:

- **Small diagnostic centers:** Limited resources to invest in new data privacy and security technologies could place them at a competitive disadvantage
- **Large diagnostic centers:** While they possess resources for compliance, navigating complex data localization norms and restrictions on cross-border data transfers could hinder their global operations
- **Global diagnostic companies:** While boasting vast resources and expertise, they must now contend with stringent data localization norms and potential restrictions on cross-border data transfers, potentially impacting their global operations and international collaborations

Exhibit 5.3

The Digital Personal Data Protection Act is expected to have significant implications for diagnostics companies

	Small diagnostic centers	Large diagnostic centers	Global diagnostic companies
Challenges	• **Limited resources** to **invest** in new **technologies** for **data privacy** and **security management** ⟶ **Competitive disadvantage** compared to **larger counterparts** • **Constrained abilities** for **data sharing** with third parties to whom services are **outsourced** due to **consent requirements**	• **Significant costs** involved in **transitioning** their existing data systems and protocols to be **compliant** with new data privacy norms • Restrictions on sharing **Indian patient data** with their **global partners or third parties** due to **localization requirements**	• Navigating **data localization norms** and **restrictions on cross-border data transfers** • Adapting **global data models and technologies** to meet **India-specific regulatory needs**
Opportunities	• Act as **localized databases** to enable patients to **share data with global companies** while retaining **local control**	• Develop **proprietary population health datasets and analytics models** • Acquire **smaller diagnostics** centers to **gain scale** and **access regional / tier 2 markets**	• Leverage **experience of data compliance** from EU, US markets to **adapt processes for India** • **Offer proprietary algorithms** and technologies for **efficient consent management and compliance**
Way forward	• Focus **consent efforts** on **specific high-priority datasets** rather than **collecting all patient data** • Collaborate on **efficient consent management** and **data anonymization technologies**	• Invest in **technologies to capture data** as per **compliance** and **derive insight from data analytics** while **protecting individual privacy** - Appoint **data protection officers** and **audit protocols** to **ensure compliance** across massive data operations	• Set up **Indian data subsidiary or acquire Indian player** to **house domestic data** to comply with localization norms • Modify **consent protocols** and **data models** to **align** with the **regulatory framework** in India

5.3.1 Ethical considerations for patient data privacy

The implementation of the Digital Personal Data Protection Act, 2023 has brought ethical considerations around patient data privacy to the forefront of the healthcare diagnostics sector. As diagnostic centers and global companies navigate this new landscape, they must address several critical ethical concerns:

- **Patient confidentiality:** Ensuring robust safeguards against unauthorized access or disclosure of patient data
- **Informed consent:** Providing clear explanations to patients on how their data will be used, requiring explicit consent
- **Data utility vs. Privacy:** Balancing data use for medical research with rigorous privacy protections
- **Data security:** Implementing strong anonymization, encryption, and regular security audits to protect sensitive information
- **AI ethics:** Mitigating biases in AI tools by using diverse data sets and regular testing to ensure fairness
- **Regulatory compliance:** Aligning with the DPDP Act, 2023, global standards, updating data management, and transfer protocols
- **Transparency:** Maintaining trust by clearly communicating data practices and providing regular updates
- **Data minimization:** Collecting only necessary data and conducting regular audits to securely delete obsolete information

This comprehensive approach to ethical data management not only ensures legal compliance but also upholds patient rights, maintains trust in the healthcare system, and facilitates responsible innovation in medical diagnostics.

06

CONCLUSION AND WAY FORWARD

6.0 CONCLUSION AND WAY FORWARD

The Indian diagnostics industry is set to undergo a transformative phase, driven by a combination of favorable demographics, urbanization, and an increasing demand for quality healthcare. However, the high fragmentation of the market poses significant challenges in terms of scalability, capability, and consistency in quality, particularly in tier 2+ cities. To address these disparities, the integration of advanced technologies such as PoC, rapid diagnostics, AI, blockchain, IoT, telemedicine, mobile diagnostics, and teleradiology will be crucial.

1. **Embrace technology adoption:** Diagnostics providers must actively invest in the integration of emerging technologies to improve diagnostic capabilities and reach underserved populations. This includes upgrading existing infrastructure, training personnel, and adopting scalable solutions that cater specifically to the needs of tier 2+ cities.

2. **Foster strategic partnerships:** Collaboration between private players, government bodies, and technology providers is essential to drive innovation and expand access. Strategic partnerships can facilitate knowledge sharing, streamline operations, and optimize resource utilization, helping to bridge the diagnostic gap in less accessible regions.

3. **Enhance quality and standardization:** To address the fragmentation challenge, there needs to be a concerted effort towards standardizing quality across all levels of diagnostics. This involves implementing stringent quality controls, accreditation processes, and leveraging AI for consistent and accurate results, thereby building trust among patients and healthcare providers.

4. **Policy advocacy and support:** Stakeholders should advocate for supportive policies that encourage technological adoption and incentivize innovation. Engaging with policymakers to create a conducive regulatory environment will accelerate the implementation of new technologies, making advanced diagnostics more accessible and affordable.

5. **Focus on patient-centric models:** The future of diagnostics in tier 2+ cities will be driven by patient-centric approaches that prioritize accessibility, convenience, and affordability. Innovators should focus on developing user-friendly solutions such as mobile diagnostics and home testing kits, ensuring that healthcare becomes truly accessible to all segments of the population.

6. **Build awareness and education:** Increasing health literacy and awareness about available diagnostic options is critical. Efforts should be made to educate communities about the benefits of early and accurate diagnostics, fostering a proactive approach to health management.

Now is the time for industry leaders, investors, and policymakers to take decisive action. By aligning on a shared vision and committing to bold investments in technology and innovation, stakeholders can transform the diagnostics landscape in India. Together, we can build a healthcare system that not only addresses current disparities but also sets the foundation for a healthier, more equitable future for all, particularly in the rapidly growing tier 2+ cities. Let's take the lead in shaping a diagnostics industry that is inclusive, resilient, and ready to meet the challenges of tomorrow.

About ASSOCHAM

The Associated Chambers of Commerce & Industry of India (ASSOCHAM) is the country's oldest apex chamber. It brings in actionable insights to strengthen the Indian ecosystem, leveraging its network of more than 4,50,000 members, of which MSMEs represent a large segment. With a strong presence in states, and key cities globally, ASSOCHAM also has more than 400 associations, federations, and regional chambers in its fold.

Aligned with the vision of creating a New India, ASSOCHAM works as a conduit between the industry and the Government. The Chamber is an agile and forward-looking institution, leading various initiatives to enhance the global competitiveness of the Indian industry, while strengthening the domestic ecosystem.

With more than 100 national and regional sector councils, ASSOCHAM is an impactful representative of the Indian industry. These Councils are led by well-known industry leaders, academicians, economists, and independent professionals. The Chamber focuses on aligning critical needs and interests of the industry with the growth aspirations of the nation.

ASSOCHAM is driving four strategic priorities - Sustainability, Empowerment, Entrepreneurship and Digitisation. The Chamber believes that affirmative action in these areas would help drive an inclusive and sustainable socio- economic growth for the country.

ASSOCHAM is working hand in hand with the government, regulators, and national and international think tanks to contribute to the policy making process and share vital feedback on implementation of decisions of far-reaching consequences. In line with its focus on being future-ready, the Chamber is building a strong network of knowledge architects. Thus, ASSOCHAM is all set to redefine the dynamics of growth and development in the technology-driven 'Knowledge-Based Economy. The Chamber aims to empower stakeholders in the Indian economy by inculcating knowledge that will be the catalyst of growth in the dynamic global environment.

The Chamber also supports civil society through citizenship programmes, to drive inclusive development. ASSOCHAM's member network leads initiatives in various segments such as empowerment, healthcare, education and skilling, hygiene, affirmative action, road safety, livelihood, life skills, and sustainability, to name a few.

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About us

Praxis Global Alliance is the next-gen management consulting firm revolutionizing how consulting projects are delivered. It delivers practical solutions to the toughest business problems by uniquely combining domain practitioner expertise, AI-led research approaches, and digital technologies. The company operates three business units, including Praxis Global Alliance Transactions, offering pre-deal support, commercial due diligence, post-acquisition value creation, Praxis Global Alliance Strategy and Transformation for practitioner-led business advisory and consulting, and PraxDigital™ delivering data engineering and analytics, AI, OpenData and visualization solutions to clients across verticals. With a presence across 6 locations in India, UAE, and Saudi Arabia, Praxis Global Alliance has successfully served over 40 countries with a dedicated team of consultants and data scientists. Team Praxis works with C-suite to the front-line executives across business streams, helping them with end-to-end business enablement, organizational transformation, and revenue maximization support in an agile environment.

For more details, please visit:
https://www.praxisga.com/

Our offerings

GrowRevenue

- Sales acceleration
- Go-to-market
- Omni-channel distribution
- Customer experience and loyalty
- Strategy & business planning

GrowPerformance

- Metric movement
- Playbook creation
- Cost efficiency
- Supply chain optimization

GrowValue

- M&A and due diligence
- Sell side: Vendor CDD and road to IPO
- Integrity DD / Forensic DD
- Operational DD
- Future tech readiness

GrowSustainably

- ESG due diligence
- ESG value creation plan
- Impact assessment
- Sustainable supply chains
- Circular economy

Senior healthcare leadership team at Praxis

Aryaman Tandon

Managing Partner

Healthcare, Technology and Internet, Auto and Renewables

Garima Malhotra

Associate Partner

Healthcare

Ayush Singh

Manager

Healthcare

Anjan Bose

Practice Leader and Advisor – Healthcare

Founder and Secretary General, NATHEALTH

Prabal Chakraborty

Practice Leader and Advisor – Medical Devices & Cons.

Ex-Boston Scientific Company, J&J Medical India

Connect with us

We will be happy to share perspectives

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Build Together.
Win Together.