

## Performance of Digital Healthcare Management System in Post Covid Time

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### Abstract

Healthcare industry is expanding at a quick pace due to the discovery of new forms of drugs and treatment procedures, which were hitherto not known. New diseases are being diagnosed at early stages which in turn are being treated with new-age drugs, procedures, and devices. Given the patient volume and the complexity of diseases, it is extremely challenging for government agencies to oversee the entire healthcare system, especially in developing nations like India. Private organizations entered the market and began to administer healthcare in a new way as a result. In the contemporary environment, adoption of digital technology is crucial for private healthcare providers as it drives operational and financial performance. Digitalization of healthcare services speeds up and improves the accuracy of the system, which increases patient happiness and decreases patient turnover. It lowers the expenses and time spent by patients and system professionals. The study attempts to examine the effects of digital technology on the healthcare industry in the aftermath of COVID-19. As is well known, COVID-19 is an internal driver of digital transformation across all industries and the healthcare industry is no different. The study will attempt to assess the operational and financial performance of a select set of healthcare providers in India in the post-pandemic period. According to the study's findings, digital initiatives have significantly improved the performance of the healthcare sector and increased customer satisfaction by enabling faster service, disease diagnostics, shorter treatment times, and a reduction in related costs and time, such as report delivery and doctor consultations.

### Introduction:

In addition to diagnostics and equipment, there have been technological advancements spurred by digitalization in healthcare delivery and administration. Several healthcare innovations have been highlighted in the scholarly literature, including implementation of the health cloud, telemedicine facilities, automated physician order entries, electronic medical records, clinical decision support structures, mobile health, and assistive services (Heath & Porter, 2019; Zobair, Sanzogni, & Sandhu, 2020). The diagnosis and delivery of medical treatment have been significantly enhanced by these developments (Choi, Park, Choi, & Yang, 2019). Digital technology improves healthcare delivery and lowers diagnostic errors (Stoumpos et al., 2023). However, certain section of users has opposed digital developments in the majority of industries, including healthcare, both overtly and covertly (Talwar, Talwar, Kaur, Singh, & Dhir, 2021).

The application of artificial intelligence (AI) in healthcare is not very old. It was first used to handle a number of healthcare-related issues during the early stages of COVID-19. For example, big data analysis and AI have been used to manage COVID-19 data and track the history of patients (Jiao et al. 2023). Detecting infection, tracking and monitoring patients, predicting cases and mortality figures, creating vaccines, and assisting in reducing the man-hours of professionals are some of the important uses of AI during the COVID-19 period (Vaishya et al. 2020).

During the pandemic, an autonomous robot was used to manage, monitor, and limit human movement during lockdown, as well as to lessen inter-human contamination (Ahmed et al. 2020; Khan et al. 2020). Without direct human contact, it also assisted in the delivery of medications and food items to infected patients in hospitals (Chen et al. 2020; Ozkil et al. 2009; Yang et al. 2020). Weekly chest X-ray data was used by Rajaraman & Antani (2020) to detect cases of COVID-19 by applying deep learning algorithms.

Telemedicine too gained prominence during the epidemic. Both remote clinical and remote non-clinical services, such as administrative meetings, are referred to as telemedicine (Bitar & Alismail, 2021). Since scarce medical resources and healthcare experts were redirected to treat COVID-19 infected patients, the COVID-19 emergency had placed a great deal of demand on already-existing healthcare facilities. Some instances of telemedicine services in India included "eSanjeevani OPD," a nationwide tele-consultation service provided by the Indian government (Iyengar et al., 2020); online doctor consultations from "Practo," "E-Doctor Seva," and "Milo Doctor." The National Digital Health Mission (NDHM) aims to create a full digital ecosystem with the aim of providing universal health care via the use of appropriate technologies. Patients will have a single, convenient site to access telemedicine, e-pharmacies, diagnostics, and insurance claims processing with the NDHM's assistance. NDHM-led growth will be driven by the following five themes: interoperability, standardization across the health claim process, digitizing the prescription, transparency of information, and an environment that encourages innovation (Bharatwaj, 2023).

### **Literature Review**

In order to improve patient care and achieve process efficiency, healthcare providers are proactively deploying digital solutions involving applications of AI, Machine Learning (ML) and big data analysis along with using smart-sensors, robots, and the Internet of Things (IoT) devices (Lee, 2019).

The healthcare industry currently has space for innovation, led by the AI-based technology stack (Safavi & Kalis 2019, Apell et al. 2023). An analysis by Accenture in 2018 predicted that hospitals would spend \$6.6 billion a year on AI-related technology in the coming years. Kalis and Safavi's 2019 prediction states that "AI applications could create up to \$150 billion in annual savings for U.S. healthcare by 2026." AI-supported technologies improve doctors' diagnostic as well as treatment processes (Khalifa & Albadawy, 2024). AI-based diagnostic algorithms are applied in the detection of breast cancer, serving as second opinion in assisting radiologists image interpretations. Additionally, AI can diagnose other forms of cancer, like skin cancer, more accurately compared to a physician since it is based on information gathered from a large training data of existing patients (Esteva et al. 2018). Virtual human robots are being used for treatment of people with mental ailment (Olawade et al, 2024). Johnson et al. (2017) stated that in order to lend reliability of reported values, healthcare providers should prioritize data quality improvement projects. According to Tobore et al. (2019), AI has the potential to augment patient care at reduced expenses. Kuwaiti et al. (2023) also opined that AI helps in executing tasks more quickly, easily, and affordably.

The diversified use of AI in both clinical and administrative capacities was noted by Le et al. (2020) in their work. For example, telemedicine uses communication technology to disseminate services and information, and its implementation is likely to impact business models of hospitals. Sun (2018) explained how the use of AI in healthcare has quite a few advantages, including bettering patient management decisions, as well as possible side effects including fewer referrals, lower expenses, and time savings. According to a review made by Ali et al. (2023), AI significantly improves analysis, treatment outcomes, and disease identification in the biomedical science field, which boosts the performance of the sector as a whole.

Machine Learning assisted diagnostics hold the potential to transform healthcare by utilizing patient data to produce accurate and customized diagnoses (Chakraborty et al., 2024; Bajwa et al. 2021). This contrasts with the way physicians diagnose patients, choosing illnesses that provide the most plausible causes of their symptoms (Gigerenzer & Marewski, 2015). The aforementioned referral study makes it evident that the use of technology has significantly improved the delivery of services.

According to a survey by Aruba in 2017, around 60% of hospitals globally have integrated Internet of Things (IoT) into their everyday operations. Therefore, it is crucial to investigate how digital gadgets are influencing customer-vendor interactions in this sector (Lee, 2018 & Lee 2019). IoT supports the healthcare industry by identifying and preventing disease, improving healthcare facilities, and conducting routine monitoring activities for patients and the general public (Li et al., 2024). By providing patients with the finest care possible, businesses can boost their operational flow, which leads to profit and new markets.

In this regard, the current study attempts to analyze a few healthcare firms which have embarked on a path of digital transformation. The objectives of this study are:

1. To explore the various digital technologies adopted by major healthcare providers in India
2. To assess the effectiveness of healthcare management systems of select healthcare firms
3. To assess the impact of these initiatives on the operational and financial performance of the providers

**Methodology:**

We have reviewed recent research articles from esteemed publishers. To confirm these findings, we have attempted to present three case studies on Indian healthcare firms which have undergone digital transformation during the aftermath of COVID-19. The study covers digital transformation stories from the following healthcare providers in India- Apollo Hospitals, Thyrocare and Dr. Lal Pathlabs.

**Case Study-I: Apollo Hospitals**

India's leading hospital chain, Apollo Hospitals (henceforth AH), is based in Chennai. With 71 owned and operated hospitals, it boasts the biggest network of private hospitals in India. In addition to hospitals, it operates more than 5000 pharmacies, 300 clinics, 1200 diagnostic centres, and more than 200 telemedicine units nationwide. More than 200 million lives from more than 120 countries have been impacted by AH, which was founded in 1983 by Dr. Prathap C. Reddy. From standard wellness and preventative healthcare to cutting-edge operations and organ transplants, they provide a broad range of treatments and diagnostic services.

In India and Asia, AH is a leading innovator in the adoption of digital technology to revolutionize healthcare delivery. AH has attained Stage-6 on three esteemed digital maturity models:

- DIAM (Digital Imaging Adoption Model)- AH is continuously strengthening the integration of all aspects of digital imaging like microbiology, biochemistry, haematology, etc. into electronic medical records.
- Outpatient Electronic Medical Record
- INFRAM- Infrastructure Adoption Model

Over the years, AH has actively implemented:

- Voice AI: Through their collaboration with Augnito, voice-based AI is used to enter data into Electronic Medical Records (EMRs) more quickly and accurately.
- Telemedicine: Through their Tele-ICU service, patients who live far away may have access to vital medical knowledge.
- AI-powered tools: Leverage AI for tasks like cardiovascular disease risk assessment, thereby empowering data-driven preventive care.

Apollo has partnered with Google, Microsoft, Zebra Medical, Intel, Oracle (Blockchain), and other companies to roll out state-of-the-art, tech-driven healthcare solutions throughout its network of clinics and hospitals.

Some of the popular digital initiatives taken by AH are as follows:

**Clinical AI:** Clinical AI helps with diagnosis, therapy, and patient care, which is expected to bring in a transformation in the industry. Apollo's Clinical Intelligence Engine (CIE), has been developed to imitate a doctor, and it powers everything from primary care to condition management, home care, and wellness. It draws information from both real-world clinical data from AH's case mix and clinical data points from its' knowledge repository. Using NLP and Deep Learning algorithms, the CIE system has been constructed with over a billion data points. The algorithm now recognizes more than 1200 illnesses, ranging from common to uncommon, that are frequent in the area, as well as more than 800 distinct symptoms.

**Apollo ProHealth:** Apollo ProHealth is an all-inclusive health program made possible by AI and personalised health risk assessment. For point-of-care decision making, it integrates with electronic medical records via straightforward Application Programming Interfaces and makes the information readily available to doctors and

their patients. With the use of suitable clinical and lifestyle treatments, ProHealth provides people with actionable health analytics that enable them to minimize or completely eliminate health risks. ProHealth is technology-driven, but it also includes a human element—a personal health coach.

**Apollo TeleHealth Services:** Apollo TeleHealth leverages cutting edge technology to provide its exceptional health services to a wider audience. Apollo TeleHealth is the largest network of TeleConsultation, TeleRadiology, and Tele-ICU services in India. As a global leader in telemedicine, AH aims to improve underprivileged people's access to high-quality healthcare in both urban and rural areas, both in India and outside. At the moment, AH offers a range of services in sixteen Indian states through public-private partnerships, partnerships with Public Sector Undertakings, CSR initiatives, and individual customers. This facility was very well received by patients across the country during the Covid period.

**Voice AI:** AH and Augnito have teamed together to take use of Augnito's speech AI technology for the EMR system. While Augnito's voice AI is in its initial stages, it has shown promise in streamlining doctors' workflows by enabling them to interact with the EMR system via voice commands, which cuts down on typing time. It also improves data entry accuracy in the EMR by minimizing the chance of typos.

**Apollo 24/7:** 24/7 makes high-quality healthcare more accessible and reasonably priced for Indians by fusing cutting-edge technology with AH's heritage of clinical expertise and research. From initial doctor consultations to high-quality medication purchases, home diagnostic bookings, follow-up appointments, hospital visits, and even long-term condition management, Apollo 24/7 is there to support patients at every step. It provides unique digital solutions which are seamlessly linked to function as an all-inclusive platform for health management. Apollo 24/7 has amassed a base of over 25 million registered users and a doctor network of over 7,000 since its inception in June, 2020.

**Paperless Hospitals:** Hospital paperwork removal is a difficult undertaking. Ensuring that all records are available in real-time and online forms is part of the process. This covers every step of the process, from patient registration to admission, care, release, and follow-ups. In order to create a paperless hospital network, AH has started a number of projects, including an online appointment booking tool, electronic invoicing, e-prescription, online payments, and an OTP-based self-registration procedure.

Apollo has reaped substantial rewards from its digital transformation, especially during and after the outbreak of Covid, through the following modes:

- Better patient outcomes
- Increased operational efficiency
- Reach and accessibility

The financial performance can be gauged by looking into gross revenue and EBITDA figures been tracked over the years. From the graph below, it can be seen that AH's revenue has more than doubled, and EBITDA has almost tripled during the last five years.

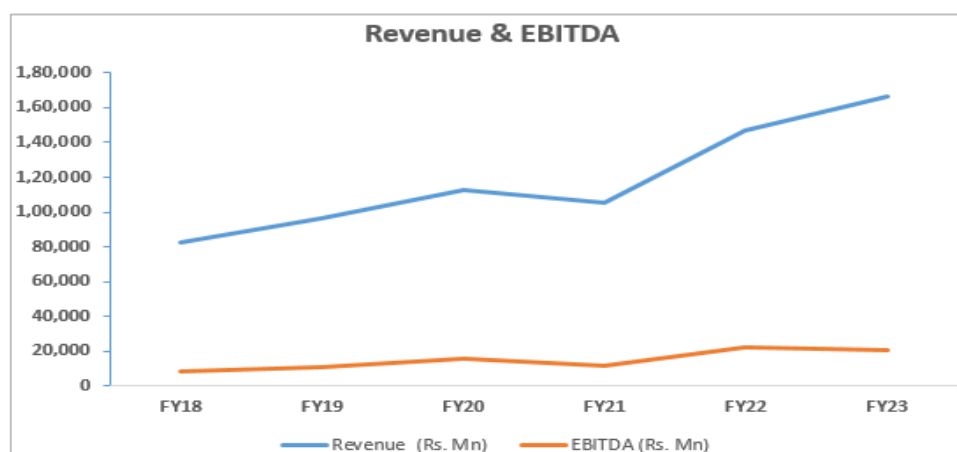


Table-1: Financial Performance

Year	Revenue (Rs. Mn)	EBITDA (Rs. Mn)	DE Ratio	Mkt Cap (Rs. Mn)
FY23	166,125	20,496	0.41	619,711
FY22	146,626	21,851	0.45	649,332
FY21	105,600	11,374	0.60	406,351
FY20	112,468	15,873	1.08	158,304
FY19	96,174	10,637	1.12	169,872
FY18	82,435	7,932	1.07	148,168

Source: Annual Reports of Apollo Hospitals Enterprise Ltd

On similar lines, during the period under study (FY18 to FY23), Market Capitalisation has also increased by four times, signifying the role of digital adoption in scaling up profitability of the organization. From 2020 onwards, there is a greater push towards implementation of digital initiatives which in turn has helped AH to expand its market share. The Debt-to-Equity ratio has also reduced significantly as the organization decided to reduce its debt burden through excess cash reserves generated after FY20.

Table-2: Operational Performance

Year	Occupancy Rate	Discharges (Thousands)	Outpatients (Million)	ALOS (Days)	ARPOB (Rs per Day)
FY23	64%	540	6.6	3.41	51,668
FY22	63%	460	6.8	3.96	45,327
FY21	55%	352	4.2	4.19	40,214
FY20	67%	478	4.3	3.86	37,397
FY19	68%	452	4.1	3.99	34,226
FY18	66%	428	3.5	3.99	31,963

Source: Annual Reports of Apollo Hospitals Enterprise Ltd

“ALOS- Average Length of Stay”

“ARPOB-Average Revenue Per Occupied Bed”

From an operational perspective, AH has managed to reduce the length of stay of patients through better and effective delivery of medical services. Although the occupancy rate took a temporary dip once the Covid vaccine was first administered, it has hovered around 65% over the last 6 years. By continuously innovating and implementing streamlined processes backed by technology, AH has managed to increase its patient base, as evidenced by an increase in patient discharges and outpatients over the years.

### Case Study-II: Thyrocare

Thyrocare is a leading diagnostic chain in India, known for its focus on preventive healthcare and affordable testing. They offer diagnostic services, including blood tests, pathology tests, imaging services, cardiac tests, and specific tests for women's and men's health. They have a large network of centers across India, with over 2,000 branches according to some sources. Thyrocare is known for being the first IT-enabled, fully automated diagnostic lab in India. They leverage automation and advanced technology to deliver high-volume testing with affordability.

Thyrocare has shown itself to be on the forefront of adopting digital tools in the diagnostics industry:

- AI-powered microscopy: They implemented SigTuple's AI100 to automate manual microscopy processes across their labs. This increases efficiency, reduces turnaround times, and improves the standardization and accuracy of reporting.
- Telepathology: Through PharmEasy's acquisition of Thyrocare, it is expanding its telepathology services, which allows digital consultations with remote pathologists.

These innovations position Thyrocare to deliver faster, more accurate diagnoses at lower costs, especially in areas with limited access to physical pathology services. Adoption of digital pathology has allowed Thyrocare for remote slide review by specialists, potentially improving access to second opinions and enhancing reporting quality. During the Covid lockdown period, they have been able to reap the benefits of these technological advancements as they were well-positioned to capitalise their technology infrastructure to counter mobility problems and pressure on financial margins. Collaboration with Kyndryl for cloud services management has enabled scalability, data analysis, and potentially supports future of AI-driven initiatives. The financial performance of the firm has been given below. Revenue from operations have significantly risen from Rs. 331.79 cr to Rs. 588.86 cr from FY18 to FY22. Profit After Tax has also almost doubled during the same timeframe.

Table-3: Financial Performance

Year	Revenue from Operations (Rs. Cr)	Earnings Before Interest & Tax (Rs. Cr)	Profit After Tax (Rs. Cr)
FY22	588.86	234.89	176.06
FY21	494.62	171.25	111.76
FY20	433.20	172.52	88.41
FY19	402.91	154.23	85.14
FY18	331.79	141.01	96.05

Source: Annual Reports of Thyrocare Technologies Ltd

Next, coming to its operational performance, Thyrocare has gradually increased its presence across the country during the last five years of its operation through technology enabled interventions. This is evident from the steady growth of its patient base from 13.60 million in FY18 to 16.32 million in FY22. Investigations performed and samples processed by the firm has also grown over the years- in FY22, it had performed more than 110 million investigations and processed more than 21 million samples.



Source: Annual Reports of Thyrocare Technologies Ltd

**Case Study-III: Dr. Lal Pathlabs**

Dr. Lal PathLabs is a diagnostic chain in India offering a wide variety of diagnostic tests and services. Founded in 1949, it has been a leader in providing diagnostic services for over 7 decades. They offer routine and specialized tests, including blood tests, urine tests, and other pathology investigations

Dr. Lal PathLabs has actively embraced digital adoption to enhance their diagnostic services and streamline processes for both patients and internal operations. Here are some key areas of their digital focus:

- Mobile App- for appointment booking, sample collection scheduling, report access, and online payments, eliminating the need for physical visits for routine tasks
- Phlebotomist Management: Phlebotomists utilize a mobile app integrated with the patient app. This allows for efficient scheduling and route planning, optimizing sample collection processes
- Chatbot: A website chatbot helps patients with report inquiries, reducing call center workload during peak times
- Reco.ai: An AI-powered recommendation engine that makes use of sophisticated algorithms to provide patients with customized suggestions for relevant assessments based on their current state of health, historical account trends and demographic data plus additional pertinent elements. This state-of-the-art technology assesses different data points to produce customized recommendations for diagnostic procedures that are most suitable for any person's different medical conditions.

This has led to an improvement in lab efficiency and reporting accuracy. Investment in automation within labs, including high-capacity sample sorting and integrated testing processes, has led to faster turnaround times and reduced human error. These digital initiatives position Dr. Lal PathLabs for continued growth and improved service delivery. They can offer faster, more accurate test results at a larger scale while providing a more convenient experience for patients.

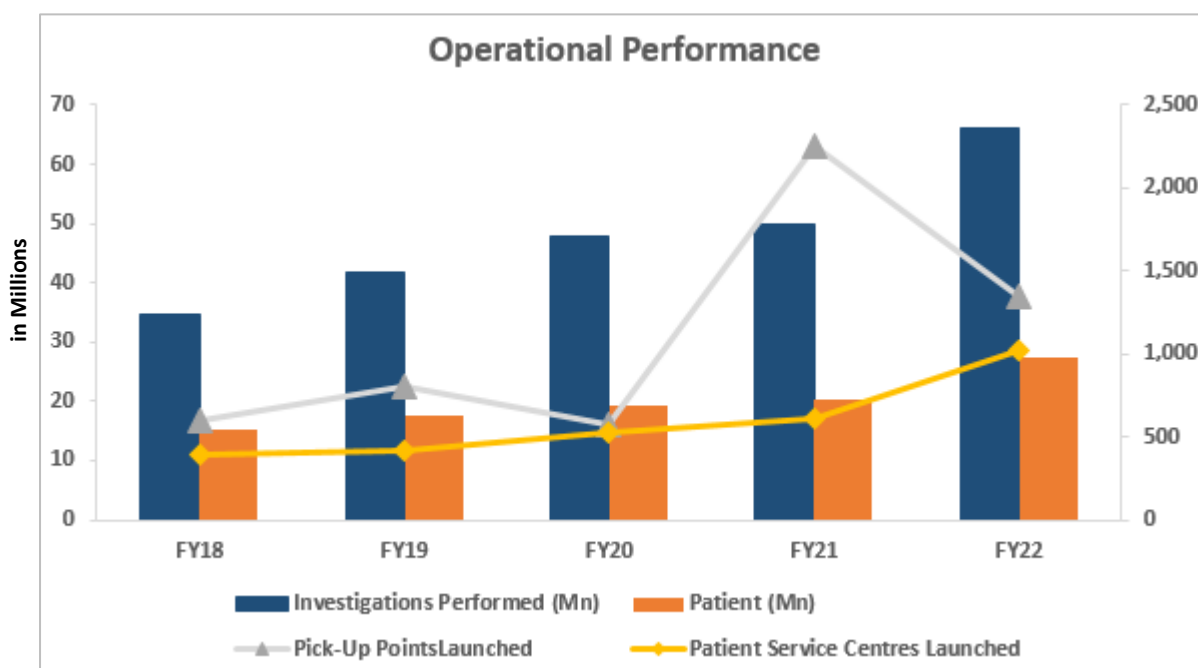
These initiatives have a direct bearing on the financial and operational performance of the organization. Dr. Lal PathLabs has shown positive financial performance over the last 5 years. Revenue has grown steadily at 18.4% (CAGR) over the past 5 years. Net profit has also seen growth, with a CAGR of around 19.5% in the last 5 years. It also maintains healthy profitability ratios like Return on Equity (ROE) of around 23.5% and Return on Capital Employed (ROCE) of around 30% over the last 5 years. Further, the company has significantly reduced its debt over the past 5 years and is virtually debt-free currently. The table below depicts the growth in revenue, EBITDA and PAT from FY18 to FY23.

Table-1: Financial Performance

<b>Year</b>	<b>Revenue from Operations (Rs. Cr)</b>	<b>Earnings Before Interest &amp; Tax (Rs. Cr)</b>	<b>Profit After Tax (Rs. Cr)</b>
FY22	2,087	600	369
FY21	1,581	463	297
FY20	1,330	366	228
FY19	1,203	313	200
FY18	1,057	261	172

Source: Annual Reports of Dr Lal Pathlabs Ltd

From an operational standpoint, Dr. Lal PathLabs has aggressively expanded its network of diagnostic centers. Historically, bulk of the company's revenue came from Delhi NCR and the northern belt of the country. To expand its presence across the country, it has aggressively set up patient service centres and pick-up points, particularly in tier-II and tier-III cities. The following graph depicts the steady improvement in operational performance over the years. The volume of patients serviced and investigations performed have almost doubled in the last five years.



Source: Annual Reports of Dr Lal Pathlabs Ltd

#### Discussion:

The Indian healthcare industry is witnessing a transformative shift, supported by the rapid adoption of digital solutions. This digital revolution is poised to reshape the delivery of health services, improve patient experiences, and enhance overall health-related outcomes. The pandemic has enhanced the scope of digital adoption in multiple spheres including, but not limited to, telemedicine consultations, online appointment booking of investigations, ePharmacy usage, usage of electronic health records, adoption of wearable tech and mobile health apps, etc. The leading healthcare providers discussed above have significantly expanded their businesses manifold especially after the outbreak of Covid by leveraging their digital and advanced analytics platforms. The key drivers of digital adoption are also being fuelled by several government initiatives, rising smartphone penetration, growing healthcare costs and increased patient expectations. The Ayushman Bharat Digital Mission (ABDM) is a cornerstone of India's digital healthcare journey. It aims to create a seamless, integrated digital health ecosystem. Further, increasing smartphone ownership has made digital health solutions accessible to a wider population. Digital solutions offer potential cost reductions through efficient operations and preventive care. Finally, patients are demanding better access, convenience, and personalized care, driving innovation in digital health.

#### Conclusion and Future Research:

It goes without saying that when compared to previous operational procedures, modern healthcare systems are geared to undergo a complete transformation. Many healthcare providers are incorporating cutting-edge technology into their service offerings. AI and ML algorithms, IoT related smart gadgets and other digital technologies are speeding up the healthcare process from disease detection to diagnosis to final billing. Along with augmenting patient satisfaction, it is also saving the lives of patients in critical condition at a reduced cost. The current study discusses how various technologies are being adopted by healthcare providers and the way they are being used to treat patients with acute diseases. This study will also give researchers and healthcare operators a better understanding of digital transformation initiatives of a few leading healthcare providers in India. Further research is needed to determine the impact of these sophisticated technologies on the patients' life expectancy measures. The true influence of these technologies on human life may only be ascertained then.

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