L.E.K.

Special Report

Making the AI Leap: Boosting Singapore's Competitiveness in Biotech

Contents

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Introduction

Objective of the report

Imagine a new vision of Singapore in 2025 ...

Following years of investment through artificial intelligence (AI)-centric venture funds and government grants, Singapore has moved beyond applying AI to disease diagnosis and management. It has developed world-class capabilities in applying AI to the discovery and development of new medicines. Singapore startups, in partnership with multinational biopharmas and local hospitals, are using clinical data and results from the national precision medicine initiative to discover new treatment paradigms for Asia-prevalent diseases. Leveraging Singapore's National Supercomputing Centre, therapeutics are designed in silico in days instead of years. Next-generation manufacturing facilities deliver new modalities — including cell and gene therapy — for downstream testing. AI platforms predict toxicity and drug metabolism to arrive at candidates for clinical development. Using large datasets from clinical studies and referencing electronic health record (EHR) systems and rich health databases, smaller, adaptive clinical studies can be run in Singapore. AI has halved the time it takes to discover and develop a drug.

Parts of this future are already in place. This *Special Report* discusses how Singapore can bring this vision to full fruition and examines Singapore's AI healthcare and biopharma strategy by drawing on AI use cases globally, the wisdom of senior executives in local AI-oriented startups, and the expertise of the L.E.K. Consulting Global and APAC Life Sciences team. This paper aims to inform the reader about the current scale of AI adoption in Singapore healthcare and discuss ways to extend its use in drug discovery and development.

Singapore's national strategy to accelerate AI development

With more than S$500 million committed to funding AI-related activities under the Research, Innovation and Enterprise 2020 (RIE2020) plan,[1] Singapore aims to be a global leader in developing and deploying AI solutions by 2030. Singapore's 2018 Digital Government Blueprint called on all ministries to implement AI in at least one project by 2023.[2] Since its unveiling in 2019, the National AI Strategy has accelerated Singapore's AI development,[3] addressing chronic disease prediction and management while encompassing AI ecosystem enablers and AI projects in transport and logistics, smart cities and estates, healthcare, education, and safety and security.

Expanding Singapore's AI focus to drug development

In recent years, medical and technological advances such as improvements in computing power, growth in genomic sequencing databases and the implementation of EHR systems have resulted in the proliferation of AI healthcare solutions. These applications cover different segments of the patient journey, including self-management of disease symptoms by symptom and biometric analysis, diagnosis using image and biomarker analysis, clinical decision-making using predictive analysis, and real-time patient adherence monitoring (Figure 1). Among AI subfields, machine learning (ML) and natural language processing (NLP) have the greatest applicability in the healthcare space. The focus has been on using AI in chronic disease management for accurate diagnosis, treatment and patient monitoring. Drug discovery and development runs parallel to the patient journey, drawing on data and insights generated during treatment and monitoring of disease to deliver therapeutics that create new treatment paradigms. This paper focuses on the possibilities of expanding Singapore's AI focus to include the drug development space, which would improve the accuracy and speed of availability of new treatment options. Furthermore, this would actively expand the biotechnology space by fostering talent pools and investments by pharma and medical device companies.

Figure 1
Healthcare AI startups

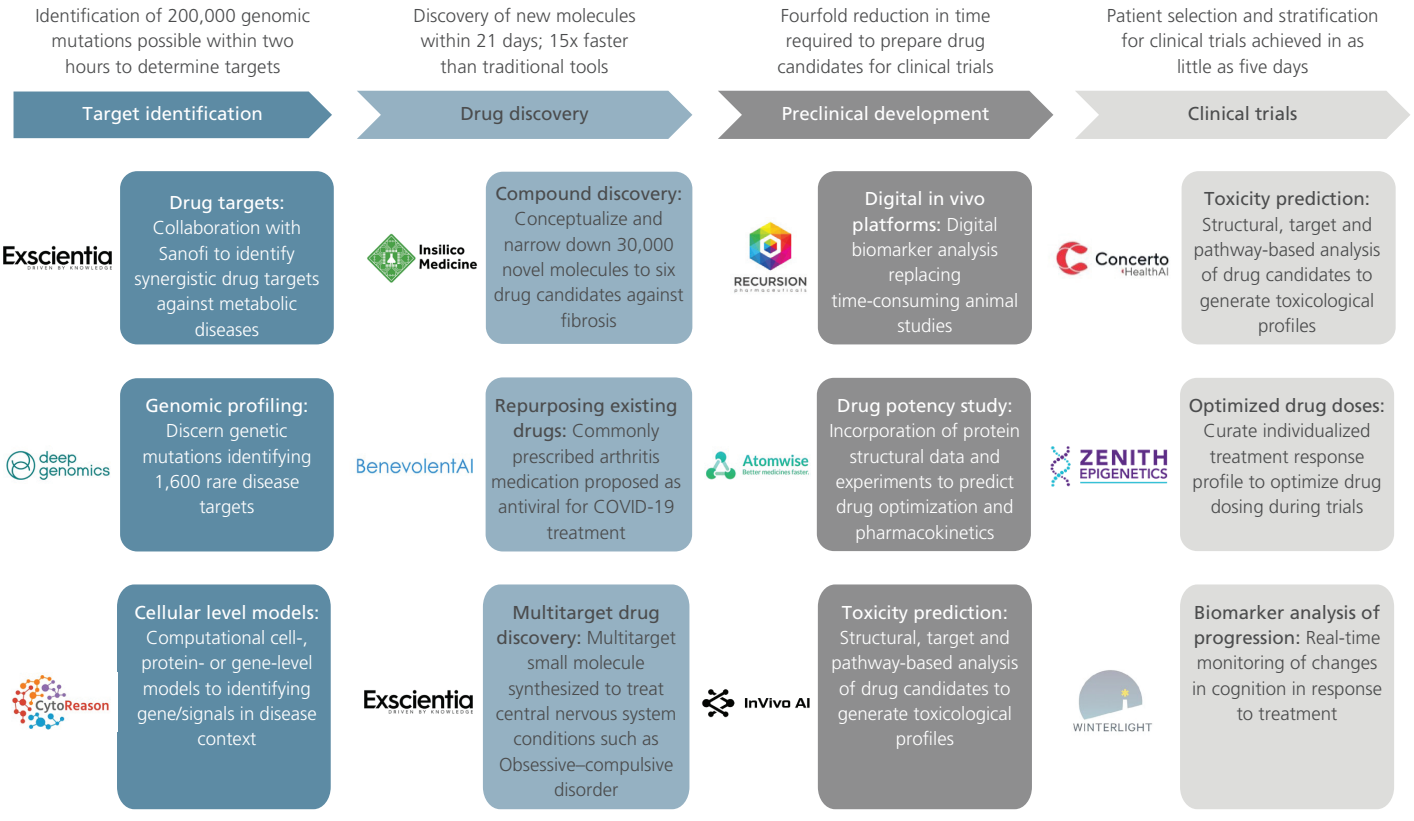
Source: L.E.K. research and analysis, CB Insights

AI can reduce drug discovery times and boost productivity

Research and development (R&D) efficiency in drug development has been on the decline (Eroom's Law),[4] with costs of R&D per drug increasing exponentially from US$800 million in 2001 to the current estimate of US$3 billion.[5] AI has the potential to boost productivity and inject innovation across all stages of the drug development process, from target discovery to postmarketing, and thus helps reduce the increasing costs associated with R&D.

In addition to curbing R&D costs, innovative AI technologies have the potential to address several drug development pain points, such as target validation, improving the design of clinical trials by biomarker-based screening and reducing the time for the trials using efficient patient recruitment.[6] Highlighted below are examples of global breakthroughs seen in each segment of drug discovery and development (Figure 2).

Figure 2
Transformative power of AI in drug discovery and development



Global breakthrough examples in each segment of drug discovery and development

Target identification

- **Exscientia** uses an AI-based system to identify the most chemically tractable targets (i.e., those that have the highest likelihood of binding a well-balanced small molecule). The algorithms facilitate analysis of large and complex databases of clinical data for platforms, such as enhanced phenotypic screening, to identify molecules that modulate the key phenotypes of the disease. These molecules can then be used as targets for the next stage of the drug development process.
- **Deep Genomics** has identified 1,600 rare disease targets using its splice-switching oligonucleotide technology, which is capable of mapping out previously unexplored parts of the genome sequence to identify mutations characteristic of disease. The speed of target identification allows for new therapies targeting the sites and validating/prioritizing therapeutic approaches.
- **CytoReason** in collaboration with Pfizer is redefining cellular-level analysis by developing libraries of molecular data using computational cell level models, which can be translated into insights for robust target discovery and drug response analysis.

Drug discovery

- **Insilico Medicine's** GENTRL AI system succeeded in using AI to design a new molecule from scratch in 21 days and validate it in 25 days, approximately 15 times faster than traditional pharma companies. Through a venture capital investment partnership, WuXi AppTec evaluates and validates drug candidates generated from Insilico Medicine's ML platform.
- **BenevolentAI** in partnership with Eli Lilly, using its AI-driven drug discovery platform, hypothesized and subsequently validated the use of baricitinib (a drug typically used to treat rheumatoid arthritis) in combination with remdesivir for the treatment of hospitalized COVID-19 patients. AI has allowed for a systematic method of repurposing existing drugs to cure diseases and brings the discovery times down to a few months as opposed to years.
- **Exscientia** in collaboration with Japanese pharma firm Sumitomo Dainippon designed a compound to treat patients with obsessive-compulsive disorder. The compound entered clinical trials phase within 12 months, a vast acceleration compared with the traditional approximately four-and-a-half-year timeline.

Preclinical development

- **Recursion Pharmaceuticals** is transforming preclinical research with its state-of-the-art digital in vivo platform, Digital Vivarium. Using physiologically relevant digital biomarkers, the high-throughput technology allows researchers to gain clinically relevant insights into drug efficacy and potential toxicity, thus industrializing the drug discovery process in order to increase the rate of bringing drugs to clinical trials.
- **Atomwise's** AtomNet platform can screen 16 billion compounds to analyze potency and mechanisms of action and to conduct lead optimization studies relevant to the target disease, proving to be 10,000 times better than wet-lab experiments as part of the preclinical research process.
- **InVivo** AI has a streamlined approach to clinical trial processes, using ML models to generate toxicological profiles of drug candidates through analysis of their properties and mechanisms, thus reducing the risk of clinical trial failure. AI can be used to streamline the preclinical testing process by using simulations to identify drugs with potential potency and predict their toxicity.

Clinical

- **Concerto** AI in collaboration with Pfizer uses prefabricated synthetic control arms based on real-world data from EHR systems to identify and match patient populations to clinical trials, enabling effective clinical trial design by reducing patient enrollment times and accelerating trial completion times.
- **Zenith Epigenetics** leverages its CURATE.AI technology platform to continuously monitor tumor progression in patients undergoing clinical trials in order to curate an individualized treatment response profile and optimize the drug doses, so as to obtain a successful outcome.
- **Winterlight Labs'** AI technology enables detection and monitoring of cognition changes in dementia patients in clinical trials. AI tools also have the potential to analyze data collected from trial participants in real time, flagging any events for clinical trial investigators that may lead to patient dropout.

State of healthcare AI in Singapore

Healthcare landscape in Singapore

Healthcare systems in developed markets face an increasing strain on resources from aging populations and a concomitant rising prevalence of chronic diseases. Healthcare price inflation in Singapore now far exceeds the general consumer price inflation rate. Singapore's estimated healthcare spend of S$18 billion in 2020 will almost triple to S$50 billion by 2029.[7]

Recognizing that this rate of spending is unsustainable in the longer term,[8] the Ministry of Health (MOH) is looking for ways to reduce expenditure while improving healthcare outcomes. Such efforts include transforming delivery care models, assessing alternative employment models and embracing innovative digital technologies such as AI.

There are several good examples of Singapore-incubated companies leveraging AI to improve healthcare outcomes. In response to the COVID-19 pandemic, two such companies quickly extended their AI solutions to support the monitoring and management of COVID-19 patients, reducing the risk of front-line staff exposure to the virus and lifting workforce productivity.

Biofourmis uses AI to predict health deterioration among post-acute heart failure patients to prevent rehospitalization. Its solution, the Biovitals Sentinel platform, has been extended to remotely monitor COVID-19-positive patients and aid in early detection of deterioration, a solution deployed by the MOH. Another company, KroniKare, uses AI technology to quickly assess and diagnose chronic wounds, allowing hospitals to care for more patients. This solution was adapted to create an automated temperature screening solution in partnership with Singapore's Integrated Health Information Systems (IHiS).

Healthcare is a pillar of Singapore's National AI Strategy

Within the healthcare sector, Singapore's National AI Strategy has three main objectives: (i) develop a personalized score for chronic diseases to help individuals receive earlier and more targeted interventions from care teams, (ii) provide clinical decision support for primary care doctors and (iii) empower patients to monitor and manage chronic diseases better. Given the rising prevalence of chronic diseases in the country and the corresponding burden on healthcare expenditure, the prominence given the role of AI in healthcare is apt. This paper, however, seeks to highlight the benefits and importance of AI in a key but overlooked preceding step of the patient treatment journey: the drug development process, an area in which Singapore is well positioned to become a global leader.

Singapore's competitive edge in AI drug development

Singapore has a thriving biotech ecosystem comprising biopharma startups, incubators and accelerators for biotech, and big pharma R&D centers and partnerships. In 2018, Singapore chalked up over $350 million in biotech deals and investments.[9] A*STAR played a key role. In that year, 29% of biotech startups were A*STAR spinoffs. Furthermore, in 2019 the Singapore Therapeutics Development Review (STDR) launched a grant supporting early-stage funding for projects up to S$750,000.[10]

Singapore's health tech investment per capita is ~US$23 in 2019, on par with the U.S. However, startup progression has been suboptimal. Despite the funding availability, only 5% of Singapore-based startups' most recent funding rounds were series B or above. In China, series C and above deals represented about 30% of all deals in 2018. In the U.S., 9% of the health tech innovators achieve an initial public offering/exit within a nine-year time frame.[11] Though Singapore's investment per capita is comparable to that of other leading nations, there remains ample scope for accelerating health tech startups.

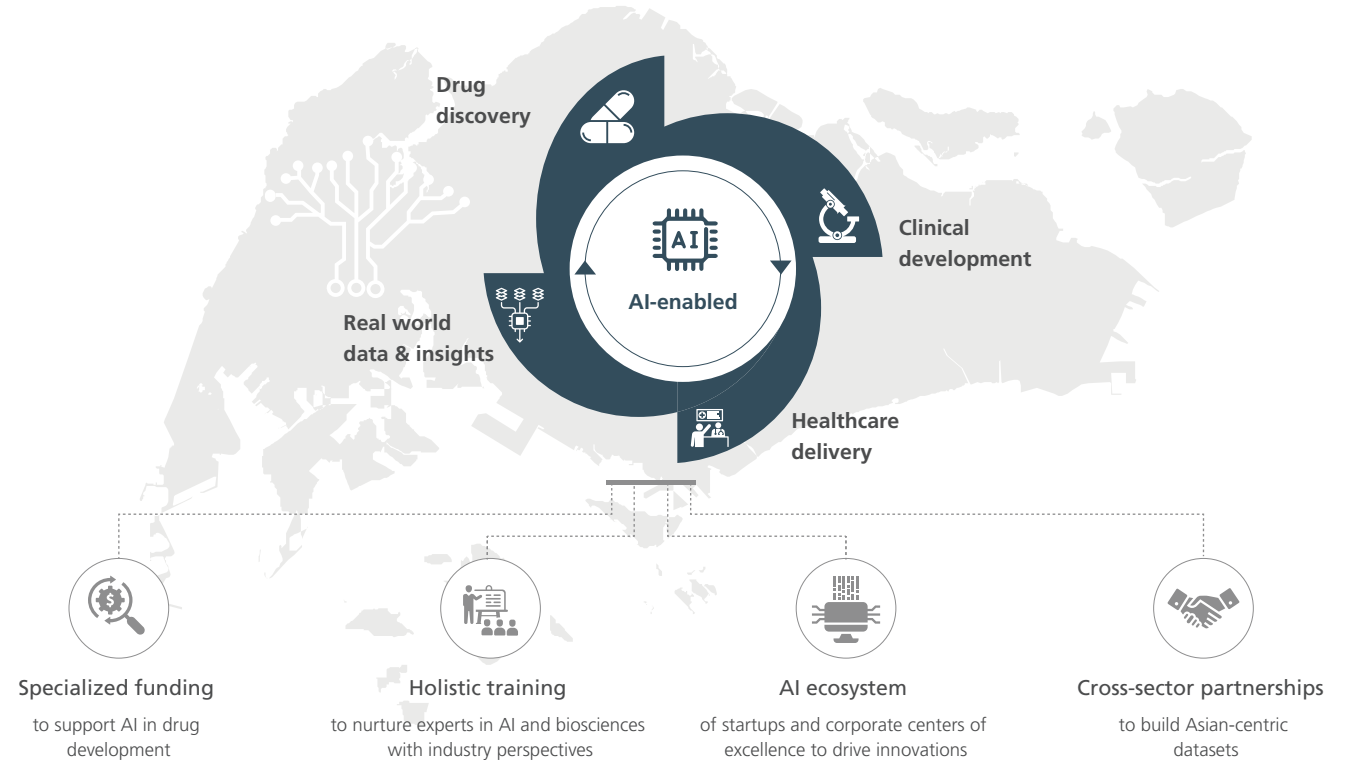
In its ambitious quest to stay ahead as a global, technology-enabled city, Singapore embraces AI as part of its Smart Nation journey. The government is familiar with the rhetoric that characterizes the nation's shortcomings as a tiny city-state. Dr. Vivian Balakrishnan, minister-in-charge of Singapore's Smart Nation Initiative, has stressed the need for finding Singapore's "sweet spot," the nation's unique AI niche given that it lacks the "oceans of data that China has or the unique (start-up) ecosystem in Silicon Valley."[12] Singapore's approach must target specific AI applications for development and deployment at scale in specific industries and must play to the country's existing strengths: state-of-the-art infrastructure, effective governance and a digitally savvy population. That sweet spot may also be found in applying digital solutions such as AI where quick productivity gains can showcase Singapore's world-class capabilities in key sectors (transport, healthcare and education).

Singapore vision for AI in medical sciences

A future as described below can be achieved if Singapore takes immediate steps toward building the AI drug discovery and development ecosystem:

- Government and industry leaders' sponsored grants have been developed specifically to support the use of AI in drug discovery and development.
- Budding talent is given holistic training and mentorship to nurture experts in data and biomedical sciences with industry perspectives. Pharma firms nurture talent internship opportunities, and there is extensive collaboration between academia, research institutions and industry.
- Building on existing AI expertise and the integration of AI across the drug discovery and development workflows, new AI-driven startups emerge; others find room to grow.
- Singapore startups in partnership with pharma/biotech giants and hospitals freely access clinical datasets for genome analysis, biomarker analysis and neural network mapping of diseases prevalent in the Asian population to identify target biomarkers for therapy development.
- Repurposing combinations of existing drugs for new disease treatment using AI tools to identify the most potent combination therapy is actively conducted.
- AI is routinely used to address common pain points in clinical trial management.
- Advanced image analysis techniques are used to identify drugs with the highest probability of success in clinical trials. In collaboration with hospitals, analysis of disease conditions facilitates patient recruitment, thereby minimizing clinical trial failures.
- A continuous feedback loop is established across the phases of drug development to strengthen the datasets used for AI analysis and improve predictive tools' accuracy.

Figure 3
Singapore vision for AI in medical sciences



Core strengths exist in Singapore today

The use of AI has vast potential to accelerate biopharmaceutical development in Singapore by reducing R&D costs for pharmaceutical companies, unlocking profits from more years of market exclusivity as a patented drug due to accelerated approval rates, and allowing faster patient treatment. Beyond its global reputation in biosciences, Singapore has several comparative advantages in the AI biopharmaceutical space.

An embedded national AI healthcare ecosystem

There are over 20 research institutes under A*STAR with strong capabilities in biomedical engineering and data science research. Funding and support from the likes of Entrepreneur First have imbued aspiring researchers with a commercial perspective.[13] The International Federation of Robotics ranks Singapore as the second-most automated economy globally. The national AI healthcare strategy — combined with the country's growing local AI expertise/training capabilities — supports the common goal of building a robust biotech digital ecosystem.

Quality data availability in a secure IP hub

Singapore is widely recognized for its world-class intellectual property (IP) and data security, attributes underpinned by the IP Hub Master Plan. Its trusted business environment and access to opportunities arising from the digital economy help attract foreign investment to Singapore. Drawing parallels with the financial sector, Singapore can become a regional, potentially global, IP leader. Singapore's National Electronic Health Record (NEHR) system has long since been adopted by public hospitals/polyclinics and has now transitioned to the cloud.[14] The resulting availability of high-quality clinical data in an organized and accessible framework facilitates the integration of disruptive AI tools. The National Supercomputing Centre (NSCC), established in 2015, further provides the data analytics infrastructure necessary to boost AI initiatives.[15]

Interdisciplinary expertise and solutions

Industry's established presence in Singapore's biotech sector is an ideal springboard for the large-scale development of therapeutics. The close alignment between the leading research institutions under A*STAR and their industry partners fosters the research that can be commercialized within a reasonable time frame. In 2019, Tan Tock Seng Hospital pioneered the use of a robotic arm to perform angioplasty, increasing precision and cutting recovery times.[16] Singapore companies such as Structo and Osteopore are working toward developing bioabsorbable implants using proprietary 3D printing technology to develop implants and prosthetics.[17] The incorporation of such engineering tools in the clinical setting is transforming patient care based on personalized treatment.[18] This type of collaboration between physical and biological sciences reflects the interdisciplinary strength of Singapore's healthcare ecosystem.

Infrastructure to study Asian-centric diseases

Singapore recently established the National Precision Medicine (NPM) program involving hospitals and A*STAR research institutions. The aim is to develop customized treatments tailored to Asian populations. The genetic diversity of its three main ethnic groups supports Singapore's ambitions in precision medicine as the country builds the infrastructure for the gathering and analysis of human genomic datasets to identify disease variants — while ensuring data security.[19] AI genome screening platforms and niche Asian genome analytical tools could be the foundation for AI drug discovery and development.

Strong technology infrastructures and investments

Singapore is recognized for being a technology hub fostered through well-developed IT infrastructures supported by government investments of up to S$3.5 billion in 2020. The key focus areas of the investments include the development of digital-centric services supporting citizens and businesses, and the building of integrated systems for cloud storage, cybersecurity and data analytics. The government has also initiated a Digital Acceleration Grant offering 80% coverage of expenses to companies adopting digital solutions in their workflow.[20] Strong technology and digital infrastructures and investments could be the impetus for the development and integration of AI in the healthcare sector, especially drug development.

Challenges and solutions

A growing ecosystem encourages AI healthcare development in Singapore, involving stakeholders such as skilled workers, investors, regulators and end users of AI solutions. Besides more health tech startups, a healthy AI ecosystem needs investments from life science professionals and multinationals. However, key challenges remain, slowing the use of AI in development. For AI to be fully integrated into the drug development process, four AI ecosystem challenges must be addressed: (i) building a specialized funding structure, (ii) nurturing entrepreneurial talent, (iii) fostering an interdisciplinary AI community and (iv) gathering high-volume data for drug development AI.

Building a specialized funding structure	
The Challenge	Solutions
While the Singapore government has initiated funding to kick-start the adoption and innovation of AI, more can be done to attract investments from venture capitalists (VCs) and other investors. The assessment of AI technologies is a challenge for the uninitiated, and the lack of AI talent includes investors with business acumen and biopharma and data science experience. The 100 Experiments (100E) program provides some financial support for AI projects, offering up to S$250,000 per 100E project. And for healthcare specifically, AI Singapore has come up with initiatives such as the AI in Health Grand Challenge, which offers up to S$35 million to three teams from academic/clinician groups to pioneer innovative AI solutions. These funding mechanisms are mainly focused on chronic disease management, with insufficient emphasis on commercial viability.	Government-led entities such as EDBI or Temasek could participate as cornerstone investors, spearheading funding for AI startups. The attraction of such co-funding investments is enhanced by the maintenance of a light regulatory burden, e.g., on the use of experimental methodologies in clinical trial phases. Incentive schemes, including tax breaks, can further encourage global VCs to participate while public-private partnerships could attract life science-knowledgeable investors. A specialized fund, or allocated funding for AI in drug discovery and development specifically, would also accelerate growth in this space. The experience of firms like DigiTx Partners and Andreessen Horowitz a16z Bio has demonstrated the need for specialized funding. On the corporate side, pharmas should be encouraged to invest in research groups or startups using AI for drug development.
Nurturing entrepreneurial talent	
The Challenge	Solutions
Singapore lacks the critical combined skill sets of clinical acumen and data science, as well as the caveats and limitations of data. There is no structured mechanism for industry experts to provide scientific and commercial support to academia and startups. A*STAR's A*ccelerate works with research institutes on multidisciplinary projects, but its guidance is limited to developing business plans for their innovations. There is much less early involvement in the technology design process to ensure commercial viability. The 100E program initiated by the Singapore government matches companies with AI researchers in institutes of higher learning. While these programs groom local talent and drive AI adoption, they are too broadly targeted at AI applications such as ML and data science.	Collaborations with national healthcare centers and dialogues with entrepreneurs in residence (EIRs) would help bridge the gap limiting the translation of technologies from academia to commercialization. EIRs can play a crucial role in building new companies and providing the technical and commercial guidance required to nurture successful entrepreneurs. Their early deep involvement in tech startups would increase the likelihood of the large-scale integration of AI tools. Such a model has been adopted by the Wyss Institute at Harvard, which drives breakthrough technologies from prototype stages to commercialization.[21]

Fostering an interdisciplinary AI community	
The Challenge	Solutions
Established structures are lacking that would support interdisciplinary workings across academia, research institutions and industry to drive new innovations to commercialization. There is an urgent need to strengthen the local community of experts, and also a lack of mentorships tailored to AI applications in healthcare. Singapore has worked to implement an interdisciplinary curriculum in the universities, one that encourages contact and collaboration across different domains in academia. Within research institutions, A*STAR further pursues this cause by fostering multidisciplinary projects across science, engineering and medicine. More interdisciplinary workings across the AI community are needed, bringing together life science domain experts with data scientists, a gap that must be bridged if the common vision of deepening the healthcare AI ecosystem is to be achieved.	Singapore could establish a knowledge-sharing consortium composed of academia, research institutions and industry leaders to form a community dedicated to addressing various aspects of drug discovery and development. Programs could support AI innovation in biopharmaceutical research wherein researchers from academia and institutions directly work with established biopharmas to address pain points in drug discovery and development. By partnering with health tech startups or academia, companies gain access to basic research with the potential to validate and build groundbreaking therapies. Industry-academia partnerships via industry-funded research or rotation programs could bridge the gap between academic knowledge, clinical science and industry perspectives. Singapore's manufacturing expertise in other AI-driven industries, such as electronics or transport engineering, could be applied to the similarly complex manufacturing processes in AI drug development (e.g., 3D drug printing).
Gathering high-volume data for drug development AI	
The Challenge	Solutions
The use of AI in different aspects of drug development requires large volumes of patient data, data that needs to be refined continuously. Though Singapore is recognized for the quality and reliability of its datasets, its small population size limits the volume of clinical data that can be generated and collated. Such limitations were evident for COVID-19, where there was insufficient historical patient data to train and test AI algorithms. Partnerships between startups and industry giants have been suggested as a solution to gain access to real-world data (RWD). However, data privacy and de-identification of personal data have proven a challenge for the plethora of datasets. Finally, the majority of the global databases are based on Caucasian datasets, making patient-specific drug development in Singapore more difficult.	Despite Singapore's small size, its reputation for good-quality clinical and medical data is a differentiator. Singapore's expertise in EHR and hospital ownership/management could be further leveraged for the collation of organized datasets specific to Asian populations. Partnership agreements could be established to exchange technical expertise and brainstorm new ways to push the frontiers of AI technology. The Clinical Data Analytics platform already enables researchers to access de-identified patient datasets.[22] Centralized clinical and medical data shared in such partnership agreements could help build a data-sharing framework accessible to the entire drug discovery and development ecosystem. Building on its existing AI expertise and high-quality data storage infrastructure, Singapore could build a data consortium using inputs from research centers, pharma companies and RWD. Singapore could yet become a regional data hub, running APAC-wide, AI-driven drug discovery initiatives and clinical trials.

Examples of new funds focused on Digital Health

DigiTx Partners: Founded in partnership with Astellas Pharma, DigiTx Partners focuses on long-term investments in startups and growth-stage companies in the digital health space. Investments are particularly driven toward digital solutions for innovative drug development and improving patient outcomes. With co-investment from 3M Ventures and Bose Ventures, recent investments of US$20 million and US$6 million in Embr Labs and Eko, respectively, aim at accelerating AI-driven patient care and real-time monitoring. In addition to financial support, the management team comprises clinicians, data scientists, consultants and EIRs with the necessary industrial expertise to successfully mentor early- to late-stage startups to deliver innovative solutions for healthcare.

Andreessen Horowitz: Founded in 2009, the U.S.-based company launched the first US$200 million Bio Fund in 2015 with a dedicated Bio Team. Its recent launch, the US$750 million Bio Fund III, has a primary focus on developing new-generation companies specializing in AI in drug development, RWD gathering and analysis, and predictive technology for disease treatment design. Recent investments as part of the bio funds include Insitro and twoXAR, both focused on integrating ML in biopharmaceuticals. In addition to the Bio Team, the fund is led by founders with a multidisciplinary background in clinical experience, data sciences and management consulting.

Value creation potential for Singapore

By overcoming the challenges of adopting AI in the drug development process, Singapore would lift the entire biotechnology ecosystem, build a bigger AI talent pool and increase the city-state's attractiveness to potential investors. By shifting its focus away from physical infrastructure development (new labs and manufacturing facilities) toward the digital infrastructure (integration of ML for disease simulation and predictive analysis), Singapore could advance to the forefront of innovative drug development. The following are examples of the value creation that such a transition could bring.

A virtuous talent cycle, enabling sustainable growth in the ecosystem

The adoption of AI in healthcare will create skilled roles such as data scientist, AI engineer, data governance expert, data entry expert, data engineer and chief AI officer. In turn, this would deepen the pool of AI talent available to other AI-driven industries.[23] Global AI firms, such as AI startup Appier from Taiwan and Darktrace from the U.K., have made Singapore a base for regional expansion, creating high-value-added employment opportunities. Government-led initiatives, such as the AI apprenticeship, ensure local talent has the necessary technical AI skills. The skills development of researchers in academia and startups can be achieved through partnerships with pharma and biotech giants in the drug development space. Entrepreneurial training programs paired with industry expert mentorships would reinforce the virtuous talent cycle and drive health tech innovation. Such efforts would contribute to an expanding community of AI and biotech experts, breaking down silos and fostering collaborative relationships across the healthcare sector.

Turbocharged biotechnology ecosystem

Globally, the digital health market is forecast to reach US$285 billion by 2022. Singapore is well positioned to acquire a significant share of this market.[24] An established AI drug development framework would drive inward big pharma investment and commitment to the local ecosystem. The knowledge and funding sponsorship from industry experts would further stimulate the growth of healthcare startups, from medical diagnostics to health management. A dedicated team in Asia, leveraging local AI capabilities, would expedite the commercialization of digital solutions and attract higher investment in the digital health space. Partnerships between corporates and startups could catalyze existing innovations to build a skilled AI healthcare hub, producing a wave of new digital health technologies and products.

Increase in ROI for the healthcare ecosystem

Globally, AI in healthcare is expected to yield a compound growth of 43.5% over a seven-year forecast period, suggesting a positive return on investment (ROI) within three years.[25] AI can help drive drug development by using automated drug discovery, trawling vast datasets to identify targets, screening clinical trial candidates and predicting synthesis routes — thereby reducing discovery times and maximizing the value of the IP. AI technologies can develop solutions that prevent serious adverse events in clinical trials by identifying high-risk individuals before they enroll.[26] This would result in higher drug approval rates and reduced time for the medications to reach the market. Drug manufacturing costs are rising with extended R&D timelines and increasing demand for multistep continuous manufacturing processes. Leveraging platforms like the Digital Factory by PIPS, Singapore can streamline workstreams by piloting AI innovations in existing manufacturing plants to facilitate operational excellence. In addition to the productivity increase in the drug development sector, the integration of AI platforms would benefit the overall healthcare ecosystem with both social and economic gains.

Conclusion

Key takeaways

With its national AI leadership, technology assets and interdisciplinary approach, Singapore is poised to establish itself as a global AI healthcare brand.

- Singapore has a head start in building a robust and competitive AI-driven healthcare community that is aligned with national strategies and follows blueprints for the development of AI in healthcare
- AI has excellent potential to accelerate compound discovery and clinical trial management, which in turn would benefit drug development and the overall healthcare ecosystem
- Leveraging Singapore's significant AI-related strengths, deeper integration of digital solutions in drug development would lift productivity and nurture a highly skilled AI talent pool
- A comprehensive AI-in-drug-development strategy will drive the continued influx of pharma giants and a secondary wave of biotech investment and growth under the multidisciplinary mentorship of industry leaders
- A centralized push for AI drug development, including initiatives at the national level, will help realize the city-state's ambitious Smart Nation vision

Call to action

Singapore must act quickly to build a successful and sustainable AI life sciences ecosystem. This will require a specialized fund for AI in drug discovery and development, new initiatives to attract and develop the requisite AI talent, and a balanced AI healthcare industry ecosystem.

- **Temasek/EDBI:** Set up a specialized funding structure for AI in drug discovery and development, attracting VCs and pharma giants as co-investors
- **Future Economy Council (FEC)/Start-up SG/Enterprise Singapore:** Nurture AI talent and biotech startups in drug discovery and development by providing mentorship in the early prototype stages and driving breakthrough technologies to commercialization
- **MOH/IHiS:** Spearhead the gathering of high-volume data for AI analytics by establishing a data consortium tailored to the Asian population, leveraging existing EHR initiatives and NPM programs
- **A*STAR/AI Singapore/Smart Nation and Digital Government Office (SNDGO):** Establish a knowledge-sharing consortium to break down existing knowledge silos and foster an interdisciplinary AI community, one that brings together experts from data sciences and biomedicine to achieve a common AI vision

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