The Economist INTELLIGENCE UNIT

FINANCING AND CULTIVATING A SUSTAINABLE ECOSYSTEM FOR US HEALTHCARE INNOVATION

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Executive summary

Today's scientific innovations in healthcare are reaching new heights. There are more cures for serious diseases, and some diseases are being transformed from life-threatening into more manageable, chronic conditions. The emerging field of precision medicine creates promise for patients who had limited or no treatment alternatives. And healthcare stakeholders now generate, capture and analyse more data than ever before.

Such accomplishments were no accident. They were made possible by an innovation ecosystem that aligns the efforts of academics, industry, government and other stakeholders to generate and finance innovation. These collective efforts have positioned the US as a leader in healthcare innovation and created a culture in which advances such as in telemedicine and personalised healthcare can quickly be adopted.

But as the science evolves, what factors are critical to sustain and evolve the ecosystem, leading to even more breakthroughs? And how does financing need to adapt to support progress?

This report, written by The Economist Intelligence Unit and sponsored by Gilead Sciences, explores these and other challenges as a way to foster the collaborative thinking and consequent strategies that have always been needed to ensure that innovation is valued and supported in order to benefit a healthy society.

The key findings include the following:

The phases of innovation—from basic research to commercialisation—require a mix of funding sources for breakthrough innovations to reach patients. The public sector and philanthropic organisations have particularly important roles in the early stages of research. When it becomes apparent that further investment is necessary to progress beyond basic science, the private sector can provide additional support for research and development (R&D), and scale advances in order to introduce innovations to patients.

Healthcare stakeholders must better align their time horizons and financial goals. Governments, insurers, researchers, medical companies and other stakeholders may all be operating with different time horizons in mind, based on their own stakeholders' expectations. If those entities communicate more closely, they could improve their understanding of other stakeholders' needs. For example, governments and healthcare companies could better co-ordinate to identify optimal or novel approaches for financing innovations that incur near-term costs but pay benefits throughout people's lives.

A cohesive approach among stakeholders is growing to enable the front-end of the innovation ecosystem, resulting in innovative trial designs, novel endpoints and broader patient participation in R&D. Issues such as the protection of intellectual property rights or the adoption of price controls, however, do not always have the same levels of alignment. Both of these areas necessitate a balance among stakeholders, weighing financial goals with support for the innovation ecosystem.

Revised payment models and delivery systems are needed to overcome systemic barriers—including the affordability challenge. Introducing new payment models such as those based on patient outcomes can better serve patients' health needs while helping to ensure that payers receive value for money. Shifting incentives away from unnecessary and costly treatments and procedures frees up resources for breakthroughs that generate the best outcomes for patients and society. To get there, however, the healthcare system needs to do a better job measuring what outcomes matter most to patients.

Digital technologies such as data analytics tools and artificial intelligence (AI) systems can strengthen the innovation ecosystem. Not only are digital health technologies innovative on their own merits, they also further the impact of other innovations by helping to connect patients to appropriate services and new treatments. They can also support the innovation ecosystem by making drug discovery more efficient, improving communication with patients through digital channels and measuring the real world effectiveness of breakthroughs.

About this report

***Financing and cultivating a sustainable ecosystem for US healthcare innovation* is a report written by The Economist Intelligence Unit and sponsored by Gilead Sciences, developed to continue the conversation following the Healthcare Forum 2018: Financing healthcare innovation, an Economist event sponsored by Gilead Sciences. It assesses the potential for improving support for US health innovations, across the healthcare spectrum, over the long term.**

This report is based on extensive desk research and in-depth interviews conducted in January-March 2018 with representatives of healthcare institutions and academic and multilateral organisations. We would like to thank the following participants (listed alphabetically) for their time and insights:

- **Christina Akerman**, president, International Consortium for Health Outcomes Measurement (ICHOM)
- **Anil Jain**, vice-president and chief health information officer, IBM Watson Health and internist at the Cleveland Clinic
- **Bob Kocher**, partner, Venrock and former special assistant to the president for healthcare and economic policy on the National Economic Council in the Obama administration
- **Steve Krein**, CEO and co-founder, StartUp Health
- **Farzad Mostashari**, co-founder and CEO, Aledade
- **Sam Nussbaum**, senior fellow, Leonard D Schaeffer Center for Health Policy and Economics at the University of Southern California, former chief medical officer for Anthem and senior adviser to Sandbox Industries
- **Andrew Schwab**, managing partner, 5AM Ventures
- **Roy Smythe**, global chief medical officer for strategy and partnerships, Philips
- **Sharon Terry**, president and chief executive, Genetic Alliance
- **Barrett Thornhill**, principal, McManus Group

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CHAPTER 1:
The innovation lifecycle throughout healthcare

At the foundation of innovation lies basic research, which is necessary to make truly groundbreaking discoveries.

"In science you don't know what you are looking for until you find it. You have to try a lot of things to come up with breakthroughs," says Andy Schwab, managing partner at 5AM Ventures and member of the board of directors of the National Venture Capital Association, citing the importance of basic research to make those discoveries.

While the public sector remains the single largest backer of basic research financing—44% of the US$86bn invested overall in 2015 (the most recent year with final data)—the balance of financing sources has been evolving for decades. In the 1960s and 1970s the federal government accounted for over 70% of basic research investment. Since 2013, however, that figure has dipped below 50%, based on data from the National Science Foundation and cited by the American Association for the Advancement of Science (AAAS).[1]

Meanwhile, private-sector funding has been on the rise, including drug company investment in basic research increasing from US$3bn in 2008 to US$8.1bn in 2014. Overall, US businesses nearly doubled their investments in basic research over that period, growing from US$13.9bn to US$24.5bn.

Laying the groundwork through research

Although government funding is levelling off and private companies have stepped in to fill the gap, the public sector still has a critical role to play in basic research financing. Because of the exploratory nature of basic research, there is a lack of secure returns, which gives the government a clear place to step in for higher-risk, pre-market investments and blue sky R&D that private capital avoids.

Although government funding is levelling off and private companies have stepped in to fill the gap, the public sector still has a critical role to play in basic research financing.

Non-profit organisations such as the Bill and Melinda Gates Foundation and the Simons Foundation, along with universities, also have a role to play in this type of financing—together these sectors account for about a quarter of basic research funding, cites the AAAS. For example, the Gates Foundation invests in research in areas ranging from tuberculosis to the causes of premature birth.

These capital investments tend to have more flexibility to focus on research that may not lead anywhere, compared with private capital that seeks a monetary return. Yet when basic research does yield discoveries, the private sector then has a more secure place to step in and scale advancements.

As an example of basic research setting the stage for additional private capital, consider Julius Axelrod of the National Institutes of Health (NIH). He shared the Nobel Prize in 1970 for his work studying the re-uptake of neurotransmitters, helping to prove the physiological component of mental illness. As a result of his foundational research, which still influences the mental health field today, private companies have been able to step in to invest in more specific areas such as pharmaceuticals for treating depression.

Footnote:

1. Jeffrey Mervis, "Data check: U.S. government share of basic research funding falls below 50%", *Science*, March 9th 2017, http://www.sciencemag.org/news/2017/03/data-check-us-government-share-basic-research-funding-falls-below-50

In other cases, organisations like the Cystic Fibrosis Foundation co-ordinate with a variety of stakeholders such as private donors, scientists and pharmaceutical companies to research the disease and ultimately bring treatments to market. The work of the Cystic Fibrosis Foundation and its partners has significantly improved the outlook of patients with this disease and could eventually lead to a cure.

Today, this type of foundational research continues, such as with the NIH All of Us research programme that aims to collect data from 1m volunteers on overall health. This ambitious study might be unattractive for private capital to fund on its own, given the lack of a clear path towards financial returns. However, assuming the study leads to discoveries about disease risk, the private sector could, if prior history holds, step in to fund more specific R&D of treatments in areas such as precision oncology medicines, building on the basic research findings.

From discovery to product

With the research in place to discover breakthroughs, the opportunities for the private sector to invest become even more apparent during the development of new healthcare products and services.

This stage has yielded countless breakthroughs that have improved lifespans and quality of life ranging from immunotherapy drugs that help fight cancer to stem cell therapies for pain management.

However, investors face difficult decisions assessing investments that can take years, if not decades, to come to fruition—or not pay off at all, which complicates the sustainability of the current innovation ecosystem.

During this stage, healthcare breakthroughs are still at risk of not getting to patients. A 2014 study by Tufts University found that, out of 1,442 drug compounds first tested in humans between 1995 and 2007, some 80.3% had been discontinued during a clinical phase, 12.6% were still active in some phase, and only 7.1% were approved.[2]

Roy Smythe, global chief medical officer for strategy and partnerships at Philips, cites this "Valley of Death" that drugs and medical technologies can face as they seek to move from early development to commercially viable products that patients and populations might need.

Since getting through this stage can be difficult, the current system sometimes incentivises development of less innovative products that can make it through the valley. Meanwhile, certain areas of need such as treatments for antibiotic-resistant infections get less attention.

Certainly, the US market potential provides an incentive to private companies to invest in development. For instance, the US is the largest pharmaceutical market in the world, accounting for more than 40% of global medicine spending, according to IQVIA.[3] Yet this market potential incentivises attempts to capture market share from both those that make incremental advances as well as those that provide groundbreaking advances.

But to move towards a more sustainable ecosystem that allows for more of the types of breakthroughs that significantly improve health outcomes and solve unmet needs, the healthcare system needs to further evolve to reward true innovators.

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Footnotes:

2. Joseph Dimasi, "Innovation in the Pharmaceutical Industry: New Estimates of R&D Costs", Tufts Center for the Study of Drug Development, November 18th 2014, http://csdd.tufts.edu/files/uploads/Tufts_CSDD_briefing_on_RD_cost_study_-_Nov_18,_2014..pdf
3. Murray Aitken; Michael Kleinrock; Deanna Nass, "Outlook for Global Medicines through 2021", QuintilesIMS Institute, December 2016, http://static.correofarmaceutico.com/docs/2016/12/12/qiihi_outlook_for_global_medicines_through_2021.pdf

Paving a path for sustainable development

To help incentivise innovation that solves healthcare challenges, the public and private sectors need to collaborate better. Both sides need to improve their understanding of patient and population needs while also considering the unintended consequences of factors like pricing controls and patent protections. These controls may have been implemented with goals such as better serving patients and improving affordability, but they can also stymie innovation if investors have less financial incentive to fund groundbreaking R&D.

Closer collaboration can also help bridge the variety of different timescales, including investors' internal financial goals, payers' budget cycles and healthcare stakeholders' goals to improve health outcomes.

One way to better align time horizons is for the public sector to provide a range of incentives that help the private sector during development, notes a study in *The Journal of Antibiotics*.[4] These may include so-called push mechanisms, which reduce the cost of R&D such as by distributing expenditure across many parties through increased access to research, research grants and public-private partnerships for sharing R&D outlays.

Closer collaboration can also help bridge the variety of different timescales, including investors' internal financial goals, payers' budget cycles and healthcare stakeholders' goals to improve health outcomes.

Alternatively, policymakers may favour so-called pull incentives, such as those that underpin successful drug development, by increasing or ensuring future revenue through outcome-based rewards. These rewards may include advanced market commitments and patent buyouts, as well as regulatory regimes that accelerate the market approval process, extend market exclusivity or increase reimbursements.

The public sector may also facilitate investment in this stage by providing more regulatory transparency that makes it easier for investors to navigate the process of moving from development to commercialisation.

"It depends on the Food and Drug Administration [FDA] process being as collaborative and reasonable as possible. That needs to be in line with the overall ecosystem, so when you make an early investment you have some idea of how long it will take to come to fruition," Mr Schwab says. "You're not always going to agree with regulators. But you can have open discussions about outcomes you need to prove to get regulators comfortable, rather than looking into a black box and hoping and praying."

In recent years, EU authorities and member states have taken the lead in encouraging greater co-operation between manufacturers and regulatory agencies ahead of market authorisation of products. And the US is catching up, Mr Schwab and others acknowledged, with the FDA showing greater flexibility and innovation in its own dealings with submissions.

For example, in response to the Generating Antibiotics Incentives Now Act, the FDA recognised that the approval process for drugs was too slow to promote the development of new antibiotics, an important public health goal. In response, the FDA has established partnerships with industry and accelerated the process of bringing new antibiotics to market.[5] Eight out of ten drug sponsors in a Government Accountability Office study said that this law has led to an increase in communication with the FDA, "typically associated with the fast-track designation."[6]

Footnotes:

4. Matthew Renwick; David Brogan; Eliad Mossialos, "A systematic review and critical assessment of incentive strategies for discovery and development of novel antibiotics", *The Journal of Antibiotics* Vol. 69, pages 73-88, October 14th 2015, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4775540/
5. Janet Woodcock, "Three encouraging steps towards new antibiotics", US Food and Drug Administration, September 23rd 2014, https://blogs.fda.gov/fdavoice/index.php/tag/gain-act/
6. "FDA Has Encouraged Development, but Needs to Clarify the Role of Draft Guidance and Develop Qualified Infectious Disease Product Guidance", US Government Accountability Office, January 2017, https://www.gao.gov/assets/690/682391.pdf

Commercialising innovations

As innovation moves from development to commercialisation, the private sector pushes new, breakthrough therapies to market, which enables access to patients.

The promise and value of new precision medicines, such as cell and gene therapies, suggests the potential for a healthcare revolution that is centred on patients and improving overall quality of care. Specifically, breakthroughs such as CAR-T therapies are saving lives and changing the R&D landscape to fuel more products in this area of immunotherapy.

Despite the benefits of bringing these developments to market, policymakers and other healthcare stakeholders must consider how to pay for cutting-edge treatments, in order to encourage more breakthroughs.

Even though these innovations may be worthwhile for improving long-term care, expenditure is often front-loaded for payers, while the benefits might accrue over time. "As premiums go up, sadly, fewer people can afford having healthcare and our state and federal budgets get even harder to manage," says Bob Kocher, a partner at Venrock in Palo Alto, California, and former special assistant to the president for healthcare and economic policy on the National Economic Council during the Obama administration. "For example, new cancer drugs like CAR-T therapies not only cost a lot for the medicine but also add thousands of dollars of additional hospital costs for each patient."

The promise and value of new precision medicines, such as cell and gene therapies, suggests the potential for a healthcare revolution that is centred on patients and improving overall quality of care.

So even though the benefits of new innovations may better serve patients' health needs, the upfront costs may not align with the timeline needed by a payer, making it difficult for patients to realise the full benefits of some innovations.

These costs are exacerbated by a number of systemic problems, including an insurance system that incentivises profitability rather than care.

"We have this cost conundrum—innovation should be leading to improved patient care and clinical outcomes and reduced costs, but this does not always occur," says Sam Nussbaum, senior fellow at the Leonard D Schaeffer Center for Health Policy and Economics at the University of Southern California and former chief medical officer for Anthem. "We're witnessing a healthcare system with breathtaking therapies that we can't afford."

However, further innovation in other areas of healthcare, as discussed in the following chapters, can help improve affordability so that these breathtaking therapies can make the most impact.

CHAPTER 2:
From innovation to outcome

Interviewees agree that the current US healthcare system makes it difficult to take advantage of innovative treatment and technology advances even when they are brought to market.

The fragmentation of the US health system limits the extent to which medical innovations can be assessed and deployed, says Sharon Terry, president and chief executive of a non-profit, Genetic Alliance.

"Genetic and genomic advances are wonderful, but they are being applied in a very broken system, and until that is rectified, the system cannot appropriately leverage these advances," she adds.

More broadly, even when research leads to effective advances, systemic inefficiencies such as uneven consumer costs and lack of insurance coverage can make it difficult for vast segments of the population to access these breakthroughs. Pharmaceutical manufacturers may not have the incentives to bring a product to mass market, or patients may have mixed incentives to request new treatments, for instance.

"I am more concerned that if we discover a medicine to cure cancer, we don't have a system that can effectively deliver it reliably," notes Dr Kocher.

The fragmentation and lack of patient continuity within insurance markets (because of employer-sponsored health insurance and frequent job-changing) also complicate innovation, particularly for preventative healthcare that can take years to pay off, notes Barrett Thornhill, principal at the McManus Group, where he advises life sciences companies and provider clients on legislative and regulatory issues.

"Bifurcation [of insurance markets] leads to pricing challenges," he says. "If insurers knew patients were locked in for a certain amount of time, they would have a way to remeasure risk and price it in."

A lack of certainty also affects financing. "The fact is long-term investors want to know there's a strong revenue stream," adds Mr Thornhill.

Overcoming these systemic challenges is possible, however, by innovating payment and delivery models, as well as increasing collaboration and corporate partnerships to expand access.

"Consumers are in a situation where they can't think about costs," Mr Schwab says. "Innovations are about how to give consumers a choice."

"Genetic and genomic advances are wonderful, but they are being applied in a very broken system, and until that is rectified, the system cannot appropriately leverage these advances."

Sharon Terry, president and chief executive of a non-profit, Genetic Alliance

Rethinking payments to encourage innovation

Innovation isn't limited to new products or services; it may also include operating models, such as in payments. Indeed, a sustainable ecosystem for innovation also requires major changes in how healthcare is delivered and paid for, thereby helping to justify costs during R&D.

In fact, payment reform is the rocket fuel for healthcare innovation, says Farzad Mostashari, co-founder and CEO of Aledade, which partners with primary care physicians to build and lead Accountable Care Organisations.

The key to this kind of innovation is the opportunity for "disruptive business models," he says. "The incumbents have a lot of advantages, but the ability to adapt to disruption isn't one of them." Developing different kinds of payment models, such as reimbursing outcomes rather than services rendered, creates new opportunities, he adds.

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New ways of assessing the cost and value of pharmaceutical innovation, for example, will be part of this process, experts say, but individual drugs can't be viewed in isolation. Instead, they need to be considered based on their overall impact on patient wellbeing, beyond their direct effects.

For example, "do we just look at the cost of a flu vaccine or the cost of productivity at work? How much have we looked at the long-term impact?", questions Dr Nussbaum.

Part of this change in payments also involves an evolution from the existing fee-for-service payment system towards payment for episodes of care and—eventually—full population health.

These new types of payment models align better with patient needs and can improve delivery of groundbreaking innovations by encouraging treatments that lead to the best outcomes. Existing indicators used to measure the results of innovative treatments are all too often driven by health providers rather than patients, note several interviewees.

And while new payment models cannot overcome some of the systemic challenges in the insurance market such as frequent job-changing, they can ultimately lead to better health for those within insurance pools, thereby reducing the need to cover certain recurring costly services.

Improving healthcare quality and access

A more innovative health system isn't just one in which health providers have incentives to deliver valuable care, but one that is centred on the patient, say interviewees. This means guaranteeing that healthcare is measured not by the number of procedures or treatments, but by positive outcomes, provider accountability and patient choice.

"Despite large amounts of measurement, there is a lack of patient-centred measurement in healthcare," says Christina Akerman, president of the International Consortium for Health Outcomes Measurement (ICHOM). "We measure very little about what matters to patients with a certain health condition, and we have very little understanding of the kinds of outcomes that are meaningful to them."

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Not only is there a lack of patient-centred measurement, but there is also the lack of standardised measuring of outcomes. When standardisation becomes more prevalent, however, providers will be able to reduce variations via sharing best practices, thereby saving resources that today are spent on healthcare services that are not beneficial to patients.

"You need to define the outcomes that matter most to patients and then understand variation before you can improve healthcare services," she observes.

Better understanding of desirable outcomes helps determine where the knowledge gaps lie and where innovation should be targeted, adds Dr Akerman.

Increased competition in the area of healthcare delivery, either among healthcare networks or the methods of delivery, can also help ensure that patients get the best care possible, similar to how competition among medical companies can push firms to continually innovate.

"Better understanding of desirable outcomes helps determine where the knowledge gaps lie and where innovation should be targeted."

Christina Akerman

While consolidation of hospitals and healthcare systems can create cost efficiencies, they do not always improve care. A single hospital or provider is likely to be prominent within a given five-mile area, the radius within which most people access healthcare.

"In most places, there is one dominant hospital that employs many specialists and primary care doctors," Dr Kocher observes, making it more challenging for patients to think of going farther afield. Compounding this problem is the fact that primary care doctors often find it difficult to know who they should refer patients to in order to maximise the chance for a great clinical outcome and total cost of care. Moreover, "health systems actively work to manage 'leakage' of patients referred outside of their health system which, in some cases, put health systems at odds with patients being referred to better physicians," he says.

Innovations such as telemedicine, however, have the capacity to widen access to healthcare as well as make it more efficient and cost-effective from the perspective of both healthcare networks and patients. For at-risk and frail adults, Dr Kocher points out, telemedicine can allow a primary care physician to check in several times a week from outside that five-mile radius, and wireless applications such as blood pressure gauges can improve monitoring of chronic conditions. Video consultations also improve the ability to diagnose, compared with telephone consultations. California-based healthcare provider Kaiser Permanente conducted 14m virtual visits in 2015 and expects virtual visits to surpass in-person visits in 2018.[7]

Start-ups such as Doctor on Demand are also seeking to take advantage of the need for more streamlined healthcare delivery. The company, which operates in all 50 states in the US by employing doctors with medical licences in multiple states, has seen rapid growth over the past few years.

Footnote:

7. Robert Pearl, "Engaging Physicians in Telehealth", NEJM Catalyst, July 10th 2017, https://catalyst.nejm.org/engaging-physicians-in-telehealth/

Partnering for disruption

Employers that supply health insurance have begun to express their own frustration with the system.

In January 2018 Amazon, Berkshire Hathaway and JP Morgan announced plans to create an independent healthcare company for their US employees, which will include a focus on transparency and improving outcomes. The companies also intend to operate the company as a non-profit, which could help remove some of the perverse cost incentives of traditional employer-sponsored healthcare. The partnership was motivated principally by spiralling health costs, and while it was unclear how the partnership would specifically overhaul the companies' existing health plans, some analysts have suggested that by using their heft to create more efficient care, the companies could become models for other businesses.

Greater market power, however, does not necessarily lead to better efficiency or outcomes, Dr Mostashari observes.

"There needs to be a new delivery system where the benefits of information and care integration do not come [only] as a necessary consequence of corporate integration and consolidation, because in healthcare corporate consolidation in local markets often leads to monopoly pricing and rent-seeking behaviour," he adds. "So the challenge is to secure the gains of clinical integration without necessarily creating local or regional fiefdoms in the healthcare system."

CHAPTER 3:
Leveraging digital technology advances

In addition to the advances made throughout the innovation lifecycle in traditional medicines and treatments, the US is also a hotbed for innovation in related information technology, which contributes to improving outcomes as well.

In this area, venture capital has been particularly active in financing innovations, which helps facilitate the advances that other companies are making in areas such as treatments and delivery.

In particular, the amount of venture funding in digital health exceeded US$11.5bn in 2017, compared with US$2bn in 2011. And in 2017 that funding was well dispersed across important health needs: companies working to improve patient and consumer experience led the digital health innovation financing space with 191 deals and US$1.6bn raised, followed closely by personalised health and big data and analytics, with workflow solutions also seeing strong growth during the year.[8]

These companies tend not to need to go through the same stages of innovation as pharmaceuticals, for example, as IT applications may not have as rigorous development regulations. Still, they can help traditional medical innovations maximise their impact by making it easier to connect patients and treatments.

For instance, one of the companies that attracted the most venture funding in 2017, Guardant Health, tests for cancer through blood rather than a tissue biopsy. Doing so can help reduce upfront costs, while also better informing patients and their doctors about treatments.

"Entrepreneurship is at an all-time high," says Steven Krein, the chief executive and co-founder of New York-based venture capital firm StartUp Health, which focuses on transformational health companies. "You can create solutions and bring companies to market in a fraction of the time [and] at a fraction of the price it used to take."

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Analysing data for maximum impact

Perhaps the most promising area of healthcare innovation, because of its potential to link to other advances, is data analytics.

More data can lead to major breakthroughs that affect entire populations, such as the NIH All of Us programme, which aims to collect enough data to find links between environmental and biological disease exposures and health outcomes. The volume and precision of data from today's medical devices can also indicate how patients are responding to treatments and nudge patients towards better behaviours. All of these possibilities make data analytics an area ripe for funding.

If payment reform is the rocket fuel for healthcare innovation, as Dr Mostashari notes, "then data is the oxygen that is needed to combust and supercharge those new business models."

Footnote:

8. StartUp Health Insights Global Digital Health Funding Report 2017 Year End Report, page 16, https://www.startuphealth.com/insights/

Today, data analysis companies "are parsing and looking at data that even a couple of years ago didn't exist, and aggregating it", Mr Krein observes. By crunching data and "layering consumer genomics," companies such as GeNID Solutions, a portfolio company of Startup Health that operates in the area of early cancer detection, are moving into new territory.

Applications such as Pear Therapeutics' reSET, the first FDA-approved mobile application to treat substance abuse, can also use data effectively by analysing user input to assess treatment progress, which can be more effective than face-to-face counselling for some patients.

Keeping data moving

Ensuring the unimpeded flow of data among all ecosystem players—hospitals, providers, pharma and payers—is the principal precondition for guaranteeing innovation, says Anil Jain, vice-president and chief health information officer for software company IBM Watson Health and an internist at the Cleveland Clinic.

However, improving the flow of information faces significant obstacles, including data privacy, security concerns and a lack of interoperability between stakeholders. But these barriers are starting to come down.

"As we start to see more value-based care contracts and population health strategies, where various dispersed stakeholders have some skin in the game, we are seeing some movement in freeing up data," Dr Jain adds. He notes that emerging regulatory frameworks such as the 2016 21st Century Cures Act will accelerate the exchange of data and the development of innovative products.[9]

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Equally, removing as many of the barriers to data sharing as possible, including the use of incentives and penalties, is an important precursor for gaining the insights necessary for disease prediction, prevention and individualised therapies, as well as making them more accurate and effective, Dr Smythe notes.

Wearables and other ambient sensing and monitoring devices also show both interest from investors and promise for facilitating better outcomes. They allow for more passive data acquisition and enable patients to provide the data needed for population-level collections. But these devices must be a natural fit for individuals.

"When people are asked to do things outside the normal context of their lives,like strapping on a watch or logging onto a site and providing keystrokes, compliance falls off," notes Dr Smythe.

Joining AI and big data

The complementary marriage of AI and data analytics is likely to be one of the biggest trends in healthcare in the future, according to interviewees.

"Data analytics and AI are going to create expert systems that will limit physicians from doing procedures and prescribing treatments that aren't evidence-based," Dr Nussbaum says. "This is an essential element of healthcare in the future: providing real-time [insights] at the time of care, not reviewing events in a retrospective manner."

Footnote:

9. 21st Century Cares Act, US Food and Drug Administration, accessed March 12th 2018, https://www.fda.gov/RegulatoryInformation/LawsEnforcedbyFDA/SignificantAmendmentstotheFDCAct/21stCenturyCuresAct/default.htm

AI is likely to reshape the health landscape in several ways, Dr Jain adds, including helping to understand the implications of large volumes of data and augment them, so that clinicians can focus on the most important elements, and using cognitive AI to curate the information.

At the same time, Dr Akerman points out that before AI can be used effectively for tasks such as advancing genomics or monitoring and managing disease, programmers and healthcare policymakers will need to agree on a common infrastructure.

"You need to have a common language so that you can capture and analyse the data in a structured way," she says. "You don't have that today."

With medical mobile phone applications "popping up like mushrooms everywhere," she adds, it is especially vital that they are based on relevant and unifiable information.

As those problems are overcome, however, AI is increasingly likely to be used in data analysis to solve severe health challenges. For example, Medtronic and Philips announced in January 2018 that they have partnered on a patient and data management platform that uses natural language processing (a type of AI) to quickly analyse data contained in medical reports and flag them for further review to help patients that potentially have lung cancer.

As another example, IBM Watson can parse big data in areas such as life sciences research, using areas of AI including machine learning and predictive analytics to speed up the identification of novel drug candidates.

Further development and implementation of AI offer even greater possibilities that support a sustainable innovation ecosystem, such as with companies like Antidote, which helps match patients to clinical trials, thereby helping more trials meet their enrolment needs. AI can also inform treatment decisions; help drug companies, insurers, governments and other stakeholders develop pricing that balances patient affordability with investment goals; and provide many other possibilities for improving the overall healthcare system.

"You need to have a common language so that you can capture and analyse the data in a structured way. You don't have that today."

Christina Akerman

Conclusion

New technologies such as telemedicine, personalised healthcare, and the interplay of data and AI are heightening the impact of innovations that all start with basic research, leading to the development and commercialisation of new drugs and treatments.

Further progress will require a blend of investments at each stage of innovation as the private and public sectors co-ordinate in ways that make healthcare both worthwhile for investors while serving the public good.

"Over the past few decades in the US, healthcare innovation has been a mixed bag—some things that legitimately create the opportunity for better health and disease outcomes, and some that frankly are designed to grab market share and revenue," says Dr Smythe. "From the standpoint of the patient, the latter is absolutely unimportant. I would define groundbreaking innovation in healthcare exclusively as something that has a direct, measurable impact on health and disease."

Many stakeholders throughout the healthcare system have made significant advancements that directly improve healthcare, ranging from the development of innovative cancer treatments to the use of telemedicine to expand healthcare access.

And there are signs of hope for funding innovations that will drive innovation across the healthcare system. As Mr Krein puts it, "This sector has a significant number of missionary versus mercenary entrepreneurs. Most entrepreneurs who are building companies and solutions in this space have a direct story as to why they are doing [what they do]. They are sick and tired of, burned by or saddened by something that happened to them or one of their loved ones—unlike other sectors, where people just have an idea and a great number of mercenaries making it happen. You need a blend if you are going to scale it up."

Fortunately, the US system allows for that blend, where both investment-driven and mission-driven financiers, together with innovators, have collaborated to bring breakthrough innovations to market. Furthering a sustainable innovation ecosystem will require continued collaboration and a blend of financing sources, all of which can improve the overall value and effectiveness of healthcare.

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