Future of Academic Medicine Series

Academic Medicine in 2025: Notable Trends and Five Future Forces
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Association of American Medical Colleges
Washington, D.C.
Future of Academic Medicine Series

Academic medicine is on the cutting edge of health care, pioneering groundbreaking medical research, educating tomorrow’s physicians, and providing the world’s most advanced health care. But changes are happening faster than ever before, whether it’s technology, demographics, economics, or politics—changes that can threaten the success of academic medicine. The AAMC’s Future of Academic Medicine Series includes research-based reports to help leaders consider the changes and strategies needed to survive and thrive.
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Executive Summary

The Institute for the Future, an independent, nonprofit research organization, developed this custom report of key external future forces affecting academic medicine for the Association of American Medical Colleges. The report offers clear depictions of plausible futures for academic medicine that may materialize as linear trends and external forces intersect, interact, and overlap with one another.

It is divided into three parts:

- **Review of Linear Factors: Notable Trends.** The first section reminds us of the diversity of trends informing health care, education, and research over the next 10 years.

- **Nonlinear Factors: External Future Forces.** The second part identifies five critical external future forces affecting academic medicine: on-demand learning, flipped clinics, networked discovery, high-resolution health, and rapid prototyping cycles. Each future force is supported by signals, or early indications of change, that bring the future force to life.

- **Artifacts from the Future.** The final section transports the reader to the world of 2025 via three artifacts from the future that tie in with the missions of academic medicine: patient care (virtual patient interactions), teaching (on-demand learning), and research (credit for research contributions). These artifacts are illustrated scenarios that blend linear factors with external future forces to immerse us in alternative futures and make them more tangible.

This report is intended for use by the leaders of academic medical centers, medical schools, faculty group practices, and universities. By engaging in a thoughtful examination of combinatorial futures, it will better position the nation's medical schools and teaching hospitals and health systems to make fruitful, sustaining, future-oriented decisions today.
Introduction

We are in a period of combinatorial innovation, or so says Hal Varian, chief economist at Google. Innovators are combining and recombining components to create new inventions. Similarly, we are in a period of combinatorial futures. To have a comprehensive view of long-term future possibilities, we need to understand both linear factors (often thought of as trends) and nonlinear factors (or external future forces) that will combine and recombine to create the future. Because of the reach, scope, and impact of academic medicine, envisioning its future requires a broad scan of both the linear trends and the external forces that could affect health care, education, and biomedical research over the next decade.

This report offers depictions of plausible futures for academic medicine that may materialize as linear trends and external forces intersect, interact, and overlap with one another. It is divided into three parts. The first section reminds us of the diversity of trends that will inform health care, education, and research over the next 10 years. The second part identifies five critical external future forces that could affect academic medicine in particular.

Each future force is supported by signals, or early indications of change, that bring the future force to life. The final section transports the reader to the world of 2025 via three artifacts from the future. These are illustrated scenarios that blend linear factors with external future forces to immerse us in alternative futures and make them more tangible.

Both the artifacts from the future and the external-forces forecasts are stories from the future designed to provoke insight in the present. They were not developed to advocate for a particular future or even to make predictions about likely outcomes and responses. Rather, the purpose of the report is to spark dynamic and thoughtful discussions about the future of health care, education, and biomedical research. By drawing attention to and imagining a 10-year horizon, this report aims to position academic medicine and the AAMC to make fruitful, sustaining, future-oriented decisions today.
Methodology

In 2015, the Institute for the Future (IFTF) developed this report for the Association of American Medical Colleges (AAMC). It is based on research carried out in IFTF’s foundational Ten-Year Forecast, Technology Horizons, Health, Workable Futures, and Future of Learning Programs and is strengthened by new research conducted specifically for the AAMC.

To develop this custom forecast report, IFTF researchers considered a wide range of trends, factors, and disruptions that will inform and influence what happens in the next decade. They then identified the five forces that they believe will have the deepest and broadest impact on academic medicine in the next 10 years. These future forces are supported by signals—early iterations of products, services, and initiatives—that are suggestive of the directional shifts being described. Signals bring the future forces to life and provide early glimpses of what may become more routine, more mainstream practices in the future. The concluding section for each future force raises important questions and offers potential implications for the future of academic medicine. These sections are intended to provoke conversations within the AAMC and its member organizations.

In addition to the potential implications and questions for consideration, IFTF developed three artifacts for the future. These visual scenarios depict everyday life and help translate today’s trends and signals into future experiences. They serve as rich starting points for futures-oriented strategic discussions by making the future forces concrete, tangible, and experiential.
Review of Linear Factors: Notable Trends

Powerful demographic, epidemiological, economic, educational, and technological trends will inform the day-to-day realities of health care delivery systems and academic medicine in the United States over the next decade. This section outlines key trends without attempting to present an exhaustive overview of all related directions.

DEMOGRAPHIC

By 2030, one in five Americans will be at least 65 years old, up from one in seven in 2012, and their numbers are projected to increase from 43 million in 2012 to about 73 million in 2030. Given that more than 92 percent of those 65 and older suffer from one or more chronic diseases, an aging population will increase demand for health care services and resources and provide an excellent opportunity to reexamine how end-of-life care is delivered. The aging of the population will also shrink the supply of American physicians: a third or more of them may retire within the next decade.

Demographic trends will also lead to a “youth bulge” as the population skews younger when the millennial generation surpasses the baby boom generation to become the largest living generation. The millennial population will continue to grow over the next decade through immigration, adding more numbers than any other group and eventually peaking in 2036 at 81.1 million.

The combination of the millennial cohort with the digital natives (the generation younger than the millennials) will result in a more racially and ethnically diverse population than today. By 2020, more than half of the nation’s children are expected to be part of a minority race or ethnic group, and by 2044, the population of the United States will have become a “plurality” of racial and ethnic groups.

In addition to racial and ethnic diversity, the changing composition of households will contribute to increased cultural diversity. What we think of as culturally competent medical care and prevention services will expand to accommodate a diversity not just of languages, social norms, and cultural health practices, but also of sexual orientations.

EPIDEMIOLOGICAL

The estimate of the proportion of the total population that will have at least one chronic condition by 2020 is 48 percent. Chronic conditions such as diabetes, heart
disease, lung disease, and Alzheimer’s disease will not only continue to be the leading causes of disability and death in the United States, but for many, they will also limit the activities—working, spending time with friends and family, accomplishing personal tasks—that enhance quality of life and a sense of well-being.

Mental health conditions will also inform the disease profile of the United States. With one in four adults and one in five children currently carrying a psychiatric diagnosis—and one in five Americans taking psychiatric medications regularly—behavioral health conditions will affect the overall health and well-being of many Americans. Violence, injuries, and infectious disease outbreaks (including pandemics) will continue to contribute to the health, disease, and rehabilitation profile of the next decade.

**ECONOMIC**

While some economists see a slowing in health care spending, little evidence suggests that the cost of health care will decline dramatically by 2025. For the public sector, beginning in 2020, spending from the federal trusts, including the Social Security Old- Age and Survivors Insurance Trust Fund and Medicare's Hospital Insurance Trust Fund, will exceed income. According to the Congressional Budget Office, there will be a cumulative net deficit of $219 billion between 2016 and 2025.

And for the private sector, the Affordable Care Act (ACA) provision that includes a 40-percent excise tax on high-cost health plans will take effect beginning in 2018. The cap on high-value insurance products will likely produce more cost sharing between employer and employee and higher deductibles. The health care economic trends will intersect and interact with larger trends around inequality. The result? Impacts on the resources (financial, time, and knowledge) that families and individuals will have to dedicate to their health and well-being.

**EDUCATIONAL AND RESEARCH**

Trends in education will not only reshape what medical students are taught but also will chip away at the centralized, structured model in place in many institutions today. Medical students will be taught a more comprehensive and holistic understanding of health, one that captures the genetic, social, and environmental determinants of health. A resurgence in population health as a focus for payers and delivery systems will require that physicians have an improved understanding of behavioral health and be prepared to participate in team-based care models.

The groundbreaking discoveries that medical researchers will uncover in academic and enterprise labs will continue to dominate scientific discovery and medical
research. Yet, outside formal institutions, researchers will experiment with innovative financing models, such as crowdsourcing, to fund research and run experiments, such as community biolabs. And clinical trials will increasingly be run by groups of patients, as more individuals use the power of biosensors, mobile diagnostics, and social networks to uncover new findings and work toward discovering new cures.

TECHNOLOGICAL

Advances in technology will continue to drive trends around information and communication patterns over the next decade. As more technology generates more data, what we think of today as Big Data will evolve into Abundant Data. And the amount of data being produced will far outpace human cognitive capabilities. Cognitive learning systems and data visualization technologies will serve as invaluable tools to make the information useful for decision making. In addition, mobile technologies will proliferate, and many of them will be equipped with inexpensive environmental, fitness, and biological sensing and tracking mechanisms. Simply having the technology will not empower all individuals to understand their health better, nor will it motivate many to change their behavior, but it will expand people’s understanding of where and when they can make healthy choices in their lives.

Over the next decade, then, demographic, epidemiological, economic, educational, and technological trends will dramatically inform health care delivery systems and academic medicine in the United States. Those potent linear factors will combine with nonlinear factors (external future forces) to shape how medicine is researched, taught, and practiced over the next decade. These future forces are described in the following section.
Nonlinear Factors: External Future Forces

External future forces are works of bricolage. They are informed by trends like those laid out in the preceding section and driven by unanticipated changes in our tools, practices, behaviors, and norms. These changes are harder to predict from studying past practices or from assuming that existing trends will continue and spread at a gradual rate. They are combinatorial—combining and recombining trends, factors, and disruptions that could lead to large cultural, social, and technological shifts over the next decade.

This section highlights five key external future forces—on-demand learning, flipped clinics, networked discovery, high-resolution health, and rapid prototyping cycles—that will inform and influence the future of academic medicine over the next decade. Each force is supported by signals, or early indications of change suggestive of a directional shift. As the novelist William Gibson famously said, “The future is already here—it’s just not evenly distributed.” Finally, discussion of each force concludes with consideration of what this could mean for the AAMC and its member organizations.
ON-DEMAND LEARNING

On-demand learning will transform educational institutions from stable hierarchical organizations to content curators, guiding students to the right learning opportunities.

Description

For the generation that is growing up with purchases, transportation, entertainment, and even dates arranged with the click of a button, expectations of how educational content will be delivered have changed. These learners assume their education will be on-demand—available anytime, anyplace. They expect learning opportunities to be embedded in everyday settings and interactions and distributed across a wide set of platforms and tools. They use personalized strategies, mobile technologies, and collaborative peer networks to move into and out of resources linked to their university (as well as other universities) in a continuous stream of deep learning.

To respond to this changing expectation, academic institutions (schools, colleges, and universities) are moving away from the model where learning is highly structured around specific dates, times, and locations. Replacing that model is a new environment in which learning is best conceived of as a flow, where learning resources are not scarce but widely available, opportunities for learning are abundant, and learners increasingly have the ability to seamlessly dip into and out of the flow. Higher-education institutions are focusing face-to-face classroom time on guidance and curation, with instructors helping their students amass the optimal mix of content and experiences to ensure academic excellence.
Signals

Using the social learning platform NovoEd, Stanford University professor of surgery Jill Helms taught an online course in 2014 called Hippocrates Challenge, in which she introduced students to human physiology and anatomy, surgical reconstruction, and regenerative medicine through an online game. Through short lectures, interactive projects, and game building, students learned about the structure and function of the human body.

Mendeley is a desktop and Web application designed to make it easier for students and researchers to manage and discover relevant research papers. Similar to music-streaming services such as Last.fm, which builds a detailed profile of each user’s musical taste by tracking what she or he listens to, this start-up has created a recommendation and matching algorithm to enable academics to both manage and share their research paper inventory, as well as to discover like-minded people and papers.

Questions for Conversation

How will medical education need to adapt to meet the changing expectations of millennial (and younger) students? How will course design in medical education transform over the next decade to keep pace with the large changes taking place in education, such as gamification and new learning platforms?
Potential Implications

Academic medical centers recognize the value of faculty and professional development, yet competing pressures make it difficult for faculty to take full advantage of such offerings. A growing number of medical schools use at least one collaborative online tool to advance faculty development, and the expectation of on-demand learning will extend to professional development as well. The changing expectation, driven by younger faculty, may demand quick adoption of the necessary tools, platforms, and mindset that will better serve this new type of learner.
FLIPPED CLINICS

Flipped clinics, enabled by innovations in digital and retail health, will reset the medical encounter between patients and their care providers.

Description

An explosion of consumer devices related to health and wellness combined with innovative care delivery models is making it possible for individuals to access clinical health information outside traditional settings. The quickly dropping price of biosensing technology means that these sensors are becoming ubiquitous—and tracking fitness data is only the beginning. Retail clinics are homing in on which services to offer and how to deliver them, using technology and the full range of allied workers to manage costs. Digital health companies are eager to break into care delivery and are working diligently to change regulations and allow individuals to have more direct access to their biological information and diagnostic tools.

Over the next decade, the flipped-classroom model—where instruction is delivered online outside class and classroom time is spent learning through activity with the teacher as guide—will come to health care. Flipped clinics (a term derived from a 2014 Robert Wood Johnson Foundation initiative called Flip the Clinic) will reset the medical encounter between patients and care providers. The activities that have historically taken place in clinical settings—collecting samples and running tests—will be distributed across new technologies and new locations. The time a provider spends with a patient (whether face-to-face or remotely) will be used to explore health concerns in greater depth. The precious 15-minute visits can be focused on sense making, problem solving, and collaborating on next steps.

Signals

Apple’s new Health app, gives people an easy-to-read dashboard of their health and fitness data, from heart rate to calories burned, collected by various other health and fitness apps. It pulls all the self-collected data into one place so people can notice and correlate patterns, such as getting better sleep.
on days that they exercise. And with Apple’s HealthKit, developers can create apps that enable users to share their health data with their doctors.

Scanadu is an early-stage company developing a suite of consumer medical devices that enable people to monitor their health anytime, anywhere. Its Scanadu Scout, the efficacy of which is being evaluated by the U.S. Food and Drug Administration (FDA), wirelessly measures and tracks vital signs. As part of the FDA review, Scripps Health in San Diego, California, is running a study of consumer health outcomes with 8,000 users.

Questions for Conversation

Current and future doctors will work with a variety of sources of information—electronic health records, urban informatics, and self-tracked and self-generated data from sensors on phones, on bodies, in cars, in beds, and so on. (Urban informatics uses data to better understand how cities work. This understanding can remedy a wide range of issues affecting the everyday lives of citizens and the long-term health and efficiency of cities—from morning commutes to emergency preparedness to air quality.) How will medical education need to adapt to the flipped-clinic model? Where will you see the impacts of this first?

Potential Implications

Providers will need to understand the digital profiles and data literacy of their patients in order to deliver the best care. While the trend toward biosensors being built directly into consumer devices such as smartphones suggests that more individuals will have access to personal health information, such technology may not be accessible to everyone. The “digital divide” between information haves and have-nots that has been discussed in relation to flipped classrooms may also afflict flipped clinics: not all patients will have the ability or the knowledge to collect and use sensor-based health data for their benefit. Others may choose not to pay attention to it. Regardless, the most resilient institutions will take a test-and-learn approach, starting today.
NETWORKED DISCOVERY

Networked discovery will disrupt how research and innovation are funded, conducted, and shared.

Description

Scientific inquiry is currently undergoing a radical transition as traditional science transforms into networked discovery. Translational research, open data, and crowdsourced and citizen science are disrupting traditional scientific practices and producing what has been called a new form of knowing. Researchers are working in diverse networks that cross academic disciplines and cut through company walls to ask more complex questions and accelerate discovery through linking information.

Over the next decade, as scientific knowledge moves out of the heads of select experts and onto networks, it will take on the properties of its new medium, becoming like the network in which it lives. By 2025, the methods and capabilities of networked discovery will have redesigned the innovation and research processes of leading universities across the globe.

Signals

The California-based Emerald Cloud Laboratory (ECL) lets scientists anywhere access the lab via the Internet and instruct robots to conduct life sciences experiments exactly as specified. The ECL offers more than 40 different experiment types that its beta users can be running in less than 48 hours. Over the next 18 months, Emerald will be expanding the number of available experiment types to more than 100, enabling scientists to do any standard in vitro experiment, including nuclear magnetic resonance (NMR), gas chromatography, flow chemistry, and DNA sequencing.
Developed at the University of Washington, Foldit is an online video game that enables players to contribute to scientific research about the way proteins are formed. This in turn can help scientists find cures for serious illnesses such as Alzheimer’s disease and HIV/AIDS. A 2010 paper in the journal *Nature* credited Foldit’s 57,000 players with providing useful results that matched or outperformed algorithmically computed solutions.

**Questions for Conversation**

By 2025, how will academic medical institutions reshape cultural expectations, adapt research processes, and change reward structures to reflect the values and practices of openness and reciprocity, which are intrinsic to networked discovery? What advantages will the first movers have?

**Potential Implications**

As networked discovery reinvents the methods behind scientific inquiry and innovation, the advantage will go to those who are best able to capitalize on these new ways of conducting research. Academic medical institutions that have built the capacity to quickly engage large networks in foundational research or rapid prototyping will benefit most from new sources of innovation and discovery.
HIGH-RESOLUTION HEALTH

High-resolution health will allow researchers and practitioners to view and understand health at multiple scales, from planetary to cellular.

Description

The convergence of Big Data, connected technologies, scientific discovery, and improved visualization tools is equipping health professionals and medical researchers with new tools and abilities to see, study, and understand human health at multiple scales. Advances in genetics and neuroscience have enabled us to understand the human body at unprecedented levels of granularity. Likewise, new networking technologies have made it possible for epidemiologists and public health experts to work with and visualize massive, diversified data sets to uncover new patterns and new understandings in population health. Equally important, high-resolution health allows health professionals to mesh social, environmental, biological, and genetic data to derive new insights and develop new interventions at the body, community, and global scales.

Signals

The Spatial Information Design Lab at Columbia University teamed up with the Justice Mapping Center to visualize criminal justice data in a project they called Million Dollar Blocks. By mapping the addresses where the more than 2 million incarcerated people lived before being locked up, the researchers were able to show that a disproportionate number of those in prisons and jails come from a few streets in major urban areas. The maps showed that states are spending in excess of a million dollars a year to incarcerate the residents of single city blocks.
The start-up Metabiota is experimenting with a radically different approach to infectious disease threats. It blends pathogen detection and discovery with modern-day information and communication tools to anticipate, validate, and help mitigate outbreak threats. By combining the ability to deploy laboratory equipment and supplies and implement systems solutions quickly, the company works to contain infectious outbreaks.

Questions for Conversation

High-resolution health will allow health professionals to connect an individual’s biological health to larger social and environmental patterns. How will this change how we approach population health and chronic disease management? How might it drive experimentation with prevention strategies and interventions to tackle lifestyle-related chronic conditions in novel ways?

Potential Implication

Over the next decade, high-resolution health will inform how genetics, precision medicine, and population health evolve. It will be possible to zoom in to measure the efficacy of therapies developed to treat illness at the genetic scale and zoom out to track the larger impact that a medical condition may have on an individual’s, a family’s, or a community’s quality of life.
RAPID PROTOTYPING CYCLES

Rapid prototyping cycles will become the norm as novel collaborations and partnerships foster a culture of accelerated experimentation in health care delivery systems.

Description

Redesigning health care has been a hot topic for the past few years, but applying and integrating new ideas into the delivery system in a measurable, impactful way has proven challenging. Recently, powerful partnerships have formed to accelerate innovation and scale it across global and domestic health care delivery systems. These collaborations blend expertise across industries and disciplines, and they aim to reduce the lag between innovation and widespread adoption of products, services, and practices to improve care delivery and reduce costs.

Over the next decade, continuous learning and improvement initiatives will propel more health care delivery systems to dedicate resources to rapid prototyping cycles. More systems will launch centers to enable clinicians and others to run large-scale, real-time experiments and trials. Physicians, nurses, and other care providers will be able to take their ideas about how to improve health care to system designers, engineers, and data scientists who can develop and create prototypes for those ideas. Sophisticated technology such as 3D printers will make it easy to produce new models in-house, accelerating the pace at which an idea can be transformed into an experiment.

Signals

Led by Dr. Atul Gawande, Ariadne Labs is a unique collaboration between Brigham and Women’s Hospital and the Harvard School of Public Health. Currently, the health innovation center is focusing on improving health care during two big human moments: childbirth and death. Applying the checklist model he first developed for surgery, Dr. Gawande is using Ariadne Labs to study and prototype guides to end-of-life conversations and safe births. The goal is to build Ariadne Labs out to a staff of 100 to 150 people who can run large-scale experiments and trials.
The Healthcare Transformation Lab (HTL) at Massachusetts General Hospital accelerates innovation by bringing together clinicians, staff, and patients to identify unmet needs. Then, they collaborate with external partners such as MIT, Harvard Business School, and private industry to develop and test potential solutions. Taking full advantage of the fact that the HTL operates within an academic medical center, they can study not only how to implement innovations efficiently, but also the impact that transformative ideas have on workplace culture, teamwork, and incentives within a health organization.

Questions for Conversation

Embracing failure is central to the success of adopting rapid prototyping cycles. In addition to creating new organization structures and processes to promote and evaluate the new experiments and solutions developed through this new innovation pipeline, how can academic health systems accelerate the adoption of a culture that values sharing and learning from failure? From whom can you learn about rapid prototyping?

Potential Implications

The obvious implication of rapid prototyping is accelerated development of new products and procedures. But beyond that, the mindset behind rapid prototyping cycles can support continuous systems improvement and creative responses to difficult challenges. A rapid prototyping approach to designing new therapies, recommendations, and care interventions may improve our ability to quickly implement promising strategies for end-of-life care, behavioral health, and chronic care management.
Artifacts from the Future

In archeology, an artifact—such as a piece of pottery, a weapon, or jewelry—reveals how individuals and communities lived in the past. Artifacts provide context and make tangible the day-to-day experiences of previous civilizations. Like relics that an archeologist might discover at a dig site, IFTF’s Artifacts from the Future give a glimpse of how individuals and communities might live a decade from now. They help us visualize what the experiences of daily life might be like as health care trends and external future forces intersect and interact.
Imagine how the aging population could be served by a doctor trained to deliver care in a flipped-clinic model, using connected technologies and real-time sensor data to get a full picture of her patient’s health and well-being. Imagine physicians reporting higher job satisfaction and patients experiencing less frustration and an improved quality of life simply because neither of them needs to leave home for routine checkups.

**What Is It?**

Melanie Reyna, an academic family physician and geriatrician, prefers working from home whenever possible. This has been made a lot easier by OmniHealth, the advanced platform designed by a university consortium that brings the traditional house call into the digital age. OmniHealth provides all the information Melanie would have gathered from a patient during a standard visit, including medical history and vital signs, but it also provides much more, thanks to the smart home and biometric sensors that have become ubiquitous over the past few years.
So What?

Thanks to ubiquitous high-speed networking and an explosion of new sensors and consumer diagnostic technologies, flipped clinics will soon reset the medical encounter between patients and care providers. The activities that have historically taken place in clinical settings will be distributed across new technologies and new locations.

OmniHealth allows Melanie’s many senior patients to check in with her without the inconvenience and, for some, the risk of trips to a clinical setting. She has access to all the real-time measurements of vital signs and patient histories she would normally have, plus she can observe environmental factors where her patients live that might detrimentally affect their health. Relevant prescriptions can easily be ordered and delivered the same day.

There are certainly downsides to the remote nature of OmniHealth, but Melanie has found that it gives her more time for intermittent check-ins with her many patients. Her dashboard extends beyond traditional data points to include patients’ recent physical activity, diet, even regional triggers and outbreaks, all of which can be collected and customized in real time.
FUTURE OF MEDICAL EDUCATION: VIRTUAL SIMULATIONS

Or imagine how the external future force of on-demand learning in medicine will help meet the changing expectations of future medical students. In addition to participating in prerounds, examining patients, gathering diagnostic data, and updating notes, medical students in the future could participate in virtual rounds taking place at different academic medical centers anywhere in the world, or they could revisit a surgery or medical service to improve their clinical judgment any time or any place.

What Is It?

Sara, a third-year medical student, is riding the public bus on her way home from her clerkship. She’s wearing an inexpensive pair of virtual-reality goggles and experiencing a simulation of a medical procedure for her clinical emergency medicine course. This kind of interactive simulation provides immersive testing that corresponds with the subjects she’s studying in her regular coursework. The simulations even earn her real credits toward her degree. She’s gotten into the habit of
using her 40-minute bus ride each afternoon to practice the trickier procedures over and over, preparing for when she’s confronted with the real-world procedure later in the semester.

So What?
Over the next decade, the future force of on-demand learning will transform medical students’ and professionals’ expectations of how and when they learn. As augmented experiences become more mainstream, we should expect to see credit-earning activities extend well beyond the classroom and campus, into consumer-oriented technologies and experiences similar to the “credified” simulations included in Sara’s course package.

While technologies like virtual reality may seem like they belong in science fiction, the goggles worn by Sara in 2025 are actually modeled after inexpensive technology that exists today. Google Cardboard is an initiative to enable virtual reality using only a smartphone and a piece of cardboard, folded to form a pair of goggles. These headsets can be purchased through Google for less than $10 today and will only improve in the next 10 years.
Finally, imagine if the intersection of networked discovery, accelerating trends in translational research, and the explosion of data expanded the methods used to demonstrate academic talent. At academic medical institutions, reward structures could reflect the values and practices of openness and reciprocity, which are intrinsic to networked discovery. Researchers could receive credit for research studies designed and run with tools such as Apple’s ResearchKit and Scanadu as well as for participating in crowdsourced and citizen science projects.

What Is It?
Alex, a junior faculty member at State University Medical School’s Interactive Health Research Group, knows that a lot is at stake in his promotion review. The task is much more complex now than it ever used to be because opportunities for publication and contribution have exploded well beyond the world of peer-reviewed journals that once dominated the field. While Alex still participates in traditional research, he often makes research contributions in nontraditional ways. His digital CV keeps track of his research
contributions in all forms and aggregates them for easy reference, so Alex feels confident that his academic talent will be recognized and rewarded.

So What?

In papers and journal articles presenting traditional medical research, the order in which authors are listed signifies levels of contribution. Hiring and promotion committees give extra weight to “first author” papers. But sometimes it’s not clear who should be listed as first author, and this “first author” problem has become more pronounced in the past decade, between the different formats of contribution and the increasingly fragmented nature of attribution. In translational scientific discovery, effort is very difficult to measure and compare. New ways of giving credit will be needed.

Besides doing traditional research, Alex often shares authorship with thousands of others, including machine-learning software and algorithms like IBM’s Watson. He has made many contributions stemming from semiautomated and machine-assisted research platforms like Apple’s HealthKit that allow him to contribute to research throughout his day using only his smartphone. His most prolific contributions stem from Foldit, an online game that facilitates the discovery of new forms of protein folding. As Alex’s participation in networked discovery becomes the norm, academic medical institutions will need to reshape their culture and change reward structures to acknowledge this new reality.
Conclusion

Academic medicine has always been informed and influenced by a broad range of trends affecting education, health care, and research. In the next 10 years, disruptions will intersect, interact, and overlap with these trends, with one another, and with the existing set of cultural norms and practices. In a decade of combinatorial innovation, it will be critical for leaders to understand and prepare for futures that might emerge from the collision of linear trends and nonlinear external forces.

Every day, leaders and faculty of the nation’s medical schools and teaching hospitals and health systems confront the need to accelerate the process of transformational change in health care delivery, education, and research. As Darrell G. Kirch, MD, president and CEO of the AAMC, has observed, "Each day, the decisions facing us seem to become more difficult. . . . [These] moments of truth are our opportunities to act positively, courageously, and decisively."

By looking out over a 10-year horizon, leaders in academic medicine can explore the combining and recombining of linear and nonlinear factors that may lead to large cultural, social, and technological shifts. Engaging in a thoughtful examination of combinatorial futures will better position the nation’s medical schools and teaching hospitals and health systems to make fruitful, sustaining, future-oriented decisions today.
Endnotes


