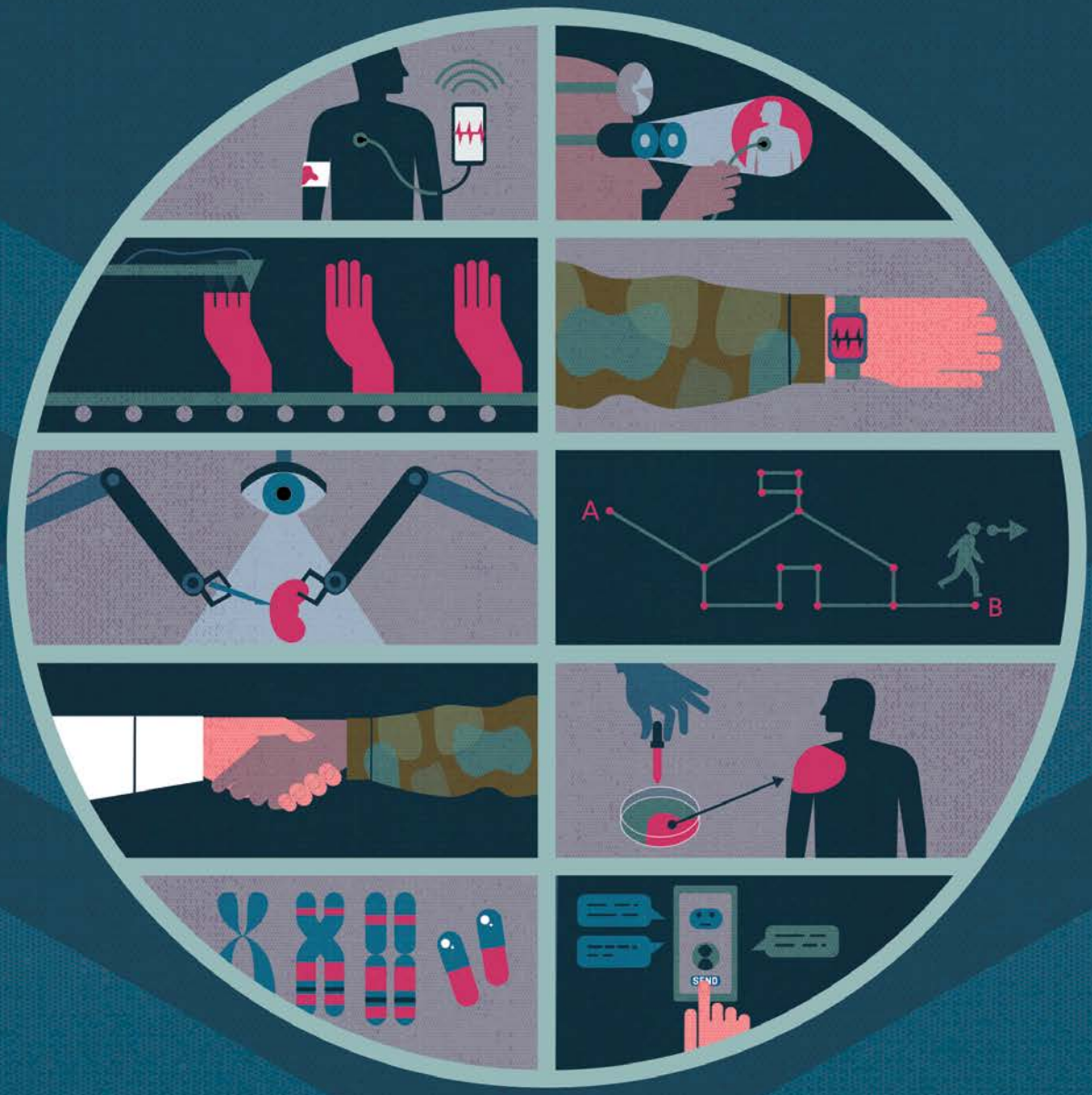
Deloitte. Insights

A REPORT FROM THE DELOITTE CENTER FOR GOVERNMENT INSIGHTS



Innovation in the Military Health System

Top 10 emerging technologies that could yield dramatic improvements

About the authors

DR. BRUCE GREEN is a managing director with Deloitte Consulting LLP, serving as chief medical officer for Deloitte's Federal Health practice. Green is an advisor to Deloitte's federal and commercial health clients and a thought leader in clinical public health leadership and preparedness. Previously he served as the 20th Air Force Surgeon General and the functional manager of the US Air Force Medical Service. Bruce has an MD, an MPH, and is board certified in aerospace medicine. Green lives in Knoxville, Tennessee.

DR. DOUGLAS ROSENDALE is the chief medical interoperability officer (CMIO) with Deloitte Consulting LLP, with more than 25 years of experience in clinical practice, executive leadership, and health IT. In his engagements across government and public health sectors, he focuses on improving health care quality and safety by advancing interoperability, informatics, and clinical and digital transformation initiatives. He is based in Rosslyn, Virginia.

MELISSA MAJEROL is a health care research manager with the Deloitte Center for Government Insights. She leads the Center's health research portfolio and supports the Deloitte Government and Public Services practice with research and comprehensive policy analysis in areas including Medicaid, health reform, emerging technology, and value-based care. She is based in Washington, DC.

About the Deloitte Center for Government Insights

The Deloitte Center for Government Insights shares inspiring stories of government innovation, looking at what's behind the adoption of new technologies and management practices. We produce cutting-edge research that guides public officials without burying them in jargon and minutiae, crystalizing essential insights in an easy-to-absorb format. Through research, forums, and immersive workshops, our goal is to provide public officials, policy professionals, and members of the media with fresh insights that advance an understanding of what is possible in government transformation.

Contents

Introduction

ONGOING WORK TOWARD achieving the "quadruple aim"—(1) ensuring readiness, (2) enhancing population health, (3) providing a convenient and high-quality experience of care, and (4) reducing health care costs—creates a strong business case for innovation in the Military Health System (MHS). In this dynamic environment, which technologies are most likely to spur innovation in the MHS over the next 10 years?

To answer this question, we started with a Deloitte Center for Health Solutions study, *Top 10 health care innovations: Achieving more for less*, in which Deloitte surveyed 85 innovation leaders across the health care system to gather their opinions about which technologies are most likely to transform health care over the next decade. (See sidebar, "Methodology.")

As we considered the list of technologies, we used a "push" innovation approach for the MHS. Unlike "pull" innovation, which begins with a customer pain point, push innovation starts with a new solution or technology and then identifies problems it can help solve. By utilizing push techniques to augment traditional pull strategies, the MHS can immerse itself in emerging approaches and technologies, while also diagnosing where and how to apply them for maximum impact.

But for this to work, the MHS needs to break the constraints of fee-for-service (FFS) clinical models to provide better care, in the optimal setting, at the right time, with the right provider. The aim would be to create better health outcomes and a better experience, using enabling technologies that lower the overall cost of managing acute and chronic care for active-duty military, reservists, retirees, and dependents. Innovation at the MHS also would require changing care delivery models to progress beyond the current limits of performance and cost of existing approaches and technologies.

The top 10 innovations have the potential to change how medical professionals in Department of Defense-staffed facilities, and private sector providers who treat TRICARE beneficiaries, prevent, diagnose, monitor, and treat disease. The potential impact of these innovations transcends traditional stakeholder segmentation (for example, TRICARE and other health plans, health care providers, and life sciences companies); it could drive transformative change in business and operating models.

By utilizing push techniques to augment traditional pull strategies, the MHS can immerse itself in emerging approaches and technologies, while also diagnosing where and how to apply them for maximum impact.

In the health care sector writ large, some organizations are already experiencing transformation arising from payment model changes, demands for patient-centric care, and increased availability of data sources. The MHS has felt these changes as well. The top 10 innovations are likely to accelerate the transformation of the MHS across each of these three areas:

Aligning financial incentives. The FFS payment model does not generally create financial incentives for providers to improve quality and does

METHODOLOGY

In 2017, the Deloitte Center for Health Solutions surveyed 85 innovation leaders across several segments of the health care system to gather their opinions about which innovations are most likely to transform health care over the next decade. These respondents included leaders from the biopharmaceutical industry; medical technology companies; diagnostics, health, and non–health focused technology companies; venture capital investors; providers (accountable care organizations, integrated delivery networks, academic medical centers, physician groups); urgent care; retail clinics; health plans; nurse practitioners; clinical pharmacists; academics; and former policymakers. After assembling the respondents' many ideas, the researchers applied the following definition of innovation to narrow the list to the top 10:

> Innovation: Any combination of activities or technologies that breaks existing performance trade-offs in the attainment of an outcome, in a manner that expands the realm of the possible. Defined in health care as providing "more for less"—more value, better outcomes, greater convenience, access, and simplicity; all for less cost, complexity, and time required by the patient and the provider, in a way that expands what is currently possible.

Reviewing the list with health care leaders at Deloitte, we came up with a modified list designed specifically for the MHS. Many of the innovations from the original list appear here as well, but we have made substitutions where appropriate. We also explain how each innovation applies to the needs of military members, dependents, and retirees and the professionals who provide their care.

not typically reimburse for the use of nontraditional services. Rather, FFS could create incentives for physicians to provide more services, even if the incremental benefit may not be commensurate to the cost. The shift to value-based care (VBC) aims to shift the incentive model by tying payment to quality and total cost of care, rather than rewarding volume. In 2016, the MHS launched a three-year series of VBC demonstration projects, using value-based reimbursement for services provided under TRICARE. The goal of this initiative is to see if tying reimbursement to outcomes will produce better care and a better experience for patients, and if it will help to control health care spending. The first demonstration project, started in May 2016 in the Tampa-St. Petersburg, Fla. area, experiments with bundled payments to hospitals that perform joint replacement or reattachment in the lower extremities for patients covered by TRICARE.[1]

Demands for patient-centric care. Consumer expectations for service delivery in health care are changing. Companies such as Amazon and Costco have trained customers to demand convenience, accuracy, and speed in all their interactions. In the health care arena, that typically means patients expect providers and payers to design services primarily around patient needs. According to the Institute of Medicine, a nonprofit affiliated with the National Academies of Science, patient-centered care is "providing care that is respectful of, and responsive to, individual patient preferences, needs, and values, and ensuring that patient values guide all clinical decisions."[2] One important aspect of patient-centric care involves patient behavior, a key component of disease management amidst the increasing prevalence of chronic conditions. Successful patient engagement could improve self-care and help achieve better outcomes; many health care stakeholders are investing in solutions to address this issue. In addition, some researchers are trying to understand what motivates different patients and are working on developing tailored solutions that incorporate individualized goals.

Data privacy, security, and interoperability. New sources of data are allowing health care professionals to generate a wealth of information

on practice patterns, health, outcomes, and costs. Using electronic health records (EHRs) has led to an increase in data volume and variety; however, much of the data are not yet interoperable. In other words, the data cannot be exchanged between different parties, or understood holistically. This limits how extensively organizations can use it for research or incorporate it into clinician workflows. Further, health care stakeholders are concerned with protecting the privacy and security of patient data. Data security can be even more crucial in the MHS than in civilian health care: When a data breach involves military personnel and/or systems, that breach may not only put individuals in jeopardy, it could also potentially pose a threat to national security.

Since it may be challenging to implement all 10 innovations at once, leaders in the MHS should set priorities and determine where to focus their efforts first in pursuit of the quadruple aim. For each innovation, we describe the changes that could be made to support greater adoption.

Top 10 technologies that could spur MHS innovation

- Virtual health
- Augmented reality
- 3D printing
- Robotic surgery
- Next-generation patient-centered care
- Wearables
- Augmented intelligence (AI)
- Blockchain
- Precision medicine
- Regenerative medicine

Virtual health

VIRTUAL HEALTH ALLOWS patients to connect with health care providers across vast distances. The MHS serves active duty service members, retirees, and their families all over the United States and across the world. For this exact reason, the MHS has used virtual health in some capacity since the 1990s.[3]

Types of service often include consultation via teleconference, mobile applications, and store-and-forward, which allows for the electronic transmission of medical information, such as photographs, diagnostic images, documents, and prerecorded videos for diagnosis or evaluation. Such services are available between providers and between patients and providers.[4]

While the MHS has long been recognized as a leader in virtual care, there is more that can be done to support all levels of care and all phases of military operations—including the battlefield. In recognition of this, the National Defense Authorization Act of 2017 requires "Enhancement of use of telehealth services in the Military Health System."[5]

Until recently, a patient needed to be at a patient-centered medical home (PCMH) in order to receive a virtual visit. In February 2016, the Assistant Secretary of Defense for Health Affairs issued a memorandum authorizing telehealth to the patient's home or other authorized location.[6] Designating the battlefield—or any location where there is internet access—as an authorized location could allow a wounded soldier on the battlefield or one of his/her fellow troops to use a mobile phone or other device to communicate with a frontline medic to stabilize the wounded soldier until she/he can receive more advanced care. Additionally, store-and-forward can be used between a soldier in the battlefield and a frontline doctor. The soldier could take a photo of a burn or rash and send it for evaluation and medical advice rather than traveling through hostile fire to receive a diagnosis and care plan.

More widespread use of virtual health may require that the MHS:

- Foster trust and address fears among patients about the quality and reliability of those services.[7]
- Educate providers about how to treat patients virtually and how to use virtual health platforms.[8] This could also increase provider adoption, which remains low.[9] The Kaiser Permanente health care system uses virtual health for 50 percent of its patient encounters;[10] the MHS has expressed a goal to match that rate.
- Encourage providers to adopt technologies that bridge the gap between otherwise noninteroperable virtual health service platforms and electronic health records (EHRs). This can be particularly important when virtual care is taking place between two providers who are documenting on a patient in two different systems simultaneously.[11]

BATDOK—which stands for Battlefield Airmen Trauma Distributed Observation Kit—is a mobile application the Air Force uses that allows a medic to monitor multiple patients with relative ease while on the battlefield. The software comes with FDA-approved sensors, which, when attached to a patient, sends the patient's vital signs back to the medic's screen in real time. If, while examining patient A, patient B's heart rate drops to a dangerous level, the medic would receive an alert so he or she can attend to patient B immediately. The sensors also document the exact geographic location where a patient is located, which can aid in communication and identifying casualties. BATDOK automatically integrates its patient data into each patient's MHS electronic medical record. The software works in conjunction with battlefield digital situation awareness maps, which helps identify the exact location of casualties.[12]

Augmented reality

AUGMENTED REALITY (AR) technology adds interactive computer-generated elements to a user's surrounding environment (or, alternatively, masks things that exist in the surrounding environment). AR is immersive, and it alters a user's perception of his or her surroundings; the computer-generated elements can be seen, heard, and touched.[13] Many people picture this technology working through a headset, though it also exists on other devices, including cell phones.

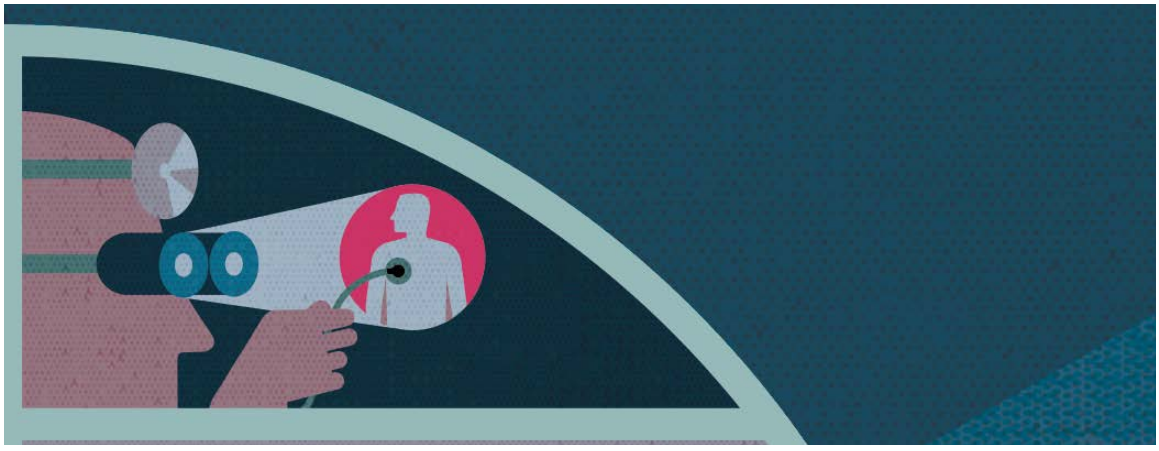
The MHS has used AR tools in its trainings for several years, but they are expected to become an even more integral component of MHS trainings in the future. The DoD may budget as much as US$11 billion for trainings that utilize AR technology by 2022.[14]

New downloadable software called a "physiology engine" allows medical trainees to see how their actions affect every other aspect of their patient's physiology. For example, a high-tech mannequin receiving CPR would be able to detect the pressure and speed of the trainee's hands. A dashboard could then display any changes to the mannequin's blood pressure and respiration rate and overall how it is responding.[15] This virtual "on the ground" training can be particularly important for MHS medics because it is difficult, if not impossible, to expose them to the exact types of wounds and injuries that might occur in a war zone.[16] The better the MHS can train its medics, the more it can fulfill its mission of readiness,[17] and the more lives those medics could save.

The expansion of AR in the MHS for both patient care and readiness will likely depend on:

- Its ability to create or procure content that addresses a specific problem or need individuals enrolled in its programs face;[18] and
- Its ability to demonstrate clinical efficacy, as it is not yet clear whether AR successfully teaches students how to avoid errors in medical training.[19]

In 2016, the Israeli Defense Forces (IDF) purchased HoloLens, Microsoft's AR goggles. According to the head of the IDF's programming department, the goggles will be used for a variety of purposes, including medical ones.[20] Medics would be able to perform surgery on wounded soldiers by using the goggles to see and hear directions from trained surgeons.[21]



3D printing

WHILE 2D PRINTING reproduces documents and photos from a computer onto paper, *3D printing* creates solid objects from a digital file by laying down the object's material in layers. 3D printing typically reduces a product's per-unit production cost and the amount of capital needed to achieve scope economies. The technology can be used to create prosthetic limbs, skin (for burn victims), organs, and implants (such as teeth) for soldiers injured in battle. Nearly 1,650 individuals who served in Iraq and Afghanistan lost all or part of one or both arms, legs, hands, and/or feet.[22] About 6,000 individuals underwent an amputation due to injuries sustained in the Vietnam War, as did 1,000 who served in the Korean War and 15,000 who served in World War II.[23]

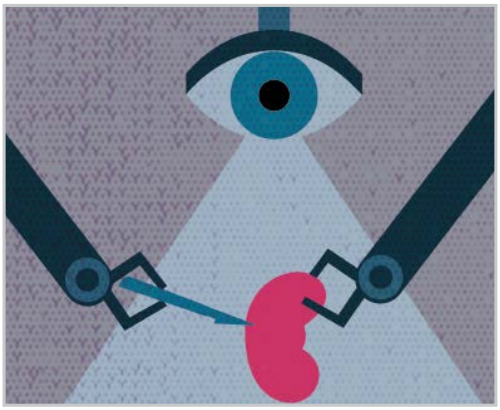
Before it can start making greater use of 3D printing, the MHS would likely need to:

- Identify innovators who can demonstrate biocompatible products' safety and consistency of process to gain FDA approval;
- Conduct clinical trials to determine the cost-effectiveness of 3D-printed products, and then use the results to develop a consistent reimbursement framework; and
- Develop methods for ensuring the quality and durability of all 3D-printed products.[24]

The 3D Medical Applications Center at Walter Reed Military Medical Center, or 3DMAC, creates custom prosthetic attachments for wounded veterans. While typical prosthetics can be generic or burdensome (for example, legs or feet need to be removed at times, such as when bathing or sleeping), 3DMAC's devices allow full range of motion, provide sensory feedback, and are designed to blend into the body naturally.[25]

Robotic surgery

ROBOTIC SURGERY IS a type of minimally invasive procedure in which a surgeon controls the tools he or she needs using a computer. It has become very precise over the last several years, and patients who undergo robotic surgery tend to experience fewer infections and recover more quickly than patients who undergo traditional surgery do.[26]



The DoD estimates 24 percent of service members who died in combat between 2001 and 2011 would have survived if they received more timely care.[27] In an effort to reduce the number of preventable casualties in future conflicts, the Defense Advanced Research Projects Agency (DARPA) funded researchers affiliated with SRI, a nonprofit research center, and universities across the country to develop "trauma pods"—trauma care units with robotic "hands." Typically, an on-site surgeon would control a robotic surgery, but the robots in the trauma pods are controlled by a surgeon off-site, who could be thousands of miles away. After a soldier has been wounded in combat, a drone would collect him and detect the nature and location of the injury. From there, a physician can remotely stabilize the patient until he or she arrives at the medical facility, viewing each step of the stabilization procedure through a camera. (The pod system is unable to fully stabilize the soldier because it cannot explore wounds or perform dissection, suction, or irrigation, or handle large masses of tissue and supplies.)[28] By combining telehealth services and robotic surgery technology, this system allows wounded soldiers to receive trauma care quickly in instances where every second counts, and time spent in transit could put their lives on the line.

Increasing adoption of robotic surgery within the MHS may require:

- Developing smoother virtual communication between the patient and the off-site provider, without transmission delays;[29]
- Implementing solid, stringent security and privacy architectures to prevent robots from being easily hacked;[30] and
- Creating more opportunities for surgical providers to learn how to use robotic surgery technology.[31]

William Beaumont Army Medical Center (WBAMC) performed its first robotic surgery in 2016 using a state-of-the-art robotic system called da Vinci Xi. Da Vinci Xi includes a magnified, 3D view of the surgical site, as well as multiple controllers so more than one physician can attend to the patient at the same time. The WBAMC claimed the surgery a success, citing patient benefits that included less blood loss, less time spent in the hospital, and a faster recovery overall.[32]

Next-generation patient-centered care

PATIENT-CENTERED CARE IS care tailored to an individual's unique needs and desired outcomes.[33] It stands in contrast to many of the traditional models of care delivery, where patients tend to have little say in the treatment they receive—as well as where, when, and how they receive it—and often feel the services are delivered in an inflexible and impersonal manner.[34] Patient-centered care models typically assume that when patients are more receptive to their care, they generally utilize health services more efficiently, which can improve health outcomes and reduce costs.[35]

Some Air Force and Navy bases began using a patient-centered care approach called the Patient-Centered Medical Home (PCMH) in 2007. Under the PCMH model,[36] a patient receives routine, comprehensive care from the same primary care physician (PCP). The PCP gets to know the patient and can provide treatment that meets his or her distinct needs. The care is designed to be comprehensive, with the PCP coordinating the individual's access to specialists if needed. The PCMH model was implemented across the MHS in 2009.[37]

The next generation of patient-centered care furthers this focus on patients by allowing patients to own their personal health data. Many military personnel and their families move frequently, and they need their medical records to keep pace with them. But MHS systems face many of the same interoperability challenges as nonmilitary health systems: Providers often cannot access a new patient's medical history, which can result in duplicative tests and a fragmented picture of the patient's health. Allowing patients to own their medical records on an electronic mobile application would ease the administrative burden of medical record transfers as military members and families move from place to place. This may help patients understand their health better and, as they monitor their health data, improve their health behaviors over time. It could also improve transparency: Being able to view and possess their health data on-demand could strengthen patients' trust with the health care system.

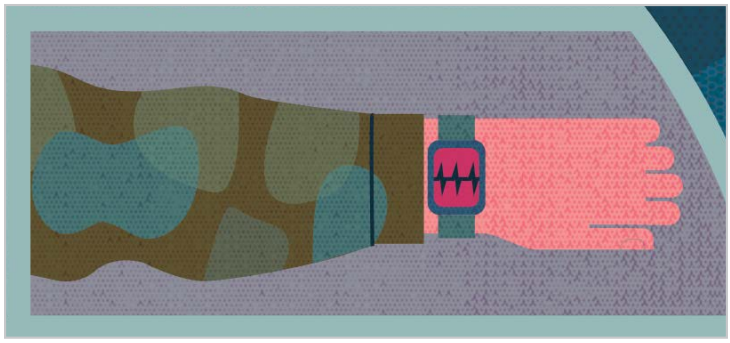
For next-generation patient-centered care to reach its full potential, the MHS should consider:

- Teaching MHS members how to access their health data, and how then to use that data to monitor their health.[38]
- Urging health care providers to implement interoperable EHR platforms or create the infrastructure that allows physicians using different platforms to easily access and share patients' data.[39] The Office of the National Coordinator for Health Information Technology has laid out a vision for interoperability among health care IT systems.[40]
- Providing patients with the tools to analyze and interpret the data.

Blue Button is an online feature that allows patients to download and view their health records. The US Department of Veterans Affairs (VA) was one of three government agencies that helped develop Blue Button and launched it in August 2010. By 2012, one-third of VA patients reported using the platform.[41] Of those, 73 percent said Blue Button helped them understand their health history better, since all the information was contained in one place. An overwhelming majority of patients who needed to share their VA health record with a non-VA provider (87 percent) said the non-VA provider found that information helpful.[42]

Wearables

WEARABLES ARE DEVICES that monitor an individual's activities without limiting or interrupting regular movement. The best-known wearables are watches or wristbands, but they also include smart clothing, high-tech hearing aids and contact lenses, and digital monitoring patches.



In the civilian realm, people use wearables to track their physical activity, measure their heart rate, and even answer phone calls. In the military, they could serve a more imperative function: detecting injured troops. When testifying before Congress in 2009 about the military's challenges, former Secretary of Defense Robert Gates said wounded troops in Afghanistan often faced delays in receiving trauma care.[43] To prevent these delays, the military is trying to develop a wearable fabric that can detect battle injuries.[44] From there, medics could dispatch and attend to soldiers who need attention. This fabric could even prevent certain injuries. For instance, a University of California, Berkeley laboratory is developing a fabric that can protect against biological and chemical warfare. The fabric will consist of three layers: A layer that touches the skin, a layer made of nanotubes, and a layer that responds to chemical agents. When the top layer detects a chemical agent, it is designed to instantaneously either shed off or collapse inside the nanotubes to block it, protecting the wearer.[45]

To make the most of wearables going forward, the DoD should consider:

- Developing technologies with strong privacy protections, and educating MHS patients about how to strengthen their privacy settings.[46] The issue of data privacy drew national attention after a popular fitness app revealed locations where soldiers were exercising on military bases in January 2018.[47]
- Designing wearables with the wearers in mind by ensuring they are not only durable, but also user-friendly and comfortable.[48]
- Encouraging developers of wearable technologies to address the challenges of data standardization and interoperability. Also, encourage them to collaborate with developers of EHRs to enable data integration.

The Ministry of Defence—the United Kingdom's DoD equivalent—provides soldiers in the field with ear-based physiological monitors. Because the ear is close to the brain, these monitors can measure core body temperature and heart rate "unobtrusively, continuously, in real time, with gold standard accuracy,"[49] as well as several other vital statistics. These devices allow commanders and clinicians to respond quickly and efficiently when someone needs medical attention (for example, after collapsing due to extreme weather conditions). In addition, the devices can track the data over time, so leaders can understand peak performance and recovery and make informed decisions around training and battle strategies.[50]

Augmented intelligence

AUGMENTED INTELLIGENCE (AI) technologies supplement, inform, or perform tasks that would otherwise require human cognitive capabilities. They are often touted for their potential to save time and money by having machines perform rote tasks; however, they may also be able to perform more complex functions that fill unmet needs and gaps in the labor force. For example, active duty service members tend to face high rates of depression, post-traumatic stress disorder (PTSD), and alcohol use disorders,[51] but the military faces a shortage of psychiatrists and psychologists.[52] Moreover, due to cultural stigma, many members of the military do not feel comfortable opening up about these issues to another person. Many active duty personnel fear that telling someone about their mental health problems will stunt their opportunities for career advancement.[53]

AI has made it possible for machines to provide services that were previously reserved for trained therapists. Researchers from the University of Southern California and Carnegie Mellon University found that, during PTSD screenings, active duty service members and veterans were more likely to open up about their symptoms to a virtual human (nicknamed "Ellie") than they were to human therapists.[54] While one of Ellie's greatest assets was the guarantee of anonymity, she also responded in nuanced ways that made her humanlike. Patients were aware that Ellie was not human, but by smiling, nodding, or sympathetically saying "mmm hmm" when appropriate based on patients' facial expressions and verbal cues, Ellie built rapport with the patients, which encouraged them to be more open.[55]

Greater adoption of AI within the MHS may require:

- Screening AI solutions to rule out the use of products whose algorithms perpetuate biases, commit errors, and/or leave themselves open to fraud;[56]
- Conducting pilots to demonstrate the value of AI technologies relative to their cost;[57] and
- Integrating AI systems with existing medical services and systems,[58] perhaps using them to supplement—rather than replace—human interaction.

A chatbot is a program that uses AI to engage in realistic conversation by text message or online chat. Woebot is a chatbot specifically designed to help people manage depression and anxiety. Modeled on cognitive behavioral therapy, in which therapists prompt patients to discuss how they feel about events in their lives, Woebot checks on users by asking questions about their mood and life events for about 10 minutes per day. Woebot may take the benefits of Ellie a step further: Some research indicates that patients are more likely to feel comfortable conversing over text than by video call.[59] While Woebot has the potential to help soldiers in all types of situations, it may be especially useful for those who are stationed remotely and lack easy access to an in-person therapist. (However, tools like Woebot probably are not a complete replacement for in-person therapy: Although patients liked him overall, many felt he didn't always converse naturally, and sometimes his answers seemed repetitive.[60])

Blockchain

AT ITS CORE, blockchain is a record of transactions. Each transaction is validated in an encrypted system before being recorded and added to the "chain." Blockchain is used to create a form of currency for data so it can be transferred between sources easily, quickly, and securely.[61] Health information and other sensitive electronic materials, like physician credentials, are just a couple of the types of data that might benefit from blockchain.

Military physicians can be transferred to a new duty station as often as every two to three years, sometimes with shorter assignments at nearby stations in between long-distance moves. Before these physicians can practice medicine at a military treatment facility (MTF), each of the facilities must determine whether the physician has the appropriate professional qualifications and clinical abilities.

Currently, the MTF physician credentialing process requires military physicians to supply a variety of data about their qualifications and experience before any transfer can be approved. The receiving organization can then spend months verifying provider credentials and past practice data—time that could be spent providing health care to those in need.

With the use of blockchain, this data can be conveyed between bases more smoothly, eliminating thousands of hours of requests for information from original sources and substantially reducing credentialing costs.[62]

Here's how it could work: MTFs would use a trusted and validated repository of data from accredited stakeholders for credentialing activities. The military physician would then consent to share components of this data with a hospital, thus retaining control over the nature of the credentialing package supplied to the hospital. This would ease the administrative burden of gathering and validating information when physicians switch hospitals. Stakeholders would use "smart contracts" to automate workflows and tasks using data on the shared ledger, including follow-up on missing data, and periodic validation of essential provider information, which would help them keep data accurate and current. This type of solution could enable disintermediation in the credentialing process by removing the need for credentialing service firms.

To make blockchain a success in the MHS, the organization should:

- Secure sufficient blockchain talent and expertise;[63]
- Demonstrate that blockchain would not make it difficult to comply with regulations such as the Health Insurance Portability and Accountability Act (HIPAA) but, rather, can promote compliance;[64]
- Develop trust between networks for shared information;
- Invest in and implement the massive computational systems required to operate blockchain, with sufficient energy to run them; and
- Secure the data below the blockchain—and maintain an audit trail.

Hashed Health is a company that focuses on "accelerating the meaningful development of blockchain" within the health care realm.[65] At the 2018 HIMSS Global Conference and Exhibition, it unveiled its Professional Credential Exchange tool, which uses blockchain to exchange information about whether a clinician is licensed to practice at a certain location or level.[66]

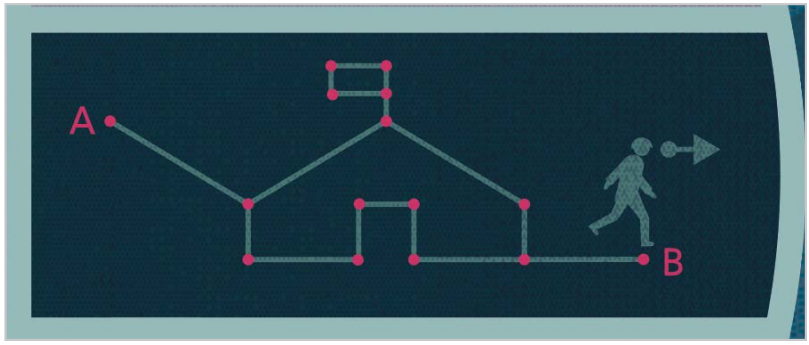
Precision medicine

PRECISION MEDICINE IS a term used by the US government and others to describe medical care that is tailored to a specific individual's behavior, social context, environment, and genome. The US government's Precision Medicine Initiative[67] includes "All of Us" and the VA's Million Veteran Program (MVP). Launched in 2015 by the National Institutes of Health (NIH), All of Us is collecting genetic and health data from one million Americans for research purposes. In 2011, MVP began a program to collect similar data among veterans; by 2016, MVP became the largest genomic database in the world.[68]

Precision medicine could be used to bolster the military's readiness with respect to smoking cessation, among other areas. A DoD report found that 24 percent of active duty service members smoke cigarettes, exceeding the civilian rate (21 percent) and the *Healthy People 2020* goal (12 percent).[69] According to the Bipartisan Policy Center, service members who use tobacco are less physically fit than are their nonsmoking peers, and tobacco is known to raise one's risk of being diagnosed with many cardiovascular, respiratory, and dental diseases.[70]

Researchers at Vanderbilt University developed a blood test that can determine how quickly an individual metabolizes nicotine. This information can be used to determine the most effective smoking cessation medication.[71] While further research is needed, other biomarkers show promise in the realm of smoking cessation as well.[72] If implemented within the MHS, precision medicine efforts to help patients quit smoking could help build a stronger, healthier, and more ready military force.

Increased utilization of precision medicine would likely require:



- Addressing confidentiality concerns and ensuring patients that their medical data will remain secure;[73]
- Hiring more geneticists to oversee testing, report results, and handle pre- and posttest counseling;[74] and
- Implementing systems that provide access to the necessary data, in standardized formats, and ensuring that the data is reliable.

Researchers at Madigan Army Medical Center in Washington state are studying how genetic variations impact an individual's risk of vitamin D deficiency. Vitamin D is a key component of bone health, and not having enough can increase a service member's risk of injury, especially when engaged in physically intensive activities, such as training or combat. The researchers want to find a way to determine how much vitamin D supplementation an individual needs based on his or her genetic information.[75]

Regenerative medicine

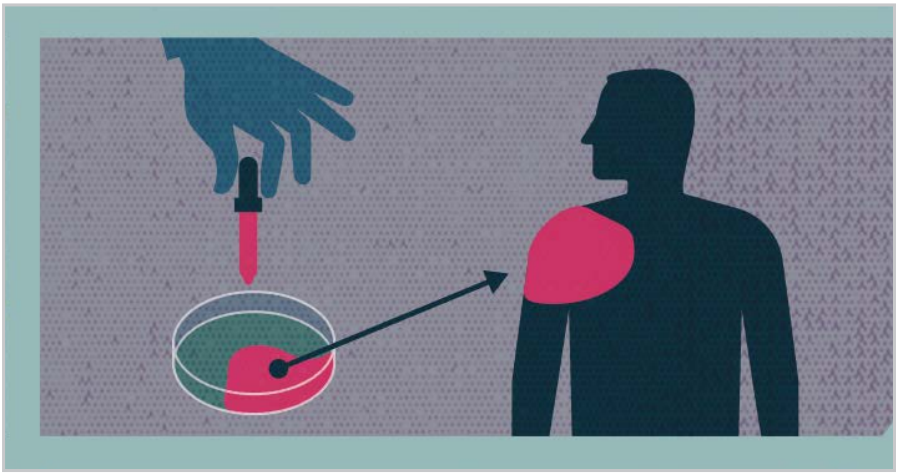
REGENERATIVE MEDICINE INVOLVES "creating living, functional tissues to repair or replace tissue or organ function lost due to age, disease, damage, or congenital defects."[76] It has the potential to treat the severe injuries caused by explosions, which are exceedingly common among members of the armed services. Of the 51,000 injuries American soldiers sustained in Iraq and Afghanistan, approximately three-quarters were the result of explosive injury mechanisms, including improvised explosive devices (IEDs). These explosives frequently cause severe damage to soldiers' limbs, heads, and faces.[77]

Most regenerative therapies that are currently available involve replacing skin, limbs, and parts of the face, and they can be of tremendous value to many service members. But neurological cells and tissues are difficult to replicate. The Center for Neuroscience and Regenerative Medicine (CNRM), part of the Uniformed Services University, conducts research on cutting-edge treatments for service members who suffer from traumatic brain injury (TBI). The CNRM hopes to study some of these treatments on animal models, and more yet on human patients, within the next two years. Ten years from now, CNRM aims to "have developed a substantial body of knowledge" about what treatments are most effective for military TBI patients.[78]

Further advances in regenerative medicine will likely depend on:

- Acquiring sufficient funding for research projects and partnering with the private sector to resolve gaps;[79] and
- Developing the expertise needed to effectively and efficiently maximize the potential of stem cell usage.[80]

Since regenerative medicine can treat injuries that are frequently seen among service members, the DoD established the Armed Forces Institute of Regenerative Medicine (AFIRM) in 2008. AFIRM's five major projects are: (1) limb and digit salvage, (2) craniofacial reconstruction, (3) scarless wound healing, (4) burn repair, and (5) compartment syndrome.[81] So far, more than 200 patients have received treatments that AFIRM developed.[82]



Embracing innovation: Next steps

THESE TOP 10 technologies have the potential to transform health care at the MHS. As MHS leaders contemplate launching one or more of these initiatives, here are several next steps to consider:

Set priorities, and then diversify the portfolio of innovations. Just as diversification is a proven method for mitigating uncertainty in financial investments, so too can it help balance risk and reward in public sector innovations.

Given the variety of promising innovations on the horizon, the MHS should consider ranking the items on this list based on how instrumental they could be at helping the MHS achieve the quadruple aim. Then, leaders at the MHS could create a portfolio of innovations that represent a mix of high-risk/high-reward initiatives and lower-risk/lower-reward initiatives. A portfolio-driven approach can help the MHS quantify the impact of their initiatives, justify future investments, and offset the risks presented by efforts that are more transformational.

Identify the MHS' role in an innovation ecosystem, then build the ecosystem. Multiple roles are often essential to making an innovation effort a success (see figure 1). A previous Deloitte study found that most innovations involve organizations playing at least one of five key roles:[83]

- Developing innovative solutions (*problem solver*);
- Giving others tools or resources to make innovation easier (*enabler*);
- Creating incentives to spur innovation (*motivator*);
- Bringing various actors together to collaborate through the innovation process (*convener*); and
- Establishing and/or sustaining the innovation ecosystem as a whole (*integrator*).

Before launching any of these innovations, leaders should identify which role(s) the MHS can fulfill in the innovation ecosystem. They can then consider establishing partnerships with other organizations to fulfill the other roles.

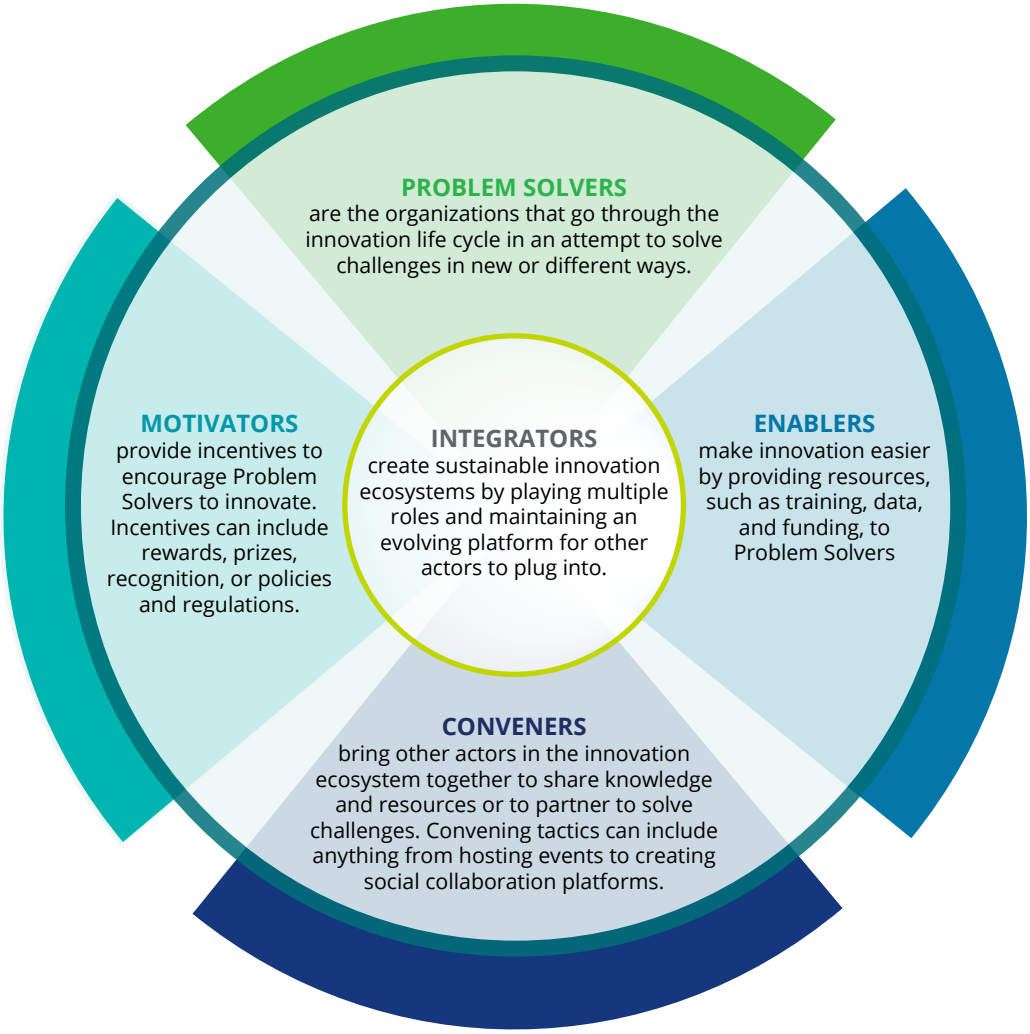
Seek knowledge from nontraditional sources. Over the past decade, a vast democratization of innovation has occurred around the globe. This includes the rise of the *maker movement*, where individuals or groups use existing materials to build new solutions that address challenges in health care and other fields.[84] Crowdsourcing has also emerged as an important way to generate fresh solutions to challenging problems. The MHS might consider exploring these sources to acquire expertise and talent.

Pilot, evaluate, and scale. As technologies continue to change at a rapid pace, the MHS should consider conducting small pilots before entering into full-scale contracts with new technology providers. This would allow the MHS to experiment with new approaches or technologies and evaluate the results before taking them to scale.

Stay up to date and stay agile. Innovation never stands still; new solutions, with significant potential for health care, keep streaming over the horizon. To keep from missing out, innovation teams within MHS should read widely and engage in discussions to learn about the latest developments. Leaders at MHS should anticipate which emerging innovations offer the greatest benefits and respond swiftly, disrupting their operational models before they become obsolete.

FIGURE 1

Five roles in public sector innovation



Source: Alan J. Holden et al., *Catalyzing public sector innovation*, Deloitte Insights, March 23, 2017.

Endnotes

1. Military Health System, "Value-based reimbursement demonstration project," accessed September 20, 2018.
2. Oneview Healthcare, "The eight principles of patient-centered care," May 15, 2015
3. Charles R. Doarn et al., "Federal efforts to define and advance telehealth—a work in progress," *Telemedicine Journal and e-Health* 20, no. 5 (2014): pp. 409–18.
4. Office of the Under Secretary of Defense, "Report in response to section 718 of the National Defense Authorization Act for fiscal year 2017 (public law 114–328)," October 17, 2017.
5. Congress.gov, "National Defense Authorization Act for fiscal year 2017: Conference report," Section 718, November 30, 2016.
6. Office of the Under Secretary of Defense, "Report in response to section 718 of the National Defense Authorization Act for fiscal year 2017 (public law 114–328)."
7. Trisha Greenhalgh et al., "Virtual online consultations: Advantages and limitations (VOCAL) study," *BMJ Journals* 6, no.1 (2016).
8. Erin Aas, "Prepare providers for telemedicine: 3 critical training areas," *Managed Healthcare Executive*, March 18, 2017.
9. Military Health System, "Health care of the future: Virtual doctor-patient visits a reality at NCR," February 20, 2018.
10. Kia Kokolitcheva, "More than half of Kaiser Permanente's patient visits are done virtually," *Fortune*, October 6, 2016.
11. Kevin Jones, "A lack of interoperability limits telehealth's potential," *HealthTech*, March 1, 2018.
12. Peter Holstein, "Embedded Air Force researchers develop innovative battlefield medical technology," Air Force Special Operations Command, August 1, 2017.
13. Thomas J. Cowper and Michael E. Buerger, *Improving our view of the world: Police and augmented reality technology*, Federal Bureau of Investigation, 2013.
14. Fedscoop, "Immersive technologies: Give military new tools for training," November 27, 2017.
15. Bryant Jordan, "US Army turns to computer software for medic training," Military.com, August 4, 2015.
16. American College of Surgeons, "Military surgeons develop framework to sustain surgical skills in a changing military and medical environment," May 12, 2016; Robert L. Mabry and Robert DeLorenzo, "Challenges to improving combat casualty survival on the battlefield," *Military Medicine* 179, no. 5 (2014): pp. 477–82.
17. Rand Corporation, "Medical readiness and operational medicine," 2001.
18. Don Karl et al., *2018 augmented and virtual reality survey report*, Perkins Coie, March 2018.
19. Bill Copeland, Michael Raynor, and Sonal Shah, *Top 10 health care innovations*, Deloitte, 2016; E. Z. Barsom, M. Graafland, and M. P. Schijven, "Systematic review on the effectiveness of augmented reality applications in medical training," *Springer Link*, February 23, 2016.
20. Kevin Parrish, "Israel using Microsoft's HoloLens to help soldiers on battlefield, train personnel," Digital Trends, August 15, 2016.

21. John Callaham, "Israeli army taps Microsoft HoloLens for augmented battlefield training," Windows Central, August 15, 2016.
22. Hannah Fischer, *A guide to U.S. military casualty statistics: Operation Freedom's sentinel, Operation Inherent Resolve, Operation New Dawn, Operation Iraqi Freedom, and Operation Enduring Freedom*, Congressional Research Service, August 7, 2015.
23. Defense Health Board, *Sustainment and advancement of amputee care*, April 8, 2015.
24. Calvin Seah Ser Thong and Choo Wei Wen, "3D Printing – Revolutionising Military Operations," *Pointer, Journal of Singapore Armed Forces* 42, no. 2 (2016).
25. US Department of Defense, "3-D printing technology helps wounded warriors," November 7, 2017.
26. UCLA Health, "What is robotic surgery?," accessed September 20, 2018.
27. United States Government Accountability Office, *Defense health: Actions needed to help ensure combat casualty care research achieves goals*, February 2013.
28. Pablo Garcia et al., "Trauma pod: A semi-automated telerobotic surgical system," *International Journal of Medical Robotics and Computer Assisted Surgery* 5, no. 2 (2009): pp. 136–46.
29. Roseanne Gerin, "SRI to develop robotics for battlefield medical care," *Washington Post*, April 4, 2005; Gary Martinic, "Glimpses of future battlefield medicine—the proliferation of robotic surgeons and unmanned vehicles and technologies," *Journal of Military and Veterans' Health* 22, no. 3 (2014).
30. Alexandra Ossola, "Robots used in long-distance surgery can easily be hacked," *Popular Science*, April 28, 2015.
31. Shireen Bedi, "Robotic surgery training program aims at improving patient outcomes," US Air Force, February 6, 2016.
32. Marcy Sanchez, "WBAMC, first to operate with latest robotic surgical system in DoD," US Army, May 9, 2016.
33. NEJM Catalyst, "What is patient-centered care?," January 1, 2017.
34. Amanda Sillars, "Medical model vs. person-centered care model," California Department of Aging, 2015.
35. Ronald P. Hudak et al., "The patient-centered medical home: A case study in transforming the military health system," *Military Medicine* 178, no. 2 (2013): pp 146–52.
36. US Department of Health & Human Services, "Defining the PCMH," accessed September 2018.
37. Hudak et al., "The patient-centered medical home."
38. Carolyn Turvey et al., "Blue Button use by patients to access and share health record information using the Department of Veterans Affairs' online patient portal," *National Center for Biotechnology Information*, April 16, 2014
39. Sara Heath, "Why interoperability is vital to patient access to health data," *Xtelligent Media*, July 14, 2016
40. Office of the National Coordinator for Health Information Technology, *Connecting health and care for the nation: A shared nationwide interoperability roadmap*, October 2015
41. Carolyn Turvey et al. "Blue Button use by patients to access and share health record information using the Department of Veterans Affairs' online patient portal," *Journal of the American Medical Informatics Association* 21, no. 4 (2014): pp. 657– 63.
42. Ibid.

43. US Department of Defense, *The challenges facing the Department of Defense: Hearing before the Committee on Armed Services*, United States Senate, January 27, 2009; Thom Shanker, "Gates seeks to improve battlefield trauma care in Afghanistan," *New York Times*, January 27, 2009.

44. Alex Hanuska et al., "Smart clothing market analysis," UC Berkeley Engineering's Center for Entrepreneurship & Technology, 2016.

45. Ibid.

46. Jim Garamone, "DoD studying implications of wearable devices giving too much info," US Department of Defense, January 29, 2018.

47. Liz Sly, "U.S. soldiers are revealing sensitive and dangerous information by jogging," *Washington Post*, January 29, 2018.

48. IDTechEX, "The intelligent soldier system—military wearables," July 23, 2015

49. Leon Marsh, "The crucial role of next generation hearables in defence," Defence Contracts Online, Ministry of Defence (the UK), 2018.

50. Ibid.

51. Psychological Health Center of Excellence, "Mental health disorder prevalence among active duty service members," accessed September 20, 2018.

52. Sandhya Somashekhar and Ellen Nakashima, "Military's mental-health system faces shortage of providers, lack of good diagnostic tools," *Washington Post*, April 5, 2014; Ronald D. Hester, "Lack of access to mental health services contributing to the high suicide rates among veterans," *International Journal of Mental Health Systems* 11, no. 47 (2017).

53. Nicholas B. Brown & Steven E. Bruce, "Stigma, career worry, and mental illness symptomatology: Factors influencing treatment-seeking for Operation Enduring Freedom and Operation Iraqi Freedom soldiers and veterans," *Psychological Trauma: Theory, Research, Practice, and Policy* 8, no. 3 (2016): pp. 276–83.

54. Gale M. Lucas et al., "Reporting mental health symptoms: Breaking down barriers to care with virtual human interviewers," Frontiers, October 12, 2017.

55. Robbie Gonzalez, "Virtual therapists help veterans open up about PTSD," *Wired*, October 17, 2017.

56. William D. Eggers et al., *How CDOs can manage algorithmic risks*, Deloitte Insights, June 7, 2018.

57. Copeland, Raynor, and Shah, *Top 10 health care innovations*.

58. Deloitte Insights, *Cognitive technologies: A technical primer*, February 6, 2018.

59. Megan Molteni, "The chatbot therapist will see you now," *Wired*, June 7, 2017.

60. Kathleen Kara Fitzpatrick, Alison Darcy, and Molly Vierhile, "Delivering cognitive behavior therapy to young adults with symptoms of depression and anxiety using a fully automated conversational agent (Woebot): A randomized controlled trial," *Journal of Medical Internet Research* 4, no. 2 (2017).

61. Jacob Kleinman, "What is blockchain?," Lifehacker, January 16, 2018.

62. United States Government Accountability Office, *DOD health care: Actions needed to help ensure full compliance and complete documentation for physician credentialing and privileging*, December 2011; David Chou and Bill Wellman, "Reinventing physician credentialing with blockchain," Health Standards, June 20, 2017.

63. Gary Meyer and Fletcher McCraw, *Healthcare: Blockchain's curative potential for healthcare efficiency and quality*, Cognizant, September 2017.

64. Compliancy Group, “Blockchain healthcare technology: HIPAA compliant?,” February 12, 2018.

65. Hashed Health, “What is Hashed Health?,” accessed September 20, 2018.

66. Jennifer Bresnick, “Hashed Health launches blockchain provider identity tool,” HealthIT Analytics, March 7, 2018.

67. The White House: President Barack Obama, “The precision medicine initiative,” accessed September 20, 2018.

68. U.S. Department of Veterans Affairs, “Million Veteran Program is now largest genomic database in the world,” August 1, 2016.

69. Frances M. Barlas et al., *2011 Department of Defense health related behaviors survey of active duty military personnel*, US Department of Defense, February 2013.

70. Bipartisan Policy Center, *Health, health care, and a high-performance force*, March 2017.

71. Vanderbilt University Medical Center, “Smoking study personalizes treatment,” November 16, 2017.

72. Li-Shiun Chen et al., “Leveraging genomic data in smoking cessation trials in the era of precision medicine: Why and how,” *Nicotine & Tobacco Research* 20, no. 4 (2018): pp 414–24.

73. Lauran Neergaard, “US seeking 1 million for massive study of DNA, health habits,” Medical Xpress, May 1, 2018.

74. Mauricio De Castro et al., “Genomic medicine in the military,” *npj Genomic Medicine* 1, article no. 15008 (2016).

75. Suzanne Ovel, “Precision medicine: The future of health,” US Army, September 29, 2016.

76. National Institutes of Health, “Regenerative medicine,” accessed September 20, 2018.

77. Armed Forces Institute of Regenerative Medicine (AFIRM), *AFIRM annual report 2013*, 2014.

78. Uniformed Services University, “Center for Neuroscience and Regenerative Medicine,” accessed September 21, 2018.

79. James F. Amos, “Regenerative medical provides new solutions for wounded warriors,” Navy Medicine Live (official blog of the US Navy Bureau of Medicine and Surgery), August 8, 2012.

80. Gregory T Christopherson and Leon J Nesti, “Stem cell applications in military medicine,” *Stem Cell Research & Therapy* 2, no. 40 (2011).

81. Armed Forces Institute of Regenerative Medicine (AFIRM), *AFIRM annual report 2013*.

82. Congressionally Directed Medical Research Programs (CDMRP), *FY17 CDMRP annual report*, September 2017.

83. Note: These roles are not mutually exclusive.

84. Anna Young, “Do-it-yourself health: How the maker movement is innovating health care,” Robert Wood Johnson Foundation, November 16, 2015.

Acknowledgments

The authors would like to thank **Rose Meltzer** for her research and writing support and **Bill Eggers** for reviewing and providing insightful edits to this report.

Contacts

Dr. Bruce Green
Managing director and chief medical officer
Deloitte Consulting LLP
+1 615 268 4216
brucegreen@deloitte.com

Dr. Doug Rosendale
Chief medical interoperability officer
Deloitte Consulting LLP
+1 970 260 7448
drosendale@deloitte.com

William D. Eggers
Executive director
Deloitte Center for Government Insights
Deloitte Services LP
+1 571 882 6585
weggers@deloitte.com

Deloitte.
Insights

Sign up for Deloitte Insights updates at www.deloitte.com/insights.

Follow @DeloitteInsight

Deloitte Insights contributors
Editorial: Karen Edelman, Blythe Hurley, and Rupesh Bhat
Creative: Sonya Vasilieff and Molly Woodworth
Promotion: Alexandra Kawecki
Cover artwork: Andrew Baker

About Deloitte Insights

Deloitte Insights publishes original articles, reports and periodicals that provide insights for businesses, the public sector and NGOs. Our goal is to draw upon research and experience from throughout our professional services organization, and that of coauthors in academia and business, to advance the conversation on a broad spectrum of topics of interest to executives and government leaders.

Deloitte Insights is an imprint of Deloitte Development LLC.

About this publication

About Deloitte