As healthcare becomes increasingly more complex, nurses must maintain the competencies necessary to deliver high-quality care. This includes the ability to respond appropriately to new technologies, which may have the potential to change nursing practice and/or to improve outcomes. As patient advocates and frontline caregivers, nurses must ensure that new technologies support and enhance the human element in healthcare.
## TABLE OF CONTENTS

- Bioprinting ................................................................. 3
- Predictive Modeling .................................................... 5
- Mobile Apps ............................................................... 7
- Virtual Simulation ....................................................... 9
- Genome Sequencing ................................................... 11
- Biometrics .................................................................. 13
- Robotics .................................................................... 15
- About American Sentinel University ......................... 17
Bioprinting is one of the most exciting new technologies in healthcare. It evolved from 3D printing, also known as additive manufacturing, in the industrial world. The additive process involves building an object in layers, typically from liquid plastic that serves as “ink,” to create a three-dimensional object. In the early 2000s, researchers began experimenting with a similar technique, known as bioprinting, for medical applications.

Bioprinting uses a bio-ink made of living cells, collagen, hormones, etc., to create solid tissue layer by layer. The idea is to create “replacement parts” for the human body. These parts are made of the patient’s own genetic material, eliminating the problem of rejection so common in tissue grafting and transplant procedures today. To date, the technology allows for the printing of simple tissues like skin and heart muscle for grafts, and researchers hope to be able to print viable, whole organs within 30 years. A major challenge has been finding ways to include blood vessels in printed organs.

Bioprinted tissue can also be useful in medical research, particularly in applications where ethics preclude using human beings as test subjects. By creating a natural cellular environment, researchers can use bioprinting to study wound healing, disease progression, factors that induce disease, and the safety and efficacy of new drugs. It could potentially be more effective than animal testing.

Many experts extend the definition of bioprinting to include biocompatible materials like plastic or titanium that can be used to build body parts. For example, in 2013, a Belgian woman received a prosthetic jawbone that was printed from layers of titanium powder and then coated with bio-ceramic artificial bone. Another case involved a baby born with tracheobronchomalacia, or a collapsing trachea. Biomedical engineers were able to keep him breathing until his windpipe strengthened, by printing a splint from a bio-polymer that his body would reabsorb over time.

A 3D printing process could also create exact models of a patient’s diseased or damaged organ, for surgeons to study and handle before entering the operating room. The opportunity to develop a surgical plan from a multi-dimensional model is a distinct advantage over using an MRI or CT scan, possibly improving outcomes or reducing the likelihood of complications.

As with any new technology, there are major considerations. Does the cost of bioprinting justify the benefits? Who will have access to the new treatments? How will printed tissues, organs, and prosthetics be evaluated.
and regulated? And what about unintended consequences? It’s possible that bioprinting will cause harm as well as good, or will prove successful in some types of procedures or medical specialties but not others. It may require new regulatory processes or a reorganization of multiple parts of the healthcare system (including insurance), which could take many years of trial and error or cost millions of dollars.

Another looming question is how bioprinting will affect nursing practice. As a new resource with the potential to improve patient outcomes, bioprinting can change the tasks that nurses perform in various areas. For example, imagine that the need for dialysis or long waiting periods for organ transplant are suddenly eliminated. This might mean fewer—or different—nursing interventions. It could perhaps result in shorter hospitalizations or fewer hospitalized patients, which in turn could affect the workplace environment, staffing ratios, etc. It’s possible that the entire care process could change for the better, with nursing staff able to spend more time developing positive relationships with each patient, encouraging healthy behaviors, and providing support.

Nursing’s patient advocacy role will likely come into play if bioprinting becomes a common treatment option. While nurses are not legally responsible for obtaining informed consent, the ANA maintains that nurses have an ethical obligation to ensure patients understand the implications of their medical decisions and are able to remedy any knowledge gaps they identify. Nurses may also have to advocate for and respect the values of patients who have religious or cultural objections to tissue regeneration or transplantation. And of course, nurse leaders and educators will have to prepare for all of the challenges associated with an emerging technology, in order to assure that nurses have the competencies they need. The profession as a whole should be proactive, rather than reactive, when it comes to addressing the future of nursing.
Predictive modeling is a process used in data analytics to create a statistical model of likely future outcomes—in other words, a method to forecast probabilities and trends. It has long been used by the life insurance industry to manage risk and balance payouts with premiums. The healthcare industry is just beginning to use predictive modeling (PM) to guide policy and practice, as more and more data is being captured by the electronic medical record (EMR).

Two other trends, both influenced by the Affordable Care Act, have also driven an interest in predictive modeling: (1) the new emphasis on population health management and (2) an increased focus on the relationship between quality and cost, rather than on one or the other alone.

Rich data streams from the EMR are the driving force behind predictive modeling efforts. Experts see PM as a potential means to predict risk, control cost, better allocate resources, prevent complications, and generate more precise diagnoses and treatment plans. Here are a few of the ways PM is currently being applied to healthcare:

- **Flexible and efficient nurse staffing.** A low nurse-patient ratio can have an impact on safety and quality of care, while over-staffing can raise costs. Predictive modeling can allow hospitals to forecast the flow of patients in each unit by day of the week and hour of the day, improving the scheduling process. PM can also help with hiring and retention and can increase job satisfaction among nurses, who are less likely to experience burnout when staffing is adequate. ([Read a case study here.](#))

- **Population health management.** PM can help to organize patient populations into sub-groups that can be targeted for specific interventions, increasing the ability to provide the right care at the right time. This can ultimately manage costs and improve outcomes. For example, a report in the *Online Journal of Nursing Informatics* described a successful effort to identify patients at increased risk of congestive heart failure (using a combination of diagnoses as a risk marker) and predict a timeframe for the onset of disease. This is exactly the type of proactive, wellness-oriented, patient-centric response to population health management that nursing should embrace.
• **Personalized medicine.** By assembling data on an individual’s gender, ethnic background, genome, current medical status, lab values, prescription history, and family history, researchers have been able to build an algorithm that predicts future health status, allowing certain patients to be tracked and monitored. But PM can also use historical data to help doctors decide on the treatment plan that is most likely to be effective for a specific individual. More targeted treatments can reduce harm to patients, increase the likelihood of good outcomes, and require fewer nursing resources.

• **Preventing unnecessary readmissions.** Clearly, predictions are most useful when they impart knowledge that can be translated into action. Efforts to use PM to reduce readmissions have been remarkably successful ([read a case study here](#)). Case managers everywhere may soon have a remarkable tool at their fingertips, in the form of an algorithm that can zero in on patients at high risk of readmission within 30 days—and identify them at the time of admission, so discharge planning can be initiated right away. Interestingly enough, nursing assessments are an important data component in these analytics. As frontline caregivers, nurses can identify social factors, mobility issues, and even financial concerns that are not captured in diagnostic codes or clinical assessments.

So what does this all mean for nurses? In summary, **predictive modeling has the potential to improve the nursing work environment through better staffing and scheduling practices.** As a new resource with the potential to improve patient outcomes, PM may change the tasks that bedside nurses and nurse case managers perform in various areas. And of course, as PM becomes more widespread and more sophisticated, it **may increase job opportunities for nurses specializing in informatics,** who can connect the dots and formulate patient-centric applications for the technology.

[Online nursing degrees](#) like American Sentinel’s [MSN with an informatics or case management specialization](#) can make you attractive to employers, provide you with case management knowledge and skills, and give you the academic background to help you pass the credentialing exam.
Mobile apps—those little software packages that turn a wireless device into a powerhouse of efficiency—are in their heyday. As they pertain to nurses, the apps tend to fall into two broad categories: enterprise apps and mobile health apps, often referred as m-health. The main difference between these two is that enterprise apps are productivity-oriented apps that face inward within the healthcare organization to support workers, while m-health apps face outward toward patients and consumers.

Early on in the mobile revolution, you may have used the same productivity apps that consumers use to keep a calendar, organize contacts, or clip and save information. You may have even added apps that include a medical dictionary or drug reference. Last year, however, nurses got a boost when IBM and Apple teamed up to present four new nursing-specific apps as part of their MobileFirst for iOS line-up. These apps are powerful tools that integrate with the hospital’s internal systems. They can track patients by location, allow access to the patient chart from anywhere in the hospital, and send push notifications of patient and staff requests. They can draw information from multiple internal sources and collate it into a single unified view. An app designed for home health nurses allows them to manage patient records; share information with colleagues; and add photos, video, and text or audio notes to the patient’s record.

Business analysts are saying that enterprise apps are a must-have for any business to remain competitive. A recent Forbes column talked about the ways in which they can empower workers and boost productivity. So it’s very encouraging that healthcare organizations are beginning to provide these tools to the nursing workforce, which is arguably the most critical labor segment in healthcare, at least in terms of direct patient interaction.

Since m-health apps are patient-facing, a nurse who understands their use and benefits can leverage them to improve outcomes and quality of care. Mobile health can be defined as any type of medical or health-oriented service that is delivered wirelessly via a mobile device—including smartphones, smartwatches, tablets, laptops, point-of-care devices, and wireless sensors that are worn or carried. Apps can support nurses’ efforts in health monitoring, patient engagement, behavior modification, and coaching patients to self-manage chronic disease.

Mobile health apps are a perfect tool for patient engagement, because they are already popular among consumers in general – millions of people have already downloaded apps that help them track calories, reach fitness goals, or even stop smoking. Patients who are already comfortable with
collecting personal health data on their mobile devices are also likely to share information with providers and agree to use wearable sensors to aid in treatment monitoring. HIPAA-compliant texting apps have already proved successful in promoting healthy behaviors, helping patients to lose weight, and coaching patients to manage chronic diseases like asthma and diabetes.

Nurses who are comfortable and proficient with mobile apps can employ them in ways that support their role as patient advocates. M-health can be part of a transformation that expands access to care, improves delivery of care, reduces health disparities, and personalizes care. But it’s important to remember the human element: patients are looking for that human connection from nurses, whether communication happens in person, over the phone, or through a texting app. Human support is the key that amplifies the effectiveness of mobile health technology.

As m-health becomes part of standard healthcare practice, nurses have to step up and advocate for patients by providing clinical input from a nursing perspective. Nurses should also be involved with developing enterprise apps. Every stage of technology development should include the nurse’s point of view about functionality, best practices, and patient safety. The next generation of nurses will have been raised on mobile technology and will have much to contribute. Healthcare is in need of nurses who can analyze technologies from both the bedside and IT perspectives, to help create patient-centric tools. If you’re a tech-savvy nurse with a keen interest in informatics, you might want to consider a career specialization in this area. An online MSN degree in nursing informatics is the perfect way to improve your knowledge, skills, and value to your organization.
As it applies to nursing education, virtual simulation can be defined as the use of an avatar (an icon or figure representing a specific person) and a realistic environment (portrayed through three-dimensional graphics) to teach high-level skills through interactive technologies. It is sometimes known as serious gaming, and can be used both in basic nursing education and continuing education of various types.

Nursing has long recognized the value of experiential learning and has used simulation in various forms since the earliest days of the profession, when student nurses practiced on each other and on pieces of fruit. This gave way to “low-fidelity” mannequins that helped new nurses learn simple skills like taking blood pressure and performing CPR. By 2011, according to National Council of State Boards of Nursing (NCSBN), a whopping 87 percent of nursing schools were using high-fidelity mannequins that interfaced with other technology to provide students with a realistic learning experience.

Advancing technology has once again raised the bar for what is possible. Through virtual simulation, student nurses can practice on a patient who can’t be harmed and can become comfortable with a new skill before trying it on a living, breathing patient. And nursing schools can both mitigate the struggle to find clinical placement sites and extend the reach of their instructors during the current shortage of nurse educators.

Here’s an example of how virtual simulation might work in the educational setting. Every nurse has to learn how to start an IV. This basic task can be taught by a lecture and Power Point slides, a video that goes through all the steps, or a demonstration by a preceptor on a living patient. These are all passive learning models that involve learning by watching. Students could also have a more kinesthetic experience by practicing on a life-sized mannequin or on a model arm designed for this purpose.

With a virtual simulation, however, the student could guide an avatar through all the proper steps, from entering the room and making an introduction, to performing hand hygiene steps, gathering supplies, assessing the insertion site, and placing the needle. The patient room is a virtual world that contains all the objects that would be found in a real hospital environment, and the objects are interactive, meaning they can be used by the avatar. The nurse avatar is controlled by the student through a touchscreen or game controller device, while the patient avatar can either be controlled by an instructor or by a software program.
The avatars “see” each other in the virtual world and interact through typed chat or voice. In this example, the patient might complain of discomfort while the IV is being started, and the nurse would have to respond appropriately. Within the virtual world, all real-world rules about distance, gravity, and movement apply. This authenticity allows students to become fully immersed in the environment and have an active learning experience.

Virtual simulation can also be used by experienced nurses as part of continuing education or in-house training requirements. For example, consider new efforts to prevent hospital-acquired infections, or evolving evidence-based practices. Sometimes nurses have to unlearn what they were originally taught and acquire new skills. Other applications for more seasoned clinicians include:

- **Clinical decision making skills.** In high-risk patient encounters, the consequences of decisions are critical. Participants could test out different clinical reasoning pathways, find out firsthand what the outcomes are, and learn from the consequences of their actions.

- **Disaster preparedness and response.** Large scale disasters are difficult and costly to simulate in real life, but it is essential to prepare for them.

- **Interdisciplinary collaboration.** In a virtual world, physicians, nurses, and other providers can practice communication and teamwork skills.

- **Chronic disease management.** Nurses who work with diabetic patients, for example, can use a time-lapse simulation to see the outcomes of their interventions over time.

**Nurse educators will have to prepare for the challenges associated with applying an emerging technology effectively,** in order to assure that nurses have the competencies they need. If you’re interested in a career in nursing education, please consider American Sentinel’s online nursing degree programs. Our [MSN in Nursing Education](http://www.americansentinel.edu) is designed for experienced nurses wanting to pursue educator roles within a clinical environment or become faculty members at traditional or non-traditional schools of nursing.
The science of genomics deals with the ways in which genes interact with each other and various environmental, psychosocial, and cultural factors. These multi-faceted genomic variations contribute to health and, according to the CDC, play a role in nine of the ten leading causes of death in the U.S. (accidents are the sole exception). This is different from the science of genetics, which studies the individual genes that cause single-gene, inherited health disorders. Our expanded understanding of genomics is translated into medical practice every day, in terms of screening, diagnosis, and treatments. For example, genome sequencing of tumors can already identify which treatment a cancer patient is most likely to respond to.

The future of genomic medicine depends on our ability to sequence an individual’s entire genome quickly, accurately, and cost effectively—which in turn depends upon next-generation sequencing technologies. Consider this: the Human Genome Project spent 15 years and $2.7 billion to sequence the first human genome, published in its entirety in 2003. The goal was to bring that cost down to $1,000, and while today’s state-of-the-art sequencers claim to do that in theory, the true price tag is much higher (equipment costs are about $10 million). Scientists believe they will need to sequence hundreds of thousands of people to be able to compare genomic variations in meaningful ways, in order to develop personalized therapies. Lower costs and better technologies can enable the huge sequencing studies that are needed. If this sounds like science fiction, it’s not: In the U.K., the government is currently undertaking a project to sequence the genomes of 100,000 patients and integrate that data into medical care.

As with any new area of medical research and treatment, there are major considerations. The use of whole-genome sequencing for clinical purposes is still limited, and it isn’t yet clear how sequencing will affect the majority of patients in terms of beneficial outcomes. For this reason, insurers (including Medicare) do not yet cover whole genome sequencing. Physicians will have to receive training about the clinical impact of specific genomic data and will have to learn how to deliver results. Electronic record systems will have to be adapted to incorporate genomic data, and there may be new privacy concerns to address.

So why should nurses care about genome sequencing technology? As an article in American Nurse Today points out, the public is already dabbling in direct-to-consumer genetic testing. At some point, the true cost of genome sequencing will fall within the realm of possibility for consumers.
and clinical laboratories, and it will go mainstream. **Nurses will be part of that transformation**—they will have to understand the implications of genomic science for their practice and for society as a whole. The ANA has already called for nurses to develop an understanding of genetics/genomics in medicine as an essential competency, so they can help patients manage genomic information as it applies to their health status or understanding of a disease process or treatment. **Additional nursing competencies related to genomics might include:**

- **Assessing a patient’s knowledge** of genetic/genomic information and participating in patient education.
- **Delivering genomic health or treatment information** to a diverse patient population in appropriate ways, based on ethnicity, culture, religion, health literacy, and language.
- Demonstrating the ability to **collect relevant family history data**.
- **Understanding and addressing ethical challenges** in genomic medicine.
- **Working collaboratively** with other members of the care team in providing personalized, genomic treatments.

Nursing’s patient advocacy role will come into play if genomic-based treatments become common. While nurses are not legally responsible for obtaining informed consent, the **ANA maintains that nurses have an ethical obligation to speak up if they believe patients are not acting autonomously**, are being coerced, or don’t understand the implications of their medical decisions—not only when it comes to treatment, but regarding participation in research studies as well. And of course, **nurse leaders and educators will have to prepare for all of the challenges associated with a new area of medicine**, in order to assure that nurses have the competencies they need. The profession as a whole should be proactive, rather than reactive, when it comes to addressing the future of nursing.
Biometrics is the science of measuring an individual’s unique physical traits for identification purposes. It includes technologies that can differentiate people by analyzing a fingerprint, palm print, retina scan, voice patterns, or facial structure. These technologies have been around for nearly three decades, but industry analysts predict they are poised for explosive growth in the next few years, as costs come down, accuracy improves, and public acceptance increases. The Biometrics Research Group estimates that the global marketplace for biometrics technologies in the healthcare market alone will reach $5 billion by 2020, driven by the need to prevent fraud, protect patient privacy, and improve safety.

Nurses can expect to start using biometric log-in procedures (if they aren’t already) to access the EMR, as hospitals move away from passwords, which can be used in unauthorized ways if they are shared or written down in an unsecure location. HIPAA calls for a tiered approach to data access, meaning that staff members should only have access to the information they need to perform their jobs. Biometrics can be effectively employed to regulate this access to data, as well as access to secure areas. For example, replacing smart badges with biometric scanners at physical access points can help guarantee the safety of newborns and prevent the theft of narcotics, by making a positive identification of people rather than badges.

Biometric computer log-ins can also improve workflow efficiencies for nurses. For example, many EMR systems automatically time out, forcing nurses to log-on repeatedly throughout the shift. Imagine how much time you could save if you could log in and out simply by touching your fingertip to a sensor or laying your hand down on a scanner. Facial recognition technologies may prove to be even more efficient—a facial scanner on top of a computer monitor can log nurses in as soon as they sit down at the work station and log them out as soon as they move away.

There is growing interest within both the healthcare and health insurance industries for using biometrics for patient identification purposes. Blood banks are beginning to use fingerprint scans of donors to help them comply with federal regulations that require positive identification at every donation. The fingerprints are stored with the donor’s profile, allowing staff to quickly pull up blood type and donation history on subsequent visits. And in Florida, a bill was introduced this year that would require all hospitals in the state to use biometrics to verify the identity of all Medicaid patients. (However,
At some point, biometrics may replace patient wristbands and barcodes as identifiers when nurses are administering medication at the bedside. And there has been at least one proposal to track childhood immunization records with a fingerprint recognition system.

When digitized patient information is shared regionally and across providers, accurate patient identification is crucial. When multiple records exist for the same patient, there’s a strong likelihood that one or all will be incomplete – potentially putting the patient at risk for drug interactions or inappropriate services. Biometric patient identification can eliminate the need for patients to fill out multiple forms at each provider visit, and ensure that all data is saved into the same patient record. It can also improve our capacity to react to medical emergencies, since patients who are unconscious or unable to talk can still be quickly identified – along with pertinent medical history like drug allergies and current medications.

Consumers are becoming more comfortable with the idea of biometric security features, since so many mobile devices now have fingerprint sensors. Supporting the use of biometric technologies and using them according to hospital policy is yet another way nurses can advocate for their patients’ privacy and safety.
Robotics is the branch of technology that deals with the operation of robots—machines that can move, react to sensory input, and perform routine tasks on command. Robots have many advantages in healthcare, including reducing labor costs, creating operational efficiencies, and increasing precision. All of these things can contribute to better patient outcomes. When combined with computer science, artificial intelligence, nanotechnology, or bioengineering, the applications for robotic technology in healthcare seem endless. Robots today can incorporate motion detectors, voice recognition software, cameras and microphones, microprocessors, GPS capability, and advanced sensors that make them increasingly useful in a healthcare setting.

Most people have heard of robotic surgical systems. These can help surgeons overcome the limitations of minimally invasive laparoscopic procedures and can give surgeons better control of instruments during open surgeries. There are also tiny “microbots” that can carry out precise tasks inside the human body—like clearing plaque from an artery or performing retinal surgery. In the lab and pharmacy, robotics can be used to automate routine tasks, and even send patient data right to the EMR. Some hospitals are already using robots for environmental disinfection and the terminal cleaning of patient rooms. And trials are currently underway to find out how robots can assist with the sterile processing of instruments. Other applications of robotics have a more direct influence on nursing workflows and patient care. These include:

- **Transporting supplies.** Automated transport systems can move medications, meals, supplies, and specimens through hospital corridors and elevators, allowing nurses to spend less time away from the bedside. Nurses can also check on the status of a delivery and monitor its whereabouts in real time, rather than having to make a follow-up phone call. This technology has the potential to enhance both nurses’ and patients’ satisfaction.

- **Lifting and moving patients.** These applications have several advantages over mechanical hoist systems. They have a wider range of motion than ceiling-mounted lifts and can come when “called,” unlike portable lifts that must be fetched by a person. They can be controlled by one person and don’t require a team effort. By moving a physical interface like a joystick, one nurse can lift and position even a very heavy patient, without risking injury to herself or the patient.
• **Recording patient data.** In Japan, a robotic assistant named Terapio follows nurses on rounds. As nurses take vital signs, the robot sends the data straight to the EMR. It can also display current information about the patient’s history, drug allergies, etc. The system is said to reduce the time nurses spend on documentation, freeing them up for more patient-centric tasks.

• **Assisting physicians in the operating room.** A report in *HealthLeaders Media* recently discussed the concept of a robotic assistant that can perform the functions of a scrub nurse. By using visual recognition technology, the robots can respond to a surgeon’s visual cues to pass instruments. The article is also quick to point out that a robotic nurse cannot advocate for the patient undergoing surgery.

• **Patient support.** Work is progressing on robotic devices that can bathe bedridden patients or help them feed themselves by controlling a robotic arm. It’s important, with these technologies, that nurses balance this high-tech care with the patient’s personal preferences and need for modesty or autonomy. A patient who prefers human assistance with bathing should have that option, for example.

As robots become more autonomous and more agile, and if nursing shortages materialize, it’s likely that hospitals will look into using robots to support or take over certain nursing tasks. Bedside nurses and nurse leaders will need to be involved in these decisions, to ensure that high-tech does not replace the “high-touch” care that nurses are known for. Robots may never be able to empathize with a cancer patient, provide personalized education about diabetes self-management, or decide when to advocate for end-of-life planning. Nurses will have to play a role in deciding when and where and how these emerging applications of robotics should be used.
American Sentinel University delivers accredited online degree programs in nursing (BSN, MSN, and DNP) and healthcare management (MBA, Healthcare, M.S. Information Systems Management, and M.S. Business Intelligence and Analytics). Its affordable, flexible bachelor’s and master’s nursing degree programs are accredited by the Commission for the Collegiate Nursing Education (CCNE), of One Dupont Circle, NW Suite 530, Washington, D.C., 20036. The DNP program is accredited by the Accreditation Commission for Education in Nursing (ACEN) of 3343 Peachtree Road NE, Suite 850, Atlanta, Ga., 30326. The University is accredited by the Distance Education Accrediting Commission, DEAC, 1101 17th Street NW, Suite 808, Washington, D.C. 20036, (202) 234-5100, www.deac.org.

For required student consumer information, please visit:
www.americansentinel.edu/doe.

American Sentinel University
admissions@americansentinel.edu
1.866.922.5691
www.americansentinel.edu
Consumer disclosure information: www.americansentinel.edu/doe