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INSIDE HEALTHCARE ARTIFICIAL INTELLIGENCE

AI is fundamentally changing healthcare, in many cases leading to cost savings and better-than-expected patient outcomes, **but trust and integration issues loom.**

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THE NUMBER OF HOSPITALS and other types of healthcare organizations ramping up AI projects and measuring results has increased dramatically over the past few years. Robot-assisted surgery, virtual nursing assistants and administrative workflow assistance are projects

INTRO attracting big investments but the spectrum of AI-related healthcare initiatives is wide. Telehealth, predictive logistics and AI-generated diagnoses, just to name a few, are also in the mix.

What's more, with genome research increasingly uncovering disease biomarkers, humans will likely require AI help to take advantage of all the new, related data.

Lack of trust is an obstacle to healthcare AI

The biggest hurdle to AI implementations in healthcare is lack of trust, according to practitioners in the field. The essential problem is that AI systems can be “black boxes,” applications that supply answers and predictions with only a select few health practitioners or data scientists understanding how the results were achieved.

The black box issue is endemic to AI in general, but is especially worrisome in healthcare since lives may be at stake and errors can be fatal. One approach is to gather multidisciplinary teams that bring together representatives from technology and medical staffs with patient advocates to work out guidelines for data that can be applied to various types of algorithms.

Data integration is key

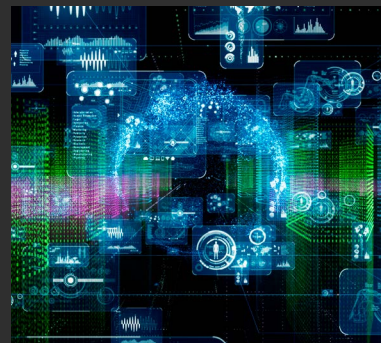
AI requires data, and the more data that can be fed into AI applications the more accurate the results will be. Healthcare information is notoriously untidy, however. Data may reside in multiple databases, in different structured and unstructured formats, and also include images and handwritten notes.

Given the ubiquity and lack of structure of health-related information in most organizations, the formation of coherent data management practices is key to the success of any healthcare AI strategy. Best practices for data cleansing and ETL (extract, transform, load) for data collection and integration need to be followed to help assure success.

Despite the difficulties, most healthcare organizations in the U.S. are planning or currently implementing AI-related applications, with average spending among the larger enterprises in the tens of millions of dollars. The prognosis for these initiatives is upbeat: ROI is generally predicted to occur within three or four years.

INSIDE

- ➔ How healthcare orgs are addressing AI challenges **3**
- ➔ Telehealth turns to AI, virtual healthcare gets real **7**
- ➔ The promise of AI in diagnosing illness **9**
- ➔ The next frontier of AI in healthcare **12**
- ➔ What's the minimum position to take in AI Investments? **15**





HOW HEALTHCARE ORGS ARE ADDRESSING AI CHALLENGES

Healthcare companies are embracing artificial intelligence for everything from drug research to diagnostics, but challenges centered around privacy, data and the AI ‘black box’ remain **BY MARIA KOROLOV**

ARTIFICIAL INTELLIGENCE IS POISED TO revolutionize healthcare, in everything from drug research to diagnostics, to healthcare delivery — all the way through to billing and accounting. According to Accenture, the AI health market will reach \$6.6 billion by 2021, and will save the industry \$150 billion a year by 2026.

But to get there, organizations need to overcome distrust of the technology, meet integration challenges, and deal with privacy and security issues.

Boston-based Beacon Health Options, which provides behavioral health treatment to more than 40 million people in all 50 states, faced all those challenges when it first turned to AI to help improve treatment.

“Beacon is the largest company solely focused on behavioral health in the country,” says Christina Mainelli, the organization’s executive vice president and chief growth officer. “Serious mental illness, substance abuse — we’re dealing with some very, very relevant issues in healthcare today.”

Mainelli says that Beacon Health is using AI to identify the patients who need the most help, and get them the interventions they need. Following is a look at how Beacon Health and other organizations are navigating AI challenges unique to the health-care industry.

The black box challenge

For healthcare organizations, the biggest worry with AI is that it can be hard to see why the system makes the decisions that it does. A mistake can literally mean the difference between life and death. This is known as the “black box” problem of AI.

Intel recently surveyed 200 decision makers from healthcare organizations, and the black box problem — the lack of trust in AI — was the obstacle that stood out, says Jennifer Esposito, general manager of health and life sciences at Intel. In particular, 30 percent said they were most worried about a fatal error.

“I don’t think there’s a solution right now

for how you resolve the black box problem,” Esposito says.

Despite that, 37 percent of the respondents said they were already using AI, and more than half said they would adopt AI within the next five years. Most surprising to Esposito, the most popular use of AI was in clinical uses, undertaken by 77 percent of those embracing AI in healthcare.

Beacon Health faced just this issue of trust when it began rolling out its AI-powered risk assessment system. The organization took a three-pronged approach to address it.

The AI health market will reach **\$6.6 billion** by **2021**, and will save the industry **\$150 billion** a year by **2026**.

SOURCE: ACCENTURE

First, a multidisciplinary team of clinicians, technologists, operators, community healthcare providers and other stakeholders was brought together to come up with the basic guidelines and algorithms for the AI system to follow, starting with the factors that were already known.

“We know which variables contribute to those who are at highest risk of admission or psychiatric event,” says Beacon Health’s Mainelli.

But while a human being can look at seven to ten factors when making a decision, the AI system can look at thousands of factors at once — and even more when unstructured data is pulled in, she says.

Then the team runs experiments. First, they pick a historical time period and run the algorithms on that data to see whether it accurately predicted how often those patients were admitted or had psychiatric events.

“We found that when we use AI, our predictions are 220 percent more accurate,” she says.

Once the AI system was being used to identify at-risk patients, the team was then able to look at potential interventions, and follow up with the recommended interventions.

“We validate that the patients truly benefited from our intervention, and

then we can deploy it as part of our business model,” says Mainelli.

Clinicians creating algorithms

Like Beacon Health, the University of Pittsburgh Medical Center addresses the “black box” challenge of AI systems by getting clinicians and administrators involved in the process of creating the algorithms.

“One can’t expect that a group of data scientists will develop models in isolation and have the folks in the trenches start using them right away,” says Oscar Marroquin, the hospital’s chief clinical analytics officer, adding that getting clinicians involved gives them a sense of ownership of the models.

The hospital currently has five AI-driven models in production, and 60 other active projects in the works. The hospital is also going to increase the complexity of the models already in use. Applications include predicting patient readmissions and condition-specific algorithms to predict patient outcomes for asthma, congestive heart failure, and low-back pain.

“The results have been very good,” he says. But the hospital was aware from the start that changing behavior isn’t easy. “Getting folks involved in

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the whole process helps them understand the strengths and weaknesses of the data and the complexities associated with consuming it, which helps with clinician buy-in.”

Another approach to solve the trust problem is to show why the system made the decision that it did. Take, for example, the use of AI in medical imaging.

Trusting machine learning

At Massachusetts General Hospital and Brigham and Women’s Hospital Center for Clinical Data Science, AI has been used to interpret radiology images since 2016.

“We put heat maps over the tops of images to help readers understand where the machine is looking,” says Mark Michalski, the center’s executive director.

That makes it easy for users to decide how much to trust the system.

For other applications of AI, solving the explicability challenge isn’t as easy, he says.

For example, the center recently began using machine learning to answer operational questions, such as how many beds are going to be needed, and questions about population health, such as the likelihood that a patient will be readmitted.

These decisions are based on electronic health record (EHR) data, so there’s a limited set of variables to be considered, he says, and the system can show the specific factors that had the most impact on a particular prediction, which increases user comfort with the predictions in most cases.

In fact, one potential problem is too much trust in the system, because it’s easy to get too comfortable with it.

“We want people to continuously understand why the systems are working the way they are working,” he says. “I’d say the one issue that’s

the scariest one from my perspective — one of the ones that’s going to be the greatest challenge — is ongoing validation and safety testing.”

Messy data, legacy systems

Artificial intelligence feeds on data. In healthcare, that data can be very messy, which can lead to compounded problems when put to use with AI.

“Classical ML and AI systems take as inputs fixed-length feature vectors in order to produce predictions, instead of the structured — relational databases — and unstructured data such as images and notes that reside in medical systems,” says Jeremy Weiss, assistant professor of health informatics at Carnegie Mellon University.

AI technology vendors who work with healthcare data need to be prepared for these formats.

“We are often faced with unstructured data in behavioral healthcare, such as case notes and survey data,” says Beacon Health’s Mainelli, who was impressed with how the vendor the organization picked, Cambridge, Mass.-based Cyft, was able to handle all the different formats.

Beacon Health already works with outside partners, getting the data out to Cyft and back again in usable form was not a problem, as it may be for many healthcare organizations.

“When the list [of at-risk patients] is returned back to us,” Mainelli says, “we can integrate that into our patient management system — it is fed into our care coordination system so it becomes part of the clinician’s workflow.”

Beacon Health is next planning to bring in third-party data, such as pharmacy records, into its AI analysis initiative.



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— CHRISTINA MAINELLI, EVP AND CHIEF GROWTH OFFICER, BEACON HEALTH OPTIONS

That could be a bigger challenge, says Carnegie Mellon’s Weiss. “Lack of standardization of protocol and policy across institutions can result in yet more data integration issues.”

But initiatives under way around the world to standardize medical information can help.

In the U.S., for example, the federal government has issued standards for the electronic health record (EHR).

The Healthy Nevada Project, sponsored by Renown Health and the Desert Research Institute, with AI technology from SAS, is one healthcare initiative that is making use of EHRs to map the health status of the state’s residents.

“We are using analytic modeling and statistical machine learning techniques to examine a variety of issues — team dynamics in the operating room, predicting patient no-shows, and forecasting emergency department load, just to name a few,” says Jim Metcalf, the project’s chief data scientist. “All of these analyses based on EHR data.”

Similar work is being done at hospitals and healthcare organizations around the country, he says.

“Based on EHR data alone, data scientists are creating statistical models to identify patients most likely to go into septic shock or

suffer from undiagnosed high blood pressure or be readmitted after discharge,” he says. “With this insight, we can personalize medicine to the individual like never before.”

Privacy and security

When it comes to patient privacy and security, healthcare is one of the most regulated industries. AI, with its demand for large volumes of data, is a particular concern.

For Beacon Health, this meant choosing a vendor that was fully HIPAA compliant, so that the data was processed in a secure way.

“That level of certification is table stakes to move into this business,” Mainelli says.

In the emerging healthcare AI market, the issue of health data privacy is being handled in several different ways. Some vendors, such as Cyft, encrypt the data to ensure only those with appropriate permission can view it.

Other vendors are looking at anonymizing or tokenizing the data, so that the AI system never sees any personally identifiable information. A third approach is to perform all the processing locally, so that the data never leaves the healthcare organization.

For example, VisualDx has recently released an AI-powered diagnostics tool, DermExpert, to identify skin conditions. The app is installed on an iOS mobile device, and the doctor takes a picture of the patient’s rash and gets an instant evaluation, without transferring any data to a third-party or the cloud.

The app is part of another trend for AI use in healthcare: enabling non-experts, such as primary care providers, emergency room and urgent care doctors, to perform preliminary diagnostics.

AI’s biggest challenge

The biggest challenge of using AI, says Beacon Health’s Mainelli, isn’t technological. The big challenge is how to adapt the business to make full use of it.

“How you will use it to reduce the cost of care, and improve patient outcomes?” she says. “It’s a new way of doing business.”

For other organizations looking to make the same journey, she recommends starting out with a clear idea of the problem that needs to be solved, and how the insights provided by AI will be used.

“If you don’t act on the data, you haven’t brought a tremendous amount of value,” she says.

Then start small and iterate rapidly.

“Leveraging AI in healthcare is new,” she says. “I think it creates an incredible opportunity, not just to impact those suffering from serious mental illness or substance abuse, but to impact total medical costs.” ♦

Maria Korolov has been covering emerging technology and emerging markets for the past 20 years.



Telehealth turns to AI, virtual healthcare gets real

Intermountain Healthcare has expanded telehealth capabilities to create a virtual hospital. CIO Marc Probst says AI-based virtual assistants will also define the sector's virtual future **BY CLINT BOULTON**

ONE DAY YOU WAKE UP with a pain in your side that persists. You want to be seen by a medical professional, but you don't want to go through the hassle of making an appointment and schlepping to your doctor. Most

large healthcare organizations now allow you to make an appointment with a physician and get observed from the comfort and privacy of your own home — via video conferencing software on your smartphone, tablet or PC.

Such “telehealth” capabilities, as they're known, have been around for several years, but they're gaining traction as the sector swivels from fee-for-service to outcomes-based care. Intermountain Healthcare, a healthcare system that operates 23 hospitals and 170 clinics in Utah and Idaho, has taken the concept of telehealth to another level by launching a virtual hospital.

The digital service, Intermountain Connect Care Pro, provides people anything from basic care to advanced services such as stroke evaluation, mental health counseling and critical care for newborns, says CIO Marc Probst.

Virtual care on the rise

Connect Care Pro marks the acceleration of a trend. Seventy-four percent of healthcare customers have already received or are interested in some form of virtual care, according to Forrester Research. The researcher also says that 55 percent of healthcare organizations are making a new investment or increasing investment in virtual care technologies, which they view as crucial to patient acquisition and retention.

“Patients seek personalized and convenient care,” Forrester analyst Arielle Trzcinski wrote in a blog post. “They will not tolerate an aggravating, time-consuming experience when options that fit their needs are just a click away.”

For Connect Care Pro, Intermountain Healthcare wove together 35 telehealth programs and allocated more than 500 caregivers. Probst

says the virtual hospital saves patients and doctors the time and trouble of meeting in person for routine ailments, such as a headache or a pulled muscle. “They do 100 percent of their work virtually,” Probst says of the physicians working for the virtual hospital.

Probst estimates that as much as 75 percent of healthcare appointments can be performed virtually.

That presents great opportunities for Intermountain, which can now more ef-

ficiently treat patients who require emergency medical attention, Probst says. Probst helped implement the software and systems for the virtual

tate exam over my computer,” says Probst, when asked for an example of a necessary in-person treatment. Indeed, while telehealth will never completely supplant on-site caregivers, Intermountain believes it can ease the burden on existing staff, particularly with the population of Baby Boomers set to exceed children in the U.S. by 2030, according to the U.S. Census Bureau.

A virtual assistant for your healthcare needs

For Intermountain, virtual care is just one piece of a larger emerging healthcare puzzle that Probst says will also include virtual assistants driven by artificial intelligence (AI) — think Iron Man’s “Jarvis” for healthcare.

recommend the person see a doctor either in-person or via virtual care, Probst says. The assistant can then make that appointment.

Probst says these capabilities, which he expects could one day be integrated into Connect Care Pro, will likely happen within his career. “It’s very much using AI and tapping into the EMR for digital triage,” Probst says. He says the AI will also, with a patient’s permission, assist with ordering prescriptions, such as an antibiotic to a CVS or Walgreens.

Eventually, AI could be extended to the exam room, assisting a doctor while he or she is examining a patient. Most doctors today spend an inordinate amount of time entering notes into a patient’s EMR on a computer.

“It may seem a little **farfetched**, but a lot of what we can do for healthcare can be completely **digitized** with little to **no human interaction** once we’ve proven out the AI.”

—MARC PROBST, CIO, INTERMOUNTAIN CONNECT CARE PRO

hospital, including integrating them with the provider’s Cerner electronic medical record (EMR) system.

The virtual hospital is one of the cornerstones of Intermountain’s multiyear digital transformation, supporting more than 2,300 physicians and clinicians. It builds off of a decade-old telehealth initiative that Probst helped expand to more than 12 non-Intermountain healthcare facilities in Utah, Wyoming and Idaho.

However, he acknowledges that the technology doesn’t work for all scenarios. “I don’t want my pros-

Take the virtual hospital or telehealth scenarios, for example.

If someone has a medical issue they want attended to, they can cue up Amazon.com’s Alexa or Google Assistant from their home-based smart appliance and describe the condition. The virtual assistant could walk the patient through questions about the location and severity of the pain, while in the background accessing the patient’s EMR (with the patient’s prior permission, of course). Ideally, the assistant could then “get close to a diagnosis” and

Probst envisions a future where computer vision and voice recognition technologies can “listen” and “understand” what a doctor is telling a patient during an exam and accurately enter the data into the EMR.

“It may seem a little farfetched, but a lot of what we can do for healthcare can be completely digitized with little to no human interaction once we’ve proven out the AI,” Probst says. ♦

Clint Boulton is a senior writer for CIO.com, covering IT leadership, the CIO role, and digital transformation.

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THE PROMISE OF ARTIFICIAL INTELLIGENCE IN DIAGNOSING ILLNESS

Artificial intelligence in healthcare is about more than predicting readmission rates – **it can also help diagnose disease.** **BY JILL DYCHÉ**

YOU VISIT YOUR DOCTOR for a routine checkup. She decides to do a fine needle aspiration for a seemingly insignificant lesion (“It’s probably nothing...”). But a few days later you get a call back. They’ve found some abnormal cells.

Your doctor recommends a specialist who performs a resection in his office, sending a tissue sample to a histology lab. The lab’s histologist preps the sample by taking sections, placing them in a “cassette,” then sending it overnight to another lab for processing. When the tissue blocks are returned the next day, a histologist cuts slides from the processed paraffin-embedded tissue and stains them with hematoxylin and eosin which differentially bind to cellular structures.

A case number is created, where-

upon the slides are placed on a plastic tray and delivered to the pathologist, as if serving hors d'oeuvres. The pathologist might walk the tray down the hall to another pathologist, who examines the specimens under a microscope, sometimes recommending additional interpretive stains. A diagnosis is made, and the pathology report is sent back to your doctor, who then creates a treatment plan. The entire process can take weeks, sometimes even months.

Patients and medical professionals have become accustomed to the drill: it's been standard practice for decades. But advancements in artificial intelligence are about to disrupt disease diagnosis.

Diagnosis, accelerated

Imagine that a histologist can scan the slides, creating electronic images that can be accessed digitally by different physicians, labs, and technicians. Tissue samples can be stored in the cloud and shared with far-flung specialists who can collaborate from afar with care providers. Diagnoses can be corroborated through deep learning algorithms that recognize specific characteristics and behaviors in the tissue sample. The digital images become a historical record of the blood or tissue sample. The entire diagnostic process could go from weeks to hours, accelerating vital patient care.

"We've always had the discussion about whether pathology is art or science," explains Dave Billiter, CEO and co-founder of Deep Lens, a digital pathology AI and cloud platform vendor. Billiter comes from more traditional healthcare, holding executive positions at Cardinal Health and The Research Institute at Nationwide Children's Hospital.

But he recognizes the promise of AI breaking new ground in medicine.

"In essence you're relying on a trained eye to render a diagnosis of a biospecimen. But there are so many different types and subtypes of a disease. Even with highly trained medical professionals, you're relying on an individual to understand them all. It's an arduous process for a pathologist. Then you start adding all these different biomarkers, genomics, metabolomics... It's a pathology information tsunami!"

As the need for more specialization increases, the number of pathologists is shrinking. According to the [Medical Laboratory Observer](#), fewer

limited, the practice entirely dependent on affiliations with either hospitals or private reference laboratories, with little opportunity for autonomy."

Humans, more than ever

Recognizing the opportunity, medical schools are beefing up their emerging technology curricula. Med students are now offered courses in technology infrastructure, deep learning, and data management alongside their biology classes, adding GPUs, robotics, and convolutional neural networks to their training.

Companies like Deep Lens and Philips package images in secure



medical school graduates are choosing pathology as a specialty, despite the increasing demand driven by an aging baby-boomer population and evolving genomic research.

"We see a decreasing pool of pathology experts," confirms Saskia Boisot MD, a board-certified hematopathologist based in Orange County, California. "Part of it is that medical schools don't feature careers in pathology as prominently as they do other specialties. Part of it is that the job market for pathologists is quite

environments and can automatically place them into a pathologist workflow. AI algorithms can optimize routing to specialists and others in a dynamic, collaborative environment.

The benefits don't stop at diagnosis. "Digitized results could move the needle for clinical trials," says software investor and Deep Lens President and co-founder Simon Arkell. "Patient enrollment is difficult and time consuming. AI can identify a cancer, feed new models, and help researchers quickly qualify

“This will be as much about humans helping AI as AI helping humans.”

DAVE BILLITER, CEO AND CO-FOUNDER, DEEP LENS

clinical trial participants. Drug companies and CROs [Contract Resource Organizations] could experience huge economies of scale.”

Then there’s the coming data deluge. According to Andrew Hessel, a biotech industry pioneer and now CEO of Humane Genomics, “It’s economically realistic for a billion human genomes to come online over the next decade or two.” It will be nearly impossible for pathologists to stay current with the emergence of new biomarkers without the help of

machine learning and digitization.

“I think there’s a fear that, much in the same way a lot of radiology interpretation is being outsourced through digitization, pathologists could become progressively obsolete,” says Dr. Boisot. “Conventional anatomic pathology is undergoing a massive transformation, as many diagnoses are now being made based on molecular studies. While these studies currently only represent an adjunct to morphologic evaluation, there’s a very real chance that they

could dwarf the need for a pathologist’s keen eye.”

Today’s problems have fomented over decades. But the pathology discipline isn’t going the way of the dinosaur. Billiter maintains that the pathology discipline will be central to personalizing medicine, with pathologists adopting new technologies drive faster, more accurate diagnostics. “This will be as much about humans helping AI as AI helping humans.”

What better partnership could there be? ♦

*Jill Dyché is an executive advisor and a noted speaker and author. She has counseled executive teams on the strategic importance of their technology investments. She is the author of four books on the business value of technology, including [*The New IT: How Technology Leaders Are Enabling Business Strategy in the Digital Age*](#) (McGraw-Hill).*



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The **next frontier** of AI in healthcare

As healthcare organizations rush to take on AI, **it is imperative to include the process-centric approach**, which could be a ticket to a sustainable competitive advantage **BY CHEONG ANG**

A RECENT **OPTUMIQ ANNUAL SURVEY** of major healthcare organizations on AI in healthcare shows an average of a \$32.4 million investment per organization over the next five years. Ninety-one percent of the 500 healthcare leaders surveyed are confident they will see an ROI on

AI – in the next four years for hospital executives, and in three years or less for 38 percent of employers and 20 percent of health plan executives. Seventy-five percent of those surveyed are either actively implementing or planning to execute an AI strategy.

In planning an AI strategy, it

would help to understand how AI may be added into the current IT mix. AI may be included in an existing application or integrated with applications in a workflow. Or in the lesser-known, process-centric approach, AI may encapsulate the workflow, which arguably would take us to the next frontier.

The application includes AI

EHR (electronic health record) vendors, [consistently blamed](#) for interfering with the patient-provider relationship for their applications' subpar UI/UX, strive to innovate by adding AI in their applications. The use of voice assistants for documentation, and Natural Language Processing (NLP) to summarize free-text notes are two examples.

However, the jury is still out whether AI will solve the EMR UI/UX problem - clinicians who have been burned by big promises before may not be rushing to believe that AI will solve all their EHR problems.

The workflow integrates AI

The Westchester Center Health Network (WMCHealth) is a good [case study](#) in adding AI to an existing workflow. WMCHealth uses both its EHR's risk model and third-party vendor Health Catalyst's predictive model in prioritizing discharged patients for readmission-reduction efforts. They add Health Catalyst's risk scores and EHR data on a dashboard with the discharge lists that organize the case managers' work to help them prioritize the patients who need to be engaged. The new risk scores from the integrated AI help to identify more true positive cases (8 percent) and reduce false positives (30 percent) vs. either the EHR risk model or LACE index alone.

Another example of applying AI in a healthcare workflow is [Beth Israel Deaconess Medical Center's use of TensorFlow on Amazon SageMaker](#) to scan pre-surgical document packages to identify and insert consent forms into the corresponding electronic



Survey of **major healthcare organizations on AI** shows an average of a **\$32.4 million** investment per organization **over five years.**

OPTUMIQ ANNUAL SURVEY

medical records. The tool delivers a notification to the EHR if the consent form is missing, to trigger the follow-up workflow action.

AI encapsulates the workflow

Meanwhile, business process management (BPM) practitioners across industries have long been codifying workflow processes into series of tasks, completion of which produces work results. A codified workflow may interface with multiple systems and workers, and its performance be monitored and analyzed.

Until recently, BPM tools were cumbersome, and BPM projects expensive. So, it isn't surprising that BPM projects have primarily been implemented in large enterprises and for cost-reduction of complex backend processes, e.g. order fulfillment, and supply chain management.

But recent interest in using BPM for customer experience and digital transformation have brought BPM out of the back room. Coincidentally, improving customer experience is also one of the main use cases of AI. This intersection is spurring BPM vendors to race toward AI-enablement of their platforms.

The shift of focus to customer (or

patient) experience increases BPM's relevance in healthcare. The codified workflow, in essence, is a digital version of what a care team currently performs manually. It enables the healthcare organization to monitor the care workflow, react to adverse conditions promptly, and continually improve the process, as illustrated in a [BPM project at Ottawa Hospital](#). AI, operating on the codified workflow, essentially includes the workflow in its predictive model, and can automate not just the workflow and its tasks, but also modifications of the workflow to continually improve the process. What is unique to this process-centric approach is that the workflow may get smarter over time as the AI analyzes how we do things and tries to do things for us.

A pathway to the future

Healthcare, however, is missing a key ingredient that has been driving the adoption of the process-centric approach in other industries: wide availability of APIs to systems a workflow typically touches. While recent low-code BPM tools have greatly eased workflow codification with drag-and-drop integration with Salesforce.com, Dropbox, Google

apps and the like, such convenience is limited in healthcare. However, over the years EHR vendors like AllScripts and Athenahealth as well as a [list of others](#) have exposed APIs to access their data. Firms like Redox and Sansoro Health have also pushed their proprietary APIs, leveraging standards like HL7 v2 and FHIR, to shield healthcare

center, and the patient such that with a simple command “refer the patient to Eastlake for testing,” it sees the care process through such that the patient is back to the office, post-test, for the next step within a reasonable timeframe. Not to mention there would be no clicking around in the EHR to enter data into appropriate screens.

also expected improved patient experience and decreased per-capita cost of care. Automating business processes, and improved patient experience, in particular, make the case for leveraging the process-centric approach, which has customer/patient experience in its focus.

In summary, a balanced, three-pronged strategy will enable a



organizations and developers from the complexity of integration across multiple systems.

Workflow codifications are leading to a new crop of [business process applications](#) that can interface with healthcare workers via a form specific to the workflow context (e.g. inpatient discharge), or some voice assistant.

As these business process applications are designed to be workflow aware, they are poised to simplify workers' interactions with multiple systems and among themselves by automating workflows, tasks and process optimizations. For example, an AI-driven, codified workflow could be doing the magic of coordinating the work among the care team, an external testing

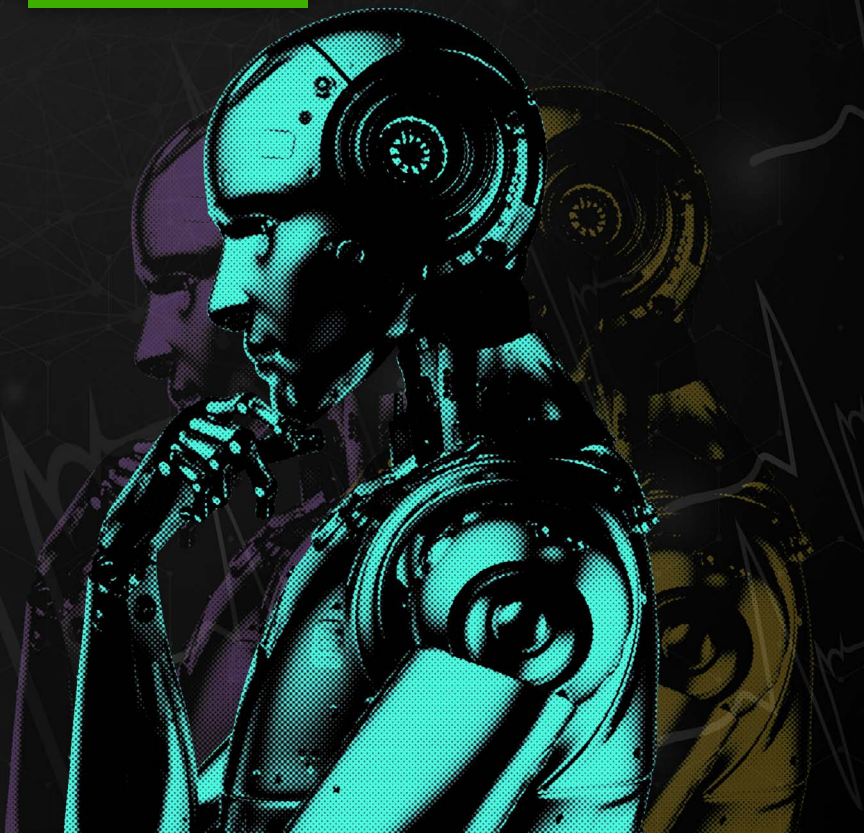
3-pronged strategy for competitive advantage

Waiting for an existing application to add AI and integrating an AI application or service into a workflow cause minimal disruption to the current IT environment. But they also greatly reduce AI's ability to improve how we do things, and to do things for us.

OptumIQ's survey revealed that top areas of AI investments include automating business processes (administrative operations or customer service), at 43 percent, and fraud, waste and abuse detections, at 36 percent. The top two expected benefits of such investments are increased efficiency and more accurate diagnosis. A third of the respondents

healthcare organization to minimize risk of disruption where necessary, but not limit its ability to innovate to its current workflows or existing applications. Gearing up the organization with capabilities to allow AI to encapsulate workflows is ultimately an opportunity to gain a sustainable competitive advantage in an era that sees continued pressure from bountiful consumer choices, profit margin pinches, and assumptions of risk in the patients' long-term wellbeing. ♦

Cheong Ang has a track record that includes Web patents licensed to leading firm such as Microsoft and Adobe, and building and operating enterprise systems in healthcare, financial and internet industries.



What's the minimum position to take in AI investments?

Here's a minimum, winning strategy based on some recent data, studies and projects **BY CHEONG ANG**

A PRIMARY CARE PHYSICIAN ONCE TOLD ME that diabetes patients are one of the hardest groups to get to adhere to their treatment plans because diabetes doesn't cause immediate or intense pain. On the IT side, the equivalent is the "nice to have" technology. You can budget for the computers, storage, secu-

rity, and EMR (electronic medical record) system that you need, but the minimum investment you should make in advanced technology like artificial intelligence (AI) is much harder to quantify.

In a report published by HHS, [Artificial Intelligence for Health and Health Care](#), the organization tasked with the study, JASON (an indepen-

dent group of scientists and academics that has been advising the Federal government on matters of science and technology for over 50 years), stated that "unlike previous eras of excitement over AI, the potential of AI applications in health may make this era different."

The HHS report also concluded "AI is beginning to play a growing role in transformative changes now underway in both health and health care, in and out of the clinical setting. At present the extent of the opportunities and limitations is just being explored." This means the innovators and some early adopters are already ramping up projects, and whether to invest depends on what position on the adoption curve you want to play.

An Accenture whitepaper, [Artificial Intelligence: Healthcare's New Nervous System](#), lists the top 10 AI applications in healthcare, and estimated their near-term values in terms of annual benefits. The top 3 are robot-assisted surgery, virtual nursing assistants and administrative workflow assistance. While pondering whether those broad categories should be the areas of your focus, it may be beneficial to take a look at what others are doing.

Step 1: Data management

One community hospital, for instance, has used unsupervised machine learning and supervised prediction to reveal optimal care pathways for pneumonia by identifying the commonalities between those with the best outcomes among thousands of patient records, according to a [Healthcare Innovation](#) case study.

The effort started with using SQL code to pull data from multiple hospital systems (AllScripts EHR,

enterprise data warehouse, surgical, financial and corporate performance), and the FHIR (Fast Healthcare Interoperability Resources) standard to deliver the results into the clinical variation management application. With the help of an intuitive interface that reveals insights (e.g. the reason, and timing, for a recommended pathway step), the project garnered sufficient support to deploy the optimal care pathway by revising the emergency department and inpatient order sets in the EHR. This initial work on pneumonia care pathway saved \$850,000 in costs. Now sepsis, heart failure, total hip replacement and COPD are among others on the horizon.

Montefiore Health System took a more fundamental approach: developing a data lake, and graph-database based infrastructure that may support a variety of patient-care use cases, according to [Health IT Analytics](#). It has enabled them to implement advanced sepsis detection tools, and also tools to support clinical decision making at the point of care. The investment in data management pays off well: their data scientists now spend 70 percent of time doing AI analytics vs. 75 percent in data management and data wrangling previously. The resulting infrastructure, Patient-centered Analytical Learning Machine (PALM), becomes the foundation that brings economies of scale to AI analytics projects.

Beside supports in the organizations, common to both projects is data integration. AI starts with data, and data management (via data governance, cleansing, ETL, semantic harmonization and others) efforts provide the foundation on which AI algorithms can source semantically harmonized data, build models,



Once you have **data management** down, plenty of opportunities exist for AI as tools to support innovations that **will bring ROI to the organization.**

make predictions and refine models. It is also necessary to bring the results to the healthcare workflows – e.g. revising order sets, or injecting insights into point-of-care system – to realize the benefits.

Once you have data management down, plenty of opportunities exist for AI as tools to support innovations that will bring ROI to the organization. For example, a combination of Natural Language Processing and Artificial Neural Network can easily surface misses in insurance verification and/or preauthorization so the care team can get them straightened out prior to an encounter for a procedure.

AI-augmented analytics

With that, the initial focus is back to data-driven initiatives, and providing the insights – be it from AI, BI (business intelligence, like OLAP and data visualization tools) or humans (e.g., case management) – to frontline workers in order to guide decision making and/or automate work, without which the AI investments will have limited impact. Gartner called this “augmented analytics” in its [Gartner Top 10 Strategic Technology Trends for 2019](#).

“Augmented analytics represents a third major wave for data and analyt-

ics capabilities as data scientists use automated algorithms to explore more hypotheses. Data science and machine learning platforms have transformed how businesses generate analytics insight,” according to David Cearley, vice president and Gartner Fellow.

Kai-Fu Lee, an AI expert, venture capitalist and the author of [“AI Superpowers: China, Silicon Valley and the New World Order.”](#) portrayed a very broad-based, cross-industry, cross-geography view of AI’s impact. Lee notes that good, widely adopted products generate a detailed treasure trove of data, which in turns allows companies to perform sophisticated AI to produce better and more widely adopted products. The virtuous cycle continues, and the industry leaders that do this well will keep widening their leads over others, resulting in winner-take-all economics.

The minimum winning AI strategy, then, is managing data to enable AI exploration. This can facilitate many other projects which use data to lead to better services and patient outcomes. ♦

Cheong Ang has a track record that includes Web patents licensed to leading firms such as Microsoft and Adobe, and building and operating enterprise systems in health-care, financial and internet industries.