



Transforming Healthcare through Artificial Intelligence



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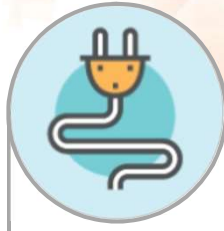


The Fourth Industrial Revolution



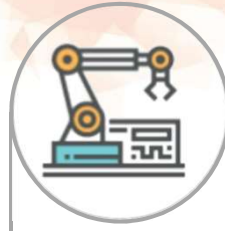
1.0 Water & Steam

Water and steam power replace human and animal power with machines



2.0 Electricity

Electricity, internal combustion engines, airplanes, telephones, cars, radios, and mass production



3.0 Automation

Electronics, the Internet and IT used to further the automation of mass production



4.0 Cyber-Physical Systems

Driverless cars, smart robotics, materials that are lighter and tougher, and a manufacturing process built around 3D printing

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We stand on the brink of a technological revolution that will fundamentally alter the way we live, work, and relate to one another. In its scale, scope, and complexity, the transformation will be unlike anything that we have experienced before. It will affect the very essence of our human experience.

The First Industrial Revolution brought mechanical innovations like the steam engine, cotton spinning, and railroads. The Second Industrial Revolution brought mass production through assembly lines and electrification. The Third Industrial Revolution brought mainframe computers, personal computing, and the Internet. It also triggered the start of the Digital Age.

Today, radical system-wide innovation can happen in only a few years. The interplay between fields like nanotechnology, brain research, 3D printing, mobile networks and computing will create realities that were previously unthinkable.

Key Transforming Technologies



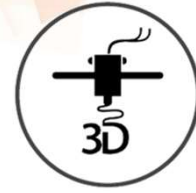
Artificial Intelligence



Autonomous Vehicles



Big Data Analytics
and Cloud



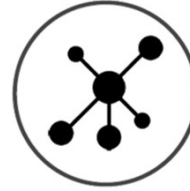
Custom Manufacturing
and 3D Printing



Internet of Things
and Connected Devices



Robots and Drones



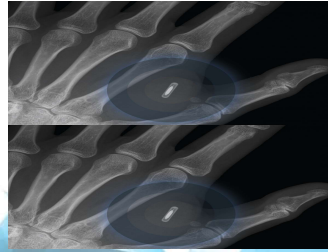
Social Media and Platforms

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The Digital Transformation Initiative of the World Economic Forum has identified seven key technologies that are already having huge impact across industries. These are now buzzwords, common language that we hear everywhere: AI, driverless cars, data science, 3D printing, IoT, drones, social media. And before you can even blink, newer technologies are disrupting industries: blockchain, implantable technology,

Key Transforming Technologies

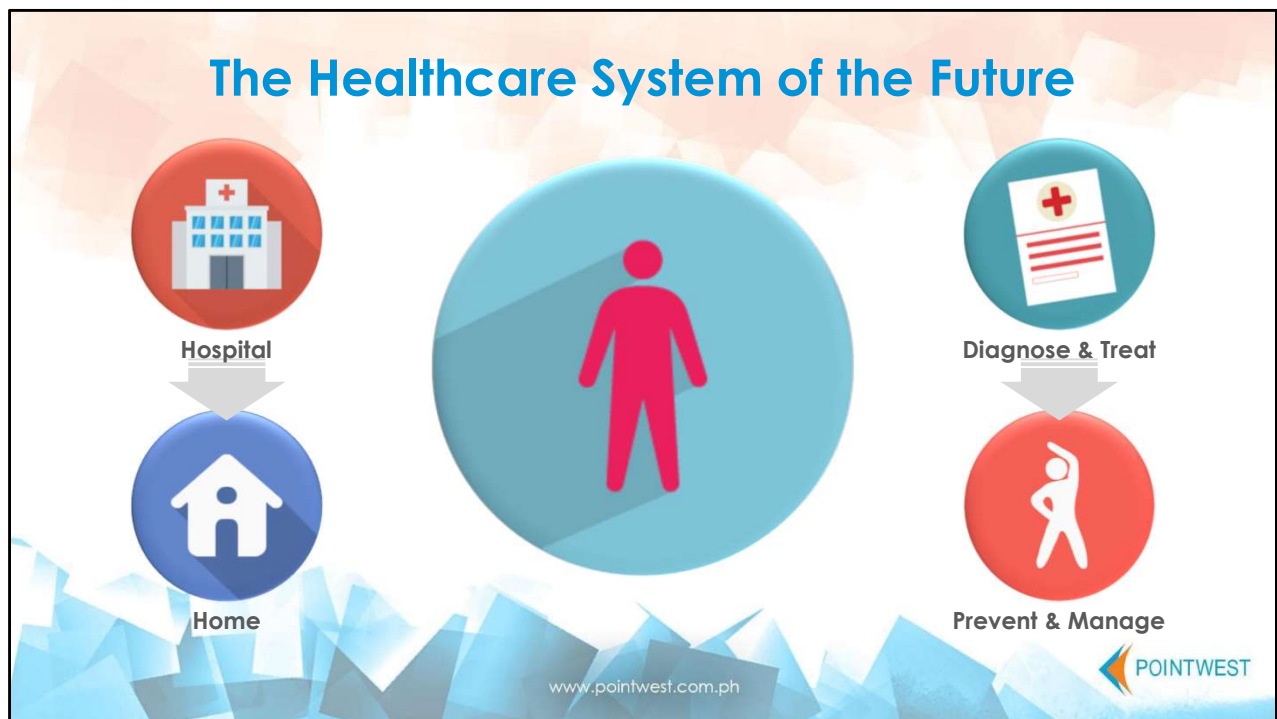


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In fact, many emerging technologies you hear about today will reach a tipping point by 2025:

- 90% of the population will have unlimited and free data storage by 2018.
- The first robotic pharmacist will arrive in the US 2021.
- 1 trillion sensors will be connected to the internet by 2022.
- 10% of the world's population will be wearing clothes connected to the internet by 2022.
- The first 3D-printed car will be in production by 2022.
- The first government will replace its census with big-data technologies by 2023.
- 10% of reading glasses will be connected to the internet by 2023.
- 80% of people on earth will have a digital presence online by 2023.
- A government will collect taxes for the first time via blockchain 2023.
- 90% of the global population will have a supercomputer in their pocket by 2023.
- Access to the internet will become a basic right by 2024.
- The first transplant of a 3D-printed liver will occur by 2024.
- By 2024, more than 50% of internet traffic to homes will be from appliances and devices.
- 5% of consumer products will be 3D printed.
- 30% of corporate audits will be performed by artificial intelligence by 2025.
- Globally, more trips will be made using car-sharing programs than privately-owned cars by 2025.
- The first implantable mobile phone will become commercially available in 2025.
- Driverless cars will account for 10% of all cars in the US by 2026.
- The first AI machine will join a corporate board of directors 2026.
- The first city with more than 50,000 people and no traffic lights will come into existence by 2026.
- By 2027, 10% of global gross domestic product will be stored using blockchain technology.



Few industries have the potential to be changed so profoundly by digital technology as healthcare. The healthcare system of the future will need to look very different. It will be more 'consumer-centric' – allowing citizens and their families to have much more responsibility for managing their healthcare. We expect the two biggest disruptions to healthcare to be:

- Shifting the location of care, out of the hospital and closer to home
- Transforming the type of care, from 'diagnose and treat' to 'prevent and manage'

The Healthcare System of the Future



Smart Care

Precision Medicine, Robotics, and Medical Printing are making healthcare smarter and more personalized.



Care Anywhere

Shifting care closer to home can broaden access to healthcare and reduce the strain on overstretched health systems.



Empowered Care

New digital offerings give citizens powerful tools to play an active role in managing their well-being and healthcare.



Intelligent Health Enterprises

Data-driven healthcare has the potential to save lives and billions of dollars but challenges relating to the use of medical data need to be overcome first.

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The World Economic Forum identified four digital themes that will be of crucial importance to the digital transformation of healthcare over the next decade:

Smart Care

Precision medicine, robotics and medical printing are making healthcare smarter and more personalized.

Recent technological and scientific breakthroughs have propelled medicine into a new era of smart care. Advances in genomics sequencing, coupled with improvements in cloud and analytics capabilities, have hastened the emergence of precision medicine. Cheaper, more capable robots have opened up a wider range of medical applications. The manufacture of individually customized medical devices and implants is now possible thanks to 3D printing.

Care Anywhere

Shifting care closer to home can broaden access to healthcare and reduce the strain on overstretched health systems.

The technology that has enabled the Internet of Things to proliferate will open up the possibility of care anywhere, through virtual care and connected home initiatives. Care anywhere initiatives will allow capacity-constrained healthcare systems to steer patients away from hospitals and shift more medical treatment closer to the home.

Empowered Care

New digital offerings give citizens powerful tools to play an active role in managing their well-being and healthcare.

The digital economy can now deliver a wide range of 'living services' – intelligent digital services that respond contextually to the user's needs. These can empower citizens to manage their own healthcare and prevent the onset of chronic conditions such as diabetes.

Intelligent Health Enterprises

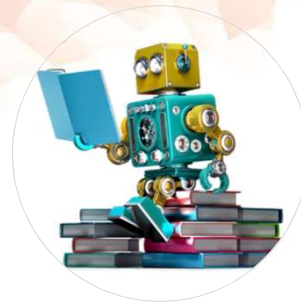
Data-driven healthcare has the potential to save lives and billions of dollars but challenges relating to the use of medical data need to be overcome first.

Advances in data collection, storage and analytics have been accompanied by the proliferation of data – for example, from sensors and devices, clinical information systems and electronic health records. At the same time, more widespread data standards and interoperability are allowing developers to find more applications for health data.

Artificial Intelligence



Robotic Process Automation (RPA) allows a software application to be configured as a “robot” to handle high-volume, repeatable tasks.



Machine Learning (ML) allows software applications to become more accurate in predicting outcomes without being explicitly programmed.

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Let us zoom in on Artificial Intelligence.

A useful definition of Artificial Intelligence is that it is the theory and development of computer systems able to perform tasks that normally require human intelligence. One application of AI is Robotic Process Automation which allows computer systems to reason, collect and extract knowledge, recognize patterns, and learn and adapt to new situations or environments. RPA does this by leveraging on recent software abilities such as Machine Learning which refers to the ability of computer systems to improve their performance by exposure to data without the need to follow explicitly programmed instructions.

Transforming Healthcare through AI



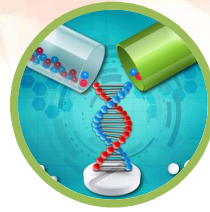
Drug Resistance Predictions

AI is a powerful tool to predict drug outcomes because it looks at the sum of all the needed relevant information.



Medication Adherence Monitoring

AI on patient's mobile devices can confirm medication ingestion during clinical trials within high-risk populations.



Smarter Drug Development

AI can look through millions of pages of medical texts and see relationships between drugs and potential diseases.



Wearable Health Tailor-Fitting

AI can execute tailored alerts, event detection, and communication with various medical informatics services.

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"How will Artificial Intelligence Change Healthcare?" by Eugene Borukhovich, <https://www.weforum.org/agenda/2015/10/how-will-artificial-intelligence-change-healthcare>

The strongly regulated healthcare industry has made little use of artificial intelligence so far. One of the problems has always been that healthcare is too complex. In order to predict anything around one's health, we need information on demographics, proteins, multi-gene interactions, environmental effects, and a whole host of other facets. But that could be changing. And the possibilities are startling and exciting!

AI to Predict Drug Resistance

Could AI predict healthcare outcomes? Researchers are working on ways to use AI and machine learning to predict responses from two chemotherapy medications used to treat breast cancer patients. The underlying problem is that not everyone with the same cancer responds in the same way. An entry in the journal *Molecular Oncology* reports that AI is a powerful tool to predict drug outcomes because it looks at the sum of all the interacting genes. Researchers found it was possible to predict which women with breast cancer would experience improvements when using certain drugs.

How AI could Support Medication Adherence

Can AI help check whether we took our pills? A company in the US does exactly that. They use AI on patient's mobile devices to confirm medication ingestion during clinical trials within high-risk populations. The smartphone's camera is used to understand whether patients took the medication correctly.

AI for Smarter Drug Development

Can AI help develop drugs? IBM Watson is probably one of the most well-known examples of a supercomputer that has proven its abilities in AI beyond the lab. Watson is also able to understand and extract key information by looking through millions of pages of scientific medical literature and then visualize relationships between drugs and other potential diseases. IBM is partnering with pharmaceuticals to teach the supercomputer to read and understand scientific papers that contain clinical trial outcomes, and then help to develop and evaluate medications and other treatments.

AI for Wearable Health

What can AI do with data from wearables? A research team at the University of California in Los Angeles is building a platform for health monitoring using wireless sensor networks. The platform is a network that supports various wearable sensors and contains on-board general computing capabilities for executing individually tailored event detection, alerts, and network communication with various medical informatics services.

Optimizing Clinical Trials through AI



Patient Selection

Through ML, we can look at historical data analysis, social media and patient discussions at forums, objective and subjective data such as age, race, socioeconomic levels, family, influencers, seasonality, etc., to **find trends associated with patient acceptance, adherence, and other metrics.**

RPA bots can then **help speed recruitment** by executing initial interactions with prospective subjects before final follow-up by clinical associates.

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"Optimizing Clinical Trials: Applying Machine Learning and Robotic Process Automation to Plan Clinical Trials" by Sagar Anisingaraju, <http://www.genengnews.com/gen-exclusives/optimizing-clinical-trials/77909233>

Specific to optimizing clinical trials, AI can help in patient selection.

Through Machine Learning, we can look into huge volumes and various types of data in any format to find trends on patient acceptance, adherence, and other metrics. Using Robotic Process Automation, we can then help speed up the recruitment process by doing the initial interactions with prospective trial subjects.

Optimizing Clinical Trials through AI



Site Selection

A learning model can be built by **analyzing site-specific failures** and by **ranking them in the order of relevance** to the specific target study being planned. This learning model can predict the success probability of a specific site for the target study.

Other **trials that may compete for patients at the same sites** allow investigators to compute the overall probability of success in patient recruitment at the site.

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AI can also help in site selection.

AI can analyze historical successes and failures of a trial site as well as rank trial sites in the order of relevance to the specific target study being planned. AI can then predict the success probability of a site for a specific study. When multiple trials compete for a site, success in patient recruitment can also be calculated.

Optimizing Clinical Trials through AI



Principal Investigators

Advanced techniques help in **analyzing availability, relevant training, and prior experience** for the target study within the needed therapeutic area, which can be used to build algorithmic models to predict investigator failures and delays.

Understanding and connecting with principal investigators on **focused social forums** might give additional data about them.

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AI can help predict investigator failures and delays.

Advanced techniques help in analyzing availability, relevant training, and prior experience for the target study within the needed therapeutic area. AI can also get data from focused social forums to get more information about principal investigators.

Optimizing Clinical Trials through AI



Competition

ML models can **analyze the complex competitive landscape** for the proposed investigational new product based on several clinical and commercial dimensions.

Running the models for publicly available drug data can be used to build probabilistic **predictors of competitive success of the product.**

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AI can help analyze the complex competitive landscape for the proposed new product based on several clinical and commercial dimensions. It can then build predictors of competitive success of the product.

Optimizing Clinical Trials through AI



Financial Outcome

Operational and financial performance data of past historical trials can be used to build **a financial model for evaluating the potential costs and timelines of future trials**. This model can analyze scenarios to predict the financial outcomes for predicted delays and failures of target studies during the next several years.

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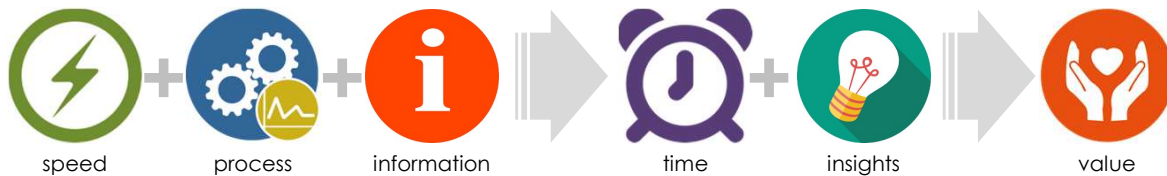
Lastly, AI can also help predict the financial outcome.

Operational and financial performance data of past historical trials can be used to build a financial model for evaluating the potential costs and timelines of future trials.

The True Transformation

The Fourth Industrial Revolution is under way, and it can benefit society by creating jobs, reducing emissions, and saving lives.

However, the true transformation happens within us.



These gains are not guaranteed; they depend on decisions we make.

WHAT DRIVES YOU . . . TODAY?

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The Fourth Industrial Revolution is under way, and it can benefit society by creating jobs, reducing emissions, and saving lives. The true transformation, however, that all of these technologies bring happens within us.

With the speed by which processes are completed through automation and by which huge amounts of information are created, collected, and processed, we now have more time to dig deep and discover greater insights leading to higher value of service we give to our stakeholders.

These gains are, however, not guaranteed. All of these are dependent on the decisions we make.

So the challenge to everyone here, amidst all of these disruptive technologies, is to answer what is it that really drives you . . . today?