DIGITALISATION: THE FUTURE OF HEALTH CARE

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Abstract

Purpose

The health care industry is way behind other industries in adopting digital technology, even though there have been rapid advances in big data and data analytics. The health care industry has adopted the first two generations of technology changes with ease but is finding it difficult to adopt the third level of digitalisation due to several factors. There have been rapid advances in the last few decades in health care informatics – electronic health record systems, genomics, remote diagnostics, wireless technologies, wearables, context-aware computing and cellular technologies that are changing the scene of the health care industry. Big data and data analytics will change the health care delivery system if adopted. The convergence of these technologies will result in a health care delivery system far ahead of customer expectations.

Approach

The objectives were achieved by secondary research. The main method for research was to identify high technology companies in the IT sphere and analyse the research work being done and the products or services developed by these companies in health care by using big data and data analytics. Do they have any commercially viable products or services and how are they useful to the health care industry? Work done by major research institutions on health care was analysed to arrive at the findings. Scholarly articles on health care digitalisation and relevant books were also referred to.

Findings

The benefits of big data are entirely dependent on how the electronic health record system develops and integrates itself into the routine of various hospitals, health care providers, doctors, diagnostic labs, etc. Genomics is being billed as a disruptive technology and game changer in health care. Genomics will transform the health care industry like never before. The pharma industry is making steady progress in "pharmacogenomics", which means developing medicines to suit individual patients' genetic profiles. This will ultimately lead to custom-made health care through digital technology. The new innovations in diagnostic wearable devices with sensors along with big data and big data analytics supported by context-aware computing in real time will lead us to global health care and health delivery models and hospitals which will be highly cost-effective. Digital technology can be used for predictive, preventative health care. Digital technology, with the help of big data and data analytics, will be able to provide remote health care.

Research limitations/implications

Further research can be undertaken on genomics data banks from cities to nations to the whole planet and on prediction of epidemics through data mining and analytics, gene-based therapy based on hard data, pharmacogenomics, predictive health care based on data analysis or genomics, preventative health care through analytics, surgery robotics, and context-aware health care at home.

Practical implications

Through digitalisation and data analytics health care providers will not be selected by patients based on country, city or geographical location but based on the expertise the patients require. The other determinants could be the cost, convenience of health care delivery and quality. The selection of a health care provider will take place at a global level as health care will transform into a world hospital offering the lowest cost anywhere at any time.

Social implications

Health care will become available to the underprivileged at an affordable cost in any part of the world. Digital technology will make it possible to have home-based health care with real-time expert

advice from anywhere in the world. Corporations and NGOs may look to the underprivileged to support remote health care.

Originality/value

The world is facing a serious health crisis. New diseases are infecting human beings. This research work provides direction in the areas where digitalisation, with the help of big data and data analytics, can make the world a healthy place for all to live in.

***Keywords**:* Health care, big data, data analytics, genomics, cost reduction

Category of paper: Technical

1. INTRODUCTION

The last few decades have seen the advent of digital technology in a big way. Businesses and companies are adopting digital technology for growth. Companies, including those in the health care industry, will have to go digital because consumers all across the world are going digital. The health care industry has adopted the first two generations of technology changes with ease but is finding it difficult to adopt the third level of digitalisation due to several factors, including privacy issues and apprehension about customer acceptance.

Health care executives are now faced with a situation in which they need to identify digital technology and processes to get onto a better health care and growth path and stay ahead of the competition.

Health care has gone through a sea change due to new technologies and the main task before health care managers is how to grow and gain a better market share across the world and provide better health care at a lower cost. The question of how to grow and gain a market share with better health care is repeatedly asked by health care managers. The answer in fact lies in digitalisation.

The question is if slow technology adoption in the health care industry may be one of the reasons for escalation of the cost of health care across the world.

Any corporate health care strategy has to consider a changing world in terms of the complex and high-end technology available and of equal importance is early adoption by companies in using the latest digital technology in health care or outsourcing to suit their requirements. Technology can no longer be regarded as one department's product in the health care industry but has to take the lead just as any process to deliver the best health care.

In the present health care business scenario, endogenous theory is becoming more and more relevant. Technology will be driving health care growth, supported by technically skilled human capital. Countries across the world have to produce more health care professionals and adopt the changing trend in technology more quickly than others to cut costs and provide better health care.

It may also be true that governments may have to change privacy laws to enable the health care industry to adopt the latest technology and carry out complex health care processes from anywhere in the world to anywhere in the world.

Berland (2015) of Intel Healthcare, in the article "Healthcare Innovation Barometer Infographic", reveals that many people are willing to share their medical data anonymously to lower the cost of health care. With this information, drug development can be fine-tuned enough to meet the needs of the individual and not just the average person.

The biggest problem in health care management with big data and data analytics is privacy laws and if people are willing to share their data, it will open up a new chapter for health care digitalisation.

There were always health care challenges in the past and technology has always found tools to handle them and provide top-of-the-line health care.

There have been rapid advances in the last decades in genomics, health care informatics, remote diagnostics, wearables, the Internet, wireless technologies, context-aware computing and cellular technologies. The health care industry will have to accept the fast-changing scene. The convergence of these technologies will result in a health care delivery system far ahead of customer expectations.

Networked diagnostic devices are replacing manual operations for diagnostics and a patient can be digitally monitored from home rather than being brought to a hospital.

Behringer (2015), in the article "The digitalisation of healthcare economy", stated that in the hospital of the future information technology (IT) will play a central role – from the management of administrative and medical data to networking with other hospitals to obtain fast access to diagnostic results, etc.

A combination of big data, database management systems and cloud computing supported by context-aware computing and business/predictive analytics is on the verge of changing the way health care will be provided in the future.

Stuart (2015), in the article "Digitalisation: enabling the future of healthcare", stated that in addition to placing the focus on quality and care management, digitalisation also helps to develop health management insights via analytics, contract and demand management, and even fraud management so that health care can ensure customers are being charged at the right time, for the right price, every time. Through these digital initiatives, health care is improving the customer experience and creating material change in its business, in addition to shaping the changing health care landscape.

One of the biggest hurdles in digitalised health care is insurance companies. They have not yet woken up to the fact that digitalised health care as a reality is almost here. Insurance companies will have to include reimbursement for remote digital health care, which may include diagnostics, consultations, monitoring, and surgical care.

2. THEORETICAL FRAMEWORK OF THE RESEARCH

The following theories were taken into consideration while conducting the research.

A study by Basu, Fernald, and Shapiro (2001) revealed that advances in technology are the only source of permanent increases in productivity.

Baumol (1967) and Nordhaus (2006) suggest that economic studies have shown that technologically stagnant sectors experience slow productivity growth and, therefore, above-average cost and price increases.

According to Tassey (2005), the closest traditional economics comes to recognizing the role of technology is so-called "endogenous growth" theory. Endogenous growth theory is an economic theory which argues that economic growth is generated from within a system as a direct result of internal processes. More specifically, the theory notes that the enhancement of a nation's human capital will lead to economic growth by means of the development of new forms of technology and efficient and effective means of production.

Salber, Dey, and Abowd (1998) define context-aware to be the ability to provide maximum flexibility of a computational service based on real-time sensing of context.

Hull, Neaves, and Bedford (1997) define context-aware computing as the ability of computing devices to detect, sense, interpret, and respond to aspects of a user's local environment and the computing devices themselves.

Feldman, Martin, and Skotnes (2012) stated in the article "Big data in healthcare: Hype and hope" that volume (scale of data) refers to the management of the amount of data, usually referred to in terms of terabytes or petabytes of data. It involves management of data storage.

Variety (different forms of data) means that the format of data can be structured, semi-structured and unstructured.

Feldman, Martin, and Skotnes (2012), in the article "Big data in healthcare: Hype and hope", stated that velocity of data means the frequency of data that is produced, processed, and analysed.

Clifford (2008), in the article "How do your data grow?", stated that veracity refers to the quality, relevance, predictive value and meaning of data.

In the same article, Clifford mentioned that the value of data refers to information's worth to various stakeholders / decision-makers.

Gartner (2009), in the paper "Context-Aware Computing Will Provide Significant Competitive Advantage", defines context-aware computing as the concept of leveraging information about the end user to improve the quality of the interaction. Emerging context-enriched services will use location, presence, social attributes, and other environmental information to anticipate an end user's immediate needs, offering more sophisticated, situation-aware and usable functions.

3. RESEARCH METHODOLOGY

This research was not empirical. The research methodology followed was secondary research.

The research started with an extensive search on the internet for global-level high technology companies that offer products or services in the big data and data analytics sphere. The next process was to research these pre-identified companies' work or research papers published in the health care sector. The products or services offered by these companies in the health care sector were also

researched.

Scholarly articles and reports on digitalisation of health care from academia, corporations, consulting firms, insurance companies, government laboratories, the WHO and government organisations were also researched.

All the work mentioned above was combined to create a paper in order to be able to explain the future of health care through digital technology.

4. ANALYSIS OF THE RESEARCH RESULTS

It is a well-known fact that use of new technologies reduces costs, improves efficiency, and enhances consumer satisfaction and experience. In the near future, a patient's medical data will be available at any given point in time anywhere in the world so that he/she may seek medical advice or remote-controlled medical intervention, including surgery. This will change the entire landscape of the health care industry.

Table 1

Summary of highlights

S. No	New digital technology	Highlights
4.1	Big data and health care	Health care is probably one of the most data-intensive industries. Basically, there are four main sources generating all the health care data: medical care providers, public and private payers, ancillary service providers – from pharmacies to laboratories – and health care consumers.
4.2	Data analytics in health care systems	Health care providers and payers can garner new insights across a spectrum of applications ranging from better personalized individual care to predictive models for large population cohorts.
4.3	Electronic health records (EHR)	Big data benefits are entirely dependent on how the electronic health record system develops and integrates itself into the routine of various hospitals, health care providers, doctors, diagnostic labs, etc.
4.4	Genomics	It is being billed as a disruptive technology and game changer in health care. Genomics will transform the health care industry.
4.5	**Personalized health care**	Health care is moving towards individual custom-made health care, including in preventative care.
4.6	Health wearables and prevention	Individuals will be able to monitor their health parameters on a continuous basis with health care professionals and seek online remedies.
4.7	Early detection	Genomics supported by EHR with predictive data analytics will be able to create algorithms that predict major types of diseases, including cancer. Big data may be the greatest weapon to wield in the global fight against Alzheimer's.
4.8	Cost reduction	The new innovations in diagnostic wearable devices with sensors along with big data and big data analytics supported by context-aware computing in real time will lead us to global health care and health delivery models and hospitals which will be highly cost-effective.
4.9	Remote health care management	Data analytics will be able to manage health care and patients can stay at home and out of hospital beds. They will still get almost the same clinical care.

4.1 BIG DATA FOR HEALTH CARE

It has been a long-practiced approach, still relevant today, that health care is an individual process and generally does not have pooled data for several reasons, including privacy laws. Big data and analytics are now on the verge of changing all that and the individualistic approach to health care. The data is stored in a highly classified manner and it is extremely difficult to access.

IBM (2016), in the article "Bringing big data to the enterprise", mentioned that every day, we create 2.5 quintillion bytes of data. Rich (2013), in the article "Redesigning healthcare. New delivery initiatives include ACOs, walk-in clinics, medical homes", quoted Karen Davis, a health policy professor at Johns Hopkins University and a long-time Washington policy leader, as having said that the innovation centre has faced challenges collecting data that is strong enough to support expanding its ideas broadly across Medicare and Medicaid.

Maniyika, Bughin, Dobbs, Roxburgh and Hung (2011), in the article "Big Data: The next frontier for innovation, competition and productivity", stated that if US health care were to use big data creatively and effectively to drive efficiency and quality, the sector could create more than $300 billion in value every year. Two-thirds of that would be in the form of reducing US health care expenditure by about 8 percent. In the developed economies of Europe, government administrators could save more than €100 billion ($149 billion) in operational efficiency improvements alone by using big data, not including using big data to reduce fraud and errors and boost the collection of tax revenues. And users of services enabled by personal-location data could capture $600 billion in consumer surplus.

It has been found (Commonwealth of Australia report 2013) that about 90% of data today was created in the last 2 years. It has been calculated that the production of data will be 44 times greater in 2020 than it was in 2009.

It has been stated (Siemens 2016) in the article "Big data in the healthcare industry**" that b**asically, there are four main sources generating all this health care data: medical care providers, public and private payers, ancillary service providers – from pharmacies to laboratories – and health care consumers. The challenge is not just in storage and access, but in making this data usable.

Marr (2015), in "How Big Data Is Changing Healthcare", mentioned that big data in health care is being used to predict epidemics, cure disease, improve quality of life and avoid preventable deaths. With the world's population increasing and everyone living longer, models of treatment delivery are rapidly changing, and many of the decisions behind those changes are being driven by data.

4.2 DATA ANALYTICS IN HEALTH CARE SYSTEMS

By gathering and analysing the many varieties of data, including medical records and traditional clinical as well as new genomic and consumer-generated types, both providers and payers can garner new insights across a spectrum of applications ranging from better personalized individual care to predictive models for large population cohorts.

It has been found (Intel 2016) in the article "Health IT: connecting patients, care teams, and data" that the amount of existing and new data flowing through today's health care model is enormous and growing. The untapped potential of that data is even greater.

4.3 ELECTRONIC HEALTH RECORDS (EHR)

Shaffer and Craft (2015), in the article "Hype Cycle for Healthcare Provider Applications, Analytics and Systems", mentioned that with EHRs increasingly in place, the future will be dominated by technologies that enable real-time "intelligent" operations, manage population health, engage and influence patients, and enhance clinicians' cognitive abilities. A "revolution" has defined the last 10 years of health care IT, the authors says.

The benefits of big data are entirely dependent on how the electronic health record system develops and integrates itself into the routines of various hospitals, health care providers, doctors, diagnostic labs, etc.

Gartner (2015) says that EHR adoption is a "trigger" for data analytics, improved care management and other innovations. However, these initiatives will take time, the analyst firm notes in a recent report, "Hype Cycle for Healthcare Provider Applications and Systems."

4.4 GENOMICS

An organism's complete set of DNA is called its genome as per the National Human Research

Institute of the USA. It has been concluded (National Human Research Institute of the USA, 2016) that the role of genetics in health care is starting to change profoundly and the first examples of the era of genomic medicine are upon us.

As per medical science every ailment has a source in our genes. It has been a long-time practice in the health care industry to take genetics into consideration for birth defects and also some life-threatening diseases. In such a way, the industry has also been able to identify certain diseases.

Data analytics will drive the whole process of genomics. This will be one of the most integrated and complex data analytics exercises undertaken on the planet and it will include entire health care service providers from hospitals to doctors' clinics to diagnostic labs and individuals and groups of individuals with similar genomics in a city, state or country or the whole planet. Researchers will be able to establish what changes in genomics cause diseases and the pharmaceutical industry will be able to develop genomic medicines.

4.5 PERSONALIZED HEALTH CARE

Health care is definitely moving towards individual custom-made health care, including preventative. Genomics will guide the entire health care industry with the help of data analytics and will change the way health care is delivered in the foreseeable future.

Patients have been going through screening and diagnostic tests for quite some time and getting medicines prescribed by doctors available on the shelf with no distinction among patients for their genetic differences. The pharma industry is making steady progress in "pharmacogenomics". In simple terms, this means developing medicines to suit individual patients' genetic profiles. This will ultimately lead to custom-made health care.

4.6 HEALTH WEARABLES AND PREVENTION

Digital technology is already playing a vital role in the prevention of health-related issues. Digital wearables are redefining preventive health care for diabetes, blood pressure, etc. Wearable devices equipped with sensors record live data and transmit it via an app to the health care provider. This will lead to better disease management, including preventive health care.

People will be able to use wearables and connected devices to manage their well-being through the analysis of an entire day's data on basic parameters and the corrections required the next day to remain in the optimum health parameters.

Wearables and context-aware computing with sensors will not only be useful for acute health conditions but will become health gadgets worn by all.

4.7 EARLY DETECTION

EHR could turn out to be a major tool for big data analysis to predict or detect several diseases. Certain EHR data, if analysed by analytics, may provide conclusive symptoms of several diseases long before they attack the body. Even now, breast cancer can be predicted long before any symptoms of the disease.

Milstein and Jha (2013), in their paper "Healthcare's "Big Data" challenge", concluded that the use of real-time big data analytics will result in early and accurate detection of illness and lower costs.

Ramachandran, Girija, and Bhuvaneswari (2014), in the article "Early Detection and Prevention of Cancer Using Data Mining Techniques", mentioned that a novel multi-layered method combining clustering and decision tree techniques to build a cancer risk prediction system has been proposed which predicts lung, breast, oral, cervix, stomach and blood cancers and is also user-friendly and time and cost-saving. This research uses data mining technology such as classification, clustering and prediction to identify a potential cancer patient.

Ahmed, Emran, Jesmin, Mukti, and Rahman (2013), in the article "Early detection of lung cancer risk using data mining", stated that by using prediction tools for significant patterns a lung cancer prediction system has been developed. This prediction system should prove helpful in detecting a person's predisposition to lung cancer.

It has been recognised by Lockheed Martin (2015), in the article "Data Analytics – Identify Illness before Your Body Does", that human beings are complex. Each of us carries a unique genome, comprised of DNA, genetic mapping, hereditary information and biological characteristics. In other

words, humans are made up of millions of individual data points. Now, as data analytics technology evolves, we can harness and sequence this data to identify trends, detect disease, predict medical complications and ultimately deliver more comprehensive and affordable care.

As genomics moves forward early detection will become realty.

Kar (2013), in the article "IBM Wants to Predict Heart Disease through Big Data Analytics", mentioned that it is just a matter of a few years until health attacks will be predicted long in advance by data analytics. IBM is already working on this.

Knowledgent (2015), in the article "Applying Big Data to One of the World's Biggest Problems: Alzheimer's Disease", says that Alzheimer's is a global crisis. Nearly 44 million people worldwide suffer from dementia, and this number will spike to 115 million by 2050. The crisis is not particular to the rich world. Nearly 60 percent of the burden of dementia is in low and middle-income nations. And this percentage will rise**.** Right now, for the first time in human history, we have the volume of data and the analytical tools to begin this project.

Stanford Medicine (2015), in the article "Precision health: Predicting and preventing disease", lays the groundwork for such a system, which will be able to quickly analyse information from large patient databases, medical literature, mobile monitoring and patients' real-life experiences with drugs, among other sources, to provide an evidence-based approach to medicine that has not been possible before.

The planned system is an example of how clinicians at Stanford Medicine are tapping health data to provide targeted, predictive and personalized care.

4.8 COST REDUCTION

Evidence-based medicine will certainly lead to cost reduction as patients will get the treatment for the disease evidenced or prevention needed and hence there will be no scope for trial and error.

Peleg and Tu (2006), in the research paper "Decision support, knowledge representation and management in medicine", highlighted cost reduction as a major advantage of big data analytics.

Home-based health care delivery will drastically reduce the cost.

Genomics, when it becomes part of regular health care, will reduce the cost of medicine and health care. Genomics will enable gene-based therapy, which will be very effective, and the treatment period will be reduced, including post-treatment. This will bring down the cost.

4.9 REMOTE HEALTH CARE MANAGEMENT

In the very near future the way an individual visits and interacts with health care professionals is going to change through telemedicine. Wearables will continuously record the health data of patients at home and transmit it to the cloud. The data thus transmitted will be analysed through data analytics with existing DBMS in sync with the transmitted data and feedback will be sent to health care professionals in real time. Health care professionals, health care service providers, diagnostic labs, and emergency services will receive their patients' data in real time and they can then decide the next course of health care in real time as well. The analysed data will come seamlessly and hospitals will be able to identify any health issues and take corrective actions.

Intel (2016), in the article "Health IT: connecting patients, care teams, and data", states that data analytics can manage care and patients can stay at home and out of hospital beds. They will still get almost the same clinical care. Context-aware computing will play a major role in this area with the help of sensors which will continuously transmit the live data for analysis through data analytics.

In the same article, Intel mentioned that one of the most promising areas of innovation and transformation in health care is the move to distributed care. By creating a patient-centred network of intelligent, connected devices that spans across the home, workplace, community, and the mobile spaces in between, data capture and analysis and communication between patients and their care team can all be enhanced and harnessed to deliver more effective health care to more people at lower cost.

In the home, this will be driven by new types of consumer medical devices and smart home connectivity and features. In the workplace and the community, new mobile devices and services including kiosks will be available. And for persistent real-time data and connectivity, new purpose-built and general purpose devices will fill in critical gaps.

Bardram (2004), in the paper "Applications of context-aware computing in hospital work – examples and design principles", found that a context-aware hospital bed will know who is using it and what and who is near it. The bed knows the nurse and the medicine tray and will display relevant information as

per the context. A context-aware medicine tray can remind the patient or nurse when the particular medicine is to be taken.

5. CONCLUSIONS

The conclusions of the research are as follows.

1. Electronic health records will replace all manual records and will ultimately create big data for the population to provide better health care to all. Governments across the world will have to change health-related privacy laws to enable the creation of big data.

2. Genomics will take the front seat in future health care and the whole population will have their personal genomics card or data for better health and preventative care. This will open the doors for personalised health care through pharmacogenomics and genomic medicine.

3. Health-related wearables will become an absolute necessity and people will monitor their health parameters on a continuous basis and take preventative measures or remedial measures without any wastage of time.

4. Future health care delivery will take place more at home than in hospitals as the remote care delivery network becomes technology-driven. Remote care health delivery is bound to expand due to the increase in internet connectivity and innovation in wearable and consumer-friendly health care instruments and portable machines supported by big data and data analytics.

5. Health care providers will not be selected by patients based on country, city or geographical location but based on the expertise the patients require. The other determinants could be the cost, convenience of health care delivery and quality. The selection of a health care provider will take place at a global level as health care will transform into a world hospital offering the lowest cost anywhere at any time.

6. Big data, data analytics, genomics and EHR will be able to predict a major epidemic long before it actually arrives and, similarly, individuals will be able to get forewarnings of diseases likely to afflict them in the future.

7. The cost of health care is likely to come down drastically through the use of technology.

8. The brick and mortar model of health care will remain similar to what we have today in terms of highly specialised hospitals and specialised diagnostic labs, but a huge number of health care professionals will be sitting in their offices and not going around brick and mortar hospitals. Health care professionals will be monitoring patients' data continuously and advising them live on what needs to be done.

9. Health care will follow a model where brick and mortar hospitals will remain but consumers will receive more and better options for health care at lower costs through technology at home. Brick and mortar hospitals and diagnostic labs will still be relevant because a sizable population of health care seekers will still need the human touch in health care to feel secure. It will take some time for seniors to become convinced that health care can be provided digitally and hence they will continue to prefer the brick and mortar model.

10. The technological evolution of the last few years has been like nothing ever seen before. The advances in robot technology, precision processing, remote-controlled computer-assisted manufacturing, and the precision with which space and missile technology works provide enough assurance that the time is not far away when a robot-assisted major surgery on any organ of the body will be conducted by an expert surgeon thousands of miles away from the patient's location. The only question that remains is whether the robot will be able to replicate the art of an expert surgeon in conducting the surgery, even if it has acquired the precision of a surgeon's hand.

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