2018

Achieving Meaningful Use of Electronic Health Records: Prospects for Blockchain in Ontario's Health Care System

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ACHIEVING MEANINGFUL USE OF ELECTRONIC HEALTH RECORDS: PROSPECTS FOR BLOCKCHAIN IN ONTARIO'S HEALTH CARE SYSTEM

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A Major Research Paper
Submitted to the Faculty of Graduate Studies
through the Odette School of Business
in Partial Fulfillment of the Requirements for
the Degree of Master of Business Administration
at the University of Windsor

Windsor, Ontario, Canada

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Abstract

Over the past decade, the Government of Ontario has devoted significant resources to the digitization of patient health records with the goal of improving data storage, management, transfers and, ultimately, patient care. Adoption rates for digitized records, known as electronic health records (EHR), and accompanying systems, has been high among health care providers in Ontario. Yet, research has demonstrated that a number of barriers appear to inhibit the effective use of EHRs among clinicians. These barriers can impede or delay meaningful use of EHRs and accordingly, limit their ability improve information exchanges, service delivery and patient care.

This paper reviews the challenges of achieving meaningful use of EHRs in health care service delivery. It also examines whether an emerging technology for data management, blockchain, may overcome the most prominent barriers to meaningful use of EHRs. A strong focus of this research concerns the legal aspects of EHRs and the legal issues surrounding their use.

The difficulties in achieving meaningful use of EHRs can stem from the time and resources required for training and change management activities, the skill-level of users and the usability of the systems adopted.

This paper proposes recommendations including a greater emphasis by the government and industry groups on designated initiatives to support meaningful use, stronger compliance measures and incentives for health care providers, and investments in new and emerging health care positions. The legal community can assist by engaging in collaborative efforts that aid in increasing certainty about the laws concerning EHRs.

These findings may provide guidance to health care industry professionals and legal practitioners, to enhance preparation for technology changes in the area of information management, and encourage activities which support meaningful use.

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Overview

The Government of Ontario has invested heavily in electronic health records (EHRs) to enhance patient care.[1] EHRs are believed to offer a number of benefits that enhance health care delivery by improving how patient data is stored, shared and managed.[2] While health care providers in Ontario have demonstrated high EHR adoption rates, research indicates that meaningful use of EHRs in Ontario is low.[3] Meaningful use entails understanding and regularly using EHR systems beyond basic or rudimentary functionality.

This paper focuses on ways to increase the meaningful use of EHRs and considers whether one particular technology, blockchain, can support such efforts. It will also examine legal and other potential risks of employing blockchain technology, and propose recommendations to overcome barriers to the meaningful use of EHRs.

Electronic health records: Current challenges and future opportunities

The province of Ontario administers a publicly-funded health care system. Although Ontarians have free access to medically necessary hospital and physician services, the

[1] eHealth Ontario, *Better Data, Better Care: eHealth Ontario 2016/17 Annual Report*, (Toronto, 2017).
[2] Manca, Donna P., "Do electronic medical records improve quality of care?" *Canadian Family Physician* 61 (October 2015): 846.
[3] Canadian Medical Association, *How can Canada achieve enhanced use of electronic medical records?* (2014).

health care system faces a number of challenges including long wait times for care, limited resources, rising costs and service delivery that lacks coordination.[4]

Health care costs in the province of Ontario presently represent more than 50% of tax revenues and are rising annually.[5] Combined with an aging population that contributes to an increased use of the health care system, there is a strong need to locate solutions to address these challenges.

Studies have demonstrated that one way to improve health care service delivery and enhance patient outcomes is through the use of EHRs.[6] Digitized health records have been shown to create efficiencies, reduce errors, save costs and enhance program evaluation.[7] It is estimated that countries which focus on managing health care information more effectively have the ability to save upwards of $300 billion annually.[8]

The province of Ontario has been working to establish a system of EHRs through its agency, eHealth Ontario, to address some of the province's health care concerns. eHealth Ontario was established in 2008 and, to date, has cost the province over $8 billion to establish an EHR system.[9]

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[4] Health Quality Ontario, *Measuring Up 2016: A yearly report on how Ontario's health system is performing* (Toronto: Queen's Printer for Ontario, 2016).
[5] Cohen, Jason and Snowdon, Anne, *Strengthening Health Systems through Innovation: Lessons Learned,* World Health Innovation Network (London: Ivey International Centre for Health Innovation, 2011).
[6] Ghany, Ahmad and Keshavjee, Karim, *"A Platform to Collect Structured Data from Multiple EMRs,"* Studies in health technology and informatics 208 (February 2015): 142.
[7] Ibid.
[8] McKinsey & Company, *Big Data: The Next Frontier for Innovation, Competition, and Productivity* (New York: McKinsey Global Institute, 2011).
[9] Office of the Auditor General of Ontario, *2016 Annual Report*, (Toronto: Queen's Printer for Ontario, 2016).

In its 2016 report on eHealth Ontario, the Auditor General of Ontario concluded that despite significant digitization of certain categories of health records, there remain a number of deficiencies in the eHealth Ontario EHR system. Some of the key findings of the report include that:

- There remains no provincially integrated system for easy and timely access to health records;
- Many health care professionals cannot connect to provincial databases; and,
- The use of the digitized systems is low.[10]

These findings demonstrate that digitization alone cannot cure the ailments of the health care system. If the value proposition of technology is unclear to system users, the technology will go unused and cannot enhance health care service delivery.

Blockchain is one technology solution that has received significant attention in recent years as a potential solution to the management of health care data. Many theorize that it will bring significant change and improvement to health care service delivery.[11] This paper will examine the value proposition of blockchain technology and explore whether it may have the ability to overcome the challenges that prevent meaningful use of EHR systems.

[10] Ibid.
[11] Ekbla, Ariel, Halamka, John D., and Lippman, Andrew, "The Potential for Blockchain to Transform Electronic Health Records," Harvard Business Review, March 3, 2017.

Structure of the research paper

The research question to be examined is: *Can blockchain technology create value for health care providers in Ontario and increase the meaningful use of electronic health records?*

The research paper will examine data retrieved from a breadth of secondary sources including journal articles, research studies, media sources and industry publications. Part I of the paper will outline the purpose, scope and methodology of the research. It will also discuss key terms and topics, including:

- A review of Ontario's health care system and EHR initiatives;
- A discussion of meaningful EHR use and the barriers that inhibit it; and,
- An overview and critique of blockchain technology.

In Part II, the research paper will provide data results and discuss the issues raised. Finally, the paper will offer recommendations for health care providers and legal practitioners servicing the industry.

The research paper aims to meet the following objectives:

- Explore barriers to the meaningful use of EHRs;
- Assess blockchain's potential to overcome barriers to meaningful use of EHRs; and,
- Provide recommendations to legal practitioners and health care providers to enhance meaningful use of EHRs.

Context and history

In Ontario, qualified residents can access a number of emergency and preventive health care services for free.[12] The province's government-run, public health care scheme provides free health care through the Ontario Health Insurance Plan, better known as 'OHIP'. Ontarians can access a number of free health care services including visits to a hospital, family doctor, or walk-in clinic, certain surgical procedures, medical tests, and ambulance services through OHIP. Funding for these services is collected through taxes paid by Ontario residents and businesses.

Under the OHIP scheme, residents present their Ontario health card to receive services, while service providers, such as doctors, invoice the Ontario Ministry of Health for reimbursement of costs associated with services rendered.[13] Although Ontarians benefit from access to medically necessary hospital and physician services, they face long wait times for medical services, endure crowded facilities with limited resources and do not receive coordinated care.[14]

The World Health Organization (WHO) outlines four key features of well-functioning health care systems which:

- Improve the health of individuals, families and communities;
- Defend against health threats;

[12] "Understanding Health Care in Ontario," Ontario Ministry of Health and Long-Term Care, last modified July 13, 2017, http://www.health.gov.on.ca/en/common/system/default.aspx#1.
[13] "Primary Care Models in Ontario," Ontario Ministry of Health and Long-Term Care. Last updated February 8, 2017. http://www.health.gov.on.ca/en/pro/programs/pcpm/.
[14] Barua, Bacchus, "Waiting your turn: Wait Times for Health Care in Canada," Fraser Institute, December 7, 2017. https://www.fraserinstitute.org/studies/waiting-your-turn-wait-times-for-health-care-in-canada-2017.

- Protect people from the financial consequences of illness; and,
- Provide equitable access to care centred on patients.[15]

The WHO cites a good health information system as an important driver to facilitate the functioning of health care systems through timely intelligence.[16]

Ontario's health care system meets some of the characteristics proposed by the WHO, such as insulating people, for the most part, from the financial implications of their health care needs. In other areas, Ontario does not meet the WHO's criteria. For instance, with respect to equity, research has shown that the poorer one is in Ontario, the less likely they are to receive quality health care or have good access to health care.[17] For those living in rural areas, one's health care quality is also more likely to be diminished. In addition, Ontario's system is poised to treat urgent, short-term injury or acute illness which poses challenges to addressing individuals' overall health care needs.

Health care in Canada

Canada's publicly-funded health care system is ranked 10th out of 11 industrialized nations, according to the international health research firm, the Commonwealth Fund.[18] In comparison to countries including the United Kingdom, Norway, Germany, Australia

[15] "Key components of a well-functioning health system," World Health Organization, May 2010. http://www.who.int/healthsystems/EN_HSSkeycomponents.pdf?ua=1.
[16] Ibid.
[17] "Income and Health: Opportunities to achieve health equity in Ontario," Health Quality Ontario, (Toronto: Queen's Printer for Ontario, 2016). http://www.hqontario.ca/Portals/0/documents/system-performance/health-equity-report-en.pdf.
[18] Davis, Karen and Lipitz, Roger C., "Mirror, mirror on the wall: How the U.S. Health Care System Compares Internationally, June 2014 Update" The Commonwealth Fund (June 2014). http://www.commonwealthfund.org/~/media/files/publications/fund-report/2014/jun/1755_davis_mirror_mirror_2014.pdf.

and several other industrialized nations, the 2014 study found Canada near the bottom of the overall ranking.

The study found that Canada performs worst among all countries in the area of timeliness of care and, in categories such as "efficiency" of the system and "safe care", placed 10th.[19] For "access to care" and "equity" Canada placed 9th while in the category of coordinated care, the country placed 8th.[20] These findings are worrying and signal that there are significant problems with the provision of health care services in Canada.

Experts have identified three key challenges affecting Canada's health care system: a fragmented structure, rising costs in the face of an aging population and a system that focuses too heavily acute chronic illness rather than holistic health care.[21]

An aging population and an outdated system

Canada's population is aging and with that comes increased use of the health care system. According to the Ontario Chamber of Commerce, health care for seniors is on average two to three times higher than that of the average person.[22] In particular, Ontario's health care costs represent more than 50% of provincial tax revenues and will continue to grow as Ontarians age.[23]

[19] Ibid at note 18.
[20] Ibid at note 18.
[21] Ibid at note 5.
[22] Challinor, Ashley, "Transformation Through Value and Innovation: Revitalizing Health Care in Ontario," Ontario Chamber of Commerce, 2016.
[23] Ibid at note 5.

According to the Ontario Chamber of Commerce, the province's health care system is ill-suited to handle the needs of modern society and was originally formulated to financially assist people in the face of catastrophic injury or acute illness.[24] These health matters were best handled in hospitals and the health care system, as originally structured, was designed to support and fund health care services provided in the hospital setting.[25]

A system based primarily on addressing acute illness and injury is no longer effective in managing the needs of society. The WHO reported in 2008 that in modern society, chronic illness is the leading cause of death.[26] Chronic illnesses such as heart disease and cancers require a different form of attention than acute illnesses which can typically be managed through urgent and short-term care. By contrast, for chronic illness or disease, patients require holistic and coordinated care that is managed over the long-term for best outcomes.

Modern approaches to health care focus on prevention, individualization and holistic care, which are concerned with all aspects of a person's overall health. These approaches, when well-implemented, reduce costs by managing health concerns before they reach a critical level, creating efficiencies in the system, and reducing the number of individuals requiring costly interventions. As the World Health Innovation Network writes, "Health systems worldwide are coming under increased pressure to deliver effective early-stage

[24] Ibid at note 21.
[25] Ibid at note 5.
[26] Ibid at note 5.

interventions that either prevent or effectively treat chronic disease conditions and their risk factors."[27]

Fragmented service delivery

In addition to an outdated model for health care, the health system in Ontario is plagued by fragmentation. Separate entities are responsible for specific aspects of care, typically in an uncoordinated manner.[28] Furthermore, each entity typically employs its own mechanisms for managing budgets, delivering services, and handling patient information. For instance, primary care offices, laboratories and hospitals maintain separate databases, or in some cases, hardcopy records concerning patient information. There is little coordination, consistency or information-sharing between separate entities.[29] Ultimately, each entity holds part of a patient's medical history with little guarantee that other parties in the health care system will gain access to the full picture.

A fragmented system produces fragmented care. Health care providers in hospitals, clinics, long-term care facilities and primary physician offices work, in many cases, with partial information of an individual's health care history. Patients ultimately receive incomplete care, while the health care system is mired with duplication of efforts, a higher potential for errors due to missing information and delays in diagnosing and treating patients due to lags in transferring patient information.

[27] Ibid at note 20.
[28] Baker, Ross G and Axler, Renata, "Creating A High Performing Health Care System for Ontario: Evidence Supporting Strategic Changes in Ontario," Institute of Health Policy, Management and Evaluation, University of Toronto (October 2015).
[29] Ibid at note 21.

Additionally, patients do not have access to their own medical records and typically have incomplete knowledge of their own health care history. Despite this, health service providers are often reliant on patients to provide verbal accounts of their medical history. This is not a reliable means to transfer information that can be critical to providing appropriate care.

The fragmentation of the health care system is a factor that further impedes the ability to ensure proactive and coordinated care that creates efficiencies, cost savings in the system and better patient outcomes.

The use of EHRs in health care

EHRs represent a digital record of an individual's health care history including medical visits, diagnoses, treatment plans, prescribed medications and laboratory results.[30] EHRs can contain health care information obtained by primary and acute care providers, and third-parties, such as medical laboratories. These digitized records facilitate the management and transfer of health care information.[31]

eHealth Ontario, an agency of the Ontario government, has been working to establish a centralized and coordinated system of EHRs for the province since 2008 and has reportedly spent $8 billion to develop the system.[32] The task has not been easy, as

[30] "What's an EHR," eHealth Ontario, 2018. https://www.ehealthontario.on.ca/ehrs-explained.
[31] "What is an electronic health record (EHR)," HealthIT.gov. Last updated March 21, 2018. https://www.healthit.gov/providers-professionals/faqs/what-electronic-health-record-ehr
[32] Green, Roy, "Ontario election next year a dry run for federal version in '19," Global News, September 15, 2017. https://globalnews.ca/news/3747706/roy-green-ontario-election-next-year-a-dry-run-for-federal-version-in-19/.

explained by The Canadian Press which outlined the difficulties faced by eHealth: "The challenge is to digitally link 29,000 doctors, 150,000 nurses, thousands of other health care providers, 156 hospital corporations operating 238 hospitals, 36 public health units, 76 community health centres, more than 4,000 pharmacies, 23 community laboratories and nearly 1,000 independent health clinics."[33]

EHRs are though to offer a number of benefits including access to a patient's complete medical history, enhanced ability to transfer and manage health care data, and both time and cost savings.[34]

A fragmented system for the documentation of medical records can be highly problematic. A Harvard University study on the quality of cancer care treatment found that significant difficulties exist in locating information about patients' medication doses and other records because there was no central repository for such information.[35] The study points to a key issue that many health systems face, a lack of coordination and information-sharing.

In its 2016 report about Ontario's health care system, the Ontario Chamber of Commerce found that "Ontario's health care system requires system-level thinking, and system-level transformation."[36]

[33] "eHealth Ontario should expand services, provide patients with access to records: Report," The Canadian Press, November 22, 2016. https://www.bnn.ca/ontario-will-not-sell-ehealth-assets-as-ed-clark-says-agency-worth-5-7b-1.613980.

[35] Bailes JS, "ASCO's groundbreaking study on cancer care quality: NICCQ," Journal of Oncology Practice 2, no. 2 (March 2006) 48.

[36] Ibid at note 21.

Hence, eHealth Ontario was established with a mandate to build an electronic system for health records that connects various health care providers across the province in a secure system.[37] The system aims to improve information-sharing, allowing clinicians to enhance patient care.[38] The project started with the goal of converting billions of paper medical records to digital format. This has required the development of a network with secure storage and robust protections, due to the highly sensitive and personal nature of health information. eHealth is also working to ensure efficient access to health records to improve information-sharing among health care providers.[39] In the long-term, eHealth aims to provide Ontarians with direct access to their health records.

eHealth captures patient data through province-wide repositories, which store health results, and registries, which contain clinician listings. These centralized databases of health care information offer a number of features:

- Secure networks for the storage and movement of data;
- Applications that allow authorized parties to input, store and retrieve data; and,
- Terminals where users can input and retrieve data.[40]

eHealth is working with various stakeholders to implement these systems including clinicians, Local Health Integration Networks and the Canada Health Infoway.[41] As a result of eHealth Ontario's progress, health care providers can presently access databases to view lab test results and patient x-rays for many Ontarians. In addition,

[37] "What we do," eHealth Ontario, 2018. http://www.ehealthontario.on.ca/en/about-us/about-us.
[38] Ibid at note 36.
[39] Ibid at note 36.
[40] Ibid at note 9.
[41] Ibid at note 36.

hospitals and emergency rooms have improved access to the drug profiles of over 2.2 million Ontarians.[42] These strides are helpful but limited.

The 2016 Report of the Auditor General of Ontario found that the eHealth EHR system was not fully functional and contained incomplete information.[43] The report also cited problems with the implementation of eHealth's EHR technology, a limited use of EHRs in Ontario and a failure to achieve 'buy-in' among clinicians. Additionally, the report discussed eHealth's lack of authority to compel clinicians to contribute information to the system as a key barrier to EHR success.

Finally, the report found that some clinicians lack the technology required to properly contribute to provincial eHealth repositories. For instance, many offices do not use digital equipment and therefore, cannot upload information such as x-rays, to the eHealth Ontario systems. [44]

eHealth Ontario has faced significant criticism in the past concerning mismanagement and overspending. The Auditor General found that after 14 years, eHealth has not fully accomplished its mandate yet has spent over $8 billion to create an EHR system.[45]

[42] eHealth Ontario 2015/16 Annual Report, eHealth Ontario, (Toronto, 2016). https://www.ehealthontario.on.ca/images/uploads/annual_reports/Annual_Report_2015-2016_EN.pdf.
[43] Ibid at note 9.
[44] Ibid at note 9.
[45] "eHealth Still Unfinished After 14 Years and $8 Billion: Auditor General," Office of the Auditor General of Ontario, November 30, 2016. http://www.auditor.on.ca/en/content/news/16_newsreleases/2016news_3.03.pdf.

Many of the above problems point to issues with the management of eHealth Ontario and not the technology it seeks to implement. However, in general, the current generation of EHR systems have not been a welcome addition in the view of many health care practitioners. A 2014 survey of nurses found that 57% felt the technology was not suitable to their role and 54% reported that using multiple logins to access different clinical systems of electronic health information posed a barrier to their work.[46] It is believed that the current systems may even be harmful to patient safety due to the disruptions they cause, the prevalence of incorrect or incomplete patient information in the systems, the complexity of using such systems and other hardware and software issues.[47]

In Ontario, clinicians continue to use a variety of EHR systems, resulting in fragmentation. Interoperability issues, due to the use of varied systems, can create delays, inefficiency, errors and extra costs.[48] Using separate databases which are not harmonized or standardized creates difficulties in reconciling records across systems.

While eHealth Ontario's system aims to provide simultaneous updates throughout provincial repositories, these changes are not reconciled across the many distinct systems used by health care providers. As a result, Ontario is left without a system-wide solution and continues to experience challenges meant to be resolved by EHRs.

[46] "Adopting eHealth Solutions: Implementation Strategies," Registered Nurses' Association of Ontario, (2017). http://rnao.ca/sites/rnao-ca/files/bpg/Adopting_eHealth_Solutions_WEB_FINAL.pdf.
[47] Ibid at note 45.
[48] Spalding, Derek, "Switch to e-records causing pain for Ontario doctors," Global News, March 25, 2013. https://globalnews.ca/news/426323/switch-to-e-records-causing-pain-for-ontario-doctors/.

Meaningful Use of EHRs

A review of the secondary data concerning the introduction and use of EHRs in Canada reveals that adoption rates by province are high and continue to grow.[49] In Ontario, the adoption rate of EHRs among primary care physicians has reached 78%.[50] However, researchers note that while adoption rates are high, meaningful use of EHR's is comparably low.[51]

"Meaningful use" refers to the ability to employ EHR technology beyond basic functionality and to integrate EHRs into regular work routines.[52] The scale from basic to meaningful use of EHR technology typically begins with data entry as a basic capability and progresses to data searches, the use of reminders and alerts, population analysis, and interconnectivity with external other sources.[53]

The effectiveness of EHRs in improving patient care is unclear in part due to barriers that have prevented meaningful use. A number of studies show that adoption of EHRs alone does not appear to improve clinical care.[54] This research indicates that meaningful use is required for EHR technology to enhance patient care. Without meaningful use, EHR

[49] "EMR Use in Canada Continues to Grow," Canada Health Infoway, August 31, 2017. https://www.cma.ca/En/Pages/physician-workforce-surveys.aspx.
[50] Ubelacker, Sheryl, "More Canadian doctors making the switch to electronic medical records," The Toronto Star, January 28, 2016, https://www.thestar.com/news/canada/2016/01/28/more-canadian-doctors-making-the-switch-to-electronic-medical-records.html.
[51] Hamade, Noura, "Improving the Use of Electronic Medical Records in Primary Health Care: A Systematic Review and Meta-Analysis," (2017). Electronic Thesis and Dissertation Repository. 4420. https://ir.lib.uwo.ca/etd/4420.
[52] Henricks, Walter H., "Meaningful use" of electronic health records and its relevance to laboratories and pathologists,"Journal of Pathology Informatics (February 2011) 2:7.
[53] Jones, Mavis, et. al., "Progress in the Enhanced Use of Electronic Medical Records: Data from the Ontario Experience," JMIR Medical Informatics, (January – March 2017), 5:1.
[54] Terry, Ken, "Fewer Physicians See EHRs Improving Quality of Care," Medscape, April 14, 2015. https://www.medscape.com/viewarticle/843156.

systems are not optimized, and can slow down health care delivery.[55] For instance, users who do not fully understand how to use such systems or find them difficult to operate may avoid inputting all patient data, use the system improperly, make errors and take longer to work with the systems.[56]

Research demonstrates that EHRs in Ontario are primarily used for basic functionality such as inputting and reviewing patient notes, using electronic reminders and reviewing drug interaction information.[57] These functions do not represent the full capabilities of EHR systems and are limited in the improvements and efficiencies they can achieve for clinical care.

A number of factors appear to be relevant to achieving meaningful use and these factors may explain the discrepancy between high EHR adoption rates in Ontario and low rates of meaningful use.[58] The greatest barriers to adoption and meaningful use of EHRs include the amount of time required for training, and a lack of compatibility with other electronic systems.[59] Other barriers identified include technical, social, psychological and legal issues.[60] Additionally, the delay in achieving meaningful use is increased when users lack technical computer literacy skills.[61]

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[55] Linder, Jeffrey A. et. al., "Barriers to Electronic Health Record Use during Patient Visits," AMIA Annual Symposium Proceedings Archive (2006) 499.
[56] Ibid at note 54.
[57] Chang, Feng and Gupta, Nishi, "Progress in electronic medical record adoption in Canada," Can Farm Physician, 12, no 61 (December 2015): 1076.
[58] "Meaningful Use," HealthIT.gov. Last updated September 5, 2017. https://www.healthit.gov/providers-professionals/step-5-achieve-meaningful-use-stage-2.
[59] Ibid at note 52.
[60] Ibid at note 52.
[61] Boonstra, Albert and Broekhuis, Manda, "Barriers to the acceptance of electronic medical records by physicians from systematic review to taxonomy and interventions," BMC Health Services Research (2010) 10:231.

A number of studies have examined whether meaningful use of EHRs is achieved through continued and long-term use and whether, after a particular period of time, meaningful use occurs.[62] A study on EHR adoption rates in Ontario revealed that increased years of use led to some improvement and progress in how physicians use of EHRs.[63] The study observed a direct correlation between years of EHR use, maturity of use and improved physician perceptions of EHR systems.[64]

Ample time for familiarization with EHR technology was shown to correlate to their effective and regular use.[65] Yet, an Ontario study of over 4000 EHR users indicated that by years four through six of EHR adoption, only basic levels of user functionality are reported.[66] This finding is concerning given that disruptions, errors and incomplete information resulting from the introduction of EHR systems can impede proper patient care.[67] Encouraging meaningful use of EHR technology in a manner that is timely can produce significant cost savings and fast-track improvements to care.[68]

Researchers have also examined whether training and other measures specifically dedicated to ensuring the meaningful use of EHRs can decrease the amount of time required to reach this stage. A number of studies have assessed the value of measures to speed up implementation and diffusion of EHR technology. One such study found that

[62] Ibid at 52.
[63] Ibid at note 52.
[64] Ibid at note 52.
[65] Ibid at note 52.
[66] Ibid at note 52.
[67] Bowman, Sue, "Impact of Electronic Health Record Systems on Information Integrity: Quality and Safety Implications," Perspectives in Health Information Management, 10 (Fall 2013).
[68] White, Sophie, Dixon, Simon, Faria, Rita, Walker, Simon, Palmer, Stephen, Sculpher, Mark and Radford, Stefanie, "Estimating the Cost-Effectiveness of Implementation: Is Sufficient Evidence Available?" Value in Health, 19, no 2, (March –April 2016) 138.

value was gained from activities specifically dedicated to increasing meaningful use and that the most value was gained within the first five years of a ten-year period evaluated.[69] The study indicated that the value of investments to improve meaningful use decreases over time as use of the technology increases.[70]

These findings suggest that the value of investments to encourage meaningful use of EHRs are greatest in the earlier stages of EHR implementation. This supports a need to ensure meaningful use training is adopted and diffused early to reap the most value on the investments made in EHR systems. In fact, training and other dedicated measures to support EHR use beyond initial introduction are believed to improve meaningful use rates.[71] Studies have indicated that among the most significant determinants of success regarding meaningful use of EHRs are leadership, on-site EHR support and the involvement of change managers.[72]

Researchers have also examined how a lack of meaningful use of EHRs may have impacts beyond health care. Some theorize that as the use of EHRs increases, novel legal issues will materialize.[73] The potential for lawsuits related to the use of EHR's is a significant concern and is amplified in the stages before meaningful use is achieved.[74]

[69] Ibid at 66.
[70] Ibid at 66.
[71] Awad, Elias Bruce, Bredfeldt, Christine E. and Joseph, Kenneth, "Training providers: beyond the basics of electronic health records," BMC Health Services Research, 13 (2013) 503.
[72] Ibid at 52.
[73] Ibid at 52.
[74] Mangalmurti, Sandeep, Murtagh, Lindsey and Mello, Michelle M., "Medical Malpractice Liability in the Age of Electronic Health Records," The New England Journal of Medicine, 363 (November 2010) 2060.

Other implications of the lack of meaningful use of EHRs include issues concerning data privacy and protection.

Experts believe that increased use of EHRs may lead to increased errors if meaningful use is not achieved, and accordingly, an increase in legal disputes. [75] Some of the most prevalent errors from EHR misuse include incorrect data entry, inadvertent data sharing, accidental mouse clicks and other mistakes based in human error.[76] In addition, poorly designed and non-synchronized systems have also been shown to be a significant cause of EHR system errors and ineffective care for patients.[77]

Researchers also suggest that over the long term, the prevalence EHRs in health care could shift the legal landscape and legal standards of care.[78] However, there are limitations inherent in the legal system which can prevent it from quickly and effectively addressing changes in technology. Legislation cannot predict every scenario that may arise.[79] Laws drafted too narrowly may limit application and those that are overly broad can lack certainty. Additionally, the time required to draft new laws or amend existing legislation can be lengthy and fail to keep pace with the rapid advancement of technology such as EHR systems.

[75] Ibid at note 72.
[76] Ibid at note 72.
[77] Ibid at note 72.
[78] Ibid at 72.
[79] Bast, Carol M. and Pyle, Ransford C., *Foundations of Law: Cases, Commentary and Ethics*, (Nelson Education, 2017).

Case law works to address scenarios not contemplated by legislation. However, case law functions on the basis of precedents which must be tested through the court system. This process can be cumbersome and lengthy.

Blockchain technology: An overview

Blockchain is well-known as the platform for cryptocurrencies such as Bitcoin. It is also widely associated with the financial sector, as it originated as a means to support and enhance financial transactions through online bookkeeping.[80] But the design of the technology can be applied to any form of transaction or record-keeping.[81] In this sense, transactions including interactions between medical providers and patients can be captured and stored in blockchain networks.

Blockchain is a distributed digital ledger that stores information about transactions across many computers.[82] Thompson describes blockchain technology as, "…a network of replicated databases, synchronized via the internet and visible to anyone within the network." Parties in a blockchain network employ algorithms which authenticate transactions. Approved, transactions are time-stamped and replicated across the network.[83]

[80] Santara, Alyssa, "What is Blockchain Used for Besides Bitcoin?" Forbes, November 12, 2017. https://www.forbes.com/sites/quora/2017/11/17/what-is-blockchain-used-for-besides-bitcoin/#39838242446e.
[81] "How could blockchain be used in the enterprise?" Computer World UK, January 23, 2018. https://www.computerworlduk.com/galleries/security/how-could-blockchain-be-used-the-enterprise-3628558/.
[82] Cheng, Steve, Daub, Mathias, Domeyer, Axel and Lundqvist, Martin, "Using blockchain to improve data management in the public sector," McKinsey&Company, February 2017. https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/using-blockchain-to-improve-data-management-in-the-public-sector.
[83] Burnette, Mark, "Will Blockchain Revolutionize the Way We Approach Health care Security?" LBMC Information Security, February 12, 2018. https://www.lbmcinformationsecurity.com/blog/will-blockchain-revolutionize-the-way-we-approach-health care-security.

The name blockchain explains how the technology operates and denotes its most basic components, blocks and chains. Blockchain technology is made up of blocks, with each block containing transaction records that are regularly encrypted and saved. The chain, in blockchain, refers to how the blocks of transaction records are paired together with other blocks that contain previous entries in a related transaction. The pairing of blocks together, creates a chain of blocks.[84]

Blockchain permits connected computers to use a single, secure and always up-to-date and ledger of information.[85] Essentially, the ledger is stored among participants in the network, not in any one place.[86] This is an important feature which gives rise to capabilities such as simultaneous updates and heightened security. As explained in the Harvard Business Review, "in a blockchain system, the ledger is replicated in a large number of identical databases, each hosted and maintained by an interested party."[87] Changes to one ledger result in immediate changes to all other copies in the blockchain. Additionally, past information in a blockchain cannot be altered or removed by any one person.

Blockchains may be public or private. The difference between the two refers to user authorization to participate in the network.[88] Public blockchains are accessible to anyone,

[84] Martindale, Jon, "What is a blockchain? Here's everything you need to know," Digital Trends, April 16, 2018. https://www.digitaltrends.com/computing/what-is-a-blockchain/.
[85] D'Aliessi, Michele, "How Does the Blockchain Work?" Medium, June 1, 2016. https://medium.com/@micheledaliessi/how-does-the-blockchain-work-98c8cd01d2ae.
[86] Church, Zach, "Blockchain, Explained," MIT Digital, May 29, 2017. http://ide.mit.edu/news-blog/blog/blockchain-explained.
[87] Iansiti, Marco and Lakhani, Karim R., "The Truth About Blockchain," Harvard Business Review, January-February 2017, https://hbr.org/2017/01/the-truth-about-blockchain.
[88] Jayachandran, Praveen, "The difference between public and private blockchain," IBM, May 31, 2017. https://www.ibm.com/blogs/blockchain/2017/05/the-difference-between-public-and-private-blockchain/.

and anyone may use, transact on, and verify transactions on these networks.[89] Public blockchains offer heightened accessibility and transparency, and eliminate the need for a central authority to oversee and validate transactions, reducing costs.

By contrast, a blockchain network can also be private, or permissioned, which restricts access to authorized members.[90] Permissioned blockchains are suitable for information exchanges within or among organizations in a network.[91] Due to the sensitivity of health and medical information, permissioned blockchain technology is better suited for the storage and management of health records. In this context, recorded transactions in the blockchain document health care services rendered to patients, and health care providers would be responsible for contributing related data to the blockchain network.

In permissioned blockchains, restrictions and rules built into the network delineate which parties may access the network, transact on it, validate transactions and how consensus about transactions is achieved.[92] Thus, permissioned blockchains lack some of the features associated with permissionless blockchains. For instance, permissioned blockchains do not offer decentralization because certain parties in the network have control over specific aspects, such as the authority to validate transactions.[93]

[89] Finestone, Mathew, "Public vs Private Blockchains," Coinsquare, October 24, 2017. https://discover.coinsquare.io/blockchain/public-vs-private-blockchains/.
[90] Bauerie, Nolan,"What is the Difference Between Public and Permissioned Blockchains?" Coindesk. https://www.coindesk.com/information/what-is-the-difference-between-open-and-permissioned-blockchains/.
[91] Kadiyala, Anant, "Nuances Between Permissioned and Permissionless Blockchains," Medium, February 2017. https://medium.com/@akadiyala/nuances-between-permissionless-and-permissioned-blockchains-f5b566f5d483.
[92] "Explainer: Permissioned Blockchains," Monax, 2018. https://monax.io/explainers/permissioned_blockchains/.
[93] Ibid at note 91.

Despite this, there is value to be gained from permissioned blockchains. These networks are well-suited for specific business tasks and can offer efficiency and cost reductions.[94] For instance, permissioned blockchains can process transactions more quickly than public blockchain networks. As Finestone writes, "private chains are able to process more transactions per second."[95] This occurs because in permissioned blockchain networks there are fewer parties required to authenticate transactions, speeding up the verification process.[96]

A number of blockchain features may enhance the management of health records. For instance, blockchain networks have the capacity to offer improved security, real-time system-wide updates, immutability and cost savings.[97] Global consulting firm McKinsey & Company asserts that blockchains enhance the security of records because they offer "…redundancy, encryption and immutable storage."[98] Redundancy refers to the fact that blockchains are constantly replicated within the network, which means they can be less vulnerable to a system failure. Redundancy ensures that information about a transaction is processed independently in each block in the network. Each block processes every transaction and if one block suffers a failure, the system as a whole is not compromised.[99]

[94] Ibid at note 88.
[95] Ibid at note 88.
[96] Ibid at note 91.
[97] Hooper, Mathew, "Top five blockchain benefits transforming your industry," IBM Blockchain Blog, February 22, 2018. https://www.ibm.com/blogs/blockchain/2018/02/top-five-blockchain-benefits-transforming-your-industry/.
[98] Higginson, Matt, Lorenz, Johannes-Tobias. Munstermann, Bjorn, and Olesen, Peter Braad, "The promise of blockchain," McKinsey&Company, March 2017. https://www.mckinsey.com/industries/financial-services/our-insights/the-promise-of-blockchain.
[99] Greenspan, Gideon, "Blockchain vs centralized databases," MultiChain, March 17, 2016. https://www.multichain.com/blog/2016/03/blockchains-vs-centralized-databases/.

The encryption feature of blockchain further enhances the security of the system using algorithms. Transactions are authenticated by having a number of computers in the blockchain network solve complex algorithms.[100] Once the algorithms are solved, the transactions are verified and, if a consensus of approval among network participants is reached, the transaction is then added to the blockchain.[101] As transactions recorded in a blockchain are certified through the consensus of those participating in the transactions, fraud is much harder to carry out.

Immutable storage means that information added to the blockchain network cannot be altered or removed. Blockchains offer a record of information that is unchangeable. Each piece of data has a digital, encrypted fingerprint. If the data is changed, this creates a new, separate and different fingerprint. Both sets of data continue to exist in the blockchain but again, any new data that is added must be authenticated and certified.

Additionally, blockchain offers the ability to use smart contracts which are meant to increase automation and save time. Smart contracts function on the basis of computer code, which performs when certain conditions are met. As they are self-enforcing, smart contracts are meant to create efficiencies and reduce the need for legal assistance.[102] Likewise, permissioned blockchains may require less monitoring and administration due to rules built into the network that increase the automation of many functions.

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[100] Jenn, Sarah, "Using Blockchain Technology for Secure Data Encryption," News BTC, July 23, 2015. http://www.newsbtc.com/2015/07/23/using-blockchain-technology-for-secure-data-encryption/.
[101] Brown, Leah, "How blockchain encryption works: It's all about math," Tech Republic. https://www.techrepublic.com/article/how-blockchain-encryption-works-its-all-about-math/.
[102] Cornell, Nicolas and Werbach, Kevin, "The Promise – and Perils – of 'Smart' Contracts," the Wharton School of the University of Pennsylvania, May 18, 2017. http://knowledge.wharton.upenn.edu/article/what-are-smart-contracts/.

For health care, blockchain networks can provide a chronological record of transactions, and simultaneous system-wide updates when new information is entered.[103] Blockchain proposes to enhance security and the ability to ensure appropriate privacy protections. For instance, permissioned blockchain networks can incorporate rules that ensure privacy legislation and regulatory requirements are respected.[104]

Additionally, it is believed that blockchain can address the interoperability issues of current EHR systems and facilitate standardization across health care providers. For instance, blockchain networks can integrate health data in varying formats from a broad range of sources, increasing interoperability to enhance the utility of digital records.[105]

Many believe that blockchain will transform data exchanges among health care providers and other stakeholders to create efficiencies, save money and improve accuracy. Data gathering for research purposes will further improve individualized care, program evaluation and interoperability among different entities.[106]

[103] Gordon, William, Landman, Adam and Wright, Adam, "Blockchain in Health Care: Decoding the Hype," NEJM Catalyst, February 9 2017. https://catalyst.nejm.org/decoding-blockchain-technology-health/.
[104] Takahashi, Ryo, "How can creative industries benefit from blockchain?" McKinsey&Company, August 2017. https://www.mckinsey.com/industries/media-and-entertainment/our-insights/how-can-creative-industries-benefit-from-blockchain.
[105] Koo, Martha B. and Linn, Laure A., "Blockchain For Health Data and Its Potential Use in Health IT and Health Care Related Research," HealthIT.gov. https://www.healthit.gov/sites/default/files/11-74-ablockchainforhealth care.pdf.
[106] "What is a blockchain?" Innovatemedtec, 2018. https://innovatemedtec.com/digital-health/blockchain.

Critique: Blockchain's limitations

Bruce Brossard, President and Chief Executive Officer of U.S.-based health insurance company Humana claims that, "blockchain technology is positioned to be the next dramatic innovation in health care…".[107] The enthusiasm for blockchain is overwhelming, as apparent through the U.S. Department of Health and Human Services' 2017 blockchain.[108] The contest sought papers on the potential uses of blockchain in health care. The 15 winning papers presented blockchain solutions for a range of matters including medical research, health information exchanges, patient outcomes, service delivery and many other facets of health care.[109]

While much of the news about blockchain is positive, it is not without its detractors. According to Gartner, Inc., an American research firm which rates emerging technologies, blockchain reached the peak of publicity and potentially overrated interest in 2016.[110] As a recent literature review notes, "an obvious problem with the Blockchain still originates from its novelty, and research thus points that there still exist many issues prior to mainstream adoption of the technology."[111]

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[107] Broussard, Bruce, "Blockchain: Transformational Technology for Health Care," LinkedIn, August 8, 2016. https://www.linkedin.com/pulse/blockchain-transformational-technology-health-care-bruce-broussard.
[108] Parker, Luke, "15 blockchain whitepapers awarded winners of US Department of Health and Human Services Challenge," Brave New Coin, August 20, 2016. https://bravenewcoin.com/news/15-blockchain-whitepapers-awarded-winners-of-us-department-of-health-and-human-services-challenge/.
[109] Ibid at note 107.
[110] "Gartner: Blockchain and Connected Home are almost at peak of the Hype Cycle," PR Wire, August 16, 2016. https://prwire.com.au/pr/62010/gartner-blockchain-and-connected-home-are-almost-at-the-peak-of-the-hype-cycle.
[111] Johansen. Stefan Konrad, "A Comprehensive Literature Review on the Blockchain Technology as a Technological Enabler for Innovation," Manneheim University, Department of Information Systems, 2016. https://www.researchgate.net/publication/312592741_A_Comprehensive_Literature_Review_on_the_Blockchain_Technology_as_an_Technological_Enabler_for_Innovation.

Blockchain technology is in the early stages of development in regards to uses outside of its original purpose as a platform for crypto-currencies. Many experts agree that critical mass adoption of blockchain is decades away.[112] For some, it is simply too early to accurately predict how blockchain will affect other industries and how it will be used.

Even in the banking sector, where progress regarding blockchain is arguably more advanced than in health care, one Canadian executive told consulting firm Accenture, "We don't even have enough information to have an opinion."[113]

Some believe that the technology is not a 'cure-all' and cannot simply be used as a blanket solution.[114] Additionally, there exists skepticism about the technology's capabilities and some worry that blockchain cannot fulfill what it promises. These detractors believe that claims about the technology are overblown and that it is not going to live up to its claims.

Beyond technical aspects, there are other challenges that blockchain must overcome. The technology consumes a significant amount of electricity and therefore, can have harmful effects on the environment.[115] As well, the cost to develop blockchain solutions for health care, purchase the required infrastructure and transition to these solutions may be untenable for publicly-funded health care systems.

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[112] Ibid at note 86.
[113] "Blockchain Technology: How Banks are Building a Real-time Global Payment Network," Accenture, 2016. https://www.accenture.com/t00010101T000000Z__w__/it-it/_acnmedia/PDF-35/Accenture-Blockchain-How-Banks-Building-Real-Time-Global-Payment-Network.PDFla=it-IT.
[114] Ibid at note 112.
[115] "The bitcoin and blockchain: energy hogs," The Conversation, May 16, 2017. http://theconversation.com/the-bitcoin-and-blockchain-energy-hogs-77761.

Adoption of the technology will also require 'buy-in' from government entities, health care practitioners and the public. A level of understanding of the technology and trust in it will be necessary to facilitate adoption. Further, the system will require a regulatory scheme to outline obligations and this will require the cooperation and input of government and private sector to be effective. As blockchain is an emerging technology and its impact on different sectors is not yet fully understood, it could take long for related policies, laws and regulations to be formulated. Finally, the network is not effective unless blockchain is broadly adopted by the industry and it may be complex to implement a blockchain network across the diverse stakeholders in the health care industry.

Perhaps the biggest challenge regarding blockchain is understanding its actual potential as a secure network. Blockchains are currently designed to allow all participants in the network run identical code, which some critics have argued can leave the entire system susceptible to anything that may compromise that code.[116] These experts agree that blockchain's security mechanisms would be challenging to compromise but still believe it can be done. The effects of such a breach could be catastrophic for the health care system.

A final critique of blockchain concerns the fact that the technology is in its infancy stage. As such, it is more suitable for early adopters that have the capital to finance research and investment in the technology. This does not typically represent those operating in the publicly-funded health care space. As well, it remains to be seen whether other

[116] Knight. Will, "Blockchain's Weak Spots Pose a Hidden Danger to Users," MIT Technology Review, April 18, 2017. https://www.technologyreview.com/s/604219/blockchains-weak-spots-pose-a-hidden-danger-to-users/.

technologies might eclipse blockchain and be more suitable for the health care information storage, sharing and management.

Discussion

Physicians who interacted with EHR technology over longer periods demonstrated more effective use.[117] This is a positive trend because it demonstrates that use of EHRs over longer periods leads to acceptance and regular use. However, this also creates challenges.

Swift adaptation to technology changes is increasingly important. Accordingly, the adoption and meaningful use of new technology cannot depend on lengthy periods of time for user training, uptake and effective use. This can slow progress, hinder the effectiveness of new technology and disrupt operations. Users will have to learn, accept, employ and adjust quickly to the changes. Investments in such technology will not be fully realized if technologies are not used to their full capacity and adopted quickly into regular use.

In such an environment, a strong ability to adapt rapidly to changes in technology is necessary. Accordingly, change management strategies must promote continued and

[117] Heisey-Grove, D., Jamoom, E.W., Scanion, P., and Yang, N., "Physician Opinions about EHR Use by EHR Experience and by Whether the Practice had optimized its EHR Use," Journal of Health Medical Informatics (July 2016) 7:4.

ongoing development and adaptability. The rapid and continuing advancement of technology has made effective adaptation to new and updated systems a necessity.

Currently, EHR systems are compiling massive amounts of data but their use has not been optimized and the risk of error is high. If blockchain technology were to be introduced, it would likely require significant preparation and strategic planning to ensure a positive outcome.

Despite the existence of advanced capabilities in blockchain, the technology may not automatically lead to meaningful, consistent or proper use. As demonstrated by the research concerning EHRs, adoption by itself did not result in physicians employing advanced features of the technology.[118] Whether blockchain solutions for health care can achieve meaningful use will depend on many characteristics including the technology design, implementation and traits specific to health care providers and users.

The research on designated initiatives to support the meaningful use of EHRs has demonstrated that these measures can be helpful.[119] These methods may prove to be useful for blockchain and should be examined along with the technology's potential applications in the health care industry. There will be a need to integrate training and incentives specifically designated to encourage meaningful use of blockchain following adoption.

[118] Ibid at note 54.
[119] Ibid at note 3.

Considerations relating to the time required to train users and achieve meaningful use of EHRs may be relevant to queries on the use of blockchain in health care. As blockchain solutions for health care are highly theoretical at this point in time, it is difficult to predict whether time will be a significant factor in adoption and meaningful use of blockchain.

Legal considerations

Legislation is adapting to changing technology but at a rate that is slow in comparison to technological advancements. In the case of privacy laws, their continued amendments to address the digitization of medical records may enhance certainty in the law, clarify liability and potentially reduce disputes. However, the law cannot pre-emptively address every potential scenario that may arise.

If the law advances to address many of the concerns that are raised by current EHR technology, it may yet still not be fully prepared to address novel legal issues related to blockchain. Some of these issues may be hard to contemplate as blockchain solutions for health care are in their infancy.

The legal treatment of EHRs may help to predict issues that could arise in relation to blockchain. Privacy, security and legal liability are prominent considerations for which the law concerning EHRs continues to evolve.

It may be helpful to examine the legal issues that have already emerged with respect to the use of blockchain in the financial sector. Furthermore, legal precedents and legislation governing the treatment of blockchain in the financial sector may be relevant to thinking

of how blockchain could be regulated in the health care sphere. Issues of particular concern that will require examination in terms of Ontario's public health care system and blockchain may include vendor versus medical provider responsibility and liability.

Additionally, new regulatory frameworks may be required as the technology proposes to offer capabilities that are not yet available or widely used in current EHR systems. A lack of adequate legal measures to address the issues raised by blockchain health care solutions could impede their proliferation, such as issues of jurisdiction, privacy and ownership.

Jurisdiction

EHRs raise a number of jurisdictional issues. In Canada, provinces and territories employ unique EHR systems and strategies. A number of provinces have implemented legislation to govern health information but the laws vary to a large degree.[120] The lack of harmonized legislation across Canada creates inconsistencies in privacy and security protections for EHRs. The problem is amplified when records are shared across jurisdictional boundaries. Variations in the law create uncertainty and may result in gaps that place privacy and security of EHRs at risk.

Blockchain technology may not escape the jurisdictional challenges that affect today's EHR systems. In fact, the decentralized nature of blockchain technology could exacerbate

[120] "e-Health Law and Policy Background Paper," Law Commission of Ontario, January 28, 2010. https://www.lco-cdo.org/en/e-health-law-and-policy-background-paper/.

jurisdictional issues as no central authority or repository linked to a particular territory might exist.

Vendor relationships

eHealth Ontario has developed a system to connect health care providers for the purpose of sharing EHRs.[121] Providers have autonomy in the selection of an EHR system which results in inconsistencies. A 2015 PwC report commissioned by eHealth Ontario found that EHR information flow among systems in Ontario is limited due to incompatibility.[122] The report recommended improved system integration and interoperability to overcome these challenges.[123]

Providers gain a number of advantages from the autonomy to select an EHR vendor and system. Benefits include the ability to work with a preferred vendor and to gain a system that meets particular cost and technical requirements or preferences. These systems must meet certain provincial criteria and standards to facilitate interoperability.[124] However, provincial requirements for standardization have not overcome the challenges of achieving interoperability across disparate systems. Much of the value of EHR systems stems from the ability to exchange data in a secure manner.[125]

It remains to be seen whether the government of Ontario will adopt blockchain in years to come. Yet even without implementing blockchain technology, system interoperability

[121] Ibid at note 37.
[122] "EMR Benefits Realization Study Update: Final Report," PwC, August 5, 2015.
[123] Ibid at note 121.
[124] "EHR Connectivity Strategy," eHealth Ontario. https://www.ehealthontario.on.ca/ehr-connectivity-strategy.
[125] Ibid at note 121.

can be largely facilitated by ensuring consistency among disparate systems. There is value in uniformity which can create cost savings through economies of scale, efficiencies in operations and improved data management. These benefits may provide incentive for the province to eventually seek out a one-system solution. This could be achieved by creating a requirement to use a specific provider and type of system.

Logistically, it could be difficult to compel health care providers to employ a particular technology due to resource constraints, and different needs and capabilities. Subsidies for certain providers and a staggered implementation would likely be a required component to allow smaller or rural providers to participate.

In the absence of government intervention, market forces may eventually lead health care providers to specific EHR vendors and systems. This could lay the groundwork for adopting a blockchain solution.

A preferred system or a dominating vendor could eliminate competitors and gain a monopoly. In this scenario, small or rural health care providers would potentially have to adapt to harsh price increases. Again, government subsidies, government agreements or antitrust laws and regulatory measures could be required to address the effects of an EHR monopoly. On the other hand, using one system across all providers may allow the province to benefit from economies of scale.

Vendor responsibility

The relationship between health care providers and EHR vendors is governed by contract. While both parties must adhere to federal and provincial privacy and health care legislation, the parties are free to negotiate, tailor and select many distinct contract features. The Canadian Medical Association (CMA) provides guidance to physicians entering EHR contracts and outlines considerations to be addressed such as data ownership, management, security, access, confidentiality, liability and termination.[126]

As the principles of contract law govern such agreements, health care providers are encouraged by the CMA to include limited liability clauses and other measures to clarify and constrain their obligations.[127] While the parties cannot contract out of legislative requirements, they can address uncertainties in the law through specific contract provisions. Where gaps or uncertainties in the law and in contract provisions exist, patient data could be at risk.

Blockchains offer smart contracts which are meant to be efficient and self-enforcing. Smart contracts are meant to reduce the need for legal assistance.[128] However, smart contracts may not overcome uncertainties in the law itself. There are also questions of how the software may interpret the contractors' intentions. From a legal standpoint, blockchain may not be a cure for current legal issues that stem from digitized records.

[126] "Data Sharing Agreements: Principles for Electronic Medical Records/Electronic Health Records," Canadian Medical Association, 2009. http://policybase.cma.ca/dbtw-wpd/Policypdf/PD09-01.pdf.
[127] Ibid at note 126.
[128] Ibid at note 102.

However, users may find smart contracts to be efficient and effective, if it can reduce the number of disputes that arise and reduce the need to rely on legal counsel.

Vendor compliance

In Ontario, the *Electronic Personal Health Information Protection Act* has introduced provincial measures to protect the privacy and security of EHRs. Among numerous requirements, health care providers using EHR systems must ensure third-party compliance with the Act's privacy and security measures.[129] It also includes mandatory breach notification and reporting to the Ontario Privacy Commissioner in the case data loss or leaks.[130]

Operational issues

Lawyers may experience operational challenges due to the lack of EHR adoption and meaningful use of EHRs. Personal injury, health law practitioners and criminal lawyers often rely on medical records as evidence in legal disputes. Document discovery is typically lengthier when medical records are handwritten and cannot be searched and retrieved electronically. Photographs of handwritten medical notes may be entered into EHR systems to retain handwritten records but may not be retrievable through keyword searches. Furthermore, voice-recorded notes that are dictated into EHR systems may include errors if not reviewed. Finally, in some practices, handwritten notes are entered

[129] Cowan, Meghan, "Recent Changes to Ontario's Personal Health Information Protection Act," Mondaq, August 23, 2017.http://www.mondaq.com/canada/x/623066/Data+Protection+Privacy/Recent+Changes+To+Ontarios+Personal+Health+Information+Protection+Act.
[130] Ibid at note 129.

into the system by clerical staff and errors may occur due to a lack of medical knowledge or as the result of misinterpreting the author's notes.

These errors may lead to inefficiencies when records must be searched as part of a legal dispute. This can increase legal costs for clients. By contrast, EHR systems containing quality health information can provide time stamps, facilitate access to a larger number of records, can allow for records to be retrieved more quickly and can potentially offer more detailed information.[131] These records can indicate what information was accessed, who accessed them and the length of time of access.[132] Such features can assist lawyers in building support for a case or detecting and avoiding risks based on the information located. Yet, it is unclear whether blockchain may eliminate the aforementioned errors. If the technology is user-friendly and implemented with initiatives to support its meaningful use, Blockchain may overcome such challenges.

Privacy

A key area of concern in relation to EHRs is privacy and security of data. Federal and provincial privacy laws regulate how public and private sector entities handle health records in Canada. The *Ontario Personal Health Information Protection Act (OPHIA)* governs the treatment of health records by providers including primary care physicians, hospitals, ambulance services, long-term care facilities, pharmacies and other entities in the health care sphere. The federal *Personal Information Protection and Electronic*

[131] "Electronic Health Records vs. Electronic Medical Records," Business News Daily, January 2, 2018. https://www.businessnewsdaily.com/8578-choosing-an-ehr-system-for-your-medical-practice.html.
[132] Carter, Jerome, "EHR Design Basics: Tracking Data Changes and Accesses Using Audit Trails," EHR Science, January 28, 2013. https://www.ehrscience.com/2013/01/28/ehr-design-basics-tracking-data-changes-and-accesses/.

Document Act (PIPEDA) governs how private health care entities, such as medical testing laboratories, treat health records.

The digitization of medical records presents new challenges for privacy legislation. Privacy concerns regarding EHRs are linked to the sensitivity of information, the vast amounts of data that can be collected, the sharing of data among entities and the ease with which these transfers can be executed.

Privacy legislation may require more robust provisions to enhance privacy protection in relation to EHRs. For instance, implied consent is an area that may require modifications of current privacy legislation. Implied consent refers to consent that is not express but is inferred.[133] This type of consent is permitted for the sharing of health information in certain circumstances. As an example, when receiving medical care, a patient may confirm express consent to receive care from one physician, and his consent to have health information shared with another physician for the purposes of providing medical care can be implied.

Obtaining express consent at every stage of the medical care process can be cumbersome and impede the ability to provide adequate care. However, patients may be unclear about the implications of implied consent when coupled with access to the vast amount of patient information available through EHRs.

[133] "Consent and Your Personal Health Information," Information and Privacy Commissioner of Ontario. https://www.ipc.on.ca/health/consent-and-your-personal-health-information/.

Blockchain and barriers to meaningful use of EHRs

A permissioned blockchain solution does not appear to be suitable for overcoming the challenges of achieving the meaningful use of EHRs. Blockchains are not conceived as a mechanism to enhance meaningful use but as a means to improve the digital recording and storage of health care interactions.

Blochains are not immune to the resistance many users experience when any new technology is introduced. Users' perceived value of a technology relates to their willingness to engage with it.[134] Where the value and utility of the technology is clear and its level of complexity is low, users will be incentivized to employ it regularly.[135] If the technology is a significant departure from existing systems and requires substantial training, resistance may be greater and achieving meaningful use can be a difficult and lengthy process.

One challenge blockchain faces is that a number of its attributes may not demonstrate added value for the daily user. For instance, users may appreciate having robust data security protections but whether this enhances daily operations and the functionality of the clinical environment may not be clear to users.

Furthermore, blockchain offers benefits once the network contains fulsome and accurate records and when the network of users is broad and usage is regular. The utility of

[134] Bernstein, Gaia, "Incentivizing the Ordinary User," Florida Law Review, vol. 66, no 3, (2015) 1275.
[135] Ibid at note 134.

blockchains increases as more users participate in the network.[136] To achieve this, blockchain must first be in place, operational, contain complete and accurate records, and users must be able to properly use it. These are the same requirements of well-functioning EHR systems. As such, it is not clear that blockchain can overcome the challenges of training, encouraging user buy-in and achieving accurate and fulsome data entry endemic to current EHR systems.

The value proposition of blockchain is not necessarily apparent to the frontline user or vastly different from the benefits proposed by existing EHR systems.

[136] "Blocchain Technology: It's Not Ready for Health care Prime Time," VertitechIT, January 22, 2018. https://www.vertitechit.com/blockchain-technology-not-ready-health care-primetime/.

The following chart illustrates blockchain strengths and limitations.

Barriers to Meaningful Use	
Barriers to Meaningful Use	**Blockchain**
Interoperability	Blockchain networks can integrate health data in varying formats from a broad range of sources.[137] This can enhance interoperability and allow for easier adaptions to changes in data requirements.[138]
Cost	Permissioned blockchains may require less monitoring and administration due to rules built into the network. Yet, the long-term costs associated with the use of permissioned blockchain networks for organizations (or groups of organizations) is unclear.[139]
Time and training requirements	Blockchain may pose new training challenges as users may have to adapt to new applications and procedures. Users will have to transition from existing EHR systems and adjust to blockchain technology. This will require training, time and may disrupt operations. The attributes of blockchain will not necessarily speed up its integration into the clinical setting.
User buy-in barriers	While blockchain may offer benefits once the system is in place and well-understood, it is not clear that users will be trusting and receptive of this new technology. Clinicians may be hesitant to embrace blockchain if it is not fully understood.
Usability	Blockchains become more useful the more users participate in the network. Yet this cannot be achieved until widespread adoption and dissemination occur. Furthermore, blockchain capabilities that enhance health data management may not immediately translate into functions that immediately improve the day to day experience of users.

Recommendations

Recommendations for the health care sector

Shift priorities

Since its inception, eHealth Ontario has been focused on the digitization of health records and facilitating information-sharing. Present efforts should shift the focus to enhancing clinicians' ability to deliver improved care. This shift recognizes the importance of

[137] Ibid at note 56.
[138] Ibid at note 56.
[139] Ibid at note 136.

examining and investing in solutions that enhance clinical care rather than simply creating a digital record. Specifically, this means focusing on enhancements to EHR systems that can improve their utility and increase meaningful use. For instance, voice input of data rather than reliance on data entry by typing, is less onerous and time-consuming. Systems that are easier to use and reduce the workload of clinicians provide a greater value proposition for users and encourage meaningful use. This shift requires a change in provincial funding and strategies to support vendor innovation to enhance EHR systems and increase aid for clinicians to access to such systems.

Increase standardization

A stronger focus on standardization may increase usability and accordingly incentivize users. The province and professional organizations should play a strong leadership role in educating clinicians on methods that can enhance their experience of using EHRs. For instance, standardizing the format and length of patient notes for EHRs may increase efficiency, even across differing vendor platforms. Accordingly, a greater use of templates with unified terminology and information requirements can create further system efficiencies. These efficiencies may reduce user resistance to EHRs and increase meaningful use, while facilitating system interoperability.

Redefine health care positions

The province and the health care industry must consider the need for new roles and positions that can facilitate the meaningful use of new technology. This may manifest as

roles that combine health care specialities and technology skills. For instance, the field of nurse informatics combines nursing skills with training in communications technology.

Emerging specializations in health care information technology may further improve EHR meaningful use rates. Currently, technical expertise regarding EHR systems resides primarily with the vendors and developers of such systems.[140] These specialists do not typically operate within the clinical environment on a regular basis.[141] Integrating these functions into the health care environment could optimize day-to-day EHR use.

Hiring dedicated IT specialists can be costly and as such, may not be an option available to every provider, most notably primary care providers. However, designated health IT specialists could ensure physicians and other health care professionals remain focused on patient care. There is also a need to transform traditional health care roles. Key areas of required expertise include harmonized roles such as health information technicians and nurse informatics specialists.[142]

Gibson et al. argue that investment in human resources to support the optimal use of EHR systems is integral to accessing the true value of these systems.[143] Furthermore, the authors predict that "health care systems will have more multidisciplinary, multisite

[140] Brown, Wiley, Jacks, Tim and Prashant, Palvia, "Critical Issues in EHR Implementation: Provider and Vendor Perspectives," Communications of the Association for Information Systems, 36 (2015) 36.
[141] "Top 7 reasons why health systems are hosting their EHR with vendors," Health IT Exchange, August 28, 2011. https://searchhealthit.techtarget.com/healthitexchange/meaningfulhealth careinformaticsblog/top-7-reasons-why-health-systems-are-hosting-their-ehr-with-vendors/.
[142] Ibid at note 146.
[143] Abrams, Kelly J., Crook, Gail F., and Gibson, Candace J., "Health Information Management Workforce Transformation: New Roles, New Skills and Experiences in Canada," Perspectives in Health Information Management (International 2015): 1-14.

health teams and increased integration with other systems, which will create the need for more skill development and help with data management issues."[144] New positions are necessary to keep pace with changing EHR technology and to address the eventuality of increased use of and reliance on such technologies.[145] A greater need for coders, data analysts and data management professionals is anticipated.[146]

The U.S Bureau of Labour Statistics estimates that employment of IT health information professionals will rise by 13% in the next eight years.[147] Due to differences in Canadian and U.S. health care systems, the rise of these positions in Canada may not be as pronounced. Nonetheless, in a survey of Ontario hospitals 55 percent of responders believed skill shortages to be a significant impediment to EHR adoption.[148] An increasing demand for multidisciplinary specialities that combine traditional health care roles with advanced information technology skills to address the increasingly digitized medical space is anticipated.

Fostering awareness of these positions, and increasing educational funding and incentives to support these positions may enhance the meaningful use of technology in the clinical setting. Professionals in these positions can in turn share knowledge within the workplace to support and enhance meaningful use. In addition to creating new

[144] Ibid at note 143.
[145] Ibid at note 143.
[146] "Health care IT Jobs and Salary" USF Health, 2018. https://www.usfhealthonline.com/resources/career/health-information-technology-jobs-and-salary-usf-health/.
[147] "Medical Records and Health Information Technicians," United States Department of Labor, Bureau of Labor Statistics. Last updated April 13, 2018. https://www.bls.gov/ooh/health care/medical-records-and-health-information-technicians.htm
[148] Ibid at note 143.

positions, training for traditional health care positions should include regular training in workplace technologies.

Increased support for meaningful use initiatives

The research examined suggests that initiatives specifically focused on encouraging meaningful use can be effective. Technology must be introduced strategically to support adoption but these efforts must go beyond this initial stage.

The province should devote funding to ensure health providers have access to measures designated to support mature and meaningful use of technology such as blockchain. This may take the form of training modules, funding incentives and yearly progress reporting that focus on helping users better understand the technology and master the skills required to reap its full benefits.

Dedicated and active initiatives focused on achieving meaningful use may require longer time periods and greater resources. Yet, the benefits allow users to improve patient care and provide value for the investment made.

Proactive and ongoing change management

The public health care sector has been slow to adopt to technology changes. Accordingly, the industry has not had to adapt quickly to such changes. This is expected to change in the coming years as technologies such as blockchain may become easier and less costly to introduce. The province and health care providers will need to be able to adapt rapidly

and frequently to changes. This will require a proactive approach to examine what technologies are on the way and how they will interact with current systems. Change management initiatives must be forward-looking and must focus on preparing health care providers for the new status quo of continual change.

Additionally, the research reviewed on EHRs showed that leadership support and having a designated onsite employee leading change management or training initiatives facilitated meaningful use. The majority of health care providers are not likely to have the resources to integrate a full-time specialist responsible for training or change management specific to blockchain, or other technology introductions. Provincial resources are similarly strained. Yet, having this capacity may speed up the ability of all employees within a practice to achieve meaningful use, allowing advanced understanding of system functionality to save time and money. To overcome the aforementioned challenges, one staff member would be required to devote a portion of their time to facilitate training and change management. A portion of provincial resources should be devoted to educating key 'training leaders' and offering the tools to achieve this, through change management programs and modules, developed by the province and industry groups.

Compliance measures and incentives

Support from leadership in the health care community is essential but should be coupled with provincial incentives and compliance measures to be effective. For instance, the CMA publishes guidelines regarding EHRs which are general in nature and rely on the

health provider to decide most aspects of training and implementation. Materials state that timelines and goals must be set, but leave the user to decide how long and what methods to use to achieve these goals.[149] This approach allows for flexibility in respect of the different resource-needs and circumstances of providers.

However, simple changes could enhance the effectiveness of such guidelines. The materials could propose recommended timelines along with change management and training methods that should be used. This would provide a higher level of leadership support and direction to encourage meaningful use.

Additionally, the province should consider how it might better incorporate incentives or compliance measures to enhance meaningful use. As it stands, providers decide what systems to incorporate and what capabilities to use in their practice, without having to meet provincial timelines or specific requirements, beyond the legal obligations that govern the use of digitized records.

The risk of errors or improper use of the technology should be a concern for the province and likewise, investment must be made in ensuring providers are taking appropriate measures. Incentives may come in the form of government subsidies specifically focused on change management and ensuring meaningful use. The province has previously

[149] "Module 7: Electronic Medical Records," Canadian Medical Association, October 2012. https://www.cma.ca/Assets/assets-library/document/en/practice-management-and-wellness/module-7-EHR-e.pdf.

concentrated funding incentives on helping physicians select and adopt EHR systems.[150] Much less focus has been placed on incentivizing users to achieve meaningful use.[151] Incentives focused on meaningful use should be incorporated to gain the best value of these earlier investments. The province should consider using 'soft' compliance measures to achieve this. For instance, in the U.S., funding incentives for EHRs are linked directly to meaningful use achievements and failure to meet required goals result in reductions to funding.[152] This model offers some insight into how the province could incentivize meaningful EHR use.

Collaboration with the private sector

Many sectors, such as the auto-industry, have witnessed the immersion of technology into their primary business functions and have accordingly merged and integrated with technology firms. Moving forward, the province and health care providers should examine options to collaborate and partner with private sector technology firms. This is not to suggest a move away from publicly-funded health care. However, collaboration with private sector technology firms is needed to take advantage of the expertise that these entities offer. Public-private partnerships will be essential to uncovering effective and cost-efficient means to improve patient care. Where the technology is more advanced, such as with blockchain, greater assistance from this type of partnership could be necessary.

[150] "Overview of EMR Funding," Ontario MD, 2017. https://www.ontariomd.ca/products-and-services/EHR-funding.
[151] Guerrier, Michael and Kim, Justin, "Taking an aggressive stance on EMRs: lessons the from the US and UK," 2018. https://www.telushealth.co/item/taking-aggressive-stance-EHRs-lessons-us-uk/.
[152] Ibid at note 152.

Recommendations for the legal community

Lawyers may enter new territory if blockchain is introduced into the health care sphere, and will not necessarily have legal precedents to rely on when novel issues arise. If the technology becomes a significant disrupter, as many predict it will, there may be a greater dependence on legal expertise.

Acquire expertise

Many specialities exist within the legal profession but these typically require significant time and training to become familiar with an area of practice. The challenge with blockchain, and other emerging technologies, will be to learn about a novel and developing area of law quickly. In the early stages, firms may benefit by integrating technology experts and consultants into law firms. This serves the dual purpose of providing an onsite expert to assist lawyers in grasping technical aspects and provides a means to train lawyers.

Firms dedicated to intellectual property typically require legal practitioners to have undergraduate training in areas such as science and engineering. Likewise, in the coming years, firms should consider developing more specialized positions that require training in computer science and other technology disciplines, to complement legal skills. This may become a necessity as technology continues to permeate and dominate most industries.

Form industry communities

Lawyers must turn to their networks to better understand the implications and legal nuances of emerging technologies. While law firms compete for business, knowledge about how best to address the novel and emerging legal issues concerning emerging technology will require a degree of information exchange. Collaborative communities can assist with problem solving, disseminating research, identifying new and emerging issues and providing guidance on how the law can best address matters. An important consideration in law is confidentiality. However, legal communities can proceed to effectively discuss issues and solutions of a general nature.

Changes to legal education

The legal community can play a role in facilitating technology integration. Doing so can offer benefits to clients and better prepare legal practitioners for changes that will affect the field and the practice of law. A starting point is legal education. A number of law schools have begun to incorporate courses that examine technology and law. These themes should also be reflected in courses that are not specifically focused on technology. For instance, business law courses should begin to incorporate discussions of smart contracts and examine how these may affect lawyers, clients, legislation and case law.

Additionally, legal curricula should examine how technology such as smart contracts may provide protections for clients who do not have access to legal counsel. Curriculum changes will require additional expertise in such areas. This can initially be achieved

through guest lecturers from industry and other faculties and the use of industry professionals as course instructors.

Law schools may further these efforts by facilitating interdisciplinary projects and initiatives to encourage close working relationships and interactions among law students and students in information technology-based programs. Stronger links between faculties through integrated events will also encourage knowledge-transfer. Such initiatives may allow law students on both sides of such exchanges to understand the practical challenges and legal ramifications of technology integration.

Conclusion

Blockchain may offer valuable solutions for health care records but it appears to lack the ability to overcome the barriers to the meaningful use of EHRs. Realizing the value of blockchain will require the development and integration of appropriate meaningful use solutions as a first step. Once these are in place, blockchain technology may reduce inefficiencies, fragmentation and costs associated with EHRs and patient care.

Presently, much of the literature on blockchain is focused on how it might enhance storage and management of patient information. The value that blockchains can bring to the management of health care records is not aligned with the barriers to meaningful EHR use and therefore cannot necessarily address these challenges.

Moving forward, a greater focus on how blockchain networks can be structured to support and enhance meaningful use of EHRs will aid in addressing the barriers that could limit the utility of these networks. Blockchain networks built for health care should be include features that seek to overcome meaningful use barriers, providing greater value for users and enhancing the technology's ability to improve patient care.

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Vita Auctoris

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