Exploring the Development of Canada's Smart Healthcare System in the Digital Era

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Abstract: In the digital era, the need for a robust and efficient healthcare system is paramount, particularly for developed countries like Canada. This paper explores the feasibility and potential benefits of integrating smart healthcare solutions into the Canadian healthcare system to address its current shortcomings. Despite Canada's comprehensive healthcare services, issues such as long waiting times, a shortage of medical professionals, and insufficient coverage in remote areas persist. The research utilizes a combination of literature review and case study methods to analyze existing problems and the impact of smart technologies in healthcare. By proposing the implementation of intelligent triage systems, a unified national electronic health record (EHR), and extensive telemedicine services, this study aims to enhance healthcare accessibility, improve service delivery, and increase overall system efficiency. The anticipated outcome is a more responsive healthcare system that can better meet the needs of Canada's diverse population. The findings will contribute to ongoing discussions and development strategies within Canadian healthcare policy circles.

Keywords: Smart healthcare, Canadian healthcare system, electronic health records, telemedicine, healthcare efficiency.

1. Introduction

Canada's health insurance system consists of 13 independent health insurance plans in 10 provinces and 3 territories. The Canada Health Act of 1984 proposed five basic principles for the health care system: publicity of system management, comprehensiveness of health care projects, broad coverage of the population, accessibility of system use, and universal rights to use the system [1]. However, with the aging of the population and the increase in chronic diseases, the Canadian medical system is facing problems such as inefficiency and long waiting times, especially in rural and remote areas, and the allocation of medical resources is seriously insufficient.

In recent years, the application of artificial intelligence (AI) technology in the medical field has made significant progress. AI technology combines advanced algorithms with medical big data to achieve efficient processing and accurate analysis of medical information, providing intelligent and personalized support for medical services. For example, AI has shown great potential in medical diagnosis, treatment plan formulation, surgical assistance, health management, etc. However, research on smart healthcare systems tailored to Canada's specific national conditions is still limited and further exploration is urgently needed.

This study aims to explore how to improve the efficiency and quality of medical services by building a Canadian smart medical system in the context of digitalization. The research will use literature survey and case analysis methods, focusing on analyzing the structural and operational challenges of the current Canadian healthcare system, drawing on the successful experience of global smart healthcare, and proposing a smart healthcare implementation plan suitable for Canada.

2. Case Description

2.1. Long Waiting Time

Canada's healthcare system is based on universal health insurance, with the goal of providing equitable and high-quality healthcare services to all citizens and permanent residents. However, the system has faced many challenges in recent years, the most prominent of which are long waiting times. The Fraser Institute's Waiting for Your Turn: Wait Times in Canadian Healthcare, 2024 Report shows that in 2024, doctors across Canada reported median wait times from GP referral to treatment was 30.0 weeks, which not only affects the patient's health status, but may also lead to worsening of the condition [2]. In some critical treatment areas, such as heart disease and cancer treatment, wait times can even reach life-threatening proportions. The main reason for this problem is the imbalance between supply and demand of medical resources, including an insufficient number of doctors and limited diagnostic equipment. In addition, residents in remote areas face particularly severe waiting problems because medical resources are scarcer in these areas. In order to solve this problem, the government began to explore smart medical systems, such as introducing artificial intelligence triage systems to optimize patient treatment processes and shorten waiting times.

2.2. Insufficient Doctors and Medical Resources

Insufficient medical resources are another significant problem. Although universal health insurance covers most basic medical services, Canada still has an insufficient number of doctors and medical facilities. According to statistics, Canada has only 2.8 doctors per 1,000 people, well below the Organization for Economic Co-operation and Development (OECD) average [3,4]. The problem of insufficient medical resources is particularly prominent in remote areas. Many patients need to travel long distances to obtain necessary medical services, which undoubtedly increases the time and economic cost of medical treatment. To alleviate this problem, the government has taken steps to bring in international medical professionals, such as implementing an international physician certification program. However, the effect of these measures is limited, and telemedicine technology still needs to be further promoted, such as optimizing the allocation efficiency of medical resources through electronic health record systems.

2.3. Low Efficiency

Inefficiency is also a key issue in Canada's health care system. From patient referral to diagnosis and treatment, cumbersome processes and a lack of information sharing severely reduce overall efficiency. Among them, the problem of information islands is one of the core reasons for low efficiency. Information islands refer to the inability to effectively communicate and share patient data and health information between medical institutions. The data of each medical institution is independent of each other and lacks unified standards and platforms, resulting in scattered, duplicated and incomplete information.

Since 2006, the adoption rate of electronic medical records (EMR) in Canada has grown from approximately 20% to approximately 62% in 2013. However, there are significant regional differences, with about 40% of doctors in New Brunswick and Quebec using electronic medical

records, and more than 75% in Alberta [5]. This information island phenomenon directly leads to problems such as repeated examinations and repeated diagnosis and treatment, which increases the waiting time of patients and increases the burden on the medical system. In addition, the lack of interoperability of medical data also causes doctors to lack comprehensive patient information when formulating diagnosis and treatment plans, affecting the timeliness and accuracy of treatment [6].

In order to solve the problem of information islands, Canada urgently needs to establish a unified national electronic health record system to realize the standardization, integration and sharing of medical data. Through such a system, medical institutions can obtain comprehensive health information of patients in real time, reduce repeated examinations and unnecessary diagnosis and treatment operations, which can not only improve the efficiency of diagnosis and treatment, but also reduce the waste of medical resources and significantly improve the patient's medical experience.

2.4. Limited Coverage

Although the universal health insurance system provides residents with basic medical services, health insurance coverage in Canada is still limited. In 2011, Canadians paid $6.8 billion more in premiums than they received in benefits, while group plan medical reimbursement ratios fell to 74% from 92% in 1991. The cost management of private insurance is 10 times that of the public sector, and there is a serious premium on drug costs, with generic drugs being 7% higher and branded drugs being 10% higher. These inefficiencies result in Canadians experiencing higher costs and receiving worse value than in the public health care system, which is a heavy financial burden for low-income families, especially patients with chronic diseases [7]. In order to solve this problem, the Canadian government has introduced some reform measures in recent years, such as the national pharmaceutical program (Pharmacare), aiming to reduce drug prices and expand medical insurance coverage. However, in order to achieve these goals, technical means, such as the introduction of smart drug distribution systems into smart medical care, are also needed to further reduce medical costs and improve residents' affordability.

In summary, the Canadian healthcare system faces many challenges in terms of wait times, resource allocation, efficiency and coverage. By introducing smart medical systems, including smart triage, electronic health records and telemedicine services, new vitality can be injected into the system, improving overall efficiency and patient experience, and providing residents with a wider range of affordable medical services.

3.   Analysis

3.1. Increase Medical Investment

The resource shortage problem in the Canadian health care system is directly related to insufficient investment in health care funds. Although universal health insurance covers most residents, many remote areas still have limited health budgets, resulting in inadequate infrastructure and poor service quality. For example, Northern Ontario faces significant health care delivery challenges due to its vast territory and sparse population. The area covers an area of 803,000 square kilometers and has a population of 780,000. Many remote areas only have one clinic providing services, which is difficult to meet the medical needs of local residents [8,9].   In addition, the "information island problem" has further exacerbated the waste of funds.

Information islands refer to the inability to effectively communicate and share patient data and health information between medical institutions. The data of each hospital and clinic are independent of each other and lack a unified platform and standards. This problem causes patients to need repeated examinations and treatments when visiting different hospitals, increasing medical costs. The article "Integrated Funding: Connecting the Silos for the Healthcare We Need" points out that the Canadian

medical system is inefficient due to the fragmentation of funds and services (information silos). Patients, especially those with chronic diseases, often have unnecessary emergency visits due to medical interruptions, and hospitalization. Canada spends $58.5 billion on hospitals each year, largely through global budget funding, which results in long wait times for surgeries and low productivity. And the fee-for-service physician compensation model creates over-medication without improving patient outcomes [10]. To this end, the government should increase investment in electronic health record systems, promote the interconnection of medical information, improve resource utilization efficiency, and reduce system operating costs.

3.2. Improve Access to Medical Services

The country's vast territory and sparsely populated country has significantly reduced the accessibility of medical services to residents in remote areas of Canada. Medical resources are severely lacking in many remote areas. For example, residents in northern areas need to travel long distances to receive basic medical services. This not only consumes time and economic costs but also reduces the patient's therapeutic effect.

To solve this problem, people need to rely on technological means, especially the development of telemedicine and the improvement of information sharing mechanisms. However, the problem of information islands is particularly serious in remote areas. Due to the lack of a unified electronic health record system, when patients require remote diagnosis and treatment, their medical records and examination records often cannot be obtained in time, which hinders the smooth development of the diagnosis and treatment process. To solve this problem, medical data standardization and nationwide interconnection are needed to ensure that the health information of patients in remote areas can be seamlessly connected with medical resources in central cities, thereby improving the accessibility of medical services.

3.3. Strengthen the Construction of Medical Personnel Resources

Canada has a serious shortage of doctors, with only 2.8 doctors per 1,000 people, far below the Organization for Economic Co-operation and Development OECD average [11]. This problem is particularly acute in remote areas. Due to the lack of incentive policies and resource support, many doctors are unwilling to practice in resource-poor areas.

To alleviate the shortage of doctors, Canadian provinces have launched International Medical Graduates (IMG) certification programs to attract overseas medical talents [12]. However, the problem of information silos also limits the effectiveness of this plan. When overseas doctors practice medicine, they often cannot access patients' complete medical records, which affects diagnosis and treatment. The establishment of a national unified electronic health record system can help doctors quickly obtain patient medical history, reduce misdiagnosis rates, and improve diagnosis and treatment efficiency. At the same time, the government can also alleviate the shortage of medical personnel by providing financial incentives, strengthening medical education, and introducing artificial intelligence technology (such as robot-assisted treatment).

3.4. About Long-term Care and Elderly Services

As the population ages, the demand for long-term care and elderly services is increasing rapidly. However, insufficient nursing resources and lack of information sharing hinder the development of this field. For example, many nursing homes do not have unified records of patient health information, resulting in caregivers lacking reference data when dealing with emergencies.

The problem of information island is particularly significant in elderly care. Due to the lack of data sharing between different medical institutions, doctors often cannot obtain timely access to the health

records of elderly patients when they are transferred or from nursing facilities to hospitals for treatment, increasing the risk of misdiagnosis and unnecessary examinations. To solve this problem, remote monitoring technology and electronic health record systems should be introduced to realize real-time sharing of health information, thereby improving the quality of care and reducing the pressure on medical institutions. In addition, the government should support home care policies so that more elderly people can receive professional care services at home while reducing the burden on the long-term care system.

4.   Suggestion

In response to the major problems in the Canadian medical system, three core recommendations are put forward to optimize the allocation of medical resources, improve system efficiency, and promote equity.

First, it is recommended to fully introduce an intelligent triage system. This system uses artificial intelligence technology to analyze and prioritize patients' conditions, optimize the diagnosis and treatment process, and reduce unnecessary waiting time. According to research, Healthcare facilities that have introduced smart triage systems have significantly reduced emergency room wait times. For example, in a quality improvement project at Alhada Armed Forces Hospital, average patient wait times were reduced from 27 minutes to 4.09 minutes by reorganizing triage areas and using minimal additional resources, a drop of more than 80%. Additionally, the integration of artificial intelligence (AI) and robotics is being explored in emergency room triage. Researchers at the University of York are studying how AI and robotics can be used to support medical staff in triage, reducing waiting times and improving patient flow. These advances demonstrate that employing smart triage technology can significantly improve emergency room efficiency and patient experience [13,14]. This will not only relieve the pressure on existing medical resources, but also significantly improve patient satisfaction. This suggestion is based on the theory of resource supply and demand balance, which believes that the intervention of technical means can allocate existing resources more efficiently and alleviate the contradictions caused by resource shortages.

Second, it is recommended to establish a unified national electronic health record system. This system can realize information exchange between different medical institutions, avoid repeated examination and diagnosis of patients in multiple hospitals, and improve medical efficiency. A study in the American Journal of Medicine estimates that adopting electronic medical record systems in primary care could save each physician approximately $86,400 over five years, primarily through improved charge capture, reduced transcription costs and fewer billing errors. Additionally, research from the American Journal of Managed Care found that hospitals with advanced EHR systems reduced patient care costs by 9.66% compared to hospitals without such systems [15,16]. Patient diagnosis and treatment times have also been significantly shortened. In addition, electronic archives can provide support for the analysis and prediction of medical data, thereby providing a scientific basis for public health decision-making. This proposal is based on information technology optimization theory to improve the overall efficiency of medical services through data sharing.

Third, it is recommended to expand the coverage of telemedicine services, especially in remote areas. Telemedicine connects doctors and patients through digital technology, reducing the impact of geographical constraints on the allocation of medical resources. Research shows that the implementation of telemedicine significantly improves the efficiency of medical services in remote areas. In the UK Department of Health's Whole System Demonstrator trial, the use of telemedicine reduced emergency admissions by 20% and hospital days by 14%. In Canada, telemedicine helps patients in remote and rural areas access medical services more quickly, improving patient satisfaction while reducing the time and expense associated with medical visits [17].   Through

telemedicine technology, the equity of medical services can be significantly improved, while reducing patients' delays in treatment due to transportation and time costs.

In summary, these three recommendations provide specific solutions to current problems from multiple perspectives such as optimizing resource allocation, improving efficiency, and promoting fairness. The implementation of these measures will inject new vitality into the modernization reform of Canada's health care system and provide useful reference for the reform of health care systems in other countries.

5. Conclusion

This study provides an in-depth analysis of the core problems faced by Canada's health care system, including long waiting times, uneven resource distribution, and system inefficiency. It reveals the underlying reasons behind these problems, such as imbalances in resource supply and demand, insufficient policy planning, and information silos. In response to these challenges, three smart medical solutions have been proposed: optimizing patient triage through intelligent triage systems, using electronic health records to share medical information, and promoting telemedicine technology to improve the accessibility of medical services in remote areas. These measures aim to improve system operating efficiency, optimize resource allocation, and resolve existing conflicts.

The significance of this study is to fill the current gap in research on Canada's smart healthcare system, provide theoretical support and practical paths for policymakers, and also provide lessons for countries around the world facing similar healthcare problems. The implementation of smart medical technology can not only alleviate the shortage of medical resources and inefficiency, but also significantly improve patients' medical experience and the fairness of medical services.

Future research can focus on the challenges and optimization directions of smart medical technology in practical applications, including cost-benefit analysis, data privacy and security protection, and the adaptability of technology in different regions. In addition, it is necessary to explore the in-depth integration of smart medical care with the existing medical system to promote the coordinated development of technology and policy.

In short, the introduction of smart medical care provides a practical way to solve the dilemma of the Canadian medical system, but further exploration is still needed in terms of policy support, financial investment, and technology application to achieve a more efficient and sustainable medical service system.

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