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Innovative Development of the Health Care Sector of the Future in the Conditions of Modern Challenges of the Covid-19 Coronavirus Infection in Ukraine

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Abstract

This article focuses on innovative development of Health Care Sector of the future in terms of modern challenges of the Covid-19 Coronavirus Infection in Ukraine

Aims: To identify innovative healthcare delivery models that have been implemented in Ukraine as well as to evaluate their effectiveness in healthcare improvement of the access and delivery, availability and distribution of medical equipment and PPE, healthcare infrastructure, healthcare workforce development and retention, and development of healthcare information systems in Ukraine.

Study design: In this study a mixed-approach strategy that combines quantitative and qualitative research methodologies was utilised.

Place and Duration of Study: The study was conducted on patients, professionals' healthcare establishment and policy maker stakeholders in Ukraine. It is a mix of different evaluations on the topic.

Methodology: Surveys, interviews, and questionnaires were examples of data collecting tools. The research was conducted online, offline, or both means. Data analysis processes included both quantitative and qualitative methods.

Results: Most countries adopted Beveridge principle-based health care system, which were 90% efficient and 98% pandemic resistant. Masks, gloves, and PPE were globally limited, and hospitals had 73, 35% medical equipment and 57% personal protective equipment in April 2020, but 32, 9% and 67,5% in December 2020 due to COVID-19 instances. In December 2020, hospital personnel rose from 85, 56% (Chernihiv region) to 94% to serve new COVID-19 patients (Kherson area). Technology, data analytics, AI, and the block chain may fix the coronavirus. Facebook is the finest example of using digital technology. Another example is to produce digital maps of population. Government efficiency and resources have powered pandemic responses.

Conclusion:

Ukraine must adopt new healthcare delivery methods and must stock and use medical and PPE. A strong, patient-centered healthcare system requires effective health finance. Healthcare professionals need ongoing training to stay. A hospital IT development initiative is needed to improve efficiency as Ukraine struggled with healthcare information systems during this pandemic.

Keywords: innovative development; healthcare sector; modern challenges.

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Introduction

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV2) is a new coronavirus responsible for the continuing pandemic calamity, with the first confirmed case in Wuhan, China in December 2019. This outbreak is known as COVID-19. The WHO has declared this to be a worldwide pandemic after verifying the pandemic. Around 300 million individuals have been infected with the current pandemic, and over 3 million have perished. There have been different peaks in the present COVID-19 pandemic, but it has been devastating to public health worldwide. As of March 3, 2020, reports of the coronavirus COVID-19 started to emerge from previously unaffected regions. The first quarantine restrictions were implemented on March 12. The healthcare system in Ukraine, like others across the globe, has been severely tested by this pandemic [1]. The Healthcare system of Ukraine like other developing countries was under intense pressure due a lack of supplies, personnel, money, and technology in the medical and public health fields [2].

Ukraine's government has implemented various measures to diminish the spread of the virus during the COVID-19 pandemic, such as lockdowns, social distancing, travel restrictions, and vaccination campaigns. All such measures have had significant economic and social impacts on Ukraine. They demanded the need for the adaptation of innovative approaches to healthcare delivery and management. Ukraine's healthcare system was not able to combat this pandemic and left the country ill-prepared to detect the spread of COVID-19 and react effectively in the early phases of the pandemic. This was partly due to the insufficient hospital logistical equipment; the lack of qualified specialists in infectious diseases, virology, and epidemiology; the distribution of infectious departments throughout Ukraine's regions; the surveillance and appropriate testing labs; and the lack of adequate personal protective equipment. In order to make the healthcare system able to fight against this pandemic the government has had to spend money on healthcare infrastructure, such as building new hospitals and renovating old ones, and buying medical equipment, medical and personal protective equipment. Most of these problems were overcame throughout the summer and autumn of 2020, but the harm had already been done, the adoption remained dispersed among clinical sites until 2021 [3].

During COVID-19 pandemic Ukraine's healthcare information systems was unable to facilitate the exchange of patient data across different healthcare providers and organisations. To cope with this problem there were an urgent need for the development of healthcare information systems able to share with patients' information across healthcare providers and institutions. This can facilitate more efficient and effective healthcare delivery, particularly in emergency situations. Because of this, emergency medical treatment, may be provided faster and more effectively [4]. The global spread of COVID-19 has hastened the introduction of cutting-edge tools and online medical advice in nations like Ukraine. Medical professionals may keep providing care to patients with the help of these innovations, which reduce the likelihood of infection for everyone involved. Several hospitals and clinics now use mobile clinics and other novel ways to the patient treatment [5-6].

An early research and a fast systematic reviews also revealed that health care workers in Asia were vulnerable to a variety of mental health issues during the pandemic, including fear, anxiety, depression, sleeplessness, traumatic stress, and exhaustion. Later researches verified a similar pattern developing from additional pandemic hotspots in Europe, including the United Kingdom. Health care workers of Ukraine were facing the same situation as a result of the pandemic [7]. Policies that encourage the retention of healthcare professionals, especially in rural and isolated locations, are necessary to guarantee the long-term viability of Ukraine's healthcare workforce [8].

Following the unexpected breakout, the most of the global authorities turned to modern approaches of governance. A lockdown policy, which had a devastating effect on national economies, was the most extreme measure, which included the implementation of social and physical barriers to prevent the virus. These measures had to be reflected in suitable specific budgetary options for central governments, with a focus on balancing the deployment of financial resources to battle the virus with money to counteract the economic consequences of such lockdown policies [9].

Another concern was the decentralisation in all COVID-19 nations, and such reform has increased and democratised local government duties for health care at the most local level, as well as boosting regional and local government responsibility for public health. Decentralisation affects three major aspects of health-care reform: money, individual health care, and public health. Changes in decentralisation impacted the form, functions, and financing of local governments, which had a direct influence on the delivery of (individual) health care services. Central and local governments presently share the funding and delivery of public health services (which include sickness prevention, health promotion, and health protection). The novel coronavirus infection 2019-nCoV (COVID-19 virus) pandemic outbreak presents enormous public health challenges to national and local authorities, with changes now ongoing and incomplete [10].

In terms of the pandemic, it should be considered how the healthcare system can innovate and evolve to meet future challenges. The COVID-19 pandemic acts as a catalyst for change, hastening the implementation of medical reforms in Ukraine. The argument for this essay is based on Ukraine's need to solve the present difficulties facing its

healthcare sector. The Covid-19 outbreak has highlighted the importance of having a robust and efficient healthcare system capable of responding to sudden and unforeseen public health disasters. Additionally, the pandemic has highlighted flaws in the healthcare system that must be rectified, such as a lack of money, a shortage of medical workers, and insufficient infrastructure. It also plans to investigate innovative ways to improve Ukraine's healthcare system, such as the use of digital technology, telemedicine, and the formation of public-private partnerships. These suggestions might help to alleviate some of the system's issues and improve the access to high-quality healthcare services.

Research Problem

The healthcare system in Ukraine can better adapt to future problems and enhance healthcare delivery and management for its population if the following research problem statements during COVID-19 pandemic in Ukraine are addressed.

- The effectiveness of telemedicine in improving access and delivery of healthcare [11].
- The effect of the COVID-19 pandemic on mental health and well-being, as well as the significance of telemedicine in mental health care [5].
- The availability and distribution of personal protective equipment (PPE) and medical equipment in the healthcare sector [12].
- The role of mobile healthcare units in providing medical care to individuals in remote and underserved areas [13].
- The need for investment in healthcare infrastructure, including the construction and renovation of healthcare facilities, and the procurement of medical equipment and PPE to enhance the sustainability of the healthcare system [14].
- The development of healthcare information systems to enable the sharing of patient information across healthcare providers and institutions [15].
- The effect of the COVID-19 pandemic on the healthcare workforce and the need for investment in training and development programs, as well as the provision of mental health support for healthcare professionals [16].
- The retention of healthcare professionals in rural and remote areas and the need for policies that promote their retention [17].

Research Focus

The study's emphasis on these areas attempts to find solutions and best practices that might improve the healthcare system's sustainability and resilience in the face of future problems.

- Innovative healthcare delivery models [18].
- Healthcare infrastructure and equipment [19].
- Healthcare workforce [20].
- Healthcare information systems [21].
- Health Governance.
- Health Financing.

Research Aim and Research Questions

Research Aim

The research aims are to:

1. To identify innovative healthcare delivery models that have been implemented in Ukraine during the COVID-19 pandemic and evaluate their effectiveness in improving healthcare access and delivery.
2. To assess the availability and distribution of medical equipment and PPE in the healthcare sector during the COVID-19 pandemic and examine the need for investment in healthcare infrastructure.
3. To evaluate the effect of the COVID-19 pandemic on the healthcare workforce in Ukraine and identify policies that promotes the retention of healthcare professionals in rural and remote areas.

4. To developed the healthcare information systems in Ukraine and their effectiveness in improving healthcare coordination and delivery.

Research Questions

1. What innovative healthcare delivery models have been implemented in Ukraine during the COVID-19 pandemic, and how effective have they been in improving healthcare access and delivery?

2. What are the challenges in the availability and distribution of medical equipment and PPE in the healthcare sector during the COVID-19 pandemic in Ukraine, and how can investment in healthcare infrastructure help address these challenges?

3. What is the impact of the COVID-19 pandemic on the healthcare workforce in Ukraine, particularly in rural and remote areas, and what policies can be implemented to promote the retention of healthcare professionals in these areas?

4. How effective have healthcare information systems been in improving healthcare coordination and delivery in Ukraine, and what are the barriers to their implementation and use?

5. Based on the findings, what recommendations can be made for the innovative development of the healthcare sector in Ukraine in the context of the COVID-19 pandemic and other future challenges?

Research Methodology

General Background

The research technique for this article is a mixed-approach strategy that combines quantitative and qualitative research methods. Some recent studies that used mixed-methods research in order to investigate healthcare systems and innovations support this approach [22-23]. The quantitative component of the research included a survey of healthcare professionals and patients in Ukraine. The qualitative component of the research included in-depth interviews with healthcare experts and important stakeholders in Ukraine [24-25]. Ukraine continues grappling with the pandemic, there is a need to develop innovative solutions to address the challenges faced by the healthcare sector [26].

Sample / Participants / Group

The following sample/participants/groups were involved in the research of the creative development of the future healthcare sector in the context of current difficulties of COVID-19 coronavirus infection in Ukraine:

1. Healthcare workers.

2. Healthcare institutions.

3. Patients.

4. Key stakeholders (healthcare policymakers, healthcare professionals, and experts in digital healthcare solutions).

Instrument and Procedures

The instruments for data collection included.

- Surveys
- Interviews
- Questionnaires

The procedures for data collection involved.

- Online
- Offline methods
- Both methods

The procedures for data analysis involved.

- Quantitative methods
- Qualitative methods

The research findings are presented in the form of

- Research reports
- Academic papers
- Policy briefs.

Data Analysis

To summarise and characterise the data acquired through surveys and questionnaires, quantitative data analysis might use descriptive statistics such as frequency tables, mean, median, mode, standard deviation, and range. Correlation, regression, and ANOVA are examples of inferential statistics that may be used to investigate the relationships between variables [27]. Qualitative data analysis can involve thematic analysis, content analysis, and discourse analysis, among other methods. These methods involve identifying and analysing themes and patterns in the data collected from interviews, focus groups, and case studies [28]. Data analysis can be done using software such as SPSS, which can facilitate both quantitative and qualitative data analysis.

Research Results

Innovative healthcare delivery models and their effectiveness during the COVID-19 pandemic

There are always flaws in healthcare facility management, which during a crisis leads to the healthcare system's failure to deal with difficulties and threats. To overcome such threats, quick decision-making processes are required.

Without digitalisation it is difficult to be fast in decision making during crises situation. With the propagation of the coronavirus pandemic, one such vulnerability in 2020-2021 is the digitalisation of healthcare institutions and their management systems. Even in industrialised nations, the degree of digitisation has been inadequate and very slow due to economic crises all over the world [29].

The literature revealed that Beveridge principle-based health care system is having the 90% efficiency rate and 98% pandemic resistance rate, making it the best. The Bismarck principal system ranked next in quality, with 88% medical efficiency and 97% pandemic resistance. The national insurance concept placed third with 68% and 96%. Market model was 60% efficient and 93% pandemic resistant as shown in table no.1. This supports the idea that health care system effectiveness and epidemiological response speed are linked together. This comparison analysis helped nations reforming their health care systems. Beveridge model was shown to be the most successful [30].

Table 1. Health Care Models and Their Efficiency Rate and Pandemic Resistance Rate [30].

Health Care Model	Efficiency Rate	Pandemic Resistance Rete
Beveridge	90%	98%
Bismarck	88%	97%
National Insurance	68%	96%
Market Based	60%	93%

WHO provided Ukraine with approximately 65,000 pieces of personal protective equipment for the COVID-19 pandemic. Turkey, Egypt, Ukraine, Kazakhstan, and Poland were working to improve healthcare availability and quality for their communities. Essential healthcare services and morbidity monitoring during the pandemic required an effective and efficient health care system. These five growing nations increased COVID-19 testing and treatment capacity over time. The five nations lacked healthcare workers and supplies. Among the other arrangements, shifting of work tasks, finances, social support, and professional incentives helped in retaining the healthcare personnel and increased their capacity to deal with this calamity. To address the shortfall, national and international medical supply production, stockpiling, and delivery were coordinated [12].

Table 2. **Status of Healthcare Workforce, Bed Availability per 1,000 population and Health Expenditure % of GDP in Ukraine and Europe** [12].

Particular	Ukraine	Europe
Physicians	2.6	3.7
Nurses	6.1	8.8
Hospital bed	7.5	4.6
GDP per capita in 2019	3,659	34,913
Health expenditure in 2019	7.72	9.85

WHO statistics showed that the total vaccination doses per 100 population were 44.18 in Ukraine as compared to 93.15 in Europe, while the vaccination dose-1 percentage was 28% in Ukraine as compared to 52% in Europe, and the second vaccination dose was 20% in Ukraine and 41 in Europe, as shown in table no.3 [31].

Table 3. **Status of the number of cases and deaths of COVID-19 per 1,000 population and vaccine doses in %** [31].

Particular	Ukraine	Global
Population in 2020	43,733,762	7,845,261,000
Percentage above 65 years	16.7%	9.09%
Cases	74.19	32.33
Deaths	1.78	0.65
Vaccine dose total	44.18	93.15
Vaccine dose 1	28%	52%
Vaccine dose 2	20%	41%

Infrastructure, medical equipment and availability and distribution of PPE

During the COVID-19 pandemic, there were shortages of masks, gloves, and PPE all around the globe. Other European nations like Poland, Turkey, and Egypt also experienced this shortage. According to the official information site of the Cabinet of Ministers of Ukraine, hospitals had 73,35% medical equipment and 57% personal protection equipment in April 2020, while in December 2020, hospitals had 32,9% equipment and 67,5% personal protection equipment, as shown in figure no.1 [32].

Healthcare workforce and COVID-19 pandemic

According to figures on Ukraine's Cabinet of Ministers' official information website, in April 2020 the supply of hospitals with medical professionals ranged from 58.13% (Luhansk region) to 92.45%. (Riverne area). Due to increase in pandemic case in December 2020, the supply of medical workers in hospitals ranged increased from 85,56% (Chernihiv area) to 94%. (Kherson area) as it is notices in figure no. 2 [31]. According to the data, labour migrants are heavily engaged in major EU vocations that battle coronavirus sickness, despite tight quarantine measures that led the partial return of migrants to their countries, the increase in unemployment, and sluggish economic development COVID-19. EU nations offer more resident permits to non-members every year, and Ukraine is the top in both residence permits and remittances [32].

Healthcare information systems and their effectiveness in improving healthcare coordination and delivery

New technologies such as information technology, data analytics tools, artificial intelligence, and block chain might be used to provide smart solutions to the coronavirus's current difficulties. Facebook is the clearest example of how artificial intelligence. Digital technology had been used to build maps that indicate patterns of population density, demography, and movement to assist select where to send supplies or how to avoid the spread [33].

Geographic information systems and information technologies, digital data acquired from sick individuals may help epidemiologists track down patient zero and identify infected patients' close relationships [34]. In Ukraine the health recommendation about hand hygiene and respiratory etiquette was made available on several social media and official health website. Television and official website played an important role on daily briefings on the COVID-19. COVID-19 scenario updates were handed out weekly through text message or video. Digital communication played an import role in mass communication during the outbreak. They had begun investing in digital health before to the crisis [35].

Governance and Finance

The COVID-19 pandemic has had a tremendous influence on nations all around the globe, and their reactions to the problem have been diverse. The efficacy of governance and financial allocation in delivering resources to healthcare systems and meeting people' demands has been a significant component of this response. Concerns have been made in Ukraine concerning the efficacy of resource allocation in response to the outbreak. Despite the country's low GDP per capita of $3,659 in 2019, healthcare spending accounted for 7.72% of GDP in the same year as show in table no.2.

Yet, there are opinions that these resources were not exploited to their full potential in addressing the pandemic's difficulties. In contrast, the United States has committed substantial resources to combat the pandemic. The nation has committed more than $178 billion USD to the healthcare industry, including financing for tests, vaccines, and provider assistance.

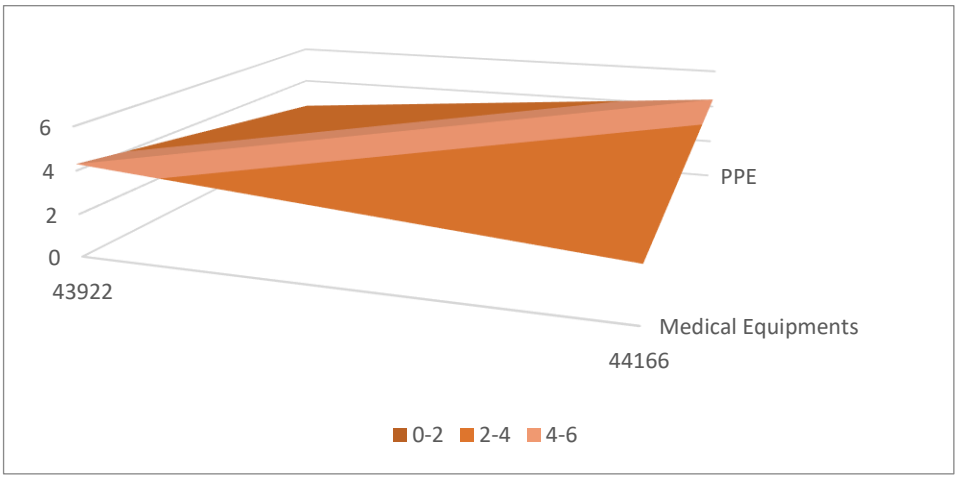

Figure 1. **Availability and distribution of medical equipment and PPE**

This money has allowed the nation to enhance its healthcare capacity and give crucial services to individuals in need. Overall, government efficacy and financial allocation have been critical in nations' responses to the pandemic. Although some nations, such as the United States, have been able to dedicate large resources to react to the crisis, others, like as Ukraine, have struggled to ensure that their resources are used properly to handle the pandemic's difficulties [12].

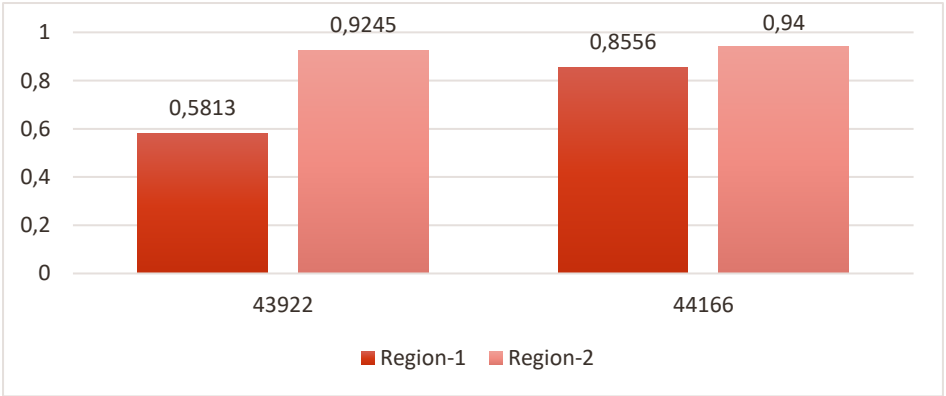

Figure 2. **Distribution status of health care workforce**

Discussion

Innovative healthcare delivery models and their effectiveness during the COVID-19 pandemic

During the sudden arise of pandemic, there are always problems with healthcare system to deal with problems and threats posed by that pandemic of, and quick management decisions are needed to deal with such dangers. Different models of health care were used in different parts of the world to deal with the COVID-19 pandemic. The health care system in Ukraine is based on the Beveridge model, which is a publicly funded and run system that gives everyone access to health care. Similarly, among those countries that used the same model were the United Kingdom, Iceland, Ireland, Norway, Spain, Cuba, and New Zealand. Germany, Austria, Belgium, the Czech Republic, France, the Netherlands, and Switzerland used the Bismarck model. Canada, Australia, Italy, and Thailand used the national insurance model, while China, India, and Portugal used the market model [30].

If analysing the most efficient model, the literature showed high efficiency rating for the Beveridge model having 96.6%, efficiency and effectiveness. It was also revealed that out of the seven nations analysed for this purpose, four countries were Ireland, Iceland, New Zealand and Great Britain achieving the highest degree of efficiency of 100% while Norway having 84% had the lowest in the group, although this figure was higher than the average for all nations. Similarly, those nations who used the health care system model based on the concept of national insurance ranked second in terms of economic efficiency, with a level of 95.5%. Those nations who used the market model of health

care system, in which the majority of money spent on medical services come from the population's own savings, had the lowest performance outcomes [30]. Total vaccination coverage in Ukraine indicated by WHO statistics were also low as compared to other countries in Europe showed poor and inefficiency of healthcare system of Ukraine [31]. During the pandemic, Ukraine expanded the Obligatory State Social Health Insurance Fund for hospitalization and intensive care for COVID-19 patients. It was also concluded that the Compulsory State Social Health Insurance Fund was also improved for healthcare delivery during the pandemic. A competitive market model is being studied for future healthcare improvements in Ukraine and for this purpose Lohinova and Marushchak examined the pros and cons of market-based healthcare in Ukraine [36]. While another study examined healthcare system in the United Kingdom where health care is entirely financed and provided by the government to all citizens. According to some evaluations, the country's National Health Service (NHS) ranks well in key health-care indicators, including preventative care, equality, and access. The NHS, which is mostly funded by taxes, offers complete coverage, including preventative care, hospital services, medications, and mental health care [37].

Infrastructure, Medical equipment and PPE availability and distribution in the healthcare sector during the COVID-19 pandemic

During the pandemic, it was hard for many countries to get enough medicines and PPE. This was also a problem for Ukraine. Due to the size of the outbreak, a number of hospitals and clinics did not have enough PPE and medical supplies. This put healthcare workers in contact with the virus, which led to a great amount of sick people [38]. All over the world, like in the US and Pakistan, people had the same kinds of problems. Doctors in both countries said they had to work without personal protective equipment (PPE). When it came to getting PPE, more doctors from Pakistan said they had been treated unfairly than in the US. Secondly due to this shortage 80.5% of doctors in the US and 60.3% of doctors in Pakistan said that they reused PPE [38].

The distribution of PPE was another problem discussed in many studies. Some hospitals and clinics were given extra supplies, but others were not. The Ukrainian government came up with a way to better get medical supplies and PPE to people who need them. The government put regional needs first when allocating supplies. A government hotline was established that can be used by healthcare workers to report shortages of supplies. Similar problems were encountered all around the globe, particularly in low-income nations. World Health Organization statistics showed that the medical PPE market was worth $8 billion in 2019 and was centralised and directed by the United States and Asia. Except for gloves, China and the United States accounted for 60% of worldwide output in most categories of PPE, while gloves were mostly manufactured in Malaysia and Thailand. Because of the widespread acceptance and continuous usage of surgical masks, consumer and non-healthcare workplace demand accounted for 60-70% of overall demand in 2020 and 2021. Due to the scale at which they can produce and their cost competitiveness, major, worldwide incumbent businesses may alter their production capacity to suit global demand and continue to grab the lion's share of future growth [39]. Another study showed that Bangladesh was also affected in the same manner regarding a severe lack of masks, hand gloves, and personal protective equipment (PPE). Unfortunately, domestically made PPEs, masks, and other kits have been noted to be of poor quality and incapable of protecting the medical workers from infection [40]. Ukraine like other countries was depended significantly on imports for medical equipment and PPE. So procurement corruption was another issue that created further unavailability of PPE and other medical supplies. Medical equipment and PPE were overpriced in the market against the government orders. Lack of local manufacturing capability and procurement malfeasance concerns remained as such in spite of government full efforts in most of the countries around the world. Nonetheless, the government's

efforts to priorities supply allocation and develop a more efficient distribution system helped minimise these issues [41].

The healthcare infrastructure was badly exposed by this pandemic showing Ukraine's inadequate healthcare system's inadequacies. Decentralization is not only beneficial. This decentralized structure has made pandemic response difficult in Ukraine. Hospital beds were few in Ukraine during the outbreak. Ukraine had 8.3 beds per 1,000 inhabitants before the pandemic, one of the lowest in Europe. The healthcare system was unprepared for COVID-19 cases. Medical personnel shortages exacerbated hospital bed shortages. Healthcare experts have left Ukraine for better prospects for years. The pandemic aggravated the doctor and nurse shortage [42].

Healthcare workforce and COVID-19 pandemic

The COVID-19 pandemic has affected healthcare systems globally, including Ukraine. Throughout the pandemic, Ukraine's healthcare system has struggled to find doctors, especially in rural regions. Ukraine has one of Europe's lowest physician and nurse per capita, and the COVID-19 pandemic has emphasized this lack. Ukraine has 2.6 doctors and 6.1 nurses per 1,000 populations to address covid pandemic while, compared to Ukraine it was 3.7 and 8.8 in Europe. This further augments the situation because of the lack of readiness for pandemic. It was worse in rural and distant locations, where healthcare services are few and quality is poor [12].

The retention of health care personal was also appeared as another major issue. The Ministry of Health announced plans for healthcare workers to complete online courses in the field of clinical management and prevention and control of infection. Ukraine has set aside medical students to be employed as replacements. WHO conducted online training programs at 200 authorized treatment centres and exchanged expertise on treatment procedures. Literature further revealed that other European countries also did similar arrangements. Turkey used the medical and dental residents as a replacement in case of burden on the doctor during pandemic. Poland utilised non-specialised personnel, retired personnel, and medical students. Another method utilized was to increase the salary by 100-300%, and the loss of income was compensated, overtime payments and time off duty were ensured. Doctors who were isolated and quarantined received 100% of their salary [12].

Literature also revealed that improving working environment for retention of healthcare worker in rural and distant healthcare is another option utilized by the world. This might involve boosting training, professional development, equipment, supplies, and support services like childcare and housing [43].

Healthcare information systems and their effectiveness in improving healthcare coordination and delivery

COVID-19 pandemic has nevertheless created new needs and changed motivation for the digital health tools utilisation for health care delivery. In this way emphasised the value of healthcare information systems in assisting, coordination, and delivery of healthcare services. For some years, Ukraine has been developing healthcare information systems with the goal of enhancing healthcare delivery and patient outcomes while Europe was utilising it more effectively [44]. Digital health tools have been used to deal with COVID-19 in four main areas: communication and information, monitoring and surveillance, helping to provide health services, and vaccination. In the early 2000s, the use of electronic medical records in some hospitals helped healthcare information systems in Ukraine to grow. The goal was to improve the quality of healthcare services by making it easy for healthcare workers to get information about patients quickly and timely. The government created the Unified State Health Information System so that health information from all over the country could be combined and made easier to find. During the COVID crisis, different countries around the world used different information technology methods to meet the needs of a tough time. Countries like Austria, Bulgaria, and Italy made Digital Apps to connect with the public, tell them about the virus, and help them recognise symptoms, get in touch with health services, or report symptoms. In the same way, France created national health data gateways in response to the crisis by funding COVID-related research projects like the Health Data Hub, which was a single way to access health data [45]. Most of the literature talked about how important it is for healthcare to become more digitalised, including changes related to the internet and digital technologies and how they affect new treatments and best practices for better health management. It also made it possible to keep track of cases, hospital beds, and medical supplies in real time, which helped medical staff deal with the crisis better. The system also had telemedicine features, which let patients talk to doctors and nurses from a distance. This made it less likely that a virus would spread [46].

Another study revealed that some governments restricted the use of digital technology in health care to maintain accountability, ethical medical practice, and patient data protection. Before the COVID-19 pandemic, these constraints and insurance coverage were major impediments to telemedicine advancement in many nations around the world. Telehealth services helped competent health care organisations manage patient load, protect patients, and staff, and assure continuity of treatment. In this regard some nations also eased telehealth legislation. During the COVID-19 outbreak, insurance companies have begun reimbursing telemedicine patient treatment is another example of technology used for social service [47].

Governance and Finance

The efficacy of governance and financial allocation in delivering resources to healthcare systems and meeting people' demands has been a significant component of the healthcare response. Efficacy of resource allocation in response to the outbreak in Ukraine remained a major concern. Despite the country's low GDP per capita of $3,659 in 2019, healthcare spending accounted for 7.72% of GDP in Ukraine while it was 34,913 GDP per capita and 9. 85 health care spending on average in Europe. This revealed poor funding situation for health care in Ukraine. While the United States has committed substantial resources to combating the pandemic was more than $178 billion USD to the healthcare industry, including financing for tests, vaccines, and provider assistance. This money has allowed the nation to enhance its healthcare capacity and give crucial services to individuals in need. Finances for the health care were 3.9 million USD for Kazakhstan and 2.0 billion USD for Poland during 2020 and 2021. Overall, government efficacy and financial allocation have been critical in nations' responses to the pandemic. Although some nations, such as the United States, have been able to dedicate large resources to react to the crisis, others, like as Ukraine, have struggled to ensure that their resources are used properly to handle the pandemic's difficulties. Health financing remained a big challenge in whole developing world [12].

While another study looked at how different countries, like China and Pakistan, used e-governance systems in healthcare. This type of governance made these countries able to the focus on sustainable development goals (SDGs) event in the period of pandemic. This study also showed how these nations meet the both current and future challenges, such as the effects of COVID-19 now and in the future [48].

Decentralisation doesn't work effectively and efficiently everywhere since federal and decentralized institutions handle the situations different ways. Numerous federations and decentralized states have tried different methods to achieve different success. So, to thoroughly analyse the pandemic, a rigorous, empirical, and comparative analytic framework must be built and updated on regular basis [49].

In terms of the global picture, Governments worldwide addressed COVID-19 and faced its health and economic impacts. Health expenditure on Covid pandemic reached a record $9 trillion, or 11% of global GDP. Government health care expenditure increased rapidly at all income levels due to rise in utilisation and cost. The outbreak forced the government to spend more on healthcare and less on other areas. High- and upper-middle-income nations increased social protection expenditures to mitigate the COVID-19 economic impact. Countries must pay for health care and other social services despite worsening macroeconomic circumstances and rising debt. For poverty reduction, health care, and pandemic preparedness, low-income nations need international financing [50].

Finally, this worldwide COVID-19 pandemic experience has shown that we need new ways to deliver healthcare, better infrastructure, and better distribution of medical equipment and personal protective equipment. The healthcare workers have been very important in dealing with the pandemic, and we must keep trying to help and protect them. Healthcare information systems have been very important in improving how care is coordinated and given, but more needs to be done to make sure they work well. Lastly, governance and finance have been very important in Ukraine's response to COVID-19, and more work needs to be done to make sure that the healthcare sector has sustainable financing and good governance. As the world continues to deal with the pandemic, it is clear that a coordinated and collaborative approach to the health care is essential for success.

Conclusions and Implications

Conclusion and implication are.

1. The pandemic of COVID-19 has underlined the significance of having proper medical equipment and personal protective equipment (PPE) to protect healthcare workers and deliver effective healthcare services. To achieve this Governments must:

- stockpile enough medical equipment and personal protective equipment (PPE);
- improve supply chains and distribution channels for medical equipment and personal protective equipment, especially in rural and underserved populations;
- boost manufacturing and delivery system during times of crisis;
- Prioritise the safety of healthcare workers.

2. The pandemic of COVID-19 has underlined the significance of having established a more resilient, patient-centred healthcare system that can better handle pandemics and other healthcare issues. For this government of Ukraine must develop:

- sustainable and efficient healthcare infrastructure;

- intersectoral coordination between government, healthcare providers, and private sector partners to work together;
- Educate and develop healthcare personnel so they have the skills and tools to offer high-quality care.

3. The COVID-19 pandemic has highlighted the challenges faced by healthcare personnel, especially those working in rural and distant areas, leading to burnout and stress:

- addressing healthcare professional shortages in rural and distant places requires retention strategies that include financial incentives, housing subsidies, and training and professional development opportunities;
- improving the healthcare infrastructure in rural and distant areas by funding modern facilities, increasing access to medical equipment and supplies, and investing in telemedicine and other technology can enhance healthcare delivery;
- legislative interventions, such as increasing healthcare worker pay, improving working conditions, and providing career progression and professional development opportunities, can help address healthcare labour shortages.
- Improved coordination, communication, and real-time data are essential for healthcare practitioners to make informed decisions and allocate resources effectively.

4. Ukraine have also struggled with the use of healthcare information systems during the COVID-19 pandemic for achieving healthcare system efficiency, provider communication, and facility burden and has responded to the COVID-19 pandemic by developing a:

- national electronic health record system;
- telemedicine, and other digital health technologies;
- the healthcare information systems involve extensive technology, infrastructure, and provider training and raise data privacy and security issues Ukraine must continue to invest in healthcare information systems to solve difficulties and provide fair access for patients and healthcare professionals.

5. Ukraine had the lowest pandemic readiness and integrated economic efficiency indices. To deal with pandemic:

- Ukraine has to introduced various innovative healthcare delivery approaches like the Beveridge, Bismarck, market, and insurance-based healthcare approaches to improve access and decrease the spread of COVID-19;
- Ukraine expanded its National Health Service and Obligatory State Social Health Insurance Fund to offer free COVID-19 testing, treatment, and hospitalization for everybody;
- Governments can also use taxes to fund healthcare systems, which can help to ensure access to healthcare for all.
- The private healthcare providers' involvement can further improve healthcare access and delivery.

In conclusion, the pandemic has shown the global healthcare system flaws, and nations must implement new healthcare delivery methods to increase pandemic preparation. During pandemics, governments should invest in healthcare infrastructure and experts to deliver high-quality treatment. All international institutions and governments should help Ukraine overcome economic issues, the war with Russia, and such pandemic.

Declarations

Author contributions

All authors have sufficiently contributed to the study and agreed with the results and conclusions.

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Ethical statement

This study does not require IRB approval as it does not involve human subjects/data.

Declaration of interest

No conflict of interest is declared by authors.

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Innovative activities in healthcare institutions of the future: models for overcoming dilemmas

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Abstract

Purpose: The Ukrainian population's insufficient protection from the prospect of high medical costs and the system's structural inefficiency, which is aggravated by an ineffective means of financing healthcare, continue to be the main problems facing the Ukrainian healthcare system. Rising rates of preventable mortality also highlight the shortcomings in the health system. Patients and medical professionals in Ukraine concur that the healthcare system needs significant reform; nevertheless, the current government's reform measures are not well embraced, and there is disturbingly high public mistrust of medical experts. Thus, in order to enable healthcare reformation, new methods, models, and activities need to be developed. However, it is not yet clear how well or how widely these initiatives have been initiated into practice.

Methodology: A literature search concerning articles looking at innovative health activities in Ukraine was conducted.

Results: In this aspect, only nine research papers were concerned with the topic. There were few studies that examined innovative practices at the institutional and governmental levels. Despite this, there were more innovative initiatives conducted on a national scale than at an institutional level. The implementation of several unique concepts has not yet been fully realised.

Implications: Ukraine is currently engaged in a number of innovative healthcare initiatives, especially at the national level. The quality of healthcare in the nation could be greatly improved by engaging in these activities. But there are still many obstacles that must be overcome. Despite these difficulties, several of the suggested models are not only original but also useful, and they might be adopted by other countries as models. Additional investigation is required to reveal all the varieties of innovative healthcare operations in Ukraine.

Keywords: Ukraine; innovation; health system; mHealth; eHealth; frameworks; invasion; USAID

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Introduction

Background

Innovative activities in healthcare refer to the development and implementation of new technologies, methods, and approaches for the improvement of the healthcare services delivery. Examples of such innovations include next-generation sequencing, 3D-printed devices, digital health tools like telemedicine and electronic health records, personalised and precision medicine, artificial intelligence, and nanotechnology (TABLE 1). These innovations are

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necessary to advance the healthcare and to provide a high-quality care by improving access to maintenance, making it more efficient and affordable and ultimately improving health outcomes for patients.

In Ukraine, some of these innovative activities are being conducted to varying degrees, but there are also significant barriers and dilemmas that are hindering progress. For example, telemedicine had become increasingly popular in Ukraine, especially during the COVID-19 pandemic when many people needed to access healthcare services from their homes [1, 2]. However, the availability and quality of internet connectivity can be a challenge in some areas, which can limit access to telemedicine services. Personalised medicine and precision medicine are still relatively new concepts in Ukraine, and there is a lack of infrastructure and funding to support these approaches [3]. Additionally, there is a need for more genetic testing facilities and trained personnel to interpret genetic data. This is all the more crucial because the accelerated pace of technological advancement necessitates the balancing of scientific-practical issues and ongoing legal issues pertaining to medicine; if to achieve it, it will allow for timely entry into unlocking the benefits of personalised medicine. The author Bezdieniezhnykh et al states how this requires careful legislative regulation of activities being conducted in the field of medical practice [3]. This is why health policy makers should be up-to-date with the ground realities, especially those on the warfront.

Artificial intelligence and nanotechnology are also relatively new concepts in Ukraine, and there is a need for more research and development in these areas. Funding and resources are limited, and there is a shortage of trained personnel to work in these fields [4]. Moreover, other countries have already made strides in artificial intelligence models, so the gap to cover is significant; this might dissuade health authorities who would rather prefer tried and tested methods over novel approaches.

In Ukraine, the healthcare system has faced challenges due to the ongoing conflict and its impact on infrastructure and access to care. According to a recent health needs assessment by the WHO Country Office in Ukraine, while the healthcare system overall is still robust, the access to key services becomes more difficult for an increasing number of civilians due to the rising costs, logistical challenges, and damaged infrastructure [5]. The cost, travel time to and from medical facilities, and the scarcity of transportation are the main obstacles to receiving healthcare that people in Ukraine cite [5]. The general public all over Ukraine complain that the expense of care is foremost among these. Moreover, one-third of people who reside in disputed areas and combat zones report having less access to resources and medications. This is compared to one-fifth of all people nationally who experience the same. The World Bank analyses that the war could push about 60% of the population below the poverty line, further compounding the scenario. Even according to WHO's evaluation, there are growing economic problems that could endanger the welfare of millions more people [5]

Table 1. Examples of innovative health activities [37]

Innovation	Description
Next-generation sequencing	The use of genetic sequencing to locate groups at risk or focus treatments on patients who will likely respond.
3D-printed devices	Products made with medical technology that are more affordable and may be fully customised to meet the physiological requirements of specific patients.
E-health	The use of telemedicine, electronic health records, and other digital tools to improve access to care and make it more efficient.
Telemedicine / mHealth	The use of telecommunications technology to provide clinical distance healthcare.
Personalized medicine	Medical care that is tailored to an individual's specific genetic makeup and medical history.
Precision medicine	An approach to patient care that takes into account individual variability in genes, environment, and lifestyle.
Artificial intelligence	The use of computer algorithms to analyse complex medical data and assist in clinical decision-making.
Nanotechnology	The use of materials and devices at the nanoscale to diagnose and treat disease.

Research Problem

The primary issues facing the Ukrainian healthcare system continue to be the population's insufficient protection from the threat of major medical bills and the system's structural inefficiency, which is exacerbated by an ineffective method of financing healthcare. Inadequacies in the health system are also emphasised by the rising incidence of preventable mortality. Both patients and medical professionals agree that the Ukrainian healthcare system needs substantial reform; nevertheless, current government reform initiatives are not well received, and public mistrust of medical professionals is alarmingly high [6]. Thus, in order to facilitate healthcare reformation, new strategies, models, and activities need to be implemented. However, it is currently unknown to what extent these initiatives have been implemented and how successful they are. This would require further investigations and surveys to be conducted within medical setups in the country, but this can prove to be difficult with the recent invasion.

Research Aim and Research Questions

The objective of this study is to conduct a search of the literature of innovative activities in healthcare within the setting of Ukraine. This will help to better understand the current state of healthcare in Ukraine, including advances

already made and faced obstacles, as well as potential areas for innovation that could improve the access to care and its quality. The end goal is to satisfy the following research questions:

1. What are the current innovative activities being conducted within Ukraine, and how successful are these in changing the present situation of healthcare within the country?

2. What obstacles are being faced within the country (be it financial, logistics, legislative, etc.) that are preventing the implementation of further innovative activities?

3. What frameworks or models have been proposed, and how many of these are being emulated successfully?

Research Methodology

Background

A literature search on several databases, including MEDLINE, Cochrane reviews, and Pedro was conducted. Specific keywords with the conjunctions 'AND' and 'OR' were utilised, and these are displayed within TABLE 2. The time frame of the articles was kept between 2018 and 2022 so as to include only the latest data. The inclusion criteria included papers discussing innovative activities or models/frameworks with respect to healthcare in Ukraine. The exclusion criteria were papers published in a language other than English, but those published in Ukrainian that had a translated abstract were included. While this was not a systematic review, an ordered approach to the search strategy was warranted in order to ensure a maximum number of articles found.

Data analysis

Table 2. Search strategy on PubMed

#	Query	Filters	Search Details	Results	Time
1	Ukraine [Title/Abstract]	from 2018 - 2021	("Ukraine"[Title/Abstract]) AND (2018:2021[pdat])	1,568	01:55:51
2	telemedicine [MeSH Terms]	from 2018 - 2021	"telemedicine"[MeSH Terms]	43,793	01:56:55
3	ehealth[MeSH Terms]	from 2018 - 2021	"telemedicine"[MeSH Terms]	43,793	01:58:08
4	personalized medicine [MeSH Terms]	from 2018 - 2021	"Precision medicine"[MeSH Terms]	29,028	01:59:05
5	ai artificial intelligence [MeSH Terms]	from 2018 - 2021	"Artificial intelligence"[MeSH Terms]	168,360	01:59:39
6	nanotechnology [MeSH Terms]	from 2018 - 2021	"nanotechnology"[MeSH Terms]	49,676	02:00:29
7	innovations, organizational [MeSH Terms]	from 2018 - 2021	"Organizational innovation"[MeSH Terms]	27,733	02:02:32
8	(Ukraine [Title/Abstract] AND (2018:2021[pdat])) AND (telemedicine [MeSH Terms])	from 2018 - 2021	"Ukraine"[Title/Abstract] AND 2018/01/01:2021/12/31[Date - Publication] AND "telemedicine"[MeSH Terms]	6	02:03:18
9	(Ukraine [Title/Abstract] AND (2018:2021[pdat])) AND (ehealth[MeSH Terms])	from 2018 - 2021	"Ukraine"[Title/Abstract] AND 2018/01/01:2021/12/31[Date - Publication] AND "telemedicine"[MeSH Terms]	6	02:04:59
10	(Ukraine [Title/Abstract] AND (2018:2021[pdat])) AND (personalized medicine [MeSH Terms])	from 2018 - 2021	"Ukraine"[Title/Abstract] AND 2018/01/01:2021/12/31[Date - Publication] AND "precision medicine"[MeSH Terms]	2	02:05:54
11	(Ukraine [Title/Abstract] AND (2018:2021[pdat])) AND (ai artificial intelligence [MeSH Terms])	from 2018 - 2021	"Ukraine"[Title/Abstract] AND 2018/01/01:2021/12/31[Date - Publication] AND "artificial intelligence"[MeSH Terms]	4	02:06:37
12	(Ukraine [Title/Abstract] AND (2018:2021[pdat])) AND (nanotechnology [MeSH Terms]) - Schema: all	from 2018 - 2021	"Ukraine"[Title/Abstract] AND 2018/01/01:2021/12/31[Date - Publication] AND "nanotechnology"[MeSH Terms]	0	02:07:39
13	(Ukraine [Title/Abstract] AND (2018:2021[pdat])) AND (nanotechnology [MeSH Terms])	from 2018 - 2021	"Ukraine"[Title/Abstract] AND 2018/01/01:2021/12/31[Date - Publication] AND "nanotechnology"[MeSH Terms]	0	02:07:39
14	(Ukraine [Title/Abstract] AND (2018:2021[pdat])) AND (innovations, organizational [MeSH Terms])	from 2018 - 2021	"Ukraine"[Title/Abstract] AND 2018/01/01:2021/12/31[Date - Publication] AND "organizational innovation"[MeSH Terms]	3	02:08:44

15	((Ukraine [Title/Abstract] AND (2018:2021[pdat])) AND (Model [Title/Abstract])) AND (Healthcare[Title/Abstract])	from 2018 - 2021	"Ukraine"[Title/Abstract] AND 2018/01/01:2021/12/31[Date - Publication] AND "Model"[Title/Abstract] AND "Healthcare"[Title/Abstract]	15	02:27:10

Literature Review

Overview of healthcare in Ukraine

The cost of healthcare in Ukraine is considerable. Patients and relatives, in 2012, paid about 40% of total healthcare expenditure out of pocket [6]. Informal payments and tips for workers, travel expenses for receiving medical attention, and prescription drug expenditures are examples of out-of-pocket expenses. Pharmaceuticals are by far the most expensive of these. Both wealthy and less wealthy households must pay out of pocket for medications and medical care, but without a doubt, the most vulnerable and impoverished households are disproportionately burdened. The cost of care is made more expensive by the requirement of spending out of pocket.

The mobilisation of sufficient resources in a way that ensures equity in access to essential health care is one of the greatest difficulties the Ukrainian health system faces. The system of healthcare finance in Ukraine may be viewed as regressive overall, as it does not meet the present requirements of being horizontally as well as vertically equal. The previously mentioned direct out-of-pocket payments undermine vertical equity. Research by the World Bank revealed that hospitals, specialty centres, and sanatoria receive about 3/4th of general government spending on health, Despite the fact that the poorest segments of the population use these facilities far less often than wealthy citizens [7]. The changes started in 2012 attempted to correct this disparity, but they have since been scaled back due to the crisis and ongoing violence.

The public's happiness with the healthcare system is low, and the Ukrainian population is extremely skeptical of the state of the healthcare system in their nation, despite the fact that data on customer satisfaction are not frequently gathered. According to Footman et al., only approximately 1/4th of the population reported to be content with their health system. While this is an increase from 2001, when only around 1/10th reported being satisfied, it is still relatively low by international standards [8]. A considerable number of service customers who responded to a survey expressed dissatisfaction with a certain component of their care [9]. The discontent is at least in part caused by the continuation of informal payments in the system, as patients choose to pay for their own care in order to receive higher quality care and minimise waiting times [10].

With regards to equity to access to healthcare, one survey revealed that only 36% of respondents believed that all individuals in their town or hamlet had access to healthcare [9]. The poorest demographics and rural populations are most deterred from obtaining medical care by the spread of informal payments. Patients with low incomes are more frequently denied care because they cannot afford services or medications [11]. People's ability to get health care in areas with varying levels of economic growth is another example of how access to care is unequally distributed. According to research, the more prosperous regions in eastern Ukraine have potentially greater financial access to health services than the poorest regions in western Ukraine [12].

Innovative activities in healthcare institutions

With regards to which innovative activities were more emphasised within healthcare, one study sought to track how Ukrainian higher education institutions for medicine and research institutions working under the Ministry of Health and Science of Ukraine supported innovation in Ukrainian healthcare institutions in 2016. More than 600 research papers on novel breakthroughs were analysed retrospectively. The work involves the application of statistical, systemic, structural-logical, cluster analysis, and expert evaluation techniques. According to the report, the specialties "Pharmacology, Pharmacy," "Surgery, Thoracic surgery, Transplantology," and "Pediatrics" saw the greatest amount of innovation in 2016 from scientific institutes. Within these, the majority were new treatment methods, followed by new diagnostic methods, and lastly, new medical devices [13].

Under new treatments, the telemedicine has made strides in improving patient outcomes [14]. The development of telemedicine has made it possible to give patients continuity of care while lowering the risk of infection from diseases, especially when it comes to pandemics, such as COVID-19, which overwhelms healthcare systems. This event particularly restricted access to supportive and palliative treatment for people with advanced cancer. Thus, this target population would potentially benefit from a strategy utilising telemedicine. This is why the research was conducted in order to determine whether telemedicine was feasible in a low-resource setting (Dnipro city). Fifty patients received one hundred sixty-five telemedicine interventions, with nutritional counselling, pain, and symptom management, and psychiatric care being the most frequently used interventions. Video conferencing was used for half of the interventions. The results showed how employing telemedicine to deliver supportive and palliative care interventions in settings with low resources was indeed feasible [1].

Many healthcare systems place a strong emphasis on creating efficient drug reimbursement processes that will lower healthcare costs and increase access to high-quality medical care [15]. Since April 1, 2017, the government of Ukraine has offered individuals with diabetes, asthma, and cardiovascular disease access to affordable medications. Moreover, the National Health Service of Ukraine (NHSU) has been using an electronic prescription system for multiple critical medications since April 1, 2019. This is substantial due to the fact that the majority of patients are unable to afford drugs. This is reinforced by findings of one research that revealed that the majority of pharmacists had 'good' awareness levels, and they reported that the majority of patients were unwilling to pay for their medications. Overall the reimbursement program's adoption of an e-prescription system has improved patients with diabetes, asthma, and cardiovascular disease access to essential drugs [16]. This is one form of activity that Ukraine stands to benefit from being emulated by other countries. This would act as an encouragement to further invest effort and resources in similar systems that serve as a model for others to follow.

In the last example, it is visible how e-health was effectively used to improve drug delivery. Another use of e-health is in the formation of databases by compiling big medical data. Big medical data refers to the integration of many datasets and includes enormous collections of information about demographic characteristics, risks, diagnostic or predictive models, healthcare provider evaluation, etc. [17]. Since health data resources are becoming more accessible, the process of digital transformation in healthcare has been actively developing over the past ten years all over the world. E-health became a focus for Ukrainian health policymakers in 2017 [18]. Big data was given emphasis in 2018 and is now in progress, with over 50% of the country's total population now covered by the national public health database [19]. This database reflects the application of eHealth, and the data can be useful for health economics and outcomes research. The use of big data in Ukraine, however, has a number of drawbacks and poses some severe ethical questions. The most significant is a quality problem brought on by a lack of strict scientific methodology employed in such research and technical challenges encountered when extracting data, organising datasets, and ensuring data accuracy and completeness. In addition, there are numerous ethical dilemmas raised by the disclosure of private information, a lack of transparency, and security problems. Given that the majority of data are traceable and some of them may come from numerous sources, such as financial information, administrative data, and social media profiles, it is unclear how the idea of informed consent should be used [19].

Models that can be applied

Several models have been shown to be effective in improving patient outcomes in the setting of Ukraine [20–24]. One which requires a spotlight is the public-private partnership (PPP). PPPs can be a helpful tool for providing high-quality infrastructure services to more people. When correctly planned and implemented, PPPs have the potential to increase the efficiency and sustainability of the supply of essential services like transportation, energy, communications, water, healthcare, and education [25]. An analysis of the public-private partnership as an innovative type of creative and financial strategy in the Ukrainian healthcare sector was done in a study. According to the results, the Ukrainian healthcare industry can definitely benefit from the deployment of PPP models [24]. Effective public-private partnerships can be challenging to create, though. In the past, the two industries have prioritised providing value to very different stakeholders, aligned around various goals, operated at various speeds, and frequently spoke quite different languages. That said public sector would benefit from emulating the private sector. This can be achieved by creating value for all potential stakeholders instead of just a select few. Prioritising societal objectives like cutting carbon emissions, upskilling workforce, and fostering more equitable workplaces are some of the ways this can be accomplished [26].

Research results

Salient findings

The given article is the first to a conduct a review on the research done covering innovative activities in healthcare within Ukraine. Only nine studies that covered the subject matter were found. There was a dearth of studies that covered innovative activities at the institutional and national levels. Despite this, the number of innovative activities at the national level outnumbered those at the institutional level. Several new models have been proposed but their implementation has not been fully realised. Many obstacles are present in the implementation of these activities. While major reforms have been agreed upon by health authorities to counter the deficiencies in the health sector, these have been confounded by the recent invasion.

Synthesis of studies

All 9 studies that were synthesised are summarised in TABLE 3 which shows the institution where the innovative activity takes place, along with notable findings from each study. Some activities were not confined to a specific institution but were applied in all medical facilities in a city or were widespread in application.

Table 3. Studies showing innovative health activities within healthcare institutions in Ukraine

Author	Institution	Innovative activity/model	Findings
Khomenko et al., 2021 [20]	National Research Centre for Radiation Medicine (NRCRM)	1. Unique product development and implementation 2. Innovative consultancy	1. The NRCRM engages in high-level innovation activities, resulting in the creation of 15 to 30 novel items each year. 2. The production of novel products, implementation, and innovative consulting are the key foci of innovation activity.
Fuzaylov et al., 2021 [22]	Burn Care Clinic	Burn Outreach Program (Telemedicine) Formation of Burn database (eHealth)	Significant decrease in complication rates for burn victims. These include wound infection, pneumonia, sepsis, UTI, and cellulitis.
Chopchik and Kaniura, 2020[21]	University Stomatological Clinic	Proposed model based on public-private partnership	Will provide high-quality dental services
Geliukh et al., 2019[23]	Primary healthcare facility	Result-based financing model (RBF) for the treatment of tuberculosis	Significant increase in favourable outcomes in new or relapse cases with the RBF model
Borsch et al., 2019[24]	Applicable to all medical facilities	Public-private partnership (PPP) model	The study discusses the prospective of the PPP model in the Ukrainian healthcare sector
Bogodistov et al., 2019[28]	Medical facilities from 2 Ukrainian cities	Job-Demands Resource model	Organizational job demand is associated with psychological effects. The latter decreases physician cooperation, leading to reduced patient satisfaction.
Mykytenkov and Gruzieva, 2019[29]	Applicable to facilities offering genetic-based services	Genetic monitoring model	The study discusses the potential benefits of the model
Romaniuk et al., 2018[30]	Conducted on a national level	Healthcare synthetic outcome measure (HSOM)	The convenience of assessment of the effectiveness of health systems
Romach and Rutka, 2018[31]	Six Ukrainian hospitals	Ukraine Paediatric fellowship program (UPFP)	Increase in physician capacity for improved paediatric care

Notable country-wide activities

There are a number of country-wide activities that have been initiated within Ukraine. A great number of these began as early as 2017 and were completed in 2022, with some still ongoing; all of the ones mentioned below were sponsored by USAID.

The USAID Health Reform Support aims of creating a healthcare system that is open, accountable, and capable of providing for the needs of the Ukrainian people. In order to promote access to healthcare and the provision of high-quality healthcare services for Ukrainians, it collaborates with several prominent health bodies, including the ministry of health (MOH), to advance health sector reforms, combat pervasive corruption, and increase transparency. One of the target objectives is to develop the professional workforce to increase efficiency of healthcare provided. Besides this the openness, accountability, and responsiveness of the healthcare system is also in need of further attention. All of the aforementioned serve to enhance service delivery systems across the board. Lastly it also supports the reform of the healthcare funding model. This is crucial because, as mentioned previously, the current system is the private model, with over half of payments being out-of-pocket. An alternative preferred is the insurance model due to its potential to increase availability of high-quality health service [27].

By enhancing the pharmaceutical system to guarantee transparency and efficiency, SafeMed helps to develop Ukraine's healthcare system to satisfy the demands of its people. The activity is enhancing public procurement of health commodities, including medication-assisted treatment for managing substance abuse, HIV, tuberculosis, and HCV medications, at the best prices, and it is helping to develop a longer-term strategy for sustaining pharmaceutical funding and reinforce sound pharmaceutical administration and the pharmaceutical supply chain [27].

Through assistance for the national eHealth system, the 'Supporting eHealth Infrastructure Development in Ukraine' activity strengthens Ukraine's eHealth system and helps to prevent corruption. The program supports the management and oversight of financial expenditures made in the development and modernisation of Ukraine's eHealth system by the MOH. The eHealth system in Ukraine is a key factor in the health sector reform, improving administration, financing, and service delivery while also making the system more open and effective [27].

By concentrating on people living with HIV and other important populations, HealthLink will speed up Ukraine's efforts to eliminate HIV as an issue of public health by 2030. This will be done by raising the demand for and accessibility to HIV services, expanding the number of people living with HIV who are aware of their status and connected to care, improving the delivery of HIV services, and lowering stigma and discrimination [27]. It should be noted that HIV is not entirely because of unsafe sex practices or prostitution; the recent war can lead to a number of rape cases, and some victims are likely to contract the virus. These patients deserve to be managed with all due health support.

By improving the diagnosis, care, and management of individuals suffering from HIV, T.B., and HCV in pre-trial custody facilities, jails, and post-prison settings in Ukraine, Serving Life will lower HIV, tuberculosis, and HCV transmission. This activity is implemented in 12 regions with the highest rates of the aforementioned diseases [27].

Through an early detection, an adequate care, and prevention for those who are living with T.B., Drug Resistant T.B., and HIV, the Support T.B. Control Efforts in Ukraine initiative is possible to reduce the T.B. pandemic in Ukraine. The initiative collaborates with medical training schools across the country and T.B. centres in 12 of Ukraine's regions with the highest incidence of co-infection. The effort is enhancing diagnoses, treatment, and care for patients with the aforementioned co-infection as well as boosting case detection. The Ukrainian MOH is closely collaborating with this activity [27].

The Strengthening Rehabilitation Services in Health Systems activity educates physical therapists in Ukraine about the most recent techniques and theories, supports the creation and application of national rehabilitation policies, rules, and protocols, and increases community demand for rehabilitation services. The activity assists the MOH in executing rehabilitation reform and closely collaborates with the WHO to develop an approach for rehabilitation services. In order to convey the function and significance of rehab services at the primary healthcare level, it is also designing an information campaign [27].

The 'Fighting misinformation against vaccines' is another activity run by USAID in Ukraine. Enhancing efficient communication at the grassroots level, it aims to enhance the supply and demand for immunisations. Through targeted, evidence-based communication and outreach to the community, the activity is fostering stronger lobbying and public discourse on immunisation at the background of the ongoing health reform. It is also improving the capacity of health authorities to organise, predict, and handle vaccines at the regional and community levels [27].

Another activity that caters to immunisation is the 'Immunisation strengthening support to Ukraine Activity". Raising the demand for and use of immunisation services are the main objectives of this activity, along with better cooperation between healthcare institutions and organisations and the activities of national advisory bodies. The Centre for Disease Control is supplying stakeholders with the required technical expertise on efficient immunisation procedures and vaccine-preventable diseases in order to achieve these goals and enhance surveillance systems [27].

Discussion

While one only found a few articles covering innovative activities at the institutional level, by no means does this imply that there is a shortage of effort towards innovation. It just means that there is a lack of coverage, and this can be attributed to the recent war. The question does arise, that if the level of innovation was indeed optimal enough to positively influence the health sector, then wouldn't the Ukrainian health system would be still be functioning even during the war. There appear to be a variety of viewpoints in regards to this. According to one source [32], more than a month after Russia's illegitimate invasion of Ukraine started; the tragic human suffering and death toll are obvious. More people die, suffer injuries, and have to battle for their lives every day. Due to this, the Ukrainian health industry is facing tremendous pressures and demands as a result of the war, and collapse of the system is only prevented due to external aid. In contrast to this, a different article mentions how the health system is as strong as ever, but admits the rising costs, logistical difficulties, and damaged infrastructure, which are making access to essential services all the more difficult for an increasing number of civilians [33; 34].

Regarding the external aid, it is interesting to note how USAID sponsored many of the innovative activities being run in the country prior to the invasion. With the turn of events, it is not unknown whether the allocation of funds towards these activities has shifted instead towards repair and salvage of the infrastructure and rescue work towards civilians. What is known is the amount of financial support being given. USAID has given the Government of Ukraine $13 billion in direct budget support to help support basic public services like healthcare, education, and crisis response; $1.4 billion in emergency aid to save lives and meet the immediate needs of the Ukrainian people; and more than $800 million in development assistance to strengthen Ukraine's energy grid, governance institutions, agricultural sector, and infrastructure [35].

Finally the question arises, what lays for the health system of Ukraine in the future. In light of the ongoing Russian Federation invasion, a discussion paper released jointly by the WHO, USAID/Ukraine, the World Bank, and the EU identifies key objectives for recuperation of the health system in Ukraine throughout the next two years. The document analyses the primary goals for the health sector, these being: service delivery, expenditure on capital,

health financing and institutional strengthening. This shows that there is indeed a steady effort in bringing the health system of Ukraine up to international standards. And this is reinforced by the fact that the National Health Service of Ukraine (NHSU) was established for the very purpose of strengthening primary care. This reform serves as another initiative in innovation, as it allows ease of contracting and payment arrangements with healthcare providers as well as new pooling and purchasing policies [36].

Regardless of the prevalence of innovation activity, the funding towards it, or the expected prospect, innovation in healthcare as a whole needs to be boosted within Ukraine. There are numerous ways this can be achieved. These include increasing financing for research and development, offering grants or tax breaks as incentives for innovation, and setting up regulatory environments that support innovation. By combining the resources and skills of both sectors, partnership between the public and private sectors can also foster innovation greatly. Additionally, fostering an innovative mind-set within healthcare organisations can support the growth of novel concepts and methods.

Conclusion

1. There are a number of innovative activities being conducted in healthcare in Ukraine.
2. Most of these are conducted primarily at the national level.
3. Few articles cover the ones conducted at the institutional level.
4. It has been acknowledged by the health sector how these activities hold great potential for enhancing the quality of healthcare in the country.
5. However, there are still multiple barriers that need to be addressed, including funding, logistics, infrastructure, policy, as well as public's attitudes.
6. Despite the challenges and the recent invasion, initiatives are still being made in Ukraine in order to suggest and put into place new healthcare methods to aid in the system's recovery.
7. Some of the proposed models are not only novel but also effective and could serve as examples for other nations to follow.
8. Further research is needed to conduct a more thorough and systematic search to identify all types of innovative activities in healthcare in Ukraine.

Declarations

Author contributions

All authors have sufficiently contributed to the study and agreed with the results and conclusions.

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Ethical statement

This study does not require IRB approval as it does not involve human subjects/data.

Declaration of interest

No conflict of interest is declared by authors.

Data sharing statement

Data supporting the findings and conclusions are available upon request from the corresponding author.

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New research and changing paradigms of coagulopathy in children after cardiac surgery: A narrative review

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Abstract

Background: Congenital heart disease (CHD) is a disorder and abnormality of the heart or the great vessels of the thorax, which usually occurs during fetal development. It has been reported that CHD is a common condition. Nearly 25% of newborns with critical types of CHD require surgical intervention in the first year of life. Hence, increasing numbers of the annually conducted cardiopulmonary bypass (CPB) cardiac surgeries are usually associated with postoperative bleeding and coagulopathy. Bleeding after CPB usually requires a replacement therapy, including the transfusion of whole blood, red blood cells, coagulation factors, or platelets.

Aim: to identify the pathophysiology of coagulopathy following cardiac surgery, how it impacts the clinical outcomes, and the available management options.

Methods: In this review, we only included English articles from common electronic databases such as PubMed /MEDLINE, Web of Science, Scopus, and the Cochrane Library with the keywords "congenital heart disease", "cardiac surgery" combined with keywords involving "coagulopathy" The end date for this review is February 2022.

Scientific novelty: This review aims to briefly review the problem of post-CPB bleeding in the pediatric population regarding multiple aspects. The medical literature lacks a comprehensive review regarding the problem of CHD, its prevalence, types, surgical options, post-cardiac surgery complications such as coagulopathy, the pathophysiology of the coagulopathy, and the preventive and therapeutic measures.

The practical significance of the result obtained: This review may help surgeons and pediatricians deeply understand post-CPB coagulopathy's pathophysiology and how to anticipate, prevent, and manage it properly. Antifibrinolytic pharmaceuticals represent the mainstay for managing this problem; their administration during CPB reduces the risk of postoperative bleeding. Blood component transfusion is also an alternative option.

Conclusion: Post-cardiac surgery, coagulopathy, and bleeding are major problems facing cardiothoracic surgeons. Postoperative bleeding, especially in the pediatric population, is one of the common causes of surgical re-exploration, leading to a higher risk of morbidities and mortalities. Meticulous preoperative examination, investigation, and intraoperative protective measures are important factors in avoiding and properly managing postoperative bleeding risk.

Keywords: congenital heart disease, cardiopulmonary bypass, coagulopathy, cardiac surgery.

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Introduction

Congenital heart disease (CHD) is the disorder and abnormality of either the heart or the great vessels of the thorax, which usually occurs during fetal development. CHD may be classified to cyanotic CHD or non-cyanotic CHD according to the nature of the structural malformation. It can be further categorized into three types of lesions such as left heart obstructive lesions, right heart obstructive lesions, and mixed lesions [1,2]. It has been reported that CHD is a common condition affecting about 1% of all live births and approximately 40,000 newborns annually in the United States [3]. Nearly 25% of newborns with critical types of CHD require surgical intervention in the first year of life. In children with transposition of the great arteries, a major and complex surgical correction is mandatory in the first week of life [4]. In spite of the great advances in the early detection programs and the rapid progress in the surgical management of CHD. It is considered one of the leading causes of mortality among pediatrics suffering from various congenital disorders [5].

Therefore, there are increasing numbers of the annually conducted cardiopulmonary bypass (CPB) and extracorporeal membrane oxygenation (ECMO) support in the various cardiac surgeries. CPB and ECMO are usually associated with post-operative bleeding and coagulopathy, which may be attributed to decreased levels of coagulants and as a complication from CHD. Bleeding after CPB usually requires a replacement therapy, including the transfusion of whole blood, red blood cells, coagulation factors, or platelets [6,7].

Research Problem

There are many complications encountered during complex cardiac surgeries in children. Post-operative coagulopathy is one of the common and serious sequences of these surgeries. Physicians cannot determine how to prevent such complications.

Research Focus

Assessing and determining the causes, consequences, and new paradigms of coagulopathy in children undergoing cardiac surgeries.

Research Questions

1. What are CHDs occurring in newborns?
2. Do all CHDs require cardiac surgery?
3. What are the causes and pathophysiology of coagulopathy encountered after cardiac surgeries in children?
4. What is the proper management of post-operative bleeding and coagulopathy encountered after cardiac surgeries in children?

Research Aim

Therefore, we performed this study to investigate the changes in coagulation profile in children undergoing cardiac surgeries due to CHD.

Research Methodology

In our review, we only included English articles from common electronic databases such as PubMed /MEDLINE, Web of Science, Scopus, and the Cochrane Library with the keywords "congenital heart disease" and "cardiac surgery" combined with keywords, involving "coagulopathy" The end date for this review is February 2022. The studies that were found using each set of keyword combinations were then pooled to create an impartial collection of publications. Studies and/or articles that weren't subjected to peer review, as well as proposals, procedures, reviews, letters, and opinions, were eliminated. The references include publications that were chosen because they are related to our topic. We concentrated on providing an overview of CHDs and its surgery-related coagulopathy.

Research Results

The result of the search using our search strategy was 1482 articles. We screened these articles to choose the articles related to our topic. We conducted a full-text screening of 173 articles after excluding the remaining article by title and abstract screening. Finally, we used 50 articles to gather information about our topic and write this review.

Literature review

CHD represents a wide range of cardiac malformations, from mild and simple disorders with good prognosis to severe and complex defects requiring difficult surgical intervention with a variable prognosis. Despite the fact that CHD is one of the leading causes of childhood morbidity and mortality, the prevalence of CHD in adults is increasing. Previous studies demonstrated that nearly 90% of pediatrics with CHD may survive into adulthood due to the recent improvement in disease identification, medical, and surgical management [8,9]. It is reported that there is a significant percentage of patients requiring at least one surgical management during their life [10,11].

Etiology

To the best of our knowledge, the cause of CHD is still unknown. However, there is evidence that it is multifactorial occurring due to combined environmental factors and genetic predisposition [12]. Recent research found that critical CHD may develop either isolated or as a consequence of a specific genetic syndrome. More than 20% of children with critical CHD were found to have a specific chromosomal abnormality, such as Turner syndrome, trisomy 21, 13, and 18. At the same time, environmental factors that showed a contributing role include maternal diabetes, infections, phenylketonuria, or exposure to toxins. It was found that the overall incidence of CHD increases by 4% if one parent is diseased or in cases of the second pregnancy after the first diseased child [13].

Epidemiology

Based on the recent data from the American Heart Association, tetralogy of Fallot (TOF), ventricular septal defect (VSD), atrial septal defect (ASD), patent ductus arteriosus (PDA), aortic stenosis, coarctation of aorta, pulmonary stenosis, and atrioventricular septal defect represent about 85% of all CHDs [14]. Critical CHDs represent about 25% of all CHDs. TOF is the most prevalent critical CHD, while TGA is the second most prevalent critical CHD. Cardiovascular anomalies are responsible for about 35% of children dying due to congenital disorders [13].

Patients may present with variable clinical manifestations from the first weeks of life according to the type of lesion. However, the proper identification of the specific etiology may be difficult as other diseases, such as pulmonary diseases, sepsis, or inborn error of metabolism may share similar manifestations. Therefore any child with suspected CHD should perform a fetal echocardiogram and other diagnostic methods [15–17].

According to the Society of Thoracic Surgeons' database, about 28,000 cardiac surgeries are performed in children in North America each year, while about five thousand cardiac surgeries, including three thousand CPB are performed per year in the United Kingdom. There is a growing number of cardiosurgical procedures every year worldwide [18,19].

Management of CHDs

The primary aim in managing children with CHDs is to stabilize the general condition and vital signs by providing appropriate oxygen therapy and prostaglandin E1 infusion in cases of malformation affecting ducts [20]. The mild and trivial lesions usually don't require surgical intervention. However, strict follow-up, prophylactic antibiotics, and lifestyle modifications are required [21]. Patients could be managed with various techniques according to the type, location, and severity of the cardiac defect. Pulmonary stenosis is the most common lesion causing right ventricular valvular outflow obstruction representing about 9% of all CHDs [22]. Surgical intervention is required if the pressure gradient across the pulmonary valve exceeds 50mmHg. Pulmonary valvuloplasty using a balloon is the gold standard technique in this defect [23]. Aortic stenosis is regarded as the most common defect causing left ventricular outflow obstruction, accounting for about 6% of all CHDs [23]. Similar to pulmonary stenosis, mild lesions could be managed conservatively, while cases with severe symptoms and pressure gradient above 50mm Hg are candidates for surgical intervention. The first line therapeutic option was surgical commissurotomy. However, balloon valvuloplasty replaced it [24]. Regarding coarctation of aorta, it is a common anomaly accounting for 5% to 8% of all CHDs. Many cases with mild or no symptoms could be treated conservatively. However, there is recommendation that urgent intervention by balloon angioplasty and stents are required when children are stabilized [25].

CHDs often require difficult and challenging surgical procedures. For open heart surgeries to be performed successfully, safety protocols and checklists must be followed. In order to achieve success in patients, especially those with narrow safety margin, safe and proper CPB is essential [26]. The principle of CPB is to isolate the patient's cardiopulmonary system, allowing better visualization of the heart and the great vessels by providing most functions of the cardiopulmonary system, such as adding oxygen, eliminating carbon dioxide, and providing proper perfusion to all body organs.

Coagulopathy after cardiac surgery

Impact of the problem

One of cardiac surgery's most frequent side effects is postoperative bleeding [27,28]. Following cardiac surgeries, 20% of patients experience substantial bleeding, and 5% of them need to be reoperated/reexplored [29]. The need for re-exploration is one of the significant factors predicting the adverse outcomes following cardiac surgery. It is associated with higher postoperative mortality, mechanical ventilation use, acute respiratory distress syndrome, arrhythmia, sepsis, and susceptibility to surgical site infection and transfusion-related infections [29].

Reducing the risk of postoperative bleeding is important for better clinical outcomes. Many factors influence the incidence of bleeding and the need for re-exploration. This includes patients' age, renal function status, CPB duration, and intracardiac repair. Surgical causes could be identified in only 50% of patients needing reoperation. Other causes are related to certain factors during the procedure, like surgical trauma, prolonged contact between the blood and the synthetic surface of the CBP machine, a higher dosage of heparin, and hypothermia. These factors aggravate the dysfunction of coagulation and the inflammatory systems [29].

So, a deep understanding of the causes, pathophysiology, and factors associated with postoperative bleeding is critical to apply the best protective measures and to help choose the suitable management approach for each case.

Pathophysiology

Many factors can explain coagulopathy following cardiac surgeries. This includes using anticoagulation for operative preparation, inflammation, fibrinolysis, and platelet dysfunction. Additionally, the hemodilution caused by the primer fluid of the bypass circuit, blood loss during surgery, activation of the extrinsic coagulation pathway by the tissue factor, activation of the intrinsic system by the contact with the CPB circuits, and the remaining of the heparin used as a part of the systemic anticoagulation preparation [30,31].

Regarding the role of inflammation, CPB extensively activates the inflammatory system. As a result, leukocytes are activated and release their granule contents. The relationship between the activation of the coagulation system and the inflammatory system during the CPB is complicated and not easy to understand. Since CPB causes acute phase reactions resembling those occurring during septic conditions, this relationship may be explained on this bases [32,33]. The marked release of the leukocytes' granules contents leads to the monocytes' activation. This, in turn, causes tissue factor (TF) subendothelial expression generation of thrombin, which finally lead to "paradoxical" activation of the coagulation cascade, causing its consumption and then its impairment. Tissue factor pathway inhibitor is a crucial TF coagulant activity suppressor. (TFPI). Heparin stimulates the release of TFPI. TFPI poses highly positive charges that strongly attract the negatively charged glycosaminoglycan, like heparin. So, post-cardiac surgery bleeding may be caused by heparin-induced TFPI.

Physiologically, the thrombolysis process inhibits the further growth of the thrombus. The fibrinolytic system is activated when the plasminogen is cleaved to plasmin. Fibrin stimulates the endothelial cells to synthesize the tissue plasminogen activator (t-PA). Additionally, fibrin stimulates the urokinase plasminogen activator (u-PA) synthesis in monocytes, macrophages, and fibroblasts. Both elements act through the extrinsic pathway that activates the plasminogen. In addition, plasminogen can be activated through an intrinsic pathway by an active factor 12 during the coagulation cascade [34,35]. The plasmin is an endopeptidase that splits the fibrinogen and fibrin into smaller fragments incapable of clotting. One of these fragments is D-dimer, which is a marker for the fibrin fragmentation process. An inhibitor of the fibrinolytic system called plasminogen activator inhibitor (PAI-1) is released after the release of t-PA and u-PA [34,35]. It was reported that patients undergoing cardiac surgery with CPB have higher levels of t-PA, D-dimer, and t-PA-PAI-1 complex and lower levels of PAI-1. And the levels of these components were higher in those undergoing CPB than in those undergoing cardiothoracic surgeries without CPB [34,35]. T-PA is released from the endothelial walls leading to external activation of the fibrinolytic system. It is important to note that the activation of the fibrinolytic system is related to the degree of activation for the coagulation system, as the thrombin and fibrin activates the fibrinolytic system. This was evidenced by the correlation between the thrombin levels and the fibrinolytic markers at the end of the operation.

Moreover, inflammatory mediators like cytokines and endotoxins activate the plasminogen and its inhibitors [34,35]. Despite the previously reported explanations, a clear relation between fibrinolysis and post-CPB bleeding remains a query. Few studies report a correlation between fibrinolytic markers and post-CPB bleeding [34,35].

Platelet dysfunction is considered one of the major causes of bleeding following CPB, As evidenced by the prolonged bleeding time and platelet contractile force tests after CPB. Moreover, a noticeable but brief decrease in platelet count is noted. This may be due to hemodilution, which is not a direct cause of platelet dysfunction.

CPB-associated platelet dysfunction may be attributed to external factors. Hypothermia may impair platelet function, as reported by many studies. In patients undergoing CPB, temperature affects the bleeding time, which reflects the overall platelet function. Moreover, the hypothermia was linked to reduced protein C and S levels, elevated thrombin levels, and thrombomodulin release indicating an overall coagulopathy [34,35].

Management approaches

Based on the understanding of the pathophysiology of post-CBP coagulopathy, several investigations have shown that administering antifibrinolytic substances during CPB reduces the stimulation of the inflammatory and fibrinolytic systems. Additionally, it reduces postoperative blood loss and the need for blood transfusion. Pharmaceutical agents include tranexamic acid, aprotinin, and aminocaproic acid. Data from a meta-analysis found that aprotinin led to a twofold reduction of mortality and decreased the number of patients needing a blood transfusion and re-exploration rates without raising the possibilities of myocardial infarction [36,37]. It is noted that plasminogen and t-PA reduce the platelets' activity. Thrombolytic agents act through the degradation of the fibrin, von Willebrand factor, and platelets surface glycoproteins (GPIb and GPIIb/IIIa). A similar action was noted during and after CPB, leading to platelet dysfunction. Therefore, the fibrinolytic-induced platelet defect may be reduced by introducing antifibrinolytic drugs like aprotinin that decrease the activation of fibrinolytic enzymes [38]. Patients undergoing CPB who receive aprotinin therapy have normal levels of 2-antiplasmin, preserved GP1b platelet receptors, improved platelet aggregation, and less blood loss than patients who do not receive aprotinin treatment. Similar effects are produced by other antifibrinolytic medications like tranexamic acid and aminocaproic acid, but they are less efficient than aprotinin against platelet dysfunction and receptors lysis [38]

Discussion

Nearly 25% of newborns with critical types of CHD require surgical intervention in the first year of life. Additionally, in children with transposition of the great arteries, a major and complex surgical correction is mandatory in the first week of life [4]. Therefore, there is an increasing number of CPB cardiac surgeries, which are usually associated with postoperative bleeding and coagulopathy [6,7]. Unlike adults, the pediatric population has relatively less circulatory blood volume [39]. So, bleeding leads to losing most of their blood components quickly, making bleeding control more challenging. This makes post-cardiac surgery bleeding prevalent in the pediatric population and needs special attention.

Control of the postoperative coagulopathy and bleeding following cardiac surgery is the mainstay for the success of cardiac surgeries, reducing the incidence of re-exploration and subsequent complications. Therapeutic and protective options are not limited to the use of the ant antifibrinolytic agents. In surgical settings, post-CPB bleeding and coagulopathy are the most frequent causes of blood product transfusion. Replacement therapy includes the transfusion of whole blood, red blood cells, coagulation factors, or platelets [6,7].

Other options include prothrombin complex concentrate (PCC) and plasma transfusion. In a randomized controlled trial of 100 patients by Smith et al. [40], there was no significant difference between both treatment options regarding postoperative bleeding and adverse effects. But, in the PCC group, fewer patients required intraoperative blood transfusion than in the plasma transfusion group [40]. We could not find any data regarding the coagulopathy paradigms changes after cardiac surgery in children in Kazakhstan.

Conclusions and Implications

1. Post-cardiac surgery bleeding is one of the major problems for cardio-thoracic surgeons.
2. Postoperative bleeding is one of the common causes of surgical re-exploration.
3. Re-exploration itself leads to a higher risk of morbidities and mortalities.
4. Meticulous preoperative examination, investigation, and intraoperative protective measures are important factors in preventing postoperative bleeding.
5. Antifibrinolytic pharmaceuticals represent the mainstay for managing this group of patients; their administration during CPB reduces the risk of postoperative bleeding. Blood component transfusion is an alternative option.

Declarations

Author contributions

All authors have sufficiently contributed to the study and agreed with the results and conclusions.

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No funding source is reported for this study.

Ethical statement

This study does not require IRB approval as it does not involve human subjects/data.

Declaration of interest

No conflict of interest is declared by authors.

Data sharing statement

Data supporting the findings and conclusions are available upon request from the corresponding author.

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Different treatment tactics of the pelvic organ prolapse according to the type and the degree of the prolapse: A narrative review

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Abstract

Background: Women frequently experience pelvic organ prolapse, significantly impacting their quality of life. Pelvic organ prolapse has a variety of treatment opportunities that should be used to each patient's needs, but the general rule is that only those exhibiting symptoms should receive care.

Aim: to evaluate the treatment options for prolapse, depending on the type of prolapse and its degree.

Methods: In this review, English studies from common databases such as Pubmed/MEDLINE, Web of science, Scopus, and the Cochrane Library with the keywords "pelvic organ prolapse," "uterine prolapse," "vaginal hysterectomy," combined with keywords, involving "laparoscopic hysterectomy," were involved. The end date for this review is February 2022.

Scientific novelty: The main objective of this paper is to evaluate the treatment options for prolapse, depending on the type of prolapse and its degree. Even though many researchers assessed these treatment options, very few researchers reported about the treatment options according to the degree of prolapse. Many researchers compared surgical interventions for the management of pelvic organ prolapse. Though there are similar works, in the present study, the results of the surgical management depending on the severity of the prolapse were evaluated.

The practical significance of the result obtained: The results may help physicians to determine the option of management depending on the degree of prolapse. First-degree (mild) usually does not require any treatment. Second-degree (moderate) may be treated with pessary, exercise, and surgery. Third-degree (severe) may be treated with pessary or surgery. Fourth-degree (complete) may be treated with vaginal hysterectomy, sacrocolpopexy, colpocleisis, and uterosacral ligament suspension.

Conclusion: Depending on the surgeon's expertise, using various approaches, pelvic organ prolapse treatment is accomplished in various situations. All previous research indicate that surgery aims to maximise patient satisfaction and return the pelvic organs to their original positions.

Keywords: Pelvic organ prolapse, sacrocolpopexy, uterosacral ligament suspension, hysterectomy.

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Introduction

Pelvic organ prolapse (POP) is a general term that refers to various disorders, including the uterine prolapse [1]. Pelvic floor dysfunction is influenced by a woman's lifetime interactions with anatomical, reproductive, lifestyle, genetic, and physiological factors. Numerous studies have found a connection between correspondence and a high prevalence of POP [2]. Due to the weakening of the endopelvic ligaments, particularly the transverse ligaments, the uterus descends into the vagina. Vaginal prolapse, anterior wall prolapse or cystocele, posterior wall prolapse or rectocele, and uterine prolapse are all examples of POP [1]. Many women with symptomatic POP experience emotional and physical anguish, negatively impacting their social, psychological, and physical well-being [3]. The outcomes of the various surgical repair procedures for uterine prolapse remain variable. They present a challenge in clinical practice. Uterine prolapse is currently treated through vaginal hysterectomy. However, its use is not evidence-based, and it is uncertain if removing or keeping the uterus is better [4]. Furthermore, there is a significant evidence that hysterectomy does not benefit women with uterine prolapse compared to uterine-preserving techniques [5]. Numerous randomised controlled trials (RCTs) comparing the safety and efficacy of hysteropreservation versus hysterectomy in women with uterine prolapse have already been performed; however, conflicting results have been reported [6,7]. So it is critical to determine the best surgical technique for women with uterine prolapse [4].

Research Problem

There are many options for managing POP (conservative and surgical management). Physicians can not easily determine the best choice regarding the prolapse type and severity.

Research Focus

Comparing the options for the prolapse treatment, especially the surgical options, determine the best treatment method regarding the severity of the prolapse.

Research Questions

5. What are different types of prolapse?
6. Does POP have different degrees of severity?
7. What is the difference between conservative and surgical management?
8. What is the best treatment option regarding the degree of POP?

Research Aim

This review was performed in order to evaluate the treatment options for prolapse depending on the type of prolapse and its degree.

Research Methodology

In this review, English studies from common databases such as Pubmed/MEDLINE, Web of science, Scopus, and the Cochrane Library with the keywords "pelvic organ prolapse," "uterine prolapse," "vaginal hysterectomy," combined with keywords, involving "laparoscopic hysterectomy were involved." The end date for this review is February 2022. The studies that were found using each set of keyword combinations were then pooled to create an impartial collection of publications. Studies and/or articles that weren't subjected to peer review, as well as proposals, procedures, reviews, letters, and opinions, were eliminated. The references include publications that were chosen because they are related to the topic. One concentrated on providing an overview of treatment options for prolapse depending on the type of prolapse and its degree.

Research Results

The result of the search using this search strategy was 2200 articles. One screened these articles to choose those related to the topic. A full-text screening of 280 articles after excluding the remaining article by title and abstract screening was done. Finally, 50 articles in order to gather information about the topic and to write this review were used (Figure 1).

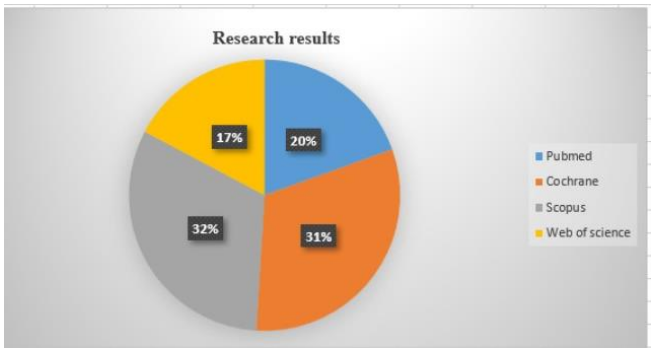

Figure 1. Research results

Literature review

Types of prolapse

POP is classified according to the prolapsed organ. Vaginal vault prolapse refers to the descent of the uterus, vaginal apex, or cervix. Cystocele suggests anterior wall herniation, and rectocele suggests posterior wall descent (Figure 2) [8,9].

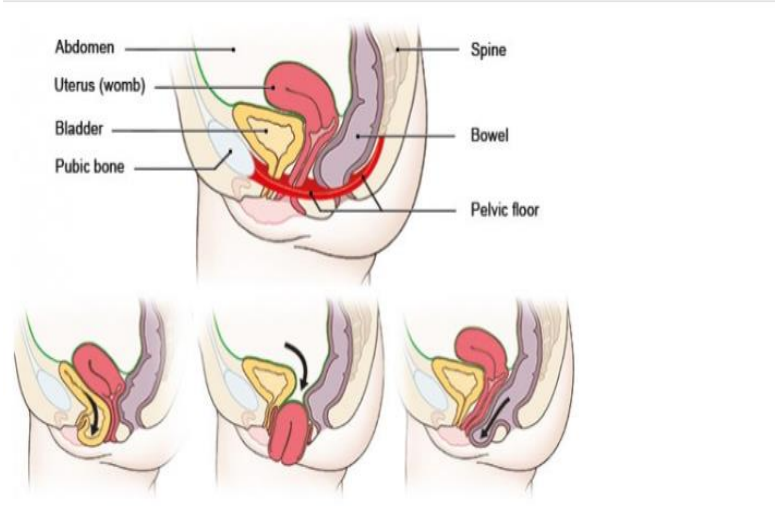

Figure 2. Above normal anatomy of organs in the abdomen; below right: posterior vaginal prolapse (rectocele), middle: uterine prolapse, left: bladder prolapse [10].

Uterine prolapse

Uterine herniation from its normal anatomical place into the vaginal canal via the hymen or the introitus of the vagina is known as uterine prolapse. This is because the surrounding support structures have weakened. Uterine prolapse is also known as genital prolapse and POP. Uterine prolapse is the most common type of POP [11,12].

Pathophysiology and risk factors

Although POP is very common, little is known about its aetiology. There are various risk factors for POP, such as hysterectomy, obesity, vaginal delivery, chronic constipation, chronic obstructive pulmonary disease, high-impact exercise, Ehler-Danols syndrome, and Marfan syndrome. The POP risk increased 4-fold following the first vaginal delivery, 8-fold following the second delivery, and 9-fold following the third delivery, demonstrating an elevated risk of POP following several vaginal deliveries. One of the main risk factors for POP is aging [13,14]. According to the research of about 1,000 females in the United States, the risk of POP increased by almost 40% every ten years of age. Women who are obese or overweight are more likely to develop POP than women who are of a healthy weight. According to a review of 22 studies, the chance of having POP increased by almost 40% to 50% in obese and overweight women compared to normal-weight women [13,14].

Clinical manifestations

The majority of patients who present uterine prolapse are asymptomatic. The most prevalent symptom of patients with uterine prolapse is the sensation or visualisation of a bulge in the vaginal region, accompanied by vaginal pressure. Other symptoms involve dyspareunia, the feeling of incomplete bladder emptying, and increased urinary frequency or urgency. When the prolapse develops, the symptoms will gradually start to appear and may get worse over time [15]. It has been demonstrated that when the prolapse's severity worsens, the number and intensity of the symptoms also rise. However, particular symptoms of the patients do not correlate well with the prolapse stage. In addition to patient complaints, the pelvic exam plays a critical role in diagnosing uterine prolapse since it allows for the clear visibility of the prolapsed section. The patient should undergo a pelvic examination while at rest and performing the Valsalva manoeuvre. Staging involves seeing the prolapsed section in relation to the hymen or introitus [16].

Diagnosis

A woman with a POP frequently visits the doctor with bladder issues or generalised abdominal pain. Vaginal examinination can already diagnose severe conditions. The doctor examines the vagina with a device known as a speculum and feels the abdominal organs with their hands, both from inside the vagina and from the outside (belly), to detect milder cases. The anus can be examined to feel where the organs are located in the back of the pelvis. These examinations are typically enough to detect a prolapse and assess its severity [17,18].

Stages

The Pelvic Organ Prolapse Quantification (POP-Q) system was used to stage uterine prolapse [19]. Measurements proximal to the hymen are denoted by negative numbers, while measurements distal to the hymen are represented by positive numbers, with the hymen as a reference point of "0". This method only considers the location of the most distal part of the prolapsed segment in relation to the hymen. While the patient is undergoing the Valsalva technique, measurements are taken (Figure 3).

- Stage 0: no visible prolapse.
- Stage 1: the most distal part of the prolapsed segment is >1 cm above the level of the hymen.
- Stage 2: the most distal part of the prolapsed segment is >1 cm or less distal or proximal to the hymen.
- Stage 3: the most distal part of the prolapsed segment protrudes >1 cm below the hymen but 2 cm less than the total length of the vagina.
- Stage 4: complete eversion of the vagina [20].

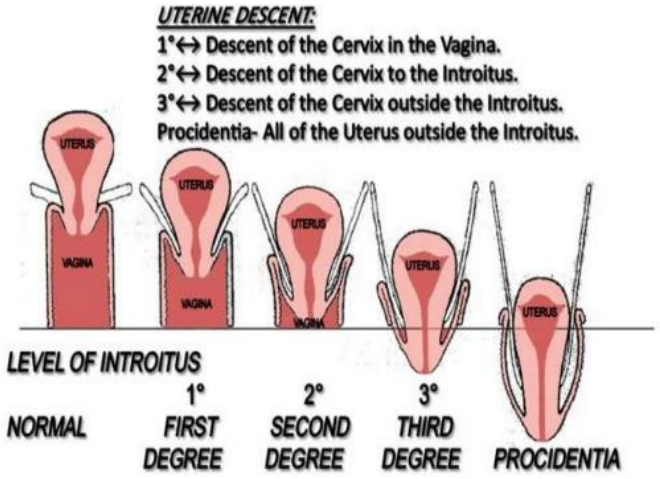

Figure 3. **Staging of uterine prolapse [20].**

Prevention

Although there are modifiable risk factors for POP, little information is available regarding the effectiveness of appropriate therapies for its prevention. POP is more prevalent among women who have had several pregnancies, difficult deliveries, or large babies. Several factors push down the organs of the pelvis against the pelvic supports. Most of these factors are operative. The failure of the levator ani muscles, the major component of the pelvic diaphragm, is critical in mediating the influence of these factors on pelvic organ support [21].

The most significant risk factor for POP is vaginal delivery, but not all women can avoid this. However, women

at high risk for prolapse can be given the option of an elective cesarean section. This risk could be evaluated using variables such as fetal weight over 4 kg, urinary incontinence predating pregnancy, body mass index (BMI), maternal height less than 160 cm, and younger age at first vaginal delivery [22].

Several techniques can help decrease pelvic floor pressure and reduce the risk of POP. For example, frequent pelvic floor exercises (Kegel exercises) have been proposed to avoid prolapse by enhancing pelvic muscle supports [23].

Treatment

Depending on the patient's age, coital function and desire for future fertility, the severity of their symptoms, and any coexisting medical conditions, surgical or conservative management may be indicated. The compartment of descent also influences treatment. Symptomatic relief, sexual function improvement or maintenance, the restoration of sufficient pelvic support, and the avoidance of incontinence and new support defects are among the objectives of management [24].

Observing and closely following up on women with mild, asymptomatic cases is appropriate. In most cases, symptoms don't appear until the protrusion extends past the opening of the vagina [25]. POP is managed when protrusion, sexual, bowel, urinary dysfunction, and other symptoms are present. Asymptomatic POP patients usually don't need treatment. In symptomatic patients, surgical or conservative management is used, and the patient's preferences determine treatment options [13].

Table 3. Comparison between the conservative and surgical management of POP

Aspect	Conservative Treatment	Surgical Management
Goal	To improuve symptoms and quality of life without surgery	To correct the anatomical defect and improuve symptoms
Effectiveness	Varies depending on the severity of prolapse and individual response to treatment	Generally effective in correcting the anatomical defect and improuving symptoms
Risks/Complications	Minimal, but may not be effective for severe cases or may require ongoing treatment	Risks associated with surgery, such as bleeding, infection, and anesthesia
Recovery Time	Immediate relief of symptoms, but ongoing treatment may be required	Recovery time varies depending on the type of surgery performed but typically involves several weeks of limited activity and restrictions on lifting or strenuous activity
Cost	Generally less expensive than surgery, but ongoing treatment costs may add up over time	Surgery can be expensive, especially if multiple procedures are required
Long-term outcomes	It may not provide a permanent solution for severe cases or those with underlying conditions that contribute to prolapse (such as obesity or chronic cough)	Surgery can provide a permanent solution for many women, but there is a risk of recurrence over time

Conservative treatment

Conservative care is helpful for individuals at high risk for complications and recurrence following surgical treatment or who refuse surgical procedures. Pessaries, hormone therapy, pelvic floor muscle exercises, and other treatments are available [13]. Kegel exercises for strengthening the pelvic floor allow the levator ani muscles to be contracted systematically. Kegel exercises are effective for women with mild POP and have been shown to reduce the symptoms of mixed incontinence and stress urge [26].

Two-thirds of patients with symptomatic POP decide to use a pessary for therapy, and up to 77% will keep using it after a year [27]. Vaginal pessaries are a conservative treatment option for POP that has been made available, primarily to women who plan to try for a new pregnancy (as a temporary solution) and for those who are not good surgical candidates or do not want to have POP surgery. According to estimates, over two-thirds of women with symptomatic POP decide on the pessary as their first course of treatment. Using the pessary reduces prolapse, intestinal, and urinary symptoms, improving quality of life. The most frequent and mildest complications

are increased vaginal discharge and vaginal erosion, which can be successfully managed with targeted therapy such vaginal estrogen therapy [28,29].

Under 65-year-old women, those with a history of pelvic reconstructive surgery or hysterectomy, posterior vaginal wall prolapse, and those with these conditions are more likely to be intolerant of the pessary after first insertion, either due to pain or due to their expulsion [16,30].

Surgical management of POP

There is no statistical data that evaluate the rates of the most frequently performed major gynecological procedures and their outcomes in Kazakhstan healthcare settings in the published sources that are currently available. The number of gynecological procedures performed in Kazakhstan has been the subject of a tiny number of reports [31]. Surgical management of POP involves repairing the weakened pelvic floor muscles and supporting structures to restore normal anatomy and function. Several surgical approaches are available depending on the severity of the prolapse, the patient's age, and overall health status. These include vaginal surgeries like anterior/posterior colporrhaphy or sacrospinous ligament fixation (SSL) and laparoscopic surgeries like sacrocolpopexy or robotic-assisted laparoscopic surgeries [32].

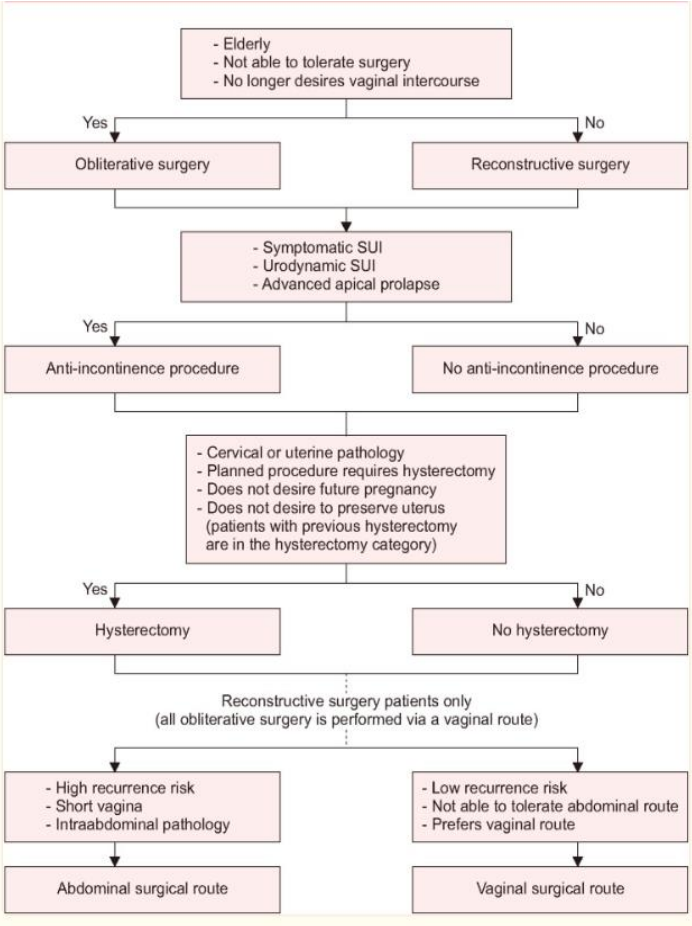

Figure 4. Choosing a primary procedure for pelvic organ prolapse [13].

Surgical management of anterior pelvic prolapse

The choice of surgical technique depends on factors such as patient preference, surgeon experience, expertise, anatomical defects present in each case, etc. Surgery aims to provide long-lasting relief from symptoms while minimising risks and complications associated with surgery [33].

As there is no established surgical protocol for treating anterior prolapse, it is essential to go over the advantages and disadvantages of each surgical approach with each patient. Several native procedures have been devised to augment tissue further and increase its durability. However, placing sutures that plicate is still the standard method for reconstructing the anterior vaginal wall. Although native tissue healing has a lower success rate than mesh-augmented repair, native repair helps minimize prolapse inside the vagina and treat symptoms of the vaginal bulge [34].

The several surgical options for treating anterior POP include; Anterior colporrhaphy, a traditional surgical technique that involves making an incision in the vaginal wall and repositioning the prolapsed tissues back into their normal position. The surgeon then sutures the vaginal wall to reinforce it [35].

Mesh-augmented repair involves using a synthetic mesh material to reinforce the weakened tissues. The mesh is inserted through small incisions in the vagina or abdomen and secured with sutures. Using the meshes for POP repair is associated with several safety concerns [36]. Unfortunately, the observed adverse effects are related to permanent morbidity and are very difficult to manage. Since then, improvements in mesh development, such as modified composition, improved design, and lower mesh densities, have been identified as variables that greatly reduce the risks of these adverse events, in addition to surgeon expertise and improved patient selection. Since then, improvements in mesh development, such as modified composition, improved design, and lower mesh densities, have been identified as factors that greatly reduce the risks of these adverse events, in addition to surgeon expertise and improved patient selection [37].

Vaginal hysterectomy with anterior repair: In cases where the uterus is also prolapsed, a vaginal hysterectomy may be performed along with an anterior repair to correct both conditions at once [38].

Laparoscopic or robotic-assisted sacrocolpopexy: This minimally invasive procedure involves attaching a synthetic mesh to the top of the vagina and anchoring it to strong ligaments in the pelvis to support the prolapsed organs. This condition can cause discomfort, pain, and urinary or bowel problems. Sacrocolpopexy is considered one of the most effective treatments for pelvic organ prolapse and involves using a mesh to support the prolapsed organs. Traditionally, sacrocolpopexy was performed through an open abdominal incision. However, with advances in technology and surgical techniques, laparoscopic and robotic-assisted approaches have become increasingly popular. These minimally invasive procedures involve making small incisions in the abdomen and using specialised instruments to perform the surgery with greater precision and less trauma to surrounding tissues [34].

Laparoscopic or robotic-assisted sacrocolpopexy offers several advantages over traditional open surgery, including shorter hospital stays, less pain and scarring, faster recovery times, and reduced risk of complications such as infection or bleeding. Additionally, these procedures allow for better surgical site visualization and greater accuracy in placing the mesh support [39].

Surgical management of apical pelvic prolapse

Apical prolapse procedures are widely classified as obliterative or restorative. Restorative procedures might be carried out either transvaginally or abdominally. Abdominal sacrocolpopexy is the gold standard for patients seeking rehabilitative solutions. Abdominal sacrocolpopexy can be done via a laparotomy, traditional laparoscopic sacrocolpopexy (LSC), or robot-assisted-laparoscopic sacrocolpopexy (RSC). Compared to laparoscopic sacrocolpopexy, open sacrocolpopexy is an excellent therapeutic option for apical prolapse repair, with long-term success rates ranging from 78% to 100%. However, it is associated with a longer hospital stay, more analgesics, and a higher cost. New surgical procedures such as LSC or RSC have been developed to overcome these difficulties. LSC or RSC reduces overall morbidity and has high anatomical durability compared to open sacrocolpopexy. A randomized study comparing open sacrocolpopexy with LSC in patients with vault prolapse discovered that the procedures had clinically identical recurrence rates at one year [40]. Costantini et al. [41] conducted the most extended randomised follow-up trial (mean follow-up of 41.7 months) comparing LSC versus open sacrocolpopexy in 2016. They discovered that both treatments are effective, with no patients in their sample reporting apical recurrences.

While LSC appears to solve the drawbacks of open sacrocolpopexy, it is technically more difficult for people inexperienced with laparoscopy. Since its introduction in 2004, RLC has enabled surgeons with high dexterity and precision to offer surgery as an alternative to LSC. Van et al [42] performed a multicentric clinical trial that compared open sacrocolpopexy with laparoscopic sacrocolpopexy. They discovered that both procedures showed comparable results on the quality of life, anatomical results and safety outcomes through a long period of follow-up that reached 9 years. RSC, which reduces the difficulty of laparoscopic knot tying and aids sacral dissection with 3-dimensional visualization, has quickly grown in favour as a means of reducing the morbidity related to open sacrocolpopexy.

Surgical management of posterior pelvic prolapse

Posterior vaginal wall prolapse might cause the sense of mass bulging into the vagina and the symptoms of difficult defecation. Because it frequently occurs in conjunction with anterior or apical prolapse, it is uncertain how common posterior compartment prolapse alone is it. The prevalence of rectocele could be underestimated because up to 80% of cases are asymptomatic [43].

The surgical management of posterior pelvic prolapse involves a range of procedures that aim to repair or reconstruct the damaged tissues and muscles in the pelvis. These procedures can be performed through various approaches, including vaginal, laparoscopic, or open surgery. The choice of the approach depends on several factors such as the severity of the prolapse, patient preference, and surgeon expertise [44].

Laparoscopic-assisted vaginal hysterectomy for management of POP

Laparoscopic-assisted vaginal hysterectomy (LAVH) is one surgical option for treating POP. This minimally invasive procedure involves removing the uterus through small incisions in the abdomen and vagina while using a laparoscope to visualize the pelvic organs. LAVH has become increasingly popular in recent years due to its numerous benefits over traditional open surgery, including reduced blood loss, shorter hospital stays, faster recovery times, and less scarring [45].

During LAVH for POP treatment, the surgeon will first make several small incisions in the abdomen to insert a laparoscope and other specialised instruments. The laparoscope provides a high-resolution view of the pelvic organs and allows the surgeon to manipulate them from outside of the body. Next, an incision is made in the vagina to remove the uterus and any other prolapsed organs. The surgeon will then use sutures or mesh to repair any damaged tissues or ligaments that support the pelvic organs [46].

Overall, LAVH is a safe and effective treatment option for women with POP who require surgery. However, like any surgical procedure, it does carry some risks such as bleeding or infection. Therefore, patients must discuss all their options with their healthcare provider before making any decisions about treatment for their POP

Discussion

POP is a condition when one or more pelvic organs, such as the uterus, the bladder, or the rectum, descend into the vaginal canal due to weakened pelvic floor muscles. The severity of POP can vary from mild to severe, and treatment options depend on the degree of prolapse. The improvement in the quality of life and patient satisfaction are considered the main factors in assessing the success of POP surgery [13]. Significantly, the postoperative absence of vaginal prominence symptoms is related to an overall improvement in quality of life after surgery [47]. Numerous randomised trials have investigated symptomatic success using a variety of indicators, such as the absence of symptoms associated with a vaginal prominence and various forms of validated questionnaires. Regarding the anterior POP, the vaginal prominence symptoms were used to measure symptomatic success, symptoms persisted in 0% to 37.9% of patients after anterior colporrhaphy and 5% to 24.6% of patients following mesh repair. According to a Cochrane review of anterior compartment prolapse, the mesh repair significantly reduced the likelihood of prolapse awareness compared to anterior colporrhaphy [48]. However, most quality-of-life surveys indicated considerable improvement following both procedures, with no significant improvement between AC and mesh repair [49].

Concerning apical prolapse, according to a recent Cochrane analysis [48], open or laparoscopic sacrocolpopexy was related to a decreased incidence of prolapse awareness, repeat surgery for prolapse, postoperative stress urine incontinence, and dyspareunia than a variety of vaginal procedures.

When comparing the supracervical hysterectomy with sacrocolpopexy, a retrospective study showed that supracervical hysterectomy with sacrocolpopexy was associated with 2.8 more incidences of recurrent prolapse than total hysterectomy with sacrocolpopexy [50].

Regarding the posterior pop, a randomised trial by Paraiso et al. compared the results of 3 different rectocele repair procedures (posterior colporrhaphy, site-specific repair enhanced with a small pig intestine submucosal graft, and site-specific repair). They reported that the patient managed with graft augmentation experienced more anatomical failure than those who received posterior colporrhaphy or site-specific repair [51]. In 2018, a recent Cochrane review included 1099 women from 10 clinical trials. They found that in view of both objective and subjective measurements, transvaginal repair for posterior wall prolapse may be more successful than transanal repair in avoiding prolapse recurrence [44].

Conclusions and Implications

1. Treatment options for pelvic organ prolapse depend on its severity.

2. Grade 1 POP: Grade 1 POP is mild and usually requires no treatment. However, women with grade 1 POP may benefit from pelvic floor exercises in order to strengthen their muscles and prevent further prolapse.

3. Grade 2 POP: Grade 2 POP is moderate and may cause discomfort or pressure in the vagina. Treatment options for grade 2 POP include:

3.a Pessary: A pessary is a small device that is inserted into the vagina to support the pelvic organs. It can be regularly removed and cleaned.

3.b. Pelvic floor exercises: Pelvic floor exercises can help strengthen the muscles that support the pelvic organs.

3.c. Surgery: Surgery may be recommended for women with grade 2 POP who have symptoms that affect their quality of life or who do not respond to other treatments.

4. Grade 3 POP: Grade 3 POP is severe and may cause significant discomfort or pain. Treatment options for grade 3 POP include:

4.a. Pessary: A pessary may be used to support the pelvic organs.

4.b. Surgery: Surgery is usually recommended for women with grade 3 POP who have symptoms that affect their quality of life or who do not respond to other treatments.

5. Grade 4 POP, including:

5.a. Vaginal hysterectomy: This procedure involves removing the uterus through an incision in the vagina.

5.b.Sacrocolpopexy: This procedure involves using mesh material to support the prolapsed organs and attaching it to a ligament in the pelvis.

5.c. Colpocleisis: This procedure involves closing off a part of the vaginal canal to support prolapsed organs.

5.d. Uterosacral ligament suspension: This procedure involves reattaching ligaments in the pelvis that support the uterus.

Declarations

Author contributions

All authors have sufficiently contributed to the study and agreed with the results and conclusions.

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Ethical statement

This study does not require IRB approval as it does not involve human subjects/data.

Declaration of interest

No conflict of interest is declared by authors.

Data sharing statement

Data supporting the findings and conclusions are available upon request from the corresponding author.

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Practical aspects of the electronic system functioning in the field of medicine of the future (Pakistan)

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Abstract

This article focused on "Practical aspects of the electronic system functioning in the field of medicine of the future in Pakistan".

Aims: To explore the practical aspects of the electronic systems functioning in the field of medicine of the future, the challenges, and opportunities of implementing these systems, and the potential solutions for optimising and enhancing their impact on outcomes in Pakistan.

Methodology: A descriptive cross-sectional study design was used. A sample of 323 was selected through non-random convenient method. Data collected through interview. Chi square test was applied.

Results: The results on telemedicine showed, out of 323 participants who practiced telemedicine, 52% had 19-24 months of medical practice experience. Among the doctors, 19.3% used laptops, 22.7% used mobile phones to search information online, while 41.1% connected with their patients through WhatsApp and 16.9% through Facebook. 80% of the doctors agreed that telemedicine was beneficial for saving money, time, effort, and for the patients. Among the group with experience above 24 months, 59% were practicing EHR systems and 41% were not utilising them. When it came to CDS Systems, 64.2% of the more experienced group were using the system, while 35.8% were not. In addition, 71.2% of the more experienced group were practicing Digital Medical Imaging. During the COVID-19 pandemic, all medical institutes taught, assigned tasks, and evaluated students through online mechanisms. However, after the pandemic, 100% of the institutes returned to traditional teaching methods. Interestingly, 60% of the participants favoured online education, considering it an easier, more effective and efficient way of learning.

Scientific Novelty: Examines Pakistan's computerised healthcare system and its impacts.

Conclusion: Improved infrastructure, healthcare education, patient computer literacy, privacy and data security rules may have the largest impact on healthcare outcomes. An international help is needed to reach global electronic health care standards.

Note: Review paper may have different types of subsections.

Keywords: electronic system; medicine; future; Pakistan; practical aspects.

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Introduction

Information and communication technology has transformed the healthcare sector into e-Health. E-Health combines business, public health, IT, and medical informatics. Reengineering healthcare with health information technology has increased efficiency, but it needs new measuring tools. Medical procedures employ electronic

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technology for surgeries, treatments, and health issues. In today's world, when customers lack high-quality healthcare, medical electronics are crucial [1].

Digital healthcare technology is reshaping the healthcare. Healthcare professionals must use cutting-edge medical technologies to be relevant in the future. Digital health is "the field of knowledge and profession connected to the create and use of digital technology for health improvement, including telemedicine, eHealth, mobile health, and advanced computer sciences, including big data, artificial intelligence, and genomics," according to the 2020–2024 WHO global strategy. Digital health, a major instrument in sustainable development, is predicted to be worth $504.4 billion in the US by 2025. [2].

Japan introduced comprehensive electronic medical record hospital information systems around 20 years ago. Since then, big hospitals and small- and medium-sized clinics have embraced similar methods. Hospital information systems are currently a basic medical school topic. This examination seeks to identify barriers and opportunities to physicians adopting electronic medical records [3].

Medical facilities are using more electronic health records. This is a fantastic chance to enhance public health management, promotion, monitoring, and service delivery. By June 2013, most American office-based doctors used EHR. EHR system deployment and purchase require large financial commitments, but the strategy's success hinges on the medical community's readiness to adopt new technology [4]. The already conducted research showed various concerns related to its use as privacy and security concerns, high start-up cost, workflow changes, system complexity, lack of reliability, and interoperability amongst the frequently mentioned barriers [5]. Several industrialised countries use them to decrease difficulties and limitations, while developing nations like Pakistan have not made significant progress in adopting the new healthcare standards due to socioeconomic and technological constraints. Such a system would allow hospitals and clinicians to exchange patient data and develop an electronic health data library that can be used for many purposes keeping in view privacy and confidentiality [6, 7].

Telemedicine is essential in low-income nations like Pakistan, where 63% of the population is rural and 37% urban. Most rural residents should travel far for metropolitan hospitals. Online patient-provider partnerships meet these demands swiftly and effectively. It shortens travel distances, eliminates the need for patients to take a day off work, and may reduce congestion in understaffed healthcare institutions [8].

Clinical decision support systems use clinical knowledge, patient data, and other health data to enhance the healthcare delivery. When comparing patient characteristics to a computerised clinical knowledge base, a CDSS presents clinicians with patient-specific evaluations or recommendations. The programme immediately aids clinical decision-making. Nowadays, doctors utilise it at the point of treatment to supplement their expertise with CDSS information. 1970s saw the first computer-based CDSSs. Non-knowledge-based and knowledge-based. Both methods employ CDSS, although they vary. Clinical decision support software, which includes mobile apps, cloud-based software, and web-based software, supports clinical practise, patient management, and caregiving [9, 10].

Medical education is now computerised. Because of the COVID-19 pandemic, schools struggled to educate kids during the lockdown. Advanced technology allows e-learning and online medical education. Pakistan, like other low-income nations, doesn't work this way. Few medical colleges and universities offered online lectures and courses before the pandemic. Lack of infrastructure may make it difficult for medical educators to build or provide online learning. Most Pakistani medical schools teach by lecture. Knowledge is another issue. The lack of collaboration between the Higher Education Commission, Pakistan Medical and Dental College, College of Doctors and Surgeons, and Pakistan Medical College. No IT department is another issue. This sector lets colleges invest in IT departments, software, and technology for high-quality education [11, 12].

Medical imaging, like other digital diagnostic and therapeutic technologies, has pros and cons. The 1970s computed tomography scanner started the digital picture revolution in medical diagnostic imaging. Digital X-ray acquisition methods like computed radiography and digital radiography, developed in the 1990s and 1980s, followed. 1980s brought magnetic resonance imaging. Due to its prevalence, digital medical imaging is the preferred approach. Poor nations must address cultural, fiscal, economic, technological, and training difficulties to migrate from film processing and storage to digital capture and display. Technical longevity, inexpensive support, and training are additional issues [13–15].

Electronic medical systems helped the mother-child crises. It enhances maternal care by making patients content by offering more instructional and encouraging care, changing meeting hours, and reacting rapidly to emergencies when a healthcare practitioner is present [16,17]. Physicians lack the training to address such conditions. Pakistani physicians got three days of online training on digital health and telehealth consultations

from Sehat Kahani Pakistan and Intelligent Project Automation System Pakistan to enhance electronics in medicine. These doctors may now provide post-abortion contraception and medicinal abortions remotely [18].

Many considerations support this study. First, medicine is evolving and technology is becoming increasingly important to healthcare. Pakistan too has a large population and an increasing disease burden. Effective and efficient healthcare services are needed, and electronic technology may help. Finally, electronic healthcare technologies have ethical, legal, and societal implications. Patient data privacy and security are challenges. Electronic healthcare technology research is needed for evidence-based policy and recommendations. This research may help Pakistan's healthcare system and evidence-based policy.

Research Problem

Since electronic systems have completely changed how healthcare is provided in Pakistan, this study focuses on EHRs, telemedicine, medical imaging, and CDSS to examine the potential and problems of integrating electronic systems into Pakistani healthcare practices.

1. How is telemedicine being used in Pakistani healthcare practices now, what are the potential and obstacles, and how can these problems be overcome to make the most of its utilisation going forward?

2. How are electronic health records now used in Pakistani healthcare practices, and what possibilities and problems exist in doing so? How may these issues be resolved to maximize their utilization going forward?

3. What are the existing methods, issues, and chances for using CDSS in Pakistani healthcare practices, and how may these issues be resolved to maximise its usage in the future?

4. What are the medical imaging implementation methods, issues, and opportunities now being used in Pakistani healthcare settings and how these issues are resolved in order to maximise their utilisation going forward?

5. What are the potential and constraints of employing electronic technology in this setting to enhance medical education and emergency situations in Pakistan?

Research Focus

The following items might be covered by the study on "Practical elements of the operation of electronic systems in the area of future medicine Pakistan:

1. Telemedicine
2. Electronic health/Medical record
3. CDSS
4. Medical Imaging
5. Digital Medical Education
6. Research and Development

Research Aim and Research Questions

Research Aim:

The aim of this research is to explore;

1. The practical aspects of the electronic systems functioning in the field of medicine of the future in Pakistan,
2. The challenges and opportunities of implementing these systems,
3. The potential solutions for optimising and enhancing their impact on outcomes.

Research Questions:

1. How are electronic technologies, such as EHRs, telemedicine, medical imaging, and CDSS, currently being used in Pakistani healthcare practices?

2. What are the challenges and opportunities of implementing electronic systems including EHRs, telemedicine, medical imaging, and CDSS, in healthcare practices in Pakistan? How can these challenges be addressed to optimise their use in the future?

3. How do electronic systems impact patient outcomes in different areas of healthcare in Pakistan, such as maternal and child health, chronic disease management, or infectious disease control?

4. What are the ethical and legal quality considerations of using electronic systems on outcome in medicine in Pakistan, and how can these be addressed to ensure the privacy and security of patient data?

5. How can electronic systems be used to improve medical education and training in Pakistan, and what are the challenges and opportunities of using these systems in this context?

Research Methodology

General Background

Technology is transforming the healthcare delivery. Electronic healthcare systems in Pakistan face usability, interoperability, data security, and cost issues. To understand the current status, challenges, opportunities, and potential solutions for maximising their use, it's important to study how electronic systems operate in Pakistan's future medical profession. The study setting was Faisalabad Pakistan. Study population included medical doctors working in private and public teaching institution. Sample size in this study 323 and a Nonprobability Convenient sampling technique was employed.

Data Analysis

Data analysis for the research on the practical aspects of the electronic systems functioning in the field of medicine of the future in Pakistan will involve both qualitative and quantitative data analysis methods. Chi Square test is applied to calculate p-value.

Research Results

Age wise frequency distribution of participants

The results of this study showed that the participants of study are distributed as age group 36–40 years of doctors accounted for 32.5% of the total population. Other age groups, from top to bottom, were as follows: 21.67% of those between the ages of 41 and 45, 19.20% belong to 31-35 years of age, 13.62% belong to 46 and above and 13% belong to the age group of 26-30 years as shown in table no.1.

Table 1. Age wise frequency distribution of physician.

Age Group	Male	Female
26-30	41	24
31-35	50	27
36-40	60	40
41-45	29	21
46 and above	20	11
Total	200	123

Telemedicine Practice

The result of the study showed that the out of 323 study participants; group having experience of medical practice of 6-12 months, were 14% who were practicing the telemedicine while those having 13-18 months of experience 17% were practicing, those having 19-24 months experience were having 52% were practicing while those having 25-29months experience, 11% were practicing and above 30 having 6% were practicing telemedicine or online medicine practice. Finally, the group having experience of 19-24 were 52 % who were practicing telemedicine as shown in table no. 2.

Table 2. Experience wise frequency distribution of physician.

Duration of experience in month	6-12	13-18	19-24	25-29	Above 30	P-Value
Telemedicine						
Yes	30(14%)	37(17%)	113(52%)	25(11%)	13(06%)	0.000
No	10(9.5%)	15(14.3%)	45(42.9%)	30(28.6%)	05(4.8%)	
Electronic Health / Medical Record						
Yes	45(23.1%)	35(17.9%)	60(30.8%)	30(15.4%)	25(12.8%)	0.000
No	20(15.6%)	15(11.7%)	45(35.2%)	25(19.5%)	23(18.0%)	

Clinical Decision Support Systems						
Yes	35(17.4%)	37(18.4%)	77(38.3%)	27(13.4%)	25(12.4%)	0.000
No	23(18.9%)	23(18.9%)	57(46.7%)	13(10.7%)	06(4.9%)	
Medical Imaging						
Yes	27(13.6%)	30(15.2%)	30(40.4%)	33(16.7%)	28(14.1%)	0.000
No	10(08%)	25(20%)	65(52%)	15(12%)	10(08%)	

When dividing it into two groups having less than equal 24 months and above 24 months of experience in medical field, the result showed the group having experience above 24 months, 69 % were practicing telemedicine. The result may be concluded as out of 323 total participants, 67.5% of the participants were working in telemedicine.

The result also showed that 19.3% of the doctors were using laptops,22.7% using mobile phones to search for medical information online, while 41.1%% of them always connect with their patients through WhatsApp and 16.9 % through Facebook. As far as the legality is concerned 60 % of the doctors have no idea about the legal bindings while interacting with patients online while 40 % were knowing little bit. Furthermore, the importance of telemedicine usage for patients as a viable approach was agreed upon by 60 % of the participants. In this study, 80% of the doctors agreed to the usage of telemedicine for saving money, time, effort, and the beneficence of telemedicine for patients as shown in graph no 2.

Electronic Health / Medical Record

The result of the study showed that the out of 323 study participants; group having experience of medical practice of 6-12 months, were 23.1% who were utilising the electronic health record system as compared to paper record system while those who were having 13-18 months of experience 17.9% were utilising, those having19-24-month experience were 30.8% were utilising while those having 25-29 moths experience, 15.4% were utilising and above 30 moths having experience, 12.8 % were utilising. Finally, the group having experience 19-24 were 52 % who were utilising electronic health record system. When we divide it into two group having less than equal 24 months and above 24 months of experience in medical field result showed that the group having experience above 24 months,59 % were practicing electronic health record system and 41% were not utilizing. Result may be concluded as out of 323 total participants only 60.37% of the participants were having experience of working in electronic health record system as shown in table no. 2.

Clinical Decision Support Systems

The result of the study showed that the out of 323 study participants; group having experience of medical practice of 6-12 months, were 17.4% who were knowing and utilising the Clinical Decision Support Systems while who were having 13-18 months of experience 18.4% were utilising, those having19-24 months of experience, were 38.3% while those having 25-29 month experience 13.4% were utilising and above 30 months having experience 12.4 % were utilising. Finally, the group having experience 19-24months were 38.3 % were utilising Clinical Decision Support Systems. When dividing it into two groups having less than equal 24 months and above 24 months of experience in medical field result showed the group having experience above 24 months, 64.2 % were using Clinical Decision Support Systems system and 35.8% were not utilizing. Result may be concluded as out of 323 total participants only 62.23% of the participants were having experience of working in Clinical Decision Support Systems as shown in table no. 2.

Digital Medical Imaging

The result of the study showed that the out of 323 study participant group having experience of medical practice of 6-12 months, 13.6% were utilising Digital Medical Imaging while who were having 13-18 months of experience, 15.2% were utilising, those having 19-24 months experience, 40.4% were utilising while those having 25-29 months experience, 16.7% were utilising and having above 30 months experience were 14.1% who were utilising. Finally, the group having experience 19-24 months, 40.4 % were using Digital Medical Imaging. When dividing it into two groups having less than equal 24 months and above 24 months of experience in medical field result showed the group having experience above 24 months, 71.20 % were practicing Digital Medical Imaging. Result may be concluded as out of 323 total participants only 61.3% of the participants were having experience of working in Digital Medical Imaging as shown in table no. 2.

Digital education and training, research and development

The result of the study revealed that during covid 19 pandemic all medical institutes were teaching, assignments and evaluation 100 % through online mechanism but after pandemic there are 100% traditional

methodology of teaching and learning. 60 % of the participants gave remarks in favour of online education considering it easier, more effective and efficient way as shown in graph no 3. The result of the study revealed that during covid 19 pandemic all medical institutes were teaching, assignments and evaluation 100 % through online mechanism but after pandemic there are 100% traditional methodology of teaching and learning. 60 % of the participants gave remarks in favour of online education considering it easier, more effective and efficient way as shown in figure no 1.

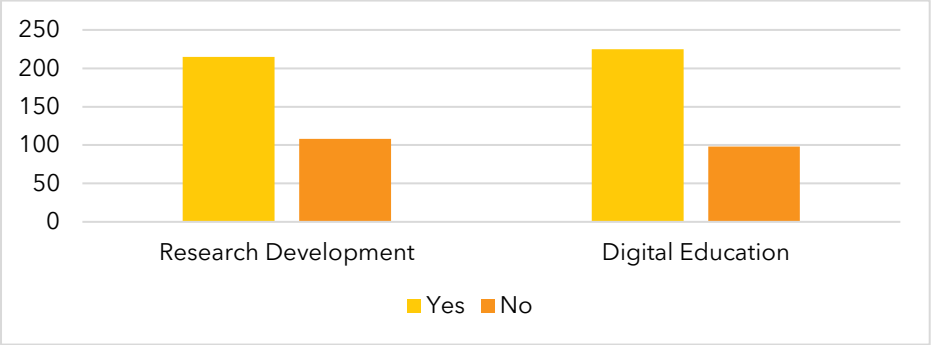

Figure 1. **Status of Opinion About Research Development and Digital Education**

Discussion

Telemedicine Practice

This study examined the usage of telemedicine. According to the research the telemedicine usage increased with the medical experience. 52% of the participants having 19–24 months of experience in medicine were practicing telemedicine. 41.1% of the physicians were using WhatsApp and 16.9% communicated with their patients on Facebook, while just 19.3% and 22.7% used laptops and mobile phones to search for medical information online respectively. 60% of doctors were ignorant of their legal duties while communicating with patients online. Telemedicine might save time, money, and effort, according to 80% of doctors. While another study found that the number of US telemedicine physicians increased from 20% in 2020 to 40% in 2021. After COVID-19 telehealth is spreading worldwide [19], and more than 50% of doctors used computers, mobile phones, and social media to engage with patients and stay updated on medical procedures literary assessments [20]. A Saudi Arabian study indicated that younger physicians utilise telemedicine more than those with 5–10 years of experience. As younger doctors are more technically elevated, they may practise more and use the internet to benefit patients [21].

Due to the advancement in information and communication technology the study's findings indicated that more than 50% of clinicians would be willing to practice telemedicine. These findings are corroborated by a research conducted in India, which revealed that more than 70% of doctors planned to continue utilising telemedicine at least periodically after the epidemic [22]. This is further supported by another study conducted in China that the physicians are most likely to have increased their telehealth use in the long term [23, 24]. Another study finding confirms that participants accepted telemedicine's advantages for a number of reasons, including its ability to save healthcare costs by reducing issues like needless emergency room visits, pharmaceutical abuse, and longer hospital stays [22, 25].

Other studies have found that up to 25% of patient-physician exchanges of information occur over the phone in settings like US internal medicine and UK primary care healthcare. This study agreed with the findings that phone consultations are the most common alternative to in-person consultations and may broaden access, convenience, and choice. Researches comparing the two methods of consultation show that patients were equally satisfied with both [26, 27]. Studies carried out in Brazil revealed that 18.5% of participants used telemedicine before to the pandemic but 63.6% of participants used telemedicine during the epidemic. Teleorientation and teleconsultation were the primary telemedicine techniques used throughout the epidemic [28, 29]. Less than a third of Polish healthcare providers utilised teleconsultations before to the epidemic, according to the same statistics. This is less than other studies have documented; for instance, in Saudi Arabia, more than half of the GPs utilised teleconsultation [30]. It can be stated that the COVID-19 pandemic has altered how telemedicine solutions are used in day-to-day healthcare work, raised interest in telemedicine, and compelled HCPs to quickly deploy teleconsultations [31].

Many studies found that Pakistan lacks a reliable telemedicine system. Medical students should learn about telemedicine so they can help implement it in the healthcare system. Telemedicine's usefulness and efficiency in diverse healthcare settings need additional investigation.

Electronic Health / Medical Record

This study revealed that 59% of individuals with more than 24 months of experience used EHR systems whereas 41% did not suggesting that clinical EHR system adoption and utilisation depend on exposure and familiarity. The research also stresses on the need of continued EHR system training especially for novices. In contrast a 10-year Indian study indicated that EMR use grew with time. Initially it was used for billing and inventories. EMRs improve patient tracking with time advancement. It is still difficult in transferring EMRs between medical institutions including pharmacies, labs, and specialists.

In 2018 Western Area a cross-sectional study showed the EMR's patient satisfaction rating was 3.7 which were significantly different from the PMR (p 0.001). Since 82.3% of patients believe doctors pay more attention to them during clinical consultations, they prefer the EMR system. According to respondent's consultations were lengthier in 80.4% of cases and tests and medications were better explained in 85.8% of cases. In presences of EHR, 84.0% of patients reported feeling better and ease in discussing their health with their doctor during professional appointments [34, 35]. This is also supported with research in Saudi Arabian that 81% of respondents claimed that their doctors treat them better when they have access to computerized health records. Also, it offers superior treatment (48%) easier scheduling (37%) and cheaper prices (50%). Moreover, Saudi consumers desire to digitally monitor and share their health information. This research brought attention to the value of digital health technologies, such as EHR, in providing Saudi citizens with high-quality healthcare [36, 37].

Overall, the study findings provide insightful information on the present level of healthcare professionals' use of EHR systems and point out areas for development in training and education to promote the uptake and use of these systems in clinical practice. There is a critical need for ongoing research to improve it.

Clinical Decision Support Systems

The research analysed clinical decision support systems that provide doctors with patient-specific diagnoses, treatment plans, and medication interactions. According to the study, 38.3% of 19 to 24-month-olds experience in clinical practice used CDSS. There might be several causes for this rise in CDSS use. Less seasoned medical professionals could be more open to using novel techniques and tools, like CDSS, to enhance patient care. Experienced physicians may not find CDSS useful since they have better knowledge and decision-making abilities. The fact that 64.2% of people with more than 24 months of experience utilised CDSS suggests that participant experience was not the main determinant of CDSS utilisation. This implies that CDSS use may be influenced by training, support, and familiarity with CDSS. The 62.23% CDSS usage rate within the participant group points to a discrepancy in CDSS adoption in the medical industry. Clinical decision-making, medical mistakes and patient outcomes may all be improved with CDSS systems. While Saudi Arabian researchers found many new factors that influence physicians' CDSS approval. They include accessibility, patient enjoyment, connection, communication, shared information, privacy, security, and perceived risks including functional performance risk and time risk. The study sheds new light on the many variables impacting doctors' CDSS adoption [38].

In primary care clinics managed by solo practitioners or physician groups, the utilization of Clinical Decision Support Systems (CDSS) varied from 68.5% to 100%, according to a US study. CDSS is utilized at 68% to 100% of primary care clinics that only use EMR/EHR systems especially for straightforward warnings about medication interactions and preventative reminders [39, 40]. While CDSS may improve patient outcomes and reduce healthcare costs, the study's findings have important ramifications for healthcare organizations and politicians. Nevertheless, the application of CDSS is hampered by insufficient training and device accessibility. To increase CDSS acceptance and utilisation, healthcare organisations should give physicians priority in their training and support. To use CDSS and improve patient care, policymakers must also regulate healthcare companies. Future research may assist in removing adoption hurdles by examining clinicians' CDSS adoption and usage [41, 42].

Digital Medical Imaging

Clinicians may take, preserve, and display X-rays, CT scans, and MRIs using the computer based DMI tool. By medical background, DMI usage varied. DMI was utilised by 13.6% of people with 6-12 months of experience, compared to 15.2% and 40.4%, respectively, for those with 13-18 and 19-24 months of experience. For individuals with 25–29 and more than 30 months of experience, the DMI utilisation fell to 16.7% and 14.1%, respectively. Further research found that DMI was utilised by 71.2% of people with over 24 months of expertise vs 28.8% of

those without such experience. The survey discovered that 61.3% of participants utilised DMI, indicating a gap in acceptance in the medical sector.

Academic Radiology illustrated how radiologists' work-life balance has changed due to rising radiological imaging demand. Mayo Clinic imaging demand increased tenfolded from 9 million in 1999 to 94 million in 2010. Radiologists' workload has increased from 2.9 images per minute in 1999 to 16.1 in 2010. Radiologists review one photo every three to four seconds to meet demand. This highlights the increased use of digital medical technology [26]. Medical technology has improved patient outcomes. When healthcare providers and technology corporations combine to create and adopt new medical technologies, we may expect more advancement [43].

Given that DMI may boost diagnosis accuracy, improve patient outcomes, and lower healthcare costs, these results have significant policy and organisational implications for the healthcare industry. In order to improve the uptake and application of DMI, healthcare institutions should think about offering professionals training and support.

Digital education and training, research and development

This study suggests that all medical institutions used internet resources for education, homework, and evaluation during the COVID-19 pandemic. After the pandemic, all schools resumed traditional instruction. 60% of participants felt online education was easier, more effective, and more efficient. This study shows the benefits of online learning, especially given the pandemic's disruption of traditional teaching methods. Online learning allowed students to study without risking the virus and allowed institutions to employ technology to better education. As 60% of participants chose online education, colleges may want to consider adding it to their curriculum following the outbreak. This analysis was supported by a state-wide survey that indicated low adoption rates for online learning in higher education throughout normal academic years. During pandemics, 22.5% of medical schools and 26.9% of dental schools provide online learning, compared to 19.5% and 17.3% during academic years. These numbers show that few colleges offer online courses year-round [44].

Another study showed the usefulness of digital learning, also known as e-learning, web-based education, interactive learning, computer-assisted teaching, and internet-based learning. Web-based educational technology has grown due to a considerable drop in cost. Several colleges now see e-learning as essential to their educational system [45, 46]. These problems related to online education might have a negative impact on how well teachers present the lesson materials. However, a separate survey carried out in Bangladesh revealed that 94.9% of students used various e-learning tools, approaches, or platforms [47].

In impoverished nations, digital health may enhance surveillance, literature, education, knowledge, and research in addition to healthcare. While Kenya, Uganda, and India have adopted digital health policies, the desired results have not yet materialised. Digital health efforts in these nations are hampered by a lack of government support, funding, and stakeholder involvement. Non-governmental organizations with donor funding usually launch d-Health programs without research [48-49].

Technology improvements over the last ten years have significantly changed the healthcare industry. The delivery, documentation, and management of healthcare have been completely transformed by the combination of telemedicine, electronic health records, clinical decision support systems, digital medical imaging, and digital education and training. While these technologies provide a wealth of potential, they also present substantial obstacles that must be overcome in order for them to be successfully implemented. In order to guarantee the efficiency of these technologies, it is crucial to understand that their adoption must be customised to the particular requirements of each healthcare institution. The healthcare sector can continue to use technology to improve patient outcomes, expedite procedures, and raise the standard of care by investing in ongoing research and development.

Conclusions and Implications

The development of electronic medical systems has completely changed how healthcare is provided on a global scale. Yet, the adoption of such systems is still in its infancy in underdeveloped nations like Pakistan. This study sought to examine the practical elements of how electronic systems might operate in Pakistan's future medical profession, as well as the possibilities and problems associated with putting these systems in place and prospective solutions for improving and optimising their effects on results conclusion and implication are:

1. Electronic systems may significantly improve the quality and efficiency of healthcare services, improve patient outcomes, and diminish healthcare costs in the healthcare sector.

- Implication: In order to increase patient outcomes, diminished healthcare costs, and improve the quality of healthcare services, healthcare practitioners and policymakers should emphasise the adoption and deployment

of electronic systems.

2. The adoption and implementation of electronic systems in healthcare practices in Pakistan are hindered by a number of factors, such as a lack of resources and infrastructure, restricted access to technology, a lack of technical experience, and opposition to change among healthcare professionals.

- Implication: In order to successfully implement electronic systems in healthcare practices in Pakistan, stakeholders must address the problems that have been identified, such as investing in infrastructure and resources, granting access to technology, helping healthcare professionals become technically proficient, and dealing with change-resistance.

3. To encourage the use and deployment of electronic technologies in healthcare practices in Pakistan, policy changes and investments are required.

- Implication: To encourage the adoption and deployment of electronic systems in healthcare practices in Pakistan, policymakers must prioritise investment in policy changes.

4. In Pakistan, there must be opportunities for ongoing growth of computerized health systems.

- Implication: To raise the standard of medical treatment and patient outcomes, Pakistan must constantly look for chances for the development of electronic health systems.

5. The sustainability of the adoption of electronic health systems in Pakistan depends on cross-sectoral cooperation.

- Implication: To guarantee the sustainability of electronic health systems in Pakistan, a cross-sectoral cooperation between healthcare professionals, decision-makers, and other stakeholders is essential.

6. For Pakistan's healthcare system to operate effectively, equity must be guaranteed in all areas.

- To ensure that all facets of the population have equal access to healthcare services and resources, equity must be a guiding concept in the development of electronic health systems in Pakistan.

7. For healthcare practitioners to become technically proficient and to encourage the adoption and deployment of electronic health systems in Pakistan, training and development programs are essential.

- To provide healthcare workers in Pakistan with the technical know-how they need to adopt and deploy electronic health systems, training and development programs are required.

Inadequate infrastructure, technical expertise, computer literacy, and healthcare professional resistance make these systems challenging to implement. The findings include improving infrastructure, educating healthcare workers, increasing patient computer literacy, and implementing privacy and data security regulations to maximise their impact on healthcare outcomes. There is a dire need for international support to achieve the global standard in electronic health care system.

Sample Size calculation

Population size (for finite population correction factor or fpc) (N):	2000
Hypothesized % frequency of outcome factor in the population (p):	50%+/-5
Confidence limits as % of 100(absolute +/- %) (d):	5%
Design effect (for cluster surveys-DEFF):	1

Sample Size (n) for Various Confidence Levels

Confidence Level (%)	Sample Size
95%	323

Results from OpenEpi, Version 3, open-source calculator [50]

Declarations

Author contributions

All authors have sufficiently contributed to the study and agreed with the results and conclusions.

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Ethical statement

This study does not require IRB approval as it does not involve human subjects/data.

Declaration of interest

No conflict of interest is declared by authors.

Data sharing statement

Data supporting the findings and conclusions are available upon request from the corresponding author.

Data Availability Statement

Data sharing not applicable: Data sharing is not applicable to this article.

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