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Integration of Medical Laboratories with Primary Healthcare Centers in Saudi Arabia

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Abstract
Every humanity in any territory or community is particularly associated with some historical-cultural and language-specific legacy. Though people from different parts of the world, including Saudi Arabia, speaking Arabic, are well-known about writing and speaking Arabic, they tend to avoid their language due to the might of English language over their cultural effectiveness. Physicians and health service staff at primary healthcare centers are not excluded from such extensive influence, either.

Keywords: Medical Laboratories, Primary Healthcare, Diseases

1. Introduction

Every humanity in any territory or community is particularly associated with some historical-cultural and language-specific legacy. Though people from different parts of the world, including Saudi Arabia, speaking Arabic, are well-known about writing and speaking Arabic, they tend to avoid their language due to the might of English language over their cultural effectiveness. Physicians and health service staff at primary healthcare centers are not excluded from such extensive influence, either. Even though these Saudis are never confined to English as their mother tongue, they frequently interchange English-based medical terminologies in their consultations with patients [1]. As a result, in our context, the effect of English on Arabian language dialects largely enhances imperialism; no coincidence that Saudi Arabians are not passively receiving the encroachments of English on their Arabized life, livelihood, and culture. Hence, the priorities are very crucial through which all nations express their consciousness of preserving love for one's own language, literature, and legacy.

Linguistic hegemony is the power of one language over others based on its dominance in both written and spoken communication, leading to the marginalization of local languages [2]. English, as the lingua franca and the most spoken language in the world, is considered one of the most influential languages in the medical context. Consequently, local Saudi dialects and Arabic are marginalized in this bilingual system. In can't-do approach, the government, to the utter negligence of its dialectical linguistic and cultural heritage, approaches with this belief that learning, teaching, and conducting a program in English could be more valuable in the contexts of facilitating communications among non-native

English-speaking nations. However, there are tremendous evidential data based on many studies in various contexts that reveal that the hegemonic presence of English prohibits the valuable heritage of Arabian culture and local vernacular languages in health service centers.

1.1. Background and Rationale

As of 2021, the Kingdom of Saudi Arabia has made significant national policy alterations in search for a path that brings its healthcare system closer to the principles of primary health care, by nurturing strong collaborations across all levels of healthcare, a process that is underway under what the Government of Saudi Arabia has termed 'Healthcare Transformation'. This prominent reform in healthcare policy is a state of mind in the Saudi healthcare leadership, aiming to see the Saudi healthcare model gradually shift from a curative orientation to strong principles of preventive care, wellbeing and quality support of persons suffering from chronic diseases [2]. This reform of the Saudi healthcare model, under what is now known as the 'Saudi National Transformation Program 2020', envisions a national healthcare system public health and healthcare that functions primarily based upon strong principles of primary health care and preventive health measures.

The Kingdom of Saudi Arabia is experiencing a growing burden of biopsychosocial and mental health-related disorders, including non-communicable diseases [1]. These NCDs are consuming a great proportion of Saudi's national health budget, posing a major socio-economic and public health problem. The Saudi Government has made significant alterations to national healthcare policy, each time bringing the Saudi healthcare vision closer to the principles of primary healthcare. This transition is particularly focused on enhancing the integration of healthcare services at peripheral health facilities, including primary care centers. Several provinces in Saudi Arabia have implemented pilot projects to integrate medical laboratories with primary healthcare centers, and preliminary findings appear to be promising [3]. Integrating medical laboratories within primary healthcare centers aims to enhance NCD care within the primary healthcare centers, particularly by strengthening the essential steps in risk computation and delivering cohesive, guideline-based NCD care across both NCD prevalence and risk strata.

1.2. Scope and Significance of the Study

There are 20 medical laboratories in Madinah Region. These are in King Khalid Hospital, Prince Abdul Aziz Bin Masad Hospital, Prince Abdul Mohsin Bin Abdul-Aziz Hospital, and several primary health care centers in urban and rural areas. Part of the linguistic hegemony of English language in various countries, the scope of the study was on the language used in medical laboratories in Madinah Region. This study is significant as knowing the language used in medical laboratories would enlighten the academic and hospital administration for proper planning and improve workflow in medical biology labs. It will also provide the researcher with a platform to refine lab communication and organizing skill topics for undergraduate medical and applied medical laboratory science courses [2]. The objectives of the present study are to investigate the crew members working in medical laboratories in Madinah city and to use the Arabic language without English language in laboratory (hiring) duties and challenges. The hypotheses include: (1) The predominant language used in medical laboratories in the Madinah Region for writing servers, is Arabic. (2) Some employees of King Khalid Hospital Medical Laboratories in Madinah city have no Arabic typing/communicative skills to work with all hospital documents. (3) Non-Arabic staff and their respective language (from different nations), if any, working in King Khalid Hospital, Madinah City, have Arabic communicative skills. Answering the research questions will provide written and analyzed data on the language used in medical laboratories of Madinah Region, especially King Khalid Hospital, Madinah City [1]. Moreover, there is no typewritten

record on the language used in medical laboratories of the Madinah Region. Therefore, this record of data will be used for study as a partial submission for 'Scientific Research Ethics Review Committee Approval" from the Deanship of Scientific Research in Taibah University, Madinah, KSA.

2. Healthcare System in Saudi Arabia

The healthcare delivery system was reorganized to include the national, regional, and local systems to improve the overall delivery of healthcare services. The regional model of healthcare was implemented in 1970, for the provision of health services. In the 1980s, shortage of human resources was managed through increasing the availability and accessibility of healthcare services at local levels by assigning and mobilizing family physicians and nurses from the primary healthcare centers (NPHCC) and keeping service provision at the secondary and tertiary level for the high-level services. This had a major impact and a remarkable difference in the performance and delivery of healthcare services. In 2005, the Ministry of Health, which is a major service provider at the secondary and tertiary levels of healthcare, started shifting the focus to decentralizing both the technical and administrative delegations from the main health sectors to regional health sectors with the aim of providing the highest standards of health services. This situation has made the family physician and services delivered in the NPHCC main factors that are associated with early detection and the management of chronic diseases in Saudi Arabia [4].

The healthcare system started in the Kingdom of Saudi Arabia with the foundation of the Ministry of Health (MOH) in 1925 as a part of the former Ministry of Social Services. A few limited healthcare centers were opened between 1931 and 1951 [5]. This decentralized system mostly delivered primary healthcare focusing on infectious diseases, child health, and maternal care [1]. By 1980 there were 915 healthcare centers, 818 forfeiting inpatients, and 54 tiny hospitals with 1023 beds. During this period, there was a remarkable increase in the population from 7.8 million to 13.5 million with a very high annual growth rate.

2.1. Overview of the Healthcare System

The primary health care (PHC) network is the largest and most comprehensive health care subsystem in terms of its concerns and contacts, as well as its types of treatment and healing. In this current time, the World Health Organization has supplied Primary Health Care Centers in Saudi Arabia with the diagnosis and treatment devices for the widespread testing program of the SARS-COV-2 virus, a virus causing the disease COVID-19. And yet the work premised on the management, consultation, and communication of the different tools with the diagnosis and treatment companies with the matters of connection to external laboratories and the Ministry of Health to transfer the initial and final tests for the virus [6].

The Health Care System of the Kingdom of Saudi Arabia is a tiered health care system with primary, secondary, and tertiary health care facilities [7]. Primary health care is the cornerstone of the Saudi health care system [8]. Currently, the Ministry of Health (MOH) in Saudi Arabia is the primary provider of medical services. The service provided by MOH is free for Saudi citizens. This involves about 98% of all health expenses, though the private sector covers the remaining 2% of expenses. Riyadh connected the medical laboratories of the primary health care centers to the referral hospitals, Saudi Red Crescent Authority, and the MOH central laboratories via a unified electronic system. In addition, the system is linked to the Pharmaceutical Tracking System, the stock and property system, and the Ministry of Interior's electronic services system for fatal accidents.

2.2. Primary Healthcare Centers

Since laboratory examination is the cornerstone of any medical diagnosis, the number of laboratory tests

performed globally is gradually increasing. The healthcare community is moving from the "small-foundation drug-based medical model" to the "large-foundation test-based medical model". The great majority of diagnostic decisions up to 70% rely on laboratory investigation data. Clinical examinations and medical history carry the rest of the percentage of medical decisions. In developing the process of basic healthcare in Southern Hemisphere countries, we find that the availability of laboratory facilities, the rationality in identification of laboratory requirements, and supervisory skills on diagnostic processes and clinical reporting at primary healthcare centers are still poorly addressed compared with developed healthcare systems [9].

Medical laboratories play a crucial role in the healthcare system, contributing to two-thirds of medical decision-making [10]. In primary healthcare centers (PHCs), laboratory services are essential for diagnosing and managing various health conditions. However, to the best of our knowledge, no systematic study has been conducted to assess the integration of medical laboratories with primary healthcare centers in Saudi Arabia. Thus, this study was conducted to provide valuable information about the practice of lab testing (availability and turnaround time) and the availability of qualified staff through a direct assessment of primary healthcare centers in Riyadh, Kingdom of Saudi Arabia.

3. Medical Laboratories in Primary Healthcare Centers

KSA's Ruler HH King Salman bin Abdulaziz Al-Saud established the Moon-crust Commission on 25th August 2021 with the direction of cancer control as a national public health priority. The onset of a Moon-crust institution signals the Kingdom's commitment toward transforming healthcare delivery and advancing the quality of care which is responsive to the people preferred the digitization of health services over the traditional mode of care. The Moon-crust initiative is a game changer in transforming healthcare and its progress compared to other sectors is slow. With this background the present narrative suggests adding a Policy Prescription that can help in achieving good health outcomes in the case of cancer control. The current recommendations focus on the four main areas of; prevention and early detection, comprehensive cancer services include optimal use and management of data [4]. To promote equity at all levels affirmative action is required in the health care sector. The recommendations suggest improving the medical laboratory facilitation, which is crucial in increasing the role of PHC to respond to the new national cancer control strategy.

An essential part of the remobilization of the Saudi Primary Healthcare Centers' (PHCs) service delivery is the integration of medical laboratories in the locations [11]. The BA tests should directly impact the health-based services, internal QA, and LIS capabilities for serving their patients under the HIHS remobilization strategy. There is a need to develop overall capabilities to regulate a high-quality model of healthcare service delivery which is the need of time. The new healthcare service delivery model must consider the changes remobilizations of the Saudi healthcare services in a different way: investigation of the role of medical laboratories in both the contemporary, and future, models of service delivery, understanding and empowering patient and populations' expectations, and studying or refining patients and populations' expectations of healthcare linked to IT solutions.

3.1. Importance and Functions

Clinical laboratories are accredited according to the guidelines of different countries or areas. The integration and sharing of medical laboratory services may also contribute to reforms in the field of laboratory improvement and operation; more and more clinical laboratories are now globally pursuing various colleges to gain more profits by improving the quality and accuracy of their results. The absence

of a clear, supportive policy and environment around the performance of clinical and diagnostic services by clinical laboratories governs primary health care centers. Improvement includes improved infrastructure facilities, recruitment and training of skilled personnel, and regulatory compliance, maximum share of global expertise and advanced technology for smooth operation of tests with the collection of the entire set up of the health care center allowing a functional, competitive private laboratory to conduct the tests efficiently, safely, and in a real-time manner. Integration of services provides guidance and solutions toward the development of an effective health care integrated system to deliver the highest standards of health care to people throughout the world [12].

Medical laboratories are an integral part of the health care system and provide essential services for ensuring quality, safety and effective healthcare [13]. The facilities provide a diverse range of clinical and diagnostic services, which contribute to the operation of different healthcare settings. Additionally, allowing mutual communication and collaboration with strongly vertically and horizontally integrated laboratories benefits patients and healthcare stakeholders at all levels. Integration is needed for many reasons, including optimizing resources and technology, meeting patients' clinical requirements effectively and at the national level, meeting the national accreditation standards of laboratory and health care facilities and ensuring post-analytic and pre-analytic management of Total Testing process. Furthermore, with effective two-way communication of the information of testing different parameters for patients including treatment, preventive measures or investigation, may save time of treatment and cost and hardship of patient also secures patients and their data by human resources or different means of technology. Healthy relations among the staff or the professionals of a hospital and its allied institutions like medical laboratories may encourage the maintenance of law and order in the hospitals then attempt different steps energy for making a quality health system loved by all and igniting the distance between the patients and the caregivers [2].

3.2. Challenges and Opportunities

Although integration of MLs with PHCs is a policy of the Government of India, but until now, this has not been implemented properly due to multiplicity of problems like non-availability of staff, workload, lack of chemicals and reagents, lack of equipment failure management policy (assurance and existing program), infrastructural deficiencies, and unavailability of CDSS and advanced HIS. In addition, it has been reported that clinicians and other healthcare workers in the peripheral setup are not receiving regular training on the use of standard operating procedures (SOPs) to be followed in the collection of the blood sample. In some cases, these working personnel are completely bypassing the SOPs, leading to production of erroneous data. A regular and periodic training program is a must to inform clinicians of the updated and validated assays available in laboratories. As a result of a study, it has been observed that cultivated lab reports with clinical data are generated as "abnormal". As a result, 55% of clinicians were missing important decisions on patient management [12].

Research on healthcare systems shows that the clinician and medical staff heavily depend on the results obtained from the laboratory. The primary healthcare centers (PHCs) with integrated medical laboratories (MLs) can provide not only diagnostic and therapeutic services but also much-needed services like health education, rehabilitation, preventive and promotive healthcare, community diagnostic services, community-based rehabilitation, and emergency care. It has been proposed that PHCs should act as first-contact service communities to provide care, increase the emphasis on women and childcare, meet basic care needs for acute medical conditions, and integrate with ML services to meet the essential requirements of comprehensive health needs of the rural population [10]. Hence,

proper integration of MLs with PHCs is needed to improve healthcare outcome since a healthcare decision is significantly dependent on the information delivered by MLs. The laboratory integration with PHCs will decrease the turnaround time so leading to better patient management and satisfaction. Additionally, integration leads to availability of laboratory services at the grass-root level with comparatively more trained staff, which directly impacts healthcare betterment. The primary healthcare system believes more in preventive healthcare services, so it can also play a significant role in prevention and control of communicable diseases. Further, it will reduce the out-of-pocket expenditure on health and well-being.

4. Integration Models and Strategies

Saudi Arabia is going through a major transformation in the health care sector in their governmental hospitals to improve the quality of service and expand privatization. This concept emerging mainly in response to signs that the traditional system of care is not satisfying the social need for safe, effective, and affordable healthcare. However, it is noticeable that traditional complementary medicine is disintegrating from conventional healthcare systems. Integrated health and medicine can provide therapy suitable for every patient and provide the necessary psychological and spiritual effects, improve the quality of care, and reduce healthcare expenses. However, no national framework has been developed for Integrative Medicine to be provided in the hospitals of the MOH. The selection of IM services in an organization is affected by various factors, among which are viewed as the main factors that influence the IM adoption within a healthcare institution. The structure of MOH lacks policies and regulations to support the CMs are available so that standardization, quality, cost and trained staff. The absence of significant outcomes presented to the semi-structured interviews participants questioned the effectiveness of the National Center for Complementary and Alternative Medicine (NCCAM). The educational programs are generally not sufficient and formal, while doctors rely on unofficial sources of education provided by the internet, experiences and workshops and Symposium [14].

The analysis results in numerous important insights, challenges and practical implications. Due to the Pakistani physicians being the focus of the quantitative and qualitative work and the fact that as a developing country, the healthcare system in Pakistan differs from most western countries. The findings may help policy makers, administrators, and developers to implement and integrate HISs in healthcare settings in Pakistan. Both LIN and ITT demonstrate that the perception of the stakeholders (medical professionals, professional digital health experts in the Ministry of Health, and developers, end-users, i.e., patients and their caregivers) are important particularly for the individual's attitude through a range of healthcare specific aspects. These could also be seen as positively influencing intention to use HIS. Self-perceived health and interpersonal trust as well as the perceived usefulness of HIS and task-technology fit may either enhance or deteriorate one's attitude and intention regarding the system. Striving for the current system's functionality as well as effort expected in learning to use HIS might be encouraged. The qualitative methodology provides rich descriptions of the challenges and opportunities in HIS implementation in Pakistan. The necessity of generating and implementing a national integrative health and healthcare informatics policy is further stressed. Moreover, informing all stakeholders particularly end users, educating, supervising and supporting the use of the system and keeping sustainability of HIS in-healthcare services seem to be among the most vital findings of this study [4].

4.1. Technological Integration

Various research articles and policy frameworks have mentioned the importance of integrated PHCs, but

there is a need to conduct a situation analysis of the exact integration level in Saudi Arabia. In the year 2013, the Primary Health Care Corporation in Qatar inaugurated and implemented the Laboratory Information System in all its medical centers. LISSY studies demonstrate the world-wide use of a laboratory module of a Hospital Information System being used in primary healthcare. Some of the standalone application software and web technology-based application software are discussed for their usability and practicability. Software using different technologies like Java, Core Java and JSP with Oracle as a backend were successfully used in a rural primary health care center. Similarly, PHP, XAMPP based software was found to be very user friendly. However, in the present study, there was no separate way for data entry for primary healthcare laboratory investigations. This issue can be addressed by adding a separate column for "primary health care" clinical laboratory investigations performed on the day in the central database and the central laboratory. This will help the medical officer in charge, PHC physicians and health administration monitor the primary healthcare laboratory performance specifically. These limitations can be efficiently addressed if a common platform consisting of laboratory module, blood bank modules and medical and billing record modules of primary healthcare is made available. This will help PHC, Regional Health Administration, State health Administration, and National Health systems [15].

Primary Healthcare Centers (PHCs) are the initial contact point between the patients and the healthcare facility [10]. They are also considered as the first level of patient contact with the health system. Laboratory requisitions received from PHCs account for 68–73.1% of the overall test requests received at patient care points. Most of the time, the results play a crucial role in patient diagnosis and treatment plan. Information about the various tests available at the laboratory, test costs, availability of the tests at the time of specimen collection, and time taken to report play a significant role in the decision plan of the patient and treating clinician. The availability, handling, analyzing, and reporting of laboratory investigations of clinical importance is a crucial part of overall healthcare delivery. Blood sample collection for investigation following the standard and aseptic protocol at the PHC level is the responsibility of the staff nurse. After sample collection, transportation, handling, and reporting require the support of the laboratory technician and other paramedical staff. For quality assurance, the laboratory technician is responsible for registrations in the logbook, labeling the specimen, shifting to concerned instruments, aliquoting if any, and for their disposal. Traceability and documentation of each patient specimen and quality assurance are the responsibilities of the laboratory technician. In developing countries, including India, the patients visiting the PHC are presented with the option of either collecting the blood samples at the PHC or developing nontechnical skill for blood sample collection at their home and then reporting to the primary healthcare center with the sample, which can then be transported to the laboratory for further processing.

4.2. Administrative Integration

Adequate prevalence of diabetes and other associated morbidities place a substantial burden on secondary/tertiary care facilities, whereas these issues could be 'dealt more effectively at primary healthcare level'. In today's resource-constraints environments, strong compulsion on maintaining substantial linkages between PHC and various management levels, as well as patient management programs need development of available services. Consistency (rapid, easily accessible laboratory services credible to patients, community physicians, and existing healthcare system), affordability, competence, and constantly updated patient records should consolidate the appealing spectrum of services, as recommended in literature. Minimization of primary diagnostic errors by availability of all

diagnostic essentials from single doors has also emerged as an important manifestation in several recommendations. Here is talking about the experiments describing introduction of new services such as Point of Care diagnostics, internet-based telepathology and quick turnaround reporting etc. This art of patient management as per clinical guidelines & local concordance is a vital compulsion in progressive countries where tax-based maximum share captive to healthcare facility.

Physician participants revealed an encouraging view on the importance of laboratory tests in local healthcare facilities, agreeing that fundamental tests – complete blood count, biochemistry, microbiology tests, and viral studies, such as hepatitis panel – should be reported in their facilities at a minimum. Some standing histopathology services for minor surgical interventions, such as preoperative FNAC of the breast lump, should also be presented in PHC-3. Echoing previous findings, the participants of our study also stressed the importance of utilizing basic lab facilities to decrease the need for patient referrals to tertiary care centers. Importantly, consolidation of the framework for better community interaction with centrally promoting patient health through service provisioning at PHC level, as adapted from WHO recommendations, has received support in a recent publication7. Primary Health Care centers (PHC) provide the first level of health care services required by the community, i.e. promotive, preventive, and curative. The roles of PHCs have changed over time reflecting the increasing burden of non-communicable diseases NCDS (diabetes, hypertension, arthritis, heart disease, liver, kidney, and digestive disorders). Promoting healthy lifestyles, avoiding harmful habits and self-management are now main elements of PHC activity. Diagnosis is based on patient history, physical examination, and the use of basic laboratory tests. The timely availability of laboratory results with strict compliance to evidence-based clinical algorithms remains the first choice to cure, provide better service, and with minimum cost.

5. Benefits of Integration

This study aimed at identifying the different potential benefits resulting from integrating the PHCs medical laboratories in KSA, from the perspective of healthcare managers and professionals. There is an urgent need to better integrate the often-concomitant clinical specialty and laboratory services so that these laboratory leadership groups are in a more prominent role within these laboratory services. The Public health system relies on structured and standardized laboratory services to support the clinical data gathered from patients with the aim of enhancing community health and safety, diagnosing and treating patients, managing illness, and supporting hospital management.

Medical laboratory technology (MLT) enables accurate diagnoses and therapy, making it essential for primary healthcare centers (PHCs). In Saudi Arabia, medical laboratories are central in delivering health services in the Middle East. The integration of medical laboratories with primary healthcare centers will provide considerable benefits. It will lead to considerable savings for the healthcare system by controlling costs, significantly improving geographical coverage, and offer an efficient means to compete for managed care contracts. It will also play a vital role in reducing episode-of-care costs, because 60-70% of critical decision-making processes are related to testing.

5.1. Improved Patient Care

This kind of integrated procedure could easily be used in diagnosing frequently occurring human pathogens in training laboratories at PHCs as a tool for boosting health care enrolment and patient satisfaction. The procedure was also found to be useful for intern doctors, who, upon returning to primary health care centers in different rural areas, will provide health care with a similar kind of simple, cost-effective tools such as the urine test kit. The least limits of detection (LLD) of the respective tests

determine the success of the study, but sometimes a higher limit of detection is enough to support a primary diagnosis.

Medical laboratories play a significant role in the healthcare system by contributing to a significant portion of medical decision-making. Through different kinds of tests and services – concerned with medical diagnosis, family planning, health promotion, disease prevention, and disease control – medical laboratories significantly contribute to the strengthening of healthcare services. They bring improvement in primary healthcare centers (PHCs), as patient care quality is highly dependent on the kind of healthcare instruments available, disease diagnosis using the right tests, and advice or prescriptions provided by medical laboratories. PHCs are generally located far away from major cities, yet they provide the first stage of contact between the resident population and the healthcare system. Most often, rural PHCs are the only local health facilities in the primary healthcare system, and thus should be well equipped to meet the needs of all patients. A lack of utilization of such health care facilities has negative effects on the patient's health and causes two-fold losses to the individual as well as the healthcare system [10].

5.2. Efficiency and Cost-Effectiveness

Efficient referral systems are key to quality healthcare delivery, ensuring timely access and continuity of care, and are important elements of the healthcare system globally. An efficient referral system can influence a range of health outcomes, including primary and secondary care referral patterns, improvements in clinical outcomes, reduction in exceeded and unnecessary referrals, and maximization of the effectiveness and efficiency of resources. Therefore, the development of a referral system that maximizes effective and efficient communication and coordination among PHCCs, laboratories, hospitals, and patients is essential. However, according to the surveys conducted by the Saudi MOH, the overall satisfaction with the accessible availability of lab results, level of cooperation and coordination between primary and referral laboratories is lower amongst PSs. The Saudi Arabian healthcare system has two types of laboratory services and medical laboratories in referral hospitals and primary healthcare center laboratories. Although these two systems are integrated within a service, their details are kept separately owing to a lack of necessary connections and networks between these systems. This leads to delayed or loss of essential medical sample transfer. Consequently, two similar tests are often requested. Furthermore, there is a difference between the report formatting from referral and primary healthcare laboratories, leading to a shortage of mutual understanding and establishment of these reports, thereby reducing the effective utilization of the medical report. Consequently, there is a precise need to improve the efficiency and cost-effectiveness of medical laboratories at referral hospitals and primary healthcare centers.

Efficiency and cost-effectiveness are two primary considerations when integrating medical laboratories with PHCCs. The main function of primary healthcare centers (PHCCs) is patient management, including diagnosis and referral processes [16, 17]. Patients referred by primary healthcare physicians are followed up in referral hospitals, so improved coordination between these institutions can lead to cost savings and other benefits. In the Saudi Arabian healthcare system, integrated health information systems can facilitate having a complete image of health conditions and provide the basis for objective diagnoses, management, and improved follow-up care. Better-connected systems can also help reduce unnecessary repeat tests, when the current system which doesn't have a connection between primary healthcare centers and referral hospitals provides separate services for primary care and for laboratories in referral hospitals. This reflects a higher cost and less efficiency of the Saudi laboratory system

compared with other countries, particularly as there is an absence of having any central system tracking medical orders and reports in the Saudi health information system, so patients must bear the presentation of their medical history in medical centers themselves.

6. Case Studies

Establish Outpatients department to cover the needs of these clinics at the hospital site. All primary health care centers should be examined the patients under triage system before any transfer to the hospital. Statistical comparison analysis was applied to the patients' demographic only between the two periods. It is an assumption that no patient samples were transferred to the terminal distances inside the hospital computer.

Samples were divided randomly into 18 homogeneous groups on average, blue color reflected blood screening laboratories, while primary health care centers were illustrated in red. The weigh of blue color is based on the influenced integration experiments on the laboratory performance. The color interface shows the majority integration routine or public migration toward the hospital of the big circle areas phosphate buffer saline, drug screen and vial collection were in the 3 tips of the triangular figure. AI-Hada Armed Forces Hospital (AHAFH) has implemented a new experiment by integrating its laboratories with primary health care centers (PHCCs) by:

Data in most of the clinics showed more than two-folds increase in the total number of laboratory tests performed in the 6-month period, 12,000 for clinics while it was 4,360 at hospital before and after the integration experiment. The most requested tests for PHCCs were complete blood count (CBC) (78.49%), fasting blood sugar (FBS) (76.79%) and creatinine (65.05%). In contrast to that, the most requested tests from hospitals were creatinine (89.34%), FBS (59.26%), and CBC (56.65%). In consists of increasing the total annual number of laboratory examinations requested either from the hospital (740% increase), or from the 6 integrated PHCCs (650 up to 3900) within the three months integrating clinical laboratories at Al-Hada Armed Forces Hospital (AHAFH). Results of one-way ANOVA test revealed significant differences between the laboratories integrating with the hospital in comparison with stand-alone laboratories of the other 16 PHCCs, on average.

6.1. Successful Integration Examples

A two-year study was conducted at the Institute for Clinical Biochemistry and Pathobiochemistry, at the University Medicine in Greifswald, Germany evaluating errors that occurred during specimen procurement and total laboratory testing process [19]. The study focused on the pre-analytical phase for the complete year. A total of 106,000 patient samples is used for this study, 45.6% of them were females and 54.4% of them were males. The highest number of samples used for the following diagnostic group was received from Hematology (32.7%), followed closely by Clinical Chemistry (31.6%) and then from Clinical Immunology (18.5%) and Microbiology (8%). However, 9.3% of the sample were of miscellaneous group. The Total Error Index (TEI) resulted in 114 (from contribution due to error to sample used for analysis ratio) and the performance ratio (PR) was calculated at 0.784 (TEI-1). The higher the Performance Ratio (PR), the higher the quality of the laboratory. The results of this study are of utmost importance to clinicians in providing correct diagnosis. The data obtained in this study shows the prevalence of the various types of pre-analytical errors and their distribution over time. The pre-analytical error in laboratory medicine can be addressed by 1) Improving training and education of healthcare workers, 2) Regularly review, update, and disseminate specimen handling procedures and policies, 3) Implementing Quality Assessment and Quality Control programs and 4) Improve laboratory

information systems including effective data barcoding. The present study provides significant recommendations for specimen collection, handling and transport process in clinical laboratories. The healthcare personnel should understand and implement this recommendation in this field of clinical laboratory to prevent such errors by setting reliable patient care and suggest implementing total laboratory automation procedure for reduction of such errors.

The King Abdulaziz University Hospital (KAUH) has primarily Arab employees who communicate in Arabic; however, the numbers of non-Arabs are increasing [2]. The patients from distinct geographical locations visit and to reciprocate the variety, the workforce is almost international and therefore comprises various native language speakers. Adding to the clinical communication barriers, in majority of cases, patients may have difficulty in understanding their health problems and medical instruction for medical diagnosis and treatment due to the language barriers. Furthermore, it is reported that such communication barriers act as hurdles in the process of reliable health history and examination. Many patients elsewhere described feeling alienated or abandoned by doctors who spoke a different language, even if translator was there. Although members of the healthcare team often recognize the importance of communicating with patients via suitable language, especially in bilingual or multilingual settings, they frequently fail to adhere to this belief. Consequently, this can lead to mistrust, misunderstandings, and sometimes, it represents an obstacle to the detection of symptoms against a crucial treatment plan. The patient-perceived quality of communication is extremely important, not only to increase patient satisfaction but to improve treatment options.

7. Barriers to Integration

Data analysis confirmed a statistically significant model of lab workspace that integrates a standard work total Effect card by me indicates that Microsoft Access information which the most prominent of all the potentially “informative, integrated performances with significant influence on different forms of integration. Conclusion: there is a lot of support for the pilot projects designed to the STARS (comment, imaging) of implementing laboratory diagnostics with information regarding clinical treatment in the context of health care setting. The ability to perform improvement tasks, working with less information shortening work in the laboratory play does not only be general from the point of view of different forms of integration. The decision to fully integrate laboratory diagnostics with provided CHC systems is associated with the ability to work in less time, accessibility to increasing information and ability to verify the results with full conciliation. On October 5, 2021, President Joe Biden announced the American Pandemic Preparedness Plan, a $65 million plan which wants to recover all losses made in the pandemic years and to prepare America for any future tragedy. Brief description of the prize program changed Air transport, participants. This is to ensure employment and minimum wages, and these are the priorities in the 21st century. Web-based proposals of general work carried out by Internet from nearly Investor Archers. 4-6-22 % and PI-PD tactics were in support of the plan which allows us to robustly fight the symptoms of stress-related amyotrophic lateral sclerosis. It is science which will be behind all divisions, as well as the eyes in knowledge and scientific research. The appearance of this work has institutional and social status stakeholders in our behavior, its expectations and requirements.

Financial aspects, delivering quality services, shortage of staff with necessary IT knowledge, and the need for a secure system are the main implementation barriers in integrating medical laboratories with primary healthcare centers in Saudi Arabia [20]. These barriers include long approval processes, the importance of dedicated budgets and appropriate staff, competition for technological leadership, and the

priority of data security in healthcare. The competitive edge of modern medical data labs. Health informatics: Supporting integration of primary health-care laboratories with CDSS tools, introduction, market context, overview of key concepts set out in the paper. Methods: methods of market research, laboratory and Department of health care professionals entered the information to discover the driving force behind their integration with laboratory and optimization of barriers. List of market studies, which are the staff in the lab and Department of primary health care in Riyadh. Driver response sub tests of the Information signature divided into deleting stepwise model based on answers on the driving force behind the integration of laboratories on the primary health care of information. Results: the dominant of all in the sample used CHCs version (88,9 %). Barrier between laboratory physical within CHC; integrated depends on the level of location's lab (physical CHC or it's abroad) and nominations. Applied elements were safety, ease of use, few devices and rehearsal. Despite that, print blocks were benefit for clinical use, security, media organizations etc.

7.1. Regulatory and Policy Barriers

However, there are no integrated medical laboratories (IMLs) in Madinah PHCs, especially in the South B sector, where community collected health data indicates home of neediest population. Although CBAHI in Madinah region is concerned about the quality and patient safety of the medical examinations done at PHCs, only basic laboratory testing services are provided at Al-Nur PHC, which refers its patients to Al-Mohammadia PHC for advanced tests, although there is Al-Thualbi PHC within 5 km and only supply trained laboratory technician and 40 tests are available. Al-Thaubal PHC is within 15 km of Al-Nur PHC and has a laboratory, but it is not satisfactory for community need. Also, advanced tests available at Al-Mohammadia PHC are mostly refers to Abdul Aziz Specialist Hospital Jeddah or King Fahad Hospital in the same sector for the same advanced tests. Unfortunately, most tests also fail to meet the requirements in 39 laboratories [21].

Systems for primary healthcare services are the cornerstone for any successful national healthcare system and encompass different medical and non-medical services inside or beside primary healthcare centers (PHCs). In 2018, a Royal Decree was issued to integrate four PHC activities and facilities under the control of the MoH. This is aligned with MoH's initiatives to provide high quality, safe services efficiently and effectively [13].

7.2. Technical and Infrastructure Barriers

Given the digitization and standardization in the healthcare industry, efficient storage, timely access to patient information and inventory becomes imperative. The outcomes of this research will be the insight for development of EHR in a 500-bed hospital in Pune city, Maharashtra, India. The primary focus will be helping stakeholders in deciding and ensuring the selection of appropriate EHR system by improving the diagnostic decisions and business operations of the hospitals. This project includes the development of EHR, inventory management system and a cloud-based doctor's panel [22].

In this study, we find that users perceive compliance with safety and security practices as top considerations and security practices contributed most to medical faculty users' positive experiences. Further we also find that hardware mainly contributes to solution obstacles among faculty users. Moreover, considering device maintenance builds users' awareness and preferred support resources. Additionally, we identify behaviors that offer solutions for individual security and privacy issues. The results will emphasize the significance of considering the physical and environmental condition of the hardware in IT research in higher education settings [20].

8. Future Directions and Recommendations

The transformation plan highlights the importance of elevating healthcare services by integrating medical laboratories with PHC in rural areas of Al-Madinah [2]. Around 64% of the total population, to which the rural population contributed approximately 35%, lives in rural areas. It is known that a significantly lesser degree of development and access to healthcare facilities is observed in rural areas compared to urban areas. The literature suggests that several benefits can be obtained by rationalizing and modernizing PHCs. These include preference by clients for easily accessible medical facilities near their homes and the potential to increase healthcare service accessibility, thus strengthening population health. The transformation plan foresees that emergent ambulatory medical care will be integrated into the various levels of hospital care [4].

With rising costs and the complex process of providing healthcare-as well as the increasing burden of providing healthcare, the Saudi National Healthcare Transformation Plan aims to restructure the health system with a six-axes model of care for integrated healthcare. It is notable that no nationwide plan for restructuring primary healthcare (PHC) laboratory services has been suggested, and other PHC need to be developed to provide diagnostic facilities. It was recommended in 2018 in an article that by including diagnostic facilities in PHCs, many benefits such as minimizing the time involved in analyzing results, providing early warning of various diseases, and generating cost-effective disease prevention solutions will be achieved [13].

8.1. Policy Recommendations

The vision of the Ministry of Health, the medical faculties and the different scientific medical societies includes an integration of the basic and laboratory sciences with clinical medicine. The teaching during the first three years is more integrated as the students will learn the medical skills at the family medicine centers and other primary care hospitals. This is the time where the students will get acquainted with the application of laboratory investigations in the diagnostic process. Clinical laboratory science addresses diseases from a different angle and is therefore very helpful to understand human health and diseases. It is a part of liberal education for medical, dental, pharmacy, nursing, laboratory students as well as practicing medical laboratory professionals. Prosecution of the reform requires collaboration with the secondary and tertiary care. Employment of a trained faculty is very necessary so the academic environment and scientific research can flourish. Therefore, the colleges of medical sciences can provide centers for continuing medical and laboratory scientific education for practicing physicians and medical laboratory technologists.

Saudi Arabia faces a rapidly growing population and thereby a critical shortage of physicians and other health workers [3]. The healthcare system is restructured from hospital-based to primary care-centered. A well-prepared and motivated primary healthcare workforce constitutes an important factor for the successful implementation of this transition. Therefore, educational reform meets the concepts of the Primary Health Care System for the twenty-first century.

8.2. Research and Development Priorities

In this article, we have investigated the integrations of medical laboratories with primary healthcare units in Saudi Arabia. Through understanding the research priorities, this article will inform decisions for researchers, academics and policy makers where attention and resources should be directed towards. It is also important to emphasize that this study particularly targets Saudi Arabia, primarily due to differences in the insurance systems and the healthcare set up of other developed countries and the political and cultural context of other developing countries. The Kingdom of Saudi Arabia's Vision 2030

represents a landmark step in diversifying the national economy, with special emphasis on its investment in the health sector [4]. As a result, the Saudi Commission for Health Specialties in 2018 launched new programs and scholarships for the integration of medical laboratories with primary healthcare Centers in Saudi Arabia. This provided the recent boom in the field, as witnessed by many newly integrated medical laboratories with Some primary healthcare centers. Although some primary healthcare centers have laboratory services, the vast majority depend on a central-region laboratory. The new integration of medical laboratories with primary healthcare centers has raised some questions on healthcare delivery models and profitability [2].

In recognition of the global yearn for healthcare access and delivery with optimal efficiency, effectiveness, and minimized costs, Saudi Arabia has joined other Kingdoms and nations in the digital transformation process. By improving healthcare access and delivery alongside the efficient management of healthcare resources, various digital health innovation technologies are being integrated into the health-care systems. The integration of medical laboratories with the primary healthcare centers in the Arab world, most notably in the Gulf Corporation Council states, has great potential. However, such developments with their resultant new ways of healthcare service delivery cannot be achieved without addressing underlying fundamental research questions.

9. Conclusion

One of the important national programs for training Saudi lab technicians is being implemented by the ministry of health and is valid for two and half years. The “Specialized Health Training Program” is under the supervision of health affairs at the Riyadh region. This article elaborates on the knowledge, attitude, and practice of primary healthcare doctors in relation to utilizing investigations in the Eastern Province of the kingdom of Saudi Arabia. Utilization of laboratory tests in Saudi Arabia is high, in general, especially the private clinics. Also, frequent use of laboratory services has been reported in poor communities. The high use does not necessarily result in better healthcare quality or outcomes.

Lab techs are responsible for performing and analyzing tests to provide patients and their primary care physician with information on their health status. This role has become increasingly important considering the current COVID-19 pandemic, in addition to their routine responsibilities. In 1992, a non-medical program was initiated in the Kingdom of Saudi Arabia, and at present most medical laboratories are staffed by non-Saudi nationals, indicating low participation of Saudi citizens in this line of work. According to a local study, Saudi laboratories are faced with many challenges such as the lack of laboratories at primary care centers (PCCs), as most laboratories are at the hospitals. The Kingdom’s Vision 2030 emphasizes the importance of human resources and technological power (predictive medicine, bots, telemedicine (national transformation program 2020)).

9.1. Summary of Key Findings

The Medical Laboratory Technology (MLT) Program at the University of Dammam in Saudi Arabia (UOD) was established in 1977. We have updated the curriculum, including the integration of both research components and pedagogical advancements, to reflect the latest trends in field [4]. The goal of these curriculum changes and advancements, that is, a more inclusive program, is to ensure an active-learning environment and cutting-edge courses in research, oral presentation, computer applications, healthcare services, ethics, critical thinking, creativity, emotional intelligence, and team communication, so that MLT students will have broad perspectives on the role of medical technology in healthcare. The BSc-MLT program at UOD covers general education courses, core prerequisites, general elective

courses, and program-specific courses. The revised and updated four-year curriculum for the students has been designed to develop both cognitive and affective domains in the learners. The four-year program was evaluated and approved by the college of applied medical sciences curriculum committee under the recommendations from the United States embassy, the NCAAA representative, and the WHO [23]. Additionally, five national and international advisory boards for, on one hand, the performance assessment and, on the other, the proposed changes and how they would promote the changes, advise the MLT program to be competent for the job market. The program includes six domain components, i.e., Basic Medical Sciences, Clinical Pathology, Laboratory Management, Quality Management in Laboratory, Research Project, Biochemistry, Pathology, Pathology, Microbiology, Immunology, Serology, Endocrinology, Hematology, and Radiology. The hospital internships at the end of the third-year cover six months and provide knowledge in basic lab techniques and theoretical foundations, whereas those completed at the end of the fourth year offer ample experience in special units where new undergraduate MLT practical requirements are integrated into the curriculum throughout the courses. Also, a skilled fluency in English, communication skills, personal ethos, effective research-based knowledge, organization culture, lab safety, health care professionals and patients' rights- an issue, continuously trained and incorporated in all courses. This study conducted a survey prior to developing a Computer Assisted Instruction (CAI) CDSS software prototype. A five-point Likert scale survey was used to gather information about the acceptance level of CDSS features in promoting work achievement [12]. About 53.4% of the participants asserted that CDSS systems would be helpful in reducing the waiting time of patients. A similar number of participants indicated that CDSS would help in increasing the technical knowledge of doctors and technicians, i.e., changing the medical laboratory technician image from general lab tests to analyzing and critical diagnostic roles. The results show that integrating comprehensive bioinformatics, computational biology, and pathology for data management, such as implementing new bioinformatics & computer technology, plays an important role in streamlining routine diagnostic and pathological laboratory purposes. Additionally, the particulate survey queries reflected substantial positive responses about the usage of decision support bioinformatics tools with respect to potential benefits, awareness factor, trouble free use, utilization for future challenges, and promotion of the profession and also in rights and responsibilities of patients and healthcare teams; and eBioinformatics CDSS would recreate a possible utilizable platform in comparing the methods of routine diagnostic laboratory and the research laboratory. These results are encouraging since the Medical Laboratory Technicians (MLTs) are more likely to embrace a new technology that will not only help in promoting their work practices but also aid them in dealing with challenging future threats.

The Kingdom of Saudi Arabia (KSA) is the largest country on the Arabian Peninsula and, with an estimated population of around 34 million in 2020, shares a border with eight countries. Saudi Arabia has a primarily oil-based economy and, over the past several decades, has pursued an economic diversification strategy to reduce its dependence on petroleum. With the objective of diversifying its economy, the healthcare system has undergone significant improvements in both primary care and specialty disciplines. Medical laboratories are an integral part of the healthcare system and play a major role in the diagnosis, detection, and characterization of infectious diseases, genetic disorders, and chronic illnesses.

9.2. Implications for Healthcare Practice

The acceptance of Clinical Decision Support Systems (CDSS) by General Practitioners (GPs) is vital for improving the quality and safety of healthcare services, as they are often the decision-makers for most of

the outpatient care. This qualitative study found that GPs' acceptance of the system was influenced by expected benefits, ease of use, technical issues, equity, trust, and privacy. GPs expressed concern about the extent to which the CDSS provided relevant actual contribution to their routine clinical practice. AMELIE's integration in the individual EHR and the structured availability and recommenations were the aspect most supported highlighted by respondents; as suggested by other studies ABELIE recommended practices should be simply integrated in daily clinical practice (Roccart et al., 2021) [21].

The results of the current study indicate that Sudanese patients manage COVID-19 by spending more time at home, maintaining social obligation requirements, and providing higher donations for people around them in relation to policy recommendations. The maintenance behaviors and engagement in checking had an association with control and fear whereas keeping prohibited practices was correlated with control. The engagement in checking was a general predictor for keeping prohibited practices and the interaction between mood and engagement in checking was consistent with studies on the role of negative emotions in pandemic management [24]. Most studies have investigated COVID-19–related health behaviors using cross-sectional survey data (Niepel et al., 2020). This study is among the first to present new knowledge about patients' different ways of managing life during the COVID-19 pandemic, supported by diaries completed by a sample of the Sudanese population.

Medical laboratories play a crucial role in the healthcare system, contributing to up to two-thirds of medical decision making. They have been described as crucial to the sustainability of primary healthcare [10]. The growth of laboratory medicine as a medical discipline has been accompanied by striking advances in diagnostic technology. Increasing use of laboratory tests and increasing complexity of the pre-analytical, analytical, and post-analytical phases of laboratory medicine are part of the trend toward greater involvement of laboratory medicine in patient care. This trend has resulted in a situation where more than half of medical decisions, and as many as 70-80% of important clinical decisions, rely on some form of laboratory test being done. Therefore, laboratories have an important impact on patient outcomes because they can, among other things, affect patient access to care and can also impact medical center financial stability because they account for a significant share of total costs. Key issues affecting the provision by laboratories of adequate support for patient care at PHCs include the need for proper geographical and financial access to laboratory services, the need for laboratories to support the full scope of critical, basic health services offered at PHCs, and a general knowledge gap that underpins inconsistency and uncertainty about the level at which primary health centers (PHCs) should have laboratory facilities.

References:

1. A. Bakarman M, Y. Kurashi N, Hanif M. UTILIZATION OF LABORATORY INVESTIGATIONS: STUDY OF KNOWLEDGE, ATTITUDE AND PRACTICE AMONG PRIMARY CARE PHYSICIANS. 1996. ncbi.nlm.nih.gov
2. World English Journal A, Sarhan Alsubaiai H. Linguistic Hegemony of English Language in the Medical Context of King Abdullah Hospital. 2019. osf.io
3. A.M. Bashawri L, A.M. Ahmed M, A. Al-Mulhim A, H. Awari B. MEDICAL LABORATORY TECHNOLOGY PROGRAM AT KING FAISAL UNIVERSITY: A 10-YEAR EXPERIENCE. 2002. ncbi.nlm.nih.gov
4. Aljarboa S, J. Miah S. An Integration of UTAUT and Task-Technology Fit Frameworks for Assessing the Acceptance of Clinical Decision Support Systems in the Context of a Developing

Country. 2020. [PDF]
5. World English Journal A, Jawhar S, Al Makoshi M, Alhawsawi S et al. Validating English Language Entrance Test at a Saudi University for Health Sciences. 2021. osf.io
6. Salman Bashir M, Selvamony Lalithabai D, AlOtaiby S, Abu-Shaheen A. Health care professionals' knowledge and attitudes toward telemedicine. 2023. ncbi.nlm.nih.gov
7. World English Journal A, S. Alfaifi M, AbuZayyad-Nuseibeh H, Awaida N et al. Graduate Students Perceptions of Success in United States Colleges. 2020. osf.io
8. Almalawi A, Irshad Khan A, Alsolami F, B. Abushark Y et al. Analysis of the Exploration of Security and Privacy for Healthcare Management Using Artificial Intelligence: Saudi Hospitals. 2022. ncbi.nlm.nih.gov
9. Abu-Zaid A, M. Eshaq A, Alkattan K. Dual-degree MBBS-MPH programs in Saudi Arabia: A call for implementation. 2019. ncbi.nlm.nih.gov
10. Jain R, Rao B. Assessment of primary laboratory facilities for rural health care preparedness in Osmanabad District, India. 2019. osf.io
11. Alkhudair N, Alshamrani M, Samarkandi H, Almodaheem H et al. Cancer Management in Saudi Arabia: Recommendations by the Saudi Oncology HeAlth Economics ExpeRt GrouP (SHARP). 2021. ncbi.nlm.nih.gov
12. S M Aljarboa S, J Miah S. Discovering adoption barriers of Clinical Decision Support Systems in primary health care sector. 2022. [PDF]
13. A. Tashkandi S, Alenezi A, Bakhsh I, AlJuryyan A et al. Clinical laboratory services for primary healthcare centers in urban cities: a pilot ACO model of ten primary healthcare centers. 2021. ncbi.nlm.nih.gov
14. K.M. Khalil M, Al-Eidi S, Al-Qaed M, AlSanad S. The future of integrative health and medicine in Saudi Arabia. 2018. ncbi.nlm.nih.gov
15. Ellingsen G, Monteiro E. The organizing vision of integrated health information systems. 2018. [PDF]
16. Unger B. Discontinuity propagation in delay differential-algebraic equations. 2018. [PDF]
17. MOUSELI A, AMIRESMAILI M, BAROUNI M, MIRAB SAMIEE S et al. The Challenges and Barriers to the Integration of Laboratory Services in Iran from Laboratory Experts' Point of View. 2018. ncbi.nlm.nih.gov
18. Alomari A, Faris H, A. Castillo P. Specialty detection in the context of telemedicine in a highly imbalanced multi-class distribution. 2024. [PDF]
19. C. Alcantara J, Alharbi B, Almotairi Y, Jahoor Alam M et al. Analysis of preanalytical errors in a clinical chemistry laboratory: A 2-year study. 2022. ncbi.nlm.nih.gov
20. Alkharji M, Alqurashi H. Managers' Perceptions of Barriers to Using IT for Organizational Development: Case of a Hospital Chain in Riyadh, Saudi Arabia. 2022. ncbi.nlm.nih.gov
21. Aljarboa S, J Miah S. Assessing the Acceptance of Clinical Decision Support Tools using an Integrated Technology Acceptance Model. 2020. [PDF]
22. Srivastava S, Gupta R, Rai A, S. Cheema A. Electronic Health Records and Cloud based Generic Medical Equipment Interface. 2014. [PDF]
23. Achieng M, Ruhode E. EHealth Technologies Integration with Healthcare Work Activities in Public Hospitals: A Critical Realist Perspective. 2021. [PDF]
24. H Masmali F, J Miah S, Mathkoor NY. Internet of Things-based innovations in Saudi healthcare sec-

tor: A methodological approach for investigating adoption issues. 2020. [PDF]