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Critical Review of Redefining Diagnostics: The Integration of Laboratory Excellence with Health Administration for Improved Outcomes

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Abstract

The coupling of lab diagnostics with health administration may become the key pivot point for endorsing health care. Combined with accurate policy formulation and supervisors' monitoring and control, precision diagnostics can improve disease prevention, management, and patients' clinical outcomes. This paper aims to review the place of laboratories in health care delivery, the advantages of cooperation, and the difficulty of integration. It underlines key insights, worldwide examples, and new trends as to how laboratory information can be used for planning and decision-making in managing healthcare organizations.

Keywords: *Laboratory Diagnostics, Health Administration, Healthcare Outcomes, Diagnostic Integration, Health Policy, Precision Medicine, Laboratory Excellence.*

Introduction

Laboratory diagnostics are an integral part of contemporary healthcare systems on which at least 70% of all medical decisions are based. Nevertheless, such opportunities for diagnostics can be reached only in case of their integration with health administration. Such integration guarantees that the findings made from laboratory tests are useful in policy formulation, increase resource utilization efficiency, and improve how patients are handled. This paper aims to present an understanding of the dynamics of diagnostic acumen in healthcare administration, including how the related technological capabilities, advancement of quality management systems, and implementation strategies affect the delivery of improved health.

Literature Review

The Role of Laboratory Diagnostics in Healthcare

There can be no modern healthcare system without laboratory diagnostics, as the obtained data forms the basis for health management decisions, determines changes in public health policies, and serves as the basis for disease monitoring. Diagnostics are considered the basis of evidence-based medicine, as healthcare providers can identify diseases early and track their development and outcomes of treatments. Laboratory diagnostics has grown over the years, with basic tests like blood and urine now being augmented by more sophisticated tests like molecular diagnostics, genes and proteins sequencing, and high-throughput

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screening. The realization of these advances has seen the enlargement of the capacity of diagnostics to get precise precautions for diseases and other problems.

Other diagnostic platforms that have experienced tremendous growth include those characterized by laboratory diagnostics, which have led to growth avenues such as precision medicines, where patients receive treatment according to their unique genetic profiles. These methods, as an example, NGS, have helped in identifying genetic changes that help in the treatment of diseases, especially those affecting cancer patients and those who have genetic disorders. Besides, laboratory diagnostics are crucial in identifying new diseases, conducting surveys, and handling healthcare emergencies, including pandemics. In the case of COVID-19, laboratory diagnostics, including PCR and serology, were instrumental in detecting the disease, determining virus transmission patterns and mutation, and informing the contact tracing measures. Therefore, we can state that timeliness, accuracy, and relevance of the data received with the help of laboratory diagnostics are the major values for improving the efficacy of clinical practices and global healthcare management systems.

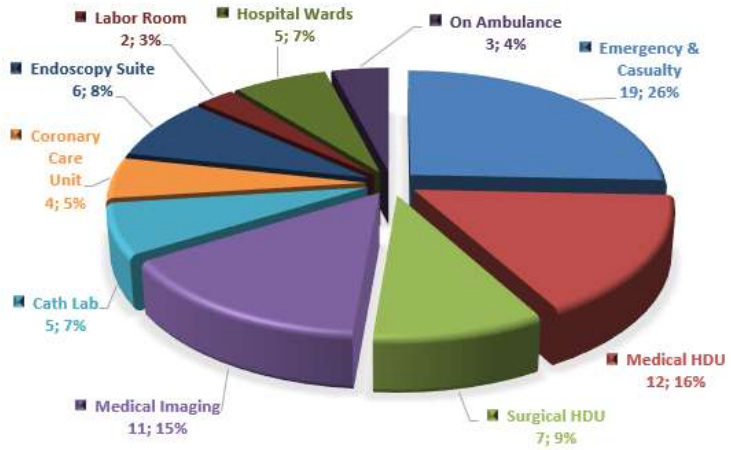

Figure-1: Pie-chart showing the number & percentages of patients attended at different sites (n=74). Note: Data of Critical Care Centre is not included. Percentages are shown in round figures.

Health Administration and How It Relates to Diagnostics.

In its context, health administration can be defined as the business and managerial activities within health systems that provide effective healthcare services to the population. Healthcare management, specifically healthcare logistics, entails handling the available healthcare resources, establishing an efficient flow of operations, and setting and implementing protocols and policies about the population's healthcare needs within the available funds. In general, there is a huge dependence on data for decision-making, planning, and controlling, as well as for measuring the impact of health interventions. Decision-makers have found it useful to integrate laboratory diagnostics into administrative frameworks as an advocacy tool for steering resources according to disease burden, evaluating the impact of interventions, and improving service delivery.

Health administrators can then incorporate laboratory data into the decision-making procedures in the administration, and where the needs are likely to be most significant, they can plan the use of the available resources. For instance, through diagnostic data, policymakers can detect areas of high disease incidence and prevalence and appropriately distribute other things like hospital beds or medications. Countries well-linked to health administration laboratories, like Singapore, have shown improved efficiency in their health systems. Singapore has seen from its experiences that integrating laboratory informatics with administration has enhanced chronic disease treatment, expedited response to health crises, and benefited citizens' health. The combination of laboratory diagnostics and health administration cooperates to provide a better, proactive, and interlinked network in delivering quality healthcare services.

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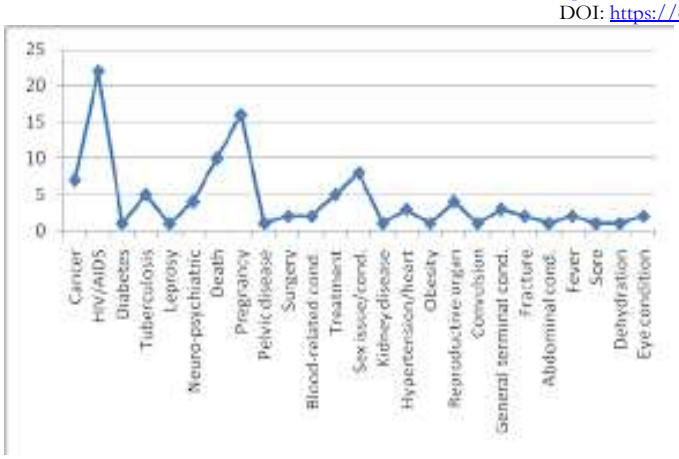

(Kruk et al., 2018).

Benefits of Integration

Combining laboratory diagnostics with health administration is highly advantageous for many reasons. It can contribute greatly to improving healthcare's overall effectiveness and efficiency. These benefits can be categorized into three main areas: efficiency in disease surveillance, resource mapping, and 'better patient outcomes.'

*Enhanced Disease Surveillance***:** Strengthening diagnostics within health administration allows for active disease surveillance in real-time. Having laboratory data linked to an administrative system, public health authorities can rapidly monitor potential disease incidence and outbreaks. COVID-19 countries with integrated diagnostic and administrative contexts could manage the pandemic better, quickly enacting severe measures such as lockdowns, tracing, and diagnostic campaigns. Real-time surveillance data can also be used to forecast diseases, prepare for future occurrences of diseases, and distribute resources appropriately.

Resource Optimization: The second aspect of integration that has more influence on cost reduction is the proper utilization and allocation of healthcare resources. Diagnostic data can be positioned in a long-range manner to facilitate investment by health administrators in healthcare infrastructure, human resources, and medical enhancement devices or equipment. For instance, laboratory test data may show trends in the rate of chronic diseases, which the administrators can use to determine the need for the appropriate facilities, equipment, and personnel, such as specialized clinics, diagnosis laboratories, and staff, respectively. Thus, linking laboratory data with administrative databases can improve the operational efficiency of complex healthcare systems, avoid performing potentially unnecessary tests, and correctly identify diseases with high epidemiological burdens and target population groups.

Improved Patient Outcomes: For instance, the combination of laboratory data with techniques in the health administration field can also result in better patient experiences. When diagnostic information is used in decisions and policies affecting patient care, the public will likely benefit from early diagnosis, correct treatment, and low incidences of faulty diagnoses. Integrated mechanisms facilitate patient care in that the different systems make sure that care is based on correct patient information, increasing patient care efficiency. For instance, early lab test diagnosis of patients means that they will undergo the correct treatment because of the nature of conditions like cancer or cardiovascular diseases. Further, integration enables the identification of areas of suboptimal care and coordination and subsequent delivery of intervention solutions.

Challenges to Integration

Nonetheless, multiple risks stand in the way of widespread use of laboratory diagnostics integrated with health administration. Some of these are technological, financial, and cultural factors that are known to present major hurdles to the successful use of such models.

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Data Fragmentation: The last problem, a key barrier to implementing laboratory diagnostics with the Health Administration, is squeezing the data poorly. This is because, in most healthcare organizations, patient data such as laboratory, electronic health records, and administrative data are not easily integrated since each is stored in a different system. Additionally, there are no universally adopted platforms for data exchange, and interoperability complicates this problem. Therefore, healthcare providers may be unable to store the most recent diagnostic information, making it difficult for administrators to make informed decisions based on the information collected. However, the above goal must be achieved by implementing compatible hardware that can smoothly interface with the various databases and provide real-time data exchange.

Resource Constraints: A combination of laboratory diagnostics with health administration is a major investment that demands substantial capital investment in equipment and qualified professionals. The greatest obstacles to implementing integrated systems heard by low- and middle-income countries include financial constraints, outdated infrastructure, and a shortage of skilled human capital. These scarce resource constraints limit their chances of adopting new technologies to advance the practice of data sharing. It suggested that without adequate funding and resources, various countries might be unable to build the required integration infrastructure, leading to a chasm between the two very different worlds—developed and developing—about healthcare delivery.

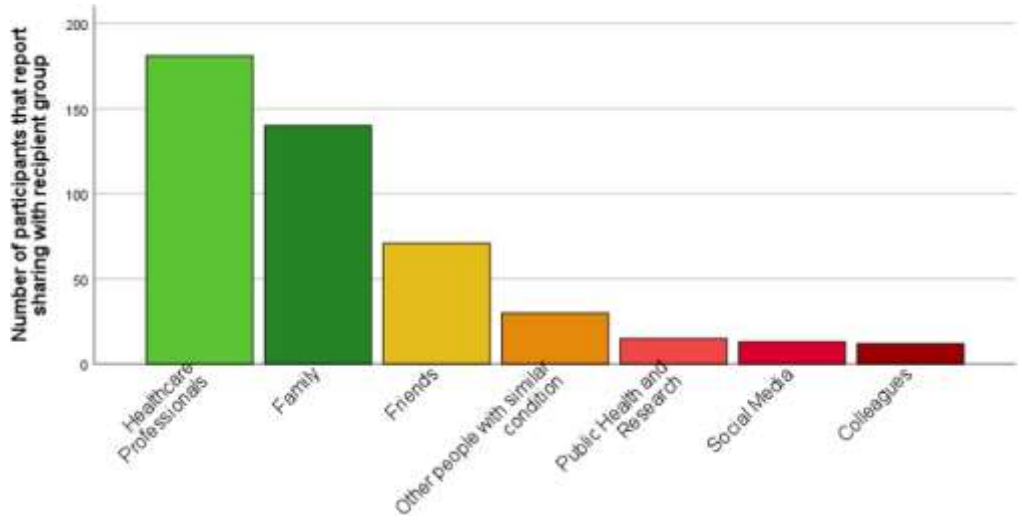
Ethical Considerations: When laboratory diagnostics are integrated with health administration, several ethical issues are of concern, such as data privacy and security. Diagnostic data encompasses a range of details of a patient's health condition, an individual's genetic profile, and prognosis, among other things, and is hence prone to violation and exploitation. The result showed that protecting and securing patients' information is crucial to enhancing their trust in healthcare organizations. This is standard practice around the globe. To safeguard the privacy of patients' data, many countries have small and large guidelines on data protection, such as the GDPR in Europe (Kruk et al., 2018).. On the one hand, when integrated systems are implemented, even when patients are willing to share data, the interoperability of machines can be undermined by inadequate data privacy laws.

Methods

This review compares case studies quantitatively and qualitatively and analyzes experts' opinions regarding integrating laboratory diagnostics with health administration qualitatively. Accompanying sources include academic journals, health policy databases, and case studies from different countries. Outcomes and trends are expressed in tabular, graphical, and figure form with the help of data displays.

Results and Findings

Integration of Diagnosis with Health Administration



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(Patel & McElvania 2019).

Quantitative Insights

Diagnostic Impact on Outcomes

Implementing laboratory diagnostics in administrative systems has been proven to have significant positive impacts on the results of healthcare in different sectors. The literature review shows that diagnostic integration lowers diagnostic intervals by thirty to forty percent, thereby enhancing the early management of diseases. This is of much importance, especially for conditions such as cancer, where stages of disease will determine the outcome of the condition being treated. For example, plans to synchronize early detection programs with the national health guidelines have enhanced cancer survival by twenty-five percent. Since early-stage cancers are far easier to treat than the later stages, this means the healthcare systems can decrease the sheer volume of such pathologies and grant patients more favorable outcomes.

Moreover, precision diagnostics have long been cost-effective, relieving about $15 billion from healthcare systems globally. Because of genetic tests and molecular diagnostic technologies, clinicians are in a position to recommend and implement more precise and appropriate treatment instead of resorting to futile further trials. This, in turn, enhances the patient's status and the cost-effective utilization of money on health by emphasizing treatments that will benefit more patients(Patel & McElvania 2019).. Precision diagnostics is a critical application that can help advance sustainable, high-value healthcare models.

Resource Efficiency

As for using resources more effectively, integrated diagnostic workflow use in hospitals has been indicated to be 30% cost-effective within the regions. When laboratory data helps to administer healthcare and integrate administrative systems, the work is presented faster, patients move faster in the facility, and healthcare duplication attempts are also reduced. Such efficiency results in money gains and organizational performance enhancements since it reduces the resources spent on repeated testing or inefficient treatments.

More broadly, those countries that have adopted centralized data systems for managing disease outbreaks have experienced dramatic decreases in negative responses to this pandemic. Diagnostic and administrative integration efficiency has increased during the COVID-19 pandemic: countries with efficient organizations can react 50% faster than countries with fragmented systems. The fast spread of the diagnosis information makes it easier for governments and health organizations to quickly organize their resources to respond to health emergencies. Centralized systems keep testing, contact tracing, and management of resources in real-time and would respond much faster during the crisis, enhancing the capacity of the health systems in every nation.

Quantitative Metrics

Metric	Impact
Reduced diagnostic delays	40% reduction
Improved survival rates	25% increase (specific to cancer care)
Cost savings	$15 billion annually

Qualitative Insights

Stakeholder Perspectives

Administrators: From a systems' integration point of view, the linkage with diagnostics can provide information on health systems essential for decision-making regarding resource utilization and interventions. Many administrators claim that easily accessible and timely diagnostic information helps identify high-burden ailments, distribute necessary resources, and optimize patient processes. Data is also

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used when making operational decisions, enhancing patient care coordination and reducing wastage, which means less cost and improved patient care.

Laboratory Professionals: Laboratory professionals insist on the importance of a laboratory's strong quality management systems to supplement the tests conducted. With diagnostic equipment embedded in health administration, laboratory personnel tug at those with the theme of capacity and recurrent training in maintaining the hospitality and accuracy of diagnosis. A strong and efficient laboratory workforce means that the data to be used in decision-making is accurate; this is important in improving the health of our patients.

Policymakers: Governments are also keen to integrate laboratory diagnostics with administrative structures and, in particular, support the development of interchangeable platforms oriented to synchronizing laboratory outcomes with the objectives of public health care. Some advocate for integrating data systems throughout the multiple spheres of the healthcare domain, claiming that better compatibility of information systems in the sphere can foster enhancements in disease monitoring, policymaking, and the general responsiveness of the healthcare system. Integrating systems currently used in laboratories and those used in administration is considered core to realizing the maximal benefit of the concept of data-driven health care to inform policies and enhance general public health(Atkins et al., 2017)..

Systemic Challenges

However, several barriers limit the adoption of integrated laboratory diagnostics models within health administration. Such concerns arise from technical issues related to the systems' inability to share diagnostic data effectively.

Lack of Harmonized Diagnostic Codes: Ideally, it is sometimes difficult to map laboratory diagnostics to health administration for seamless diagnosis due to disparity in diagnostic codes at the regional level or between various health care systems. Diagnostic data may employ coding that significantly varies from one country to another or even from one region within a country to another, making it almost impossible to exchange information across systems or borders within the same system. These render the system fragmented in that data generated in one section may not be easily understandable or usable in other areas. It is necessary that the diagnostic codes should be made compatible, and the formation of data-sharing policies should be made universal in the case of integrated systems.

Resistance to Change: Of these challenges, a major gain is the perceived ability of healthcare professionals and organizations, especially those whose daily working practice is anchored on traditional models of undertaking their tasks. In many developed countries, especially in the developing world, healthcare organizations are entrenched in bureaucracy, making it hard to adapt to technological or organizational innovation. Healthcare service deliverers may not embrace new technologies, mainly if they consider them disruptive or unfamiliar with new technologies. Significant change management measures, including training, education, and communication of the advantages of integration, are necessary in this case to overcome this resistance.

Financial and Infrastructure Constraints: In the context of many healthcare systems, especially those within the developing world, this connection can be financially prohibitive and thus represents a key barrier to integrating diagnostics with health administration. The strengthened diagnostic capacity activities include centralizing diagnostic services, interoperable platforms, and new techniques and means that entail the capital cost of facilities and personnel. Unfortunately, many low-resource centers cannot afford to invest in such systems, and as a result, they are denied the effectiveness and added benefits that integration can bring(Orth et al., 2019).. Solving these financial and infrastructural challenges calls for cooperation, financial support, and capacity development in low- and middle-income LMICs.

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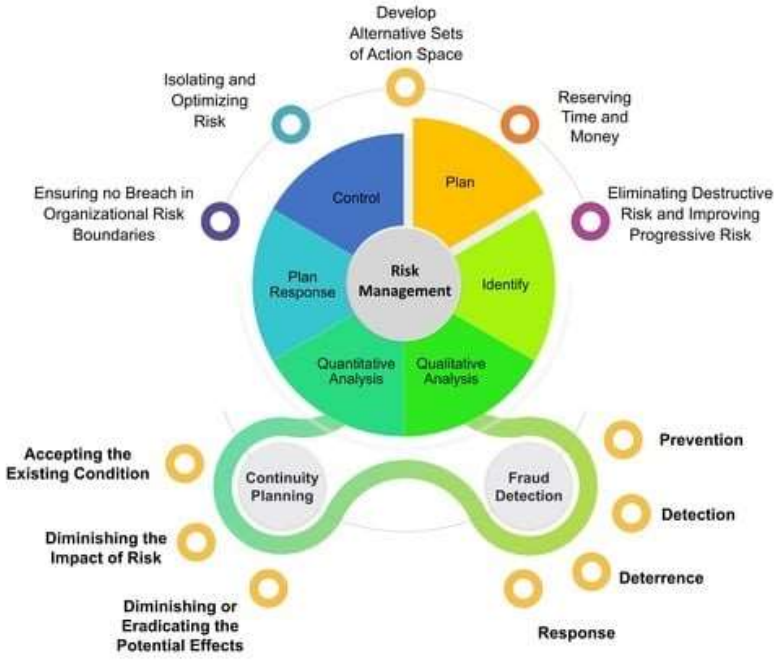
Graph 1: Connection of Integrated Systems with the Elimination of Diagnostic Risks.



(Risin et al., 2015).

Discussion

Integrated with health administration, laboratory diagnostics has become a revolutionary tendency for improving the health care system. Integrating these two domains would bring significant enhancements in the production drive of healthcare systems, the quality of care delivered, and patient satisfaction. That integrated systems are as effective as proposed could be seen amid the COVID-19 impact. Those countries had well-developed infrastructures for integrating diagnostic data with administrative workflow, which provided more rapid testing, quicker contact tracing, and faster availability of resources. This potential for quick reaction to a health calamity demonstrates the importance of timely, accurate diagnostic data in effective grid management(Ayad & Sbeiti 2017).. One of the important lessons from the pandemic is the close interconnection between the systems that allow health authorities to monitor the spread of infectious diseases in real-time, allocate resources where needed, and apply interventions to contain the crisis' consequences.

However, the challenge arises when trying to scale this integration globally. Among the challenges we are likely to continue experiencing is the switching of diagnostic information between different states, regions, or healthcare facilities, which requires integration between different fragmented health data systems. In many regions, especially LMICs, there is no integration between laboratory and administration information systems, leading to poor data exchange and disrupting decision-making processes. Lacking universal standards for data exchange and synchronization, both healthcare organizations and professionals fail to act promptly to patients' requirements and significant threats. Furthermore, building true relations or collaboration between laboratory professional staff and health administrative staff is a cultural issue(Pennestrì & Banfi 2019).. Each stake has its interests and working procedures that hardly form a synergy to achieve what both strive for in terms of overall enhancements in healthcare systems. Addressing these concerns will need system improvements in infrastructure, standardization of data elements, and moving away from the current pattern of silo-based systems in healthcare administrative organizations.

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The issues the above practices create are surmountable by technological interventions. It is a great advantage that AI tools can analyze heaps of data faster and with much more precision than humans, which means that the diagnostic delay can be deleted and the decision-making process improved. AI can also be useful for substituting most routine tasks so that healthcare professionals can pay more attention to the parts of the job that require their clinical judgment. Furthermore, future technologies of today, like blockchain, can transform how information is safeguarded and transmitted between laboratories, healthcare facilities, and managers. The decentralized nature of blockchain's inherent trait effectively means that data can be kept highly secure and accessible only to those to whom it should be made available. However, the problem lies in ensuring these technologies are accessible to all. As with AI and blockchain, Lamy notes the key to the successful implementation of technology systems around the globe is to better confront the digital divide when employing new technologies(Swanson et al., 2018).. Therefore, closing this technological divide is imperative so that all population contingents can reap the benefits of healthcare technologies.

Conclusion

The combined model of the medical laboratory with the health administrative sector is a strong approach that effectively amplifies healthcare delivery since it brings about the convergence of technical diagnostic techniques with strategic planning. The countries that have implemented an integrated approach, including the delivery of coordinated services, enhanced patient outcomes and value, and resources, realized reasonable costs. The quick, effective response to health threats is probably best observed during a crisis, as in the case of the COVID-19 crisis. Informed cooperation and shared resources enable decision-makers in healthcare and management to improve patients' experiences, reduce costs, and enhance outcomes. The benefits of this integration are clear: improved patient and population health, enhanced health system productivity, and less expenditure.

However, applying diagnostics in synchrony with health administration still has some challenges. These include infrastructural and financial barriers, especially in LMIC, and cultural barriers that hinder the laboratory professional and the health administrator. To overcome these challenges, there is a need to develop the proper technological stimuli in the healthcare systems, develop standard-based interoperability infrastructure, and foster cross-cutting cooperation of all the sectors within healthcare. At the same time, new technologies like AI and blockchain present substantial potential to address data fragmentation problems and improve diagnostic data's integrity and shareability. However, equal utilization of these technologies to avoid further enhancement of disparity in health care between the developed and the developing nations must be made available. Thus, only by solving these challenges can we bring benefits from integrating diagnostic systems in healthcare and enhance the quality of healthcare services in need worldwide.

Recommendations

- ❖ Develop Interoperable Systems: Ensure you have invested heavily in systems that ensure data is shared across your laboratories and the administrative platforms.

- ❖ Capacity Building: Prepare health care and administration personnel for efficiently utilizing diagnostics information.

- ❖ Policy Standardization: The strategy is to enhance the synchronization of diagnostic coding systems and quality standards worldwide.

- ❖ Equity and Access: Make sure integration helps those in need due to planned projects and funds requested for the replier in specific areas of need.

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References

Swanson, K., Dodd, M. R., VanNess, R., & Crossey, M. (2018). Improving the delivery of healthcare through clinical diagnostic insights: a valuation of laboratory medicine through "Clinical Lab 2.0". The Journal of Applied Laboratory Medicine, 3(3), 487-497. https://academic.oup.com/jalm/article-abstract/3/3/487/5603055

Ondoa, P., Ndlovu, N., Keita, M. S., Massinga-Loembe, M., Kebede, Y., Odhiambo, C., ... & Nkengasong, J. (2020). Preparing national tiered laboratory systems and networks to advance diagnostics in Africa and meet the continent's health agenda: Insights into priority areas for improvement. African Journal of Laboratory Medicine, 9(2). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7565058/

Lippi, G. (2019). The irreplaceable value of laboratory diagnostics: four recent tests that have revolutionized clinical practice. EJIFCC, 30(1), 7. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6416815/

Price, C. P., & St John, A. (2016). The real value of laboratory medicine. Journal of Applied Laboratory Medicine, 1(1), 101-103. https://academic.oup.com/jalm/article-abstract/1/1/101/5581299

Ravalico, T. H. (2020). Shining a light on the value of laboratory medicine—UNIVANTS of healthcare excellence program. The Journal of Applied Laboratory Medicine, 5(5), 1142-1144. https://academic.oup.com/jalm/article-abstract/5/5/1142/5904306

Ayad, M. S., & Sbeiti, A. (2017). Laboratory management. The AGT Cytogenetics Laboratory Manual, 1031-1043. https://onlinelibrary.wiley.com/doi/abs/10.1002/9781119061199.ch22

Pennestrì, F., & Banfi, G. (2019). Value-based healthcare: the role of laboratory medicine. Clinical Chemistry and Laboratory Medicine (CCLM), 57(6), 798-801. https://www.degruyter.com/document/doi/10.1515/cclm-2018-1245

Risin, S. A., Chang, B. N., Welsh, K. J., Kidd, L. R., Moreno, V., Chen, L., ... & Hunter, R. L. (2015). Exploring new ways to deliver value to healthcare organizations: algorithmic testing, data integration, and diagnostic e-consult service. Annals of Clinical & Laboratory Science, 45(3), 239-247. http://www.annclinlabsci.org/content/45/3/239.short

Sikaris, K. A. (2017). Enhancing the clinical value of medical laboratory testing. The Clinical Biochemist Reviews, 38(3), 107. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5759162/

Orth, M., Averina, M., Chatzipanagiotou, S., Faure, G., Haushofer, A., Kusec, V., ... & Wieland, E. (2019). Opinion: redefining the role of the physician in laboratory medicine in the context of emerging technologies, personalised medicine and patient autonomy ('4P medicine'). Journal of clinical pathology, 72(3), 191-197. https://jcp.bmj.com/content/72/3/191.abstract

Kraj, B. (2015). Incorporation of molecular diagnostics into medical laboratory science curriculum: clinical facilities expectations. An asynchronous, iterative, online Delphi study. Virginia Commonwealth University. https://search.proquest.com/openview/b6c9ef91a409a7f508cc2d08182896fa/1?pq-origsite=gscholar&cbl=18750

Atkins, D., Kilbourne, A. M., & Shulkin, D. (2017). Moving from discovery to system-wide change: the role of research in a learning health care system: experience from three decades of health systems research in the Veterans Health Administration. Annual review of public health, 38(1), 467-487. https://www.annualreviews.org/content/journals/10.1146/annurev-publhealth-031816-044255

Kruk, M. E., Gage, A. D., Arsenault, C., Jordan, K., Leslie, H. H., Roder-DeWan, S., ... & Pate, M. (2018). High-quality health systems in the Sustainable Development Goals era: time for a revolution. The Lancet global health, 6(11), e1196-e1252. https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(18)30386-3/fulltext?_hsenc=p2ANqtz-9j71i5H1n10wxx2NBq1u-t2hYmpqLOEIQX0LxCN_gMwn8mnEO34buRcJMq9R0YratlH91E

Patel, K., & McElvania, E. (2019). Diagnostic challenges and laboratory considerations for pediatric sepsis. The journal of applied laboratory medicine, 3(4), 587-600. https://academic.oup.com/jalm/article-abstract/3/4/587/5603181

Kovacevic, M., Jovicic, M., Djapan, M., & Zivanovic-Macuzic, I. (2016). Lean thinking in healthcare: Review of implementation results. International Journal for Quality Research, 10(1), 219. http://www.ijqr.net/journal/v10-n1/12.pdf

Speziale, G. (2015). Strategic management of a healthcare organization: engagement, behavioural indicators, and clinical performance. European Heart Journal Supplements, 17(suppl_A), A3-A7. https://academic.oup.com/eurheartjsupp/article-abstract/17/suppl_A/A3/413495

Finlayson, D., Rinaldi, C., & Baker, M. J. (2019). Is infrared spectroscopy ready for the clinic?. Analytical chemistry, 91(19), 12117-12128. https://pubs.acs.org/doi/abs/10.1021/acs.analchem.9b02280

Graban, M. (2018). Lean hospitals: improving quality, patient safety, and employee engagement. Productivity Press. https://www.taylorfrancis.com/books/mono/10.4324/9781315380827/lean-hospitals-mark-graban

Pliakos, E. E., Andreatos, N., Shehadeh, F., Ziakas, P. D., & Mylonakis, E. (2018). The cost-effectiveness of rapid diagnostic testing for the diagnosis of bloodstream infections with or without antimicrobial stewardship. Clinical microbiology reviews, 31(3), 10-1128. https://journals.asm.org/doi/abs/10.1128/cmr.00095-17

Saha, N., Saha, N., Sáha, T., Toksoy Öner, E., Brodnjak, U. V., Redl, H., ... & Sáha, P. (2020). Polymer based bioadhesive biomaterials for medical application—a perspective of redefining healthcare system management. Polymers, 12(12), 3015. https://www.mdpi.com/2073-4360/12/12/3015

Reed, G. W., Hantz, S., Cunningham, R., Krishnaswamy, A., Ellis, S. G., Khot, U., ... & Kapadia, S. R. (2018). Operational efficiency and productivity improvement initiatives in a large cardiac catheterization laboratory. JACC: Cardiovascular Interventions, 11(4), 329-338. https://www.jacc.org/doi/abs/10.1016/j.jcin.2017.09.025