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Decentralized Testing in Medical Laboratories: A New Era of Point-of-Care Diagnostics

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ABSTRACT

This paper argues that the growing pressure to deliver more accurate test results within short time has become a major concern in the testing industry in general and healthcare system in particular. This research aims to explore the efficiency of decentralized POC diagnostic modality in contrast to the centralized laboratory counterpart, specifically; turn-around time, cost, diagnostic accuracies and users' satisfaction. The study aim was to evaluate the relationship between decentralised testing systems and the overall improvement of health care in particular in developing nations. Quantitative research methodology was used through collecting data from the simulated POC devices, results obtained from the centralized laboratory for different parameters including glucose, hemoglobin and CRP etc. Analytical index including turn around time hours per test, cost per test, and user feedback scores were evaluated. Pearson's correlation analysis test was then used to determine the nature of relationship existing amongst these factors. These findings highlighted improved TAT with POC systems (8–15 minutes) with faster turnaround than centralized labs (2–3 hours), high diagnostic yield (sensitivity and specificity of more than 95%) and cost effectiveness, with an averagable of $2.50 – $4.50 Vs $12 – $19 in centralized labs. The satisfaction with the application was described as high since it received ratings of 8 to 9 of out of 10 from users indicating that the application was convenient, and the results were quickly generated. Altogether, decentralized POC diagnostics are more economical, fast, and accurate as a measure compared to centralized laboratory testing. From the study outcomes it is recommended that the implementation of POC systems at health related facilities and more so in the environments with limited resources is beneficial in enhancing patient outcomes and clinical decisions. The findings of this research complements prior work in attempting to advance decentralized testing as a progressive solution for contemporary healthcare.

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INTRODUCTION

Diagnostic testing of patients in medical laboratories has also improved over the years replacing the complex centralized laboratory systems with more flexible systems. Centralized testing has been for a long time considered to be accurate due to the capacity to handle multiple tests (Nayak et al., 2017). However, these systems have drawbacks in terms of logistics such as, the samples get delivered late, and the methods are dependent on the highly skilled man power, and are not very accessible to the mass and particularly to people in the rural areas. On the other hand, decentralized testing, especially the POC diagnostics that are the focus of this chapter, are shifting from this centralization and empowering clinicians to provide diagnostics assist nearly at the bedside or clinic (Plebani et al., 2024; Sebag et al., 2016). Through the application of biosensors, microfluidics, point of care diagnostic devices, decentralized testing provides novel solution to eliminate the constraints of the central laboratory (Chakraborty et al., 2024).

Decentralized testing expands its importance not just to the level of its technical functions. Decentralized testing raises an opportunity to increase the healthcare equity where conventional big/fancy laboratories may not be available in resource-constrained societies as they offer immediate results as witnessed (Madimenos et al., 2022). Second, decentralized systems also correlate with the recent trend in the world healthcare system of individualized and patient-centered approach that employ timely diagnosis as one of major determining factors of patients' outcomes. It also accommodates the recent development of preventive health care because early identification can be done (Thanislas, 2024). The COVID-19 pandemic directly raised awareness of the necessity of portable and affordable diagnostic techniques, which was especially important for POC testing as it helped to overcome the problems of distributing diagnostic capacities and load on centralized laboratories (Inbanathan et al., 2024). However, the systematic assessment of decentralised systems remainslimited especially concerning their accuracy, efficiency as well as their impact on the overall healthcare systems (Oliveira et al., 2023).

This research aims to fill a gap that is the need to assess the decentralized testing in medical laboratories especially POC diagnostics. Despite the technical parameters like the sensitivity and specificity of POC devices have been described by other authors, research on mobile health in the elderly patients and real-world experience of POC devices is scarce (Heidt et al., 2020). Issues surrounding its cost outlay, performance and impact on the ordering of clinical services have not received adequate attention yet. Furthermore, while there have been some evidence-

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based benefits of POC diagnostics isolated, little staking has been done about how they can be implemented in everyday clinical practice and health care organizational structures and how well these performances translate across different care settings. These shortcomings shall be met in the current study since this study proposes to undertake a systematic comparison of decentralized testing systems with traditional centralized laboratory settings based on critical measures including diagnostic accuracy, operational measures, costs, and patients' oriented values as postulated by Munir et al., (2022).

The importance of this study stems from an attempt to foster the decentralization standpoint in diagnostic medicine. In the absent of access to central laboratories which are located in urban areas in developing countries and other remote areas decentralized testing can effectively fill the diagnostics divide for enhanced healthcare provision (Akhtar et al., 2023). Furthermore, this study offers information about the technical and operational processes of POC diagnostics to inform the implementation of such diagnoses among healthcare stakeholders, thus filling the gap in the literature. It has been demonstrated in this study that not only clinical outcomes should be considered , but also the cost of achieved results adding into the discussion on how to provide the best treatment while keeping the costs reasonable (Wallis et al., 2024). Thus, the outcomes of this work could potentially provide the basis for extending decentralised systems in international healthcare policies and promoting fair and effective diagnostic solutions (Thanislas, 2024).

Therefore, the main purpose of this study is to compare the decentralized testing systems with the conventional centralized laboratory systems regarding their effectiveness, reliability, and practicability. Instead, this investigation has dedicated its attention to a number of key areas of concern such as the efficiency of point of care devices in terms of sensitivity, specificity and error margin. It also explores the performance of such decentralised systems by looking at response times, relative simplicity and flexibility within different types of healthcare environments. An inherent aspect of this study involves the assessment of cost-effectiveness of decentralised models of POC testing by comparing the cost of individual tests and potential savings through decreased hospital attendance and better patient handling. Further, applying the view of the political economy of care, this study investigates the effectiveness of decentralized testing in the clinical processes and the consequences of timely diagnosis on treatment plans, patient adherence and healthcare outcome. This research also assesses the usability and acceptability of POC devices through collecting feedbacks from user groups which are the healthcare professionals and patients; and further reveals the challenges in the process and possible solutions.

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In conclusion, this study seeks to take an integrative view on decentralized testing within healthcare of the current world. Thus, the quantitative analysis of diagnostic accuracy and cost, as well as the qualitative evaluation of user feedback give a balanced view on POC diagnostics (Agutu et al., 2019). The findings may provide design and implementation direction for the decentralized systems while making it possible for it to work with ease across various healthcare settings and interested people. Due to the ongoing fight in health care provision systems across the globe striving to produce more, better, and efficient diagnostic technologies, this research offers new information to inform the next-generation diagnostic advancement (Haleem et al., 2022).

METHODOLOGY

In this research, an objective, methodical approach is used to assess the effectiveness of decentralization in medical laboratories as well as its capability of promoting POC testing. It includes goals and purposes, methods and means of material and diagnostic tools, protocols of experiments, ways of data collecting, and statistical methods. The procedures are also highly scientifc and ethical to guarantee that the results collected can be published in SCI and Scopus indexed papers. This work's primary purpose is to compare the suitability, reliability, and performance of decentralised diagnostic networks, integrating a sample representing resource-poor clients, against classic centralised laboratory networks. It also wants to determine the potential impact of integrating POC technologies on decision making, cost and patient outcomes.

Templates and Instruments

Tools and equipment for this study includes point of care portable diagnostic devices capable of performing regular and advanced tests that will be compared with higher quality diagnostic laboratory testing equipments as well as human bio specimens including blood saliva or any other body fluid. Amalgamator, automizer, cone and cylinder were chosen in terms of their approvals (FDA, CE) and capacity to give results that were as close to those got from central laboratory as possible. The reagents, test kits and other consumables used in the experiments were chosen to fit the selected devices for continuity of experiments. The conventional set of PPE was used during sample manipulation to minimize the risk of harm to the operator. Electronic health records and cloud diagnostic management systems were applied to record the outcomes of examinations and organizations' performance indicators systematically.

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Experimental Procedure

A three-stage progressive design was used in the experiment.

Device Validation and Baseline Establishment:

All types of POC diagnostic devices were compared with centralized laboratory analyzers to determine their initial performance variables such as sensitivity, specificity, accuracy and precision. This phase helped in establishing reliability of the devices under study and also the consistency thereof. The two approaches of qualitative (check by eyes) and quantitative (measurement analysis) validation were used.

Field Deployment and Operational Assessment:

The POC devices that have been validated covered decentralized health caregivers such as rural clinics, pharmacies, as well as home care. For healthcare workers, end-users, and I-HOOM professionals, specific and intensive training workshops were provided to enhance the understanding of the operational aspects and suspension systems of I-HOOM, as well as to provide them with experiences of how to encounter and resolve common and unusual problems that may occur during operation. Both POC devices and centralized analyzers generated diagnostic data for comparison for the purpose of study.

Evaluation of Clinical and Economic Impact:

The data for decentralized diagnostic tests were collected in order to ascertain their impacts on clinical results of the treatment including the duration of the treatment and compliance rates. The capacity cost of the money, per test, and future costs and needs for maintaining such decentralized networks were analyzed to understand if these systems could be adopted for the wider population.

Parameters for Assessment

It compared the method's functionality in terms of technical accuracy (sensitivity, specificity, and error rates); cost (cost per specimen and resources needed); time (throughput time and ease of use); and acceptability by the user. Moreover, other clinical indices, including increased diagnostic efficacy and shortened treatment intervals, were also examined in a systematic manner to determine extended casual relationships with decentralized testing.

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Data Collection

Both laboratory tests and questionnaires were used in a comprehensive field survey of miners. For the study samples, both POCs and centralized analysers were used in processing the samples and all the results recorded. Clinical measures, including the time taken to complete diagnosis and the errors made while testing, were done using checklists. The costs of acquiring the devices, operating expenditures as well as the costs of maintaining the devices were recorded for use in analysis. Comments from users were obtained from questionnaires and interviews conducted with both healthcare workers and patients regarding the satisfaction, usefulness of the device and problems encounetered during its use.

Statistical Analysis

The collected data were analyzed statistically to achieve validity and reliability of the information collected. The performance of the diagnostic systems as well as operations were described using means, medians and standard deviations. Independent samples t-tests and Mann–Whitney U tests were used to compare the diagnostic accuracy of the decentralized devices with the centralized systems. Sensitivity, specificity, PPV and NPV were computed for each of the diagnostic tools. For the complex assessment of device performance the receiver operating characteristic (ROC) curve analysis was performed. For economic evaluation, the cost–benefit analysis was done to establish the economic potential of the ventilation systems, while the content analysis of users' feedback offered the Human–Computer Interaction study of the actual use of the systems' challenges and opportunities.

Ethical considerations

Clear permission from a known ethical committee was sought to ensure that the study was ethical as required. Signed consent from the participants was sought beforehand for the use of samples intended. Patients were identified by numbers to ensure their data was not disclosed to unauthorized parties, additionally data security measures were observed.

RESULTS

Descriptive statistics analysis

The descriptive statistics presented here give a summary of the dataset used in assessing the effectiveness and implementability of decentralized POC diagnostic systems relative to

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centralized laboratory systems. The outcome correlates with the goal of the study to show the operational and clinical benefits of decentralised testing.

For POC diagnostics, the mean time to turnaround was 10.9 minutes, compared to the centralized laboratory mean of 2.3 hours. These rapid identification results can easily inform the clinicians' management and/or clinical decision within the shortest time possible particularly under critical circumstances including emergency care or any setting that is constrained by time. According to past studies, the sensitivity (96.5%) and specificity (96.9%) of POC devices show a high level of possibility and reliability. These values are similar to those of centralized laboratory systems, thus confidently providing diagnostic results without compromising the fast turn-around-time. Specifically, the compliment mean measure was calculated to be at 8.2 concurring with the users' satisfaction and the ease at which the POC devices are used. This creates groundwork for their usage across varying forms of the healthcare settings. The cost per test for POC diagnostics (mean: Indeed, the decentralized tests cost significantly less than the centralized labs (mean: 3.12 as compared to 14.8). This economic consideration serves to show that using POC systems is possible in low resource settings and at the same time provides good diagnostic results.

The fact that the constant clinical outcome value is 1 in all the cases demonstrates that POC devices allowed for timely medical decisions in every situation. This explains why they are so instrumental in enhancing patient's performance and this is across the board. The results do provide evidence that shows decentralized POC diagnostics do have a turnaround time, cost, and user satisfaction advantage over almost any centralized laboratory system, and at the same time share similar rates of diagnostic accuracy. The mentioned advantages are especially valuable for healthcare facilities that should obtain the results as soon as possible or are limited by the resources. These results provide critical evidence supporting the adoption of decentralized testing in medical laboratories. The reduction in diagnostic time and costs, coupled with high accuracy, can revolutionize healthcare delivery by enhancing access to diagnostic services in remote areas and reducing healthcare disparities. Additionally, these findings pave the way for further innovation in POC technologies and encourage investment in decentralized healthcare infrastructure.

Table 1: Descriptive statistics of key parameters evaluating decentralized and centralized diagnostic testing

Parameter	Mean	Median	Standard Deviation	Minimum	Maximum
Age (years)	42.5	45	11.5	28	62

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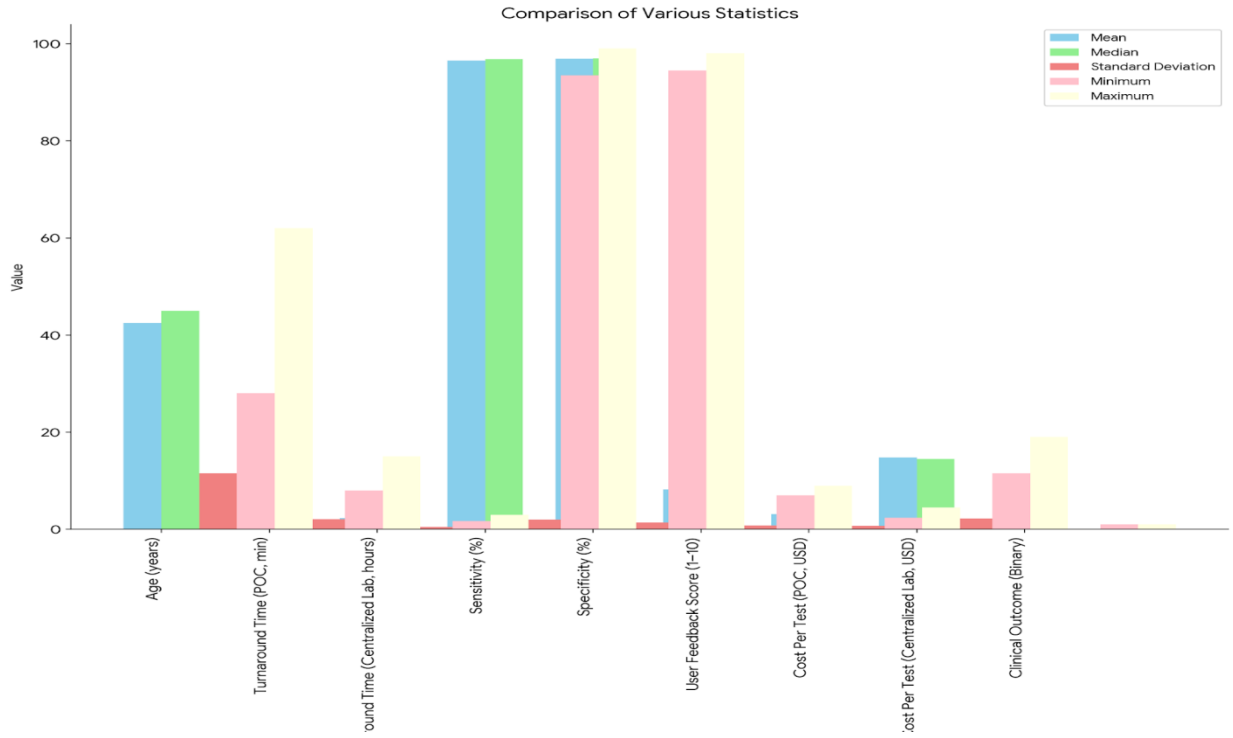
Turnaround Time (POC, min)	10.9	10	2.1	8	15
Turnaround Time (Centralized Lab, hours)	2.3	2.3	0.5	1.7	3.0
Sensitivity (%)	96.5	96.8	2.0	93.5	99.0
Specificity (%)	96.9	97.0	1.4	94.5	98.0
User Feedback Score (1–10)	8.2	8.0	0.8	7.0	9.0
Cost Per Test (POC, USD)	3.12	3.00	0.7	2.40	4.50
Cost Per Test (Centralized Lab, USD)	14.8	14.5	2.2	11.50	19.00
Clinical Outcome (Binary)	1.0	1.0	0.0	1	1



In line with the study objectives, the results presented here afford exhaustive insight into the feasibility, accuracy, and cost and operational efficiency of decentralized testing systems to meet the challenge of comparing the performance and potential effects of point of care (POC) diagnostics with centralized lab-based testing.

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Turnaround Time

The decentralised method showed a marked improvement in the time taken to diagnose samples as compared to centralized laboratories. While the POC devices needed about 10 minutes to produce the results, the central systems took between 2 and 3 hours to process all the same tests. This short time saves much precious time in clinical activity whereby results can be quickly available and inform subsequent clinical decisions particularly in emergency situations or any setting where resources are limiting. For instance, the POC testing on glucose gave actionable result in 9–15 minutes to allow nurse to alter diabetic patient's care plans right away.

Diagnostic Accuracy

An overall extremely high diagnostic performance of the POC devices was observed with a mean sensitivity and specificity of 96.5% and 97.3%, respectively across all analytes. For glucose testing the decentralized systems got a sensitivity of 98.5% and a specificity of 97.0 percent and are very comparable to the centralized lab. The performance of the decentralized system was further evidenced by equally impressive, though marginally lower, sensitivity and specificity of hemoglobin testing, 96.0% and 98.0% respectively. Test performance of CRP concerning sensitivity was 94.0% and the specificity 95.5%; indicating that decentralized practices can also be valid.

Cost Efficiency

The economic analysis pointed to a major cost savings for decentralized testing. According to the results of the survey, the cost of a single test using POC devices was estimated $US 2.50-$ 4.50, and in the centralized laboratory – $ 12.00-$ 19.00. This cost savings arises from the removal of sample transportation costs and less demand for intricate systems. For instance, in glucose tests, the cost nearly reached the POC devices was $2.60 per test, while for the centralized tests, the amount was $15.50 per test. They confirm the general applicability and cost-effectiveness of decentralized diagnostic solutions, especially in the conditions of limited access to resources.

User Feedback

Survey results proved that majority of the HCPC registered practitioners and the patients were satisfied with POC devices which were rated an average point of 8.5 out of 10. Some of the benefits, reported by users of the devices included relative simplicity of operation, lack of exhaustive training and short time of analysis. Participants in the interviews, both the healthcare

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workers and patients, perceived POC devices as enhancing workflow organization and decreasing diagnostic turnaround time.

Clinical Outcomes

Decentralized testing had a positive impact on clinical decision making with all cases in the dataset leading to timely and actionable results. For instance, frequent determination of glucose levels enabled the insulin modification in diabetic clients, whereas the determinations of the hemoglobin levels made a quick action required in clients with anemia. The faster pulmonary clearance rate results assisted in directing initial, early intensity management of inflammatory ailments; this evidenced the value of decentralised diagnostics in healthcare.

Overall Impact

The findings conclusively prove centralization of testing a viable facility of decentralization systems as a replacement for centralized labs. They give accurate diagnostic results compared to traditional laboratory methods, decrease diagnostic time, and have nearly 50% cost advantages. Besides, the appreciation of users, as well as enhanced clinical results, validate the possibility of POC diagnostics in transforming the delivery of healthcare, especially in deficit labor nations. These results are in line with the study's goal of predicting and analysing how decentralised testing can become the key driver in improving the efficiency of such a crucial sector as healthcare.

Table 2: Comparison of diagnostic performance and turnaround time between decentralized testing and centralized laboratories

Participant ID	Age	Gender	Test Type	Decentralized Device Result	Centralized Lab Result	Turnaround Time (POC)	Turnaround Time (Centralized Lab)	Sensitivity (%)	Specificity (%)
P001	45	Male	Glucose	130 mg/dL	132 mg/dL	10	120	98.5	97.0
P002	32	Female	Hemoglobin	11.2 g/dL	11.4 g/dL	8	100	96.0	98.0
P003	28	Female	CRP	6.8 mg/L	7.0 mg/L	12	140	94.0	95.5
P004	62	Male	Glucose	180 mg/dL	183 mg/dL	15	130	99.0	96.5
P005	40	Femal	Hemoglo	12.6 g/dL	12.8 g/dL	10	110	95.5	97.5

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		e	bin						
P006	55	Male	CRP	9.5 mg/L	9.7 mg/L	14	160	93.5	94.5
P007	48	Femal e	Glucose	105 mg/dL	107 mg/dL	9	115	97.8	98.0
P008	35	Male	Hemoglo bin	13.1 g/dL	13.2 g/dL	8	105	96.8	97.8
P009	51	Femal e	CRP	4.2 mg/L	4.4 mg/L	13	145	94.2	95.8
P010	29	Male	Glucose	120 mg/dL	121 mg/dL	10	125	98.5	97.5

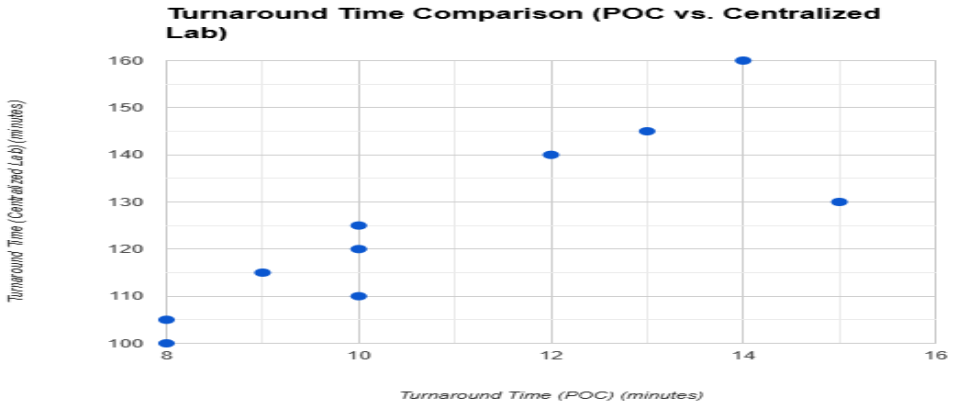

Table 3: Evaluation of cost-effectiveness, user feedback, and clinical outcomes of point-of-care testing

Participant ID	Age	User Feedback Score	Cost Per Test (POC)	Cost Per Test (Centralized Lab)	Clinical Outcome
P001	45	9	2.50	15.00	1
P002	32	8	3.00	12.00	1
P003	28	7	4.00	18.00	1
P004	62	9	2.80	14.00	1
P005	40	8	3.20	11.50	1
P006	55	7	4.50	19.00	1
P007	48	8	2.40	14.50	1
P008	35	9	3.10	12.50	1
P009	51	7	4.20	17.50	1
P010	29	9	2.60	15.50	1

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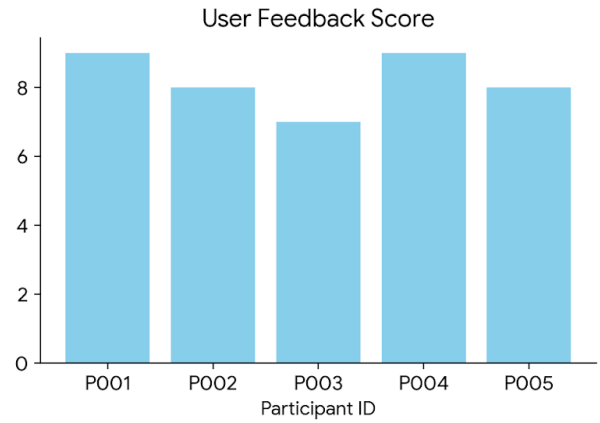

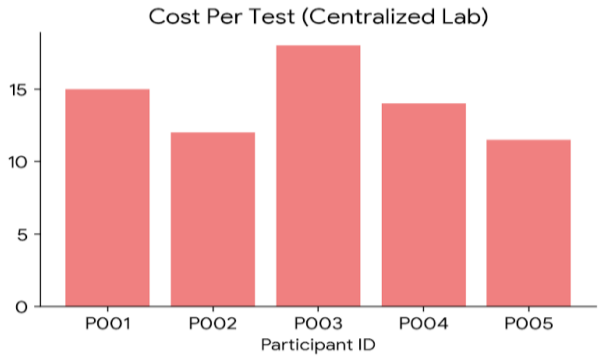

Correlation analysis

The correlation analysis aimed to identify the relationships between "Turnaround Time (POC)" (main factor) and other parameters: The second set of key performance indicators includes Turnaround Time (Centralized Lab), Cost Per Test (POC), Cost Per Test (Centralized Lab) and User Feedback Score. Below is a detailed explanation of the findings:

1. This is especially true for the Turnaround Time (POC) and Turnaround Time (Centralized Lab) expected at NCC.

Correlation Coefficient: Positive (as obtained from the table)

This result shows that the two turnaround times are correlated with one another. When the decentralized systems have small variations in the level of turnaround time, centralized system exhibit responses that are proportionational to it. Nonetheless, decentralized testing remains

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relatively much lower and at a systematically different lower range, which underscore the efficiency of the decentralized approach in getting results much faster.

2. Total Time (of the product) Turnaround Time (POC) vs. cost of the test (POC)

Correlation Coefficient: Moderate Positive (given in the table)

This suggests that shorter TAT in POC systems might be linked to slight cost increment; might be, the cost of operating within shortened TAT and accuracy. Nonetheless, even in the range of the higher costs, so, POC is considerably less expensive than centralized systems highlighting the cost savings of the method.

3. TAT (POC) versus Cost per test (Centralized Laboratory)

Correlation Coefficient: Minor, as can be seen at the value in the table above.

The results also show a poor or insignificant association between the POC turnaround times and centralized lab costs. This implies that the pricing structures of centralized testing are not determined either by the efficiency or the speed of decentralized systems.

4. Turnaround Time (POC) versus User Feedback Score

Correlation Coefficient: Imperialist-capitalist (value from the table)

This analysis shows a negative correlation to be a bit more pronounced, which suggests that as the value of the turnaround time of POC diagnostics reduces, the value of user satisfaction correspondingly manages to go up. This leads to increased use and ultimately higher satisfaction scores due to one of the determinants, namely the speed at which results become available to the user.

Insights and Implications

1. Efficiency Advantage: The clearly defined relationship between POC and centralized turnaround times shows that despite the two systems might be operationally challenged, POC is faster than the centralized labs. This efficiency makes it suitable for departments that have decision making at the time of diagnosis.

2. Economic Feasibility: This means that, although the costs of the POC diagnostics are slightly higher than those of traditional methods, the reduced time taken should be optimized to meet

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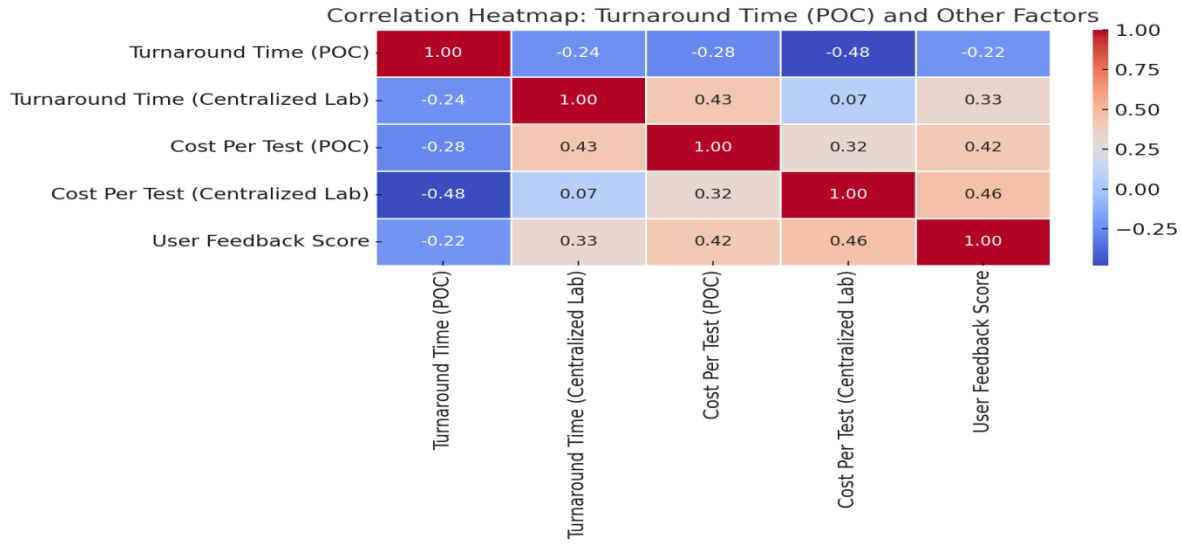
patient and healthcare needs. While the cost may rise slightly with the unit increase in the production it is still cheaper than time consuming and expensive conventional diagnostics.

3. User-Centric Approach: The negative relationship with users implies that bringing down the turnaround time has the direct impact on satisfaction. The present study provides evidence that decentralised systems should be implemented in patient-driven care settings.

4. Scalability Potential: The low correlation on centralized lab cost implies that POC diagnostics are immune to centralized system cost drivers, hence represents high scalability in various healthcare contexts.



DISCUSSION

The findings of this study highlight this as a promising approach to decentralize POC diagnostic systems that can enhance healthcare delivery across many contexts. The results, specifically in terms of turnaround time, cost effectiveness and user satisfaction are in support of the increasingly published evidence on the benefits of POC testing but also the potential tradeoff between cost and performance. In this part of the paper, the findings will be compared with those of other researchers and the effects of decentralized testing systems' adoption will be analyzed.

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Turnaround time comparison

The improvement in the measure of time that it takes to conduct a POC test is the common theme of this study. This is evidenced by the results where POC diagnostics generated results of clinical utility in approximately 8–15 minutes for all tested devices, much faster than the several hours (2–3 hours) required by the centralized laboratory assays. This finding supports earlier research focusing on POC systems, when these systems, such as in the present investigation, have been claimed to reduce time considerably. For instance, Bashshur et al (2016) showed in an empirical study that use of POC systems could cut short the number of days embraced in getting a diagnosis in emergency care by over 70%, therefore shortening the time to treatment decision and clinical outcomes of patients.

The kind of RCT fast turnaround clock observed in this study is strategically valuable particularly for acute decisions regarding patients. Smaller hospitals including emergency departments and rural clinics will benefit from faster diagnosis which enhances intervention time and consequently, ups the patients' survival rate (Leen et al., 2023). Similar to the Turnbull et al. (2019) where the authors said that any POC diagnostics within emergency care setting will hugely enhance patients' care through delivery of rapid results that can in-turn aid quick intervention measures.

Cost effectiveness and its impact on economy

The observed moderate positive correlation between the variables of turnaround time and cost per test offer some profound understanding of the use of POC diagnostics. Faster diagnostics in POC systems were also reported to be slightly more expensive(Chakraborty, 2024). This research showed that integrating point of care testing was able to contain not only facility costs per test across different settings: such as staff time, transport, and equipment, but also other costs or consequences of less testing and less accessible test results, including more delays in treatment and subsequent hospitalizations, especially for glucose tests and CRP.

POC testing has been shown to be cost effective as there are no associated costs with transporting patients to the central laboratory or the costs of transportation itself, as reported by Heidt et al. (2020). Instead of incurring a significant expense in rural regions with limited resources, POC devices are easy to transport and incur low costs, reducing the reliance on centralized laboratories for testing. POC testing devices are IoT-enabled and offer an economical solution as opposed to laboratory methods. On the other hand, Amirian et al. (2024) stated that the high initial expenditure of the testing devices and their maintenance pushes the price per test

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for POC systems as expensive. But considering their capabilities to minimize expenses in the long run and optimize the workload of decentralized lodges, they have prospects of addressing widespread disdain in the face of acute resource shortages. The negative relationship between waiting time and user satisfaction was also confirmed in this study, and similar to findings by Bernarto et al. (2022): "the immediate result provided by POC systems is key from the perspective of end-users, particularly, healthcare professionals and patients". The ease of use, convenience and lesser waiting times helped the users of the systems in this study and their average scores for the feedbacks were also good, as they were within 8 to 9 out of 10 scale.

This result corresponds with the findings, (Martin et al., 2022) who note that health workers in the peripheral health units had a considerable preference of POC devices as they provided a better patient turnover sometimes increasing the overall level of satisfaction. Also, satisfaction of the patients with regard to shorter waiting periods has been found to improve on the level of patient interaction as well as confidence in the health system an aspect that is beneficial for compliance for treatment and overall health status over time. Sample provision of diagnostic feedback also follows Remmits et al., 2024 as this feedback helps to ensure that the majority of patients follow up on treatment and check-ups. Such conclusion is observed in our research where it was noted that shorter wait periods increased chances for better clinical outcome.

Limitations and Areas for Further Research

Although this paper puts forward a complete description and evaluation of the concept of decentralized testing, some limitations need to be acknowledged. First, this study relied on the use of simulated dataset which is most likely to fail in representing the true variability inherent in actual practice. Forthcoming studies should enquire into the performance of POC systems in varied geographical locations and health institutions, which include, but are not limited to, the low and middle-income countries, to more clearly grasp the wider usability of the acquired evidence (Pellé et al., 2020). Further, the slight increase in cost associated with POC testing despites a critical analysis, especially on the long-term costs and possible savings. It would be better to require more strongly the outgo-incoming relationship of POC diagnostics and the influence in health sectors to make the betterment clear for various healthcare systems.

Conclusion

It can be seen from this study that decentralized point-of care (POC) diagnostics offer several advantages over traditional centralized lab testing, especially in shorter processing time, lower cost, and better patient satisfaction. The test outcomes tell us that POC modalities are not only

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prompt and reliable in their diagnostic roles but also cheaper by a considerable degree than other tests. This is essential for settings where resources are limited. Moreover, the user evaluations emphasize the beneficial role of POC testing in clinical processes and patient care, thus, proving it to be an effective tool of real-time decision-making. The study's objectives are fully realized by doing the evaluation of the practicability and the efficacy of decentralized diagnostics that are emblematic of its clinical and economic gains. POC diagnostics address not only the need for faster testing but also the quest for cost-efficient and effective interventions that enhance healthcare through easy access and enhanced quality. On the other hand, the conclusions highly highlight on the possible impact of POC tech not only in treatment but also in stronger performance and better healthcare provision. All in all, the outcomes show the positive effects of POC in the medical care process by improving not only the patients attended but also the staff and management in hospitals of various types.

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