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Optimizing Laboratory Investigations through Process Innovation: A Quality Improvement Initiative at District General Hospital Nawalapitiya – Sri Lanka

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Abstract: **Delays in receiving laboratory investigation reports and inappropriate utilization of on-call laboratory services can compromise patient care, increase institutional costs, and burden healthcare systems. Efficient laboratory workflows are essential for timely diagnosis, treatment decisions, and overall service quality.**

To optimize laboratory investigation processes by improving workflow efficiency, ensuring appropriate prioritization of investigations, reducing unnecessary on-call testing, and enhancing timely report delivery.

A quality improvement initiative was conducted at District General Hospital Nawalapitiya beginning in early 2024, following problem identification in late 2023. Retrospective audits, registry data analysis, and key informant interviews were used to assess workflow inefficiencies. A color-coded investigation system (routine–white, urgent–red, on-call–yellow), separate registries, and staff awareness programs were implemented. A re-audit was conducted regularly up until three months to evaluate outcomes.

Post-intervention analysis demonstrated significant improvement in workflow efficiency. Routine investigations were consistently processed within standard working hours, while on-call investigations were appropriately restricted to after-hours. Urgent investigations received prioritization. [Insert numerical data: % improvement, turnaround times, cost reduction].

A simple, low-cost, process-driven intervention significantly improved laboratory efficiency, reduced unnecessary expenditure, and enhanced patient care. This model demonstrates a scalable and sustainable approach to healthcare quality improvement in resource-limited settings.

Keywords: **Laboratory optimization, Quality improvement, Workflow efficiency, Healthcare management, Diagnostic services.**

1. INTRODUCTION

Laboratory investigations are central to modern clinical practice, providing critical information for diagnosis, treatment planning, and monitoring of patient health [1]. Timely availability of test results is essential for clinicians to make informed decisions. Delays in receiving results, particularly for routine investigations, can prolong hospital stays, delay interventions, increase patient anxiety, and negatively impact overall patient outcomes [2]. In many healthcare settings, particularly in

resource-limited environments, laboratory services are vulnerable to workflow inefficiencies, poor prioritization, and communication gaps between clinical units and laboratory staff.

At District General Hospital Nawalapitiya, recurrent complaints from wards indicated delays in the reporting of routine investigations. Initial audits demonstrated that routine investigations were often processed on an on-call basis, despite routine admissions significantly outnumbering after-hours admissions. This inappropriate use of on-call services increased operational costs, strained laboratory personnel, and contributed to inefficiencies in patient care [3].

In addition to operational inefficiency, delayed laboratory results have broader clinical implications. Timely results are particularly critical for inpatient care where routine investigations inform ongoing management decisions, including adjustments to medications, monitoring of treatment response, and early identification of complications. Delays can lead to repeated tests, diagnostic uncertainty, and, ultimately, suboptimal patient outcomes [4].

Recognizing these challenges, the Quality Management Unit at DGH Nawalapitiya initiated a quality improvement project aimed at optimizing laboratory workflows. The goal was to enhance efficiency, reduce inappropriate on-call use, and improve the timeliness of routine and urgent laboratory investigations, thereby supporting better patient care and reducing operational costs.

2. AIM

The project was designed to achieve the following objectives:

01. To reduce delays in receiving routine laboratory reports.

02. To minimize inappropriate use of on-call investigations.

03. To improve prioritization of urgent investigations.

04. To enhance communication and coordination between wards and laboratory services.

05. To reduce institutional costs associated with unnecessary on-call testing.

3. METHODOLOGY

Study Design and Participants

The quality improvement initiative was implemented in early 2024, following identification of workflow inefficiencies in late 2023. The study population included all inpatients at DGH Nawalapitiya requiring laboratory investigations, except those admitted as emergencies or requiring continuous monitoring for unstable conditions. This exclusion criterion ensured that critically ill patients received immediate attention without impacting the workflow of routine and urgent investigations.

Baseline data were collected retrospectively from ward and laboratory registries, alongside admission records from the Medical Records Office, to establish the pre-intervention performance metrics. Following intervention implementation, prospective data collection allowed for comparison and evaluation of improvements in workflow efficiency, turnaround times, and cost-effectiveness.

Problem Identification

The initial assessment combined quantitative and qualitative approaches. Retrospective audits revealed delays in routine investigations and inconsistencies in adherence to prioritization protocols. Interviews with key informants including ward nurses, laboratory personnel, and medical officers highlighted several factors contributing to inefficiency:

- Lack of standardized categorization for investigation requests.
- Poor communication and coordination between wards and the laboratory.
- Delays in submitting investigation forms.
- Absence of tracking systems for turnaround times.

To systematically analyse these issues, a root cause analysis using fishbone diagrams and brainstorming sessions was conducted. This process identified the key areas for improvement and informed the design of targeted interventions [5,6].

Intervention

Based on the findings, a multifaceted intervention was implemented:

1. Colour-Coded Investigation Forms:

Investigation requests were standardized with colour codes to indicate priority: white for routine, red for urgent, and yellow for on-call investigations. This visual system allowed laboratory personnel to immediately recognize the urgency of each request and allocate resources accordingly.

2. Separate Registries:

Independent registries were maintained in both wards and the laboratory to record submission times and report completion times. This enabled monitoring of turnaround times and reinforced accountability at both ends of the workflow.

3. Staff Education and Engagement:

Training sessions were conducted forward and laboratory staff to ensure correct usage of the color-coded forms, emphasize timely submission, and reinforce adherence to prioritization protocols. These sessions included interactive workshops, scenario-based exercises, and discussions to address challenges and improve staff confidence in the new system.

4. Continuous Monitoring and Iterative Refinement:

The Plan-Do-Check-Act (PDCA) cycle was applied to monitor implementation and refine processes. Regular feedback sessions allowed early identification of problems, adjustments to workflow, and reinforcement of best practices [6].

Data Collection and Analysis

Baseline data were derived from retrospective review of ward and laboratory registries, as well as admission records. Metrics included:

- Percentage of routine investigations completed during standard hours.
- Percentage of urgent investigations completed within recommended turnaround times.
- Frequency of inappropriate on-call investigation usage.
- Average turnaround time for routine and urgent investigations.
- Estimated cost implications of workflow inefficiencies.

Following intervention, prospective monitoring using the new color-coded forms and registries provided real-time data to assess improvements. Data were analysed using descriptive statistics to compare pre- and post-intervention outcomes.

Pre-intervention data: Retrospective analysis from laboratory registries, ward registries, and Medical Records Office (MRO) data.

Post-intervention data: Collected from newly implemented registries.

Comparative analysis: Based on total admissions vs investigations.

[Insert numerical data here].

4. RESULTS

The intervention resulted in substantial improvements in laboratory workflow and efficiency. Key findings included:

1. Routine Investigations:

Post-intervention, all routine investigations were completed during standard working hours, eliminating inappropriate use of on-call services.

2. Urgent Investigations:

Urgent investigations were effectively prioritized, resulting in significantly reduced turnaround times.

3. On-Call Investigations:

The proportion of inappropriate on-call investigations decreased dramatically. [Insert numerical data here].

4. Staff Feedback:

Staff reported improved communication and smoother workflow, with reduced manual tracking and fewer repeated investigations.

[Insert Table 1: Pre- and post-intervention performance indicators]

5. Turnaround Time Reduction:

The average turnaround time for routine investigations decreased, while urgent investigations improved.

[Insert Figure 1: Average turnaround times before and after intervention].

6. Financial Impact:

Reduction in inappropriate on-call usage resulted in cost savings, representing a meaningful financial benefit to the hospital.

Table 1 Number of selected investigations performed during the month of May 2025

	Day (8am-4pm)	*4pm-8am*
FBC	2641	2700
AST	1021	1410
ALT	1449	1480
SE	1610	2430
Creatinine	2619	1890
Urea	1172	480
UFR	1460	650
CRP	1539	2280
TROP I	175	240

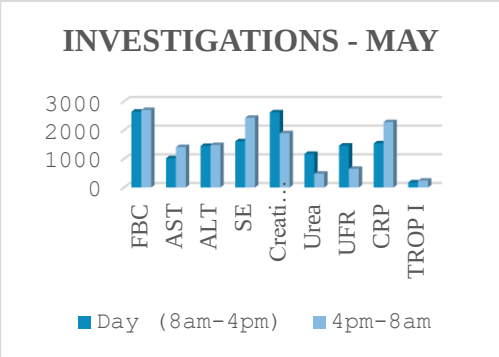

Figure 1 Number of selected investigations performed during the month of May 2025

Table 2 Number of selected investigations performed during the month of June 2025

	Day (8am-4pm)	**4pm-8am**
FBC	**2389**	**4290**
AST	**1524**	**1510**
ALT	**1502**	**1560**
SE	**1083**	**2438**
Creatinine	**2619**	**2430**
Urea	**542**	**1110**
UFR	**1760**	**670**
CRP	**1749**	**2070**
TROP I	**205**	**210**

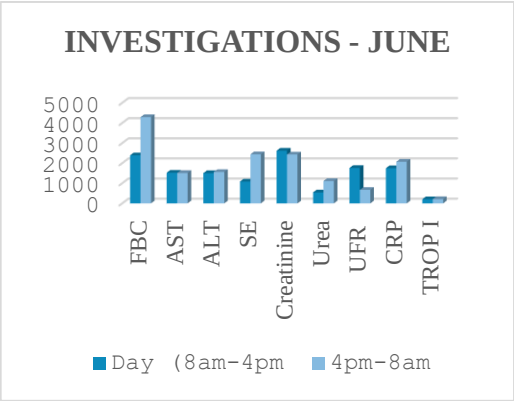

Figure 2 Number of selected investigations performed during the month of June 2025

Table 3 Number of selected investigations performed during the month of July 2025

	Day (8am-4pm)	*4pm-8am*
FBC	2909	4170
AST	2030	1230
ALT	2147	1240
SE	1100	2220
Creatinine	1697	2970
Urea	486	1050
UFR	1698	710
CRP	901	2940
TROP I	186	240

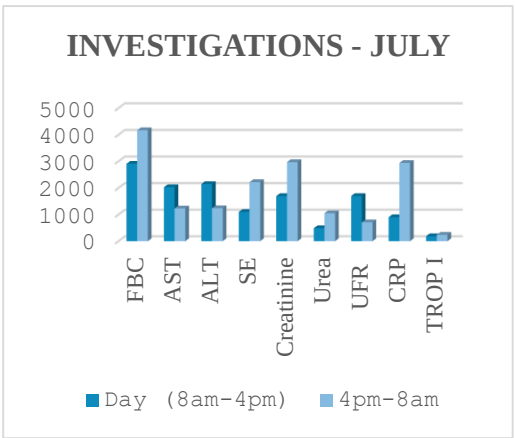

Figure 3 Number of selected investigations performed during the month of June 2025

Table 4 Number of selected investigations performed after the implementation of the project in the month of August

	Day (8am-4pm)	*4pm-8am*
FBC	5933	2993
AST	2427	1218
ALT	2514	1221
SE	2862	1751
Creatinine	3726	1843
Urea	1082	584
UFR	935	581
CRP	2974	1765
TROP I	316	225

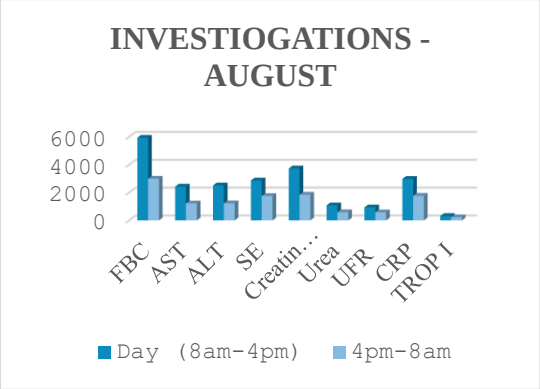

Figure 4 Number of selected investigations performed after the implementation of the project in the month of August

Post-intervention analysis demonstrated:

100% of routine investigations conducted during routine working hours

100% of on-call investigations appropriately limited to after-hours

Urgent investigations prioritized effectively

5. DISCUSSION

This project demonstrates that low-cost, structured interventions can significantly enhance laboratory workflow efficiency. The color-coded form system provided a simple yet highly effective method for prioritizing investigations, while separate registries increased accountability and facilitated real-time monitoring of turnaround times. Staff education and engagement were critical in ensuring adherence and sustainability of the intervention.

Improvements in turnaround times and reduced inappropriate on-call usage are consistent with prior studies emphasizing the benefits of workflow standardization and process optimization in laboratory services [1,3,5]. Beyond operational gains, financial benefits were evident through decreased reliance on costly on-call services and reduced repeated investigations.

The PDCA cycle played a key role in continuous improvement, allowing the team to identify issues early and refine interventions. Sustainability is supported through ongoing monitoring, staff training, and iterative feedback mechanisms. Future enhancements could include integration with electronic laboratory information systems to automate tracking, provide real-time alerts, and further reduce manual workload.

Sustainability and Standardization

Ensuring the long-term sustainability of quality improvement initiatives is critical to maintaining the gains achieved through process innovation. In this project, sustainability was embedded through the establishment of structured monitoring systems, standardization of workflows, and continuous staff engagement. Continuous monitoring mechanisms were implemented using dual registries maintained at both ward and laboratory levels. These registries enabled real-time tracking of investigation requests and report generation, allowing early identification of delays or deviations from the standard workflow. Such monitoring ensured that the improvements achieved during the initial implementation phase were consistently maintained over time.

Regular audits were institutionalized as part of the quality assurance process, with formal evaluations conducted at three-month intervals. These audits served multiple purposes: they assessed adherence to the color-coded system, evaluated turnaround times, and identified emerging challenges within the workflow. By incorporating periodic audits, the system transitioned from a one-time intervention to a dynamic, continuously improving process aligned with established quality improvement principles [1,2].

Standardization played a central role in sustaining the intervention. The introduction and consistent use of color-coded investigation forms created a uniform method of communication between wards and the laboratory. This reduced ambiguity in prioritization and ensured that all staff adhered to a common protocol. Over time, this standardization became embedded in routine practice, minimizing variability and enhancing reliability of the laboratory workflow.

Ongoing staff training and reinforcement further strengthened sustainability. Given the rotational nature of healthcare staff and the potential for lapses in adherence, periodic training sessions were conducted to reinforce the importance of proper

categorization and timely submission of investigation requests. These sessions also provided a platform for addressing practical challenges and incorporating feedback from frontline staff. By fostering a culture of shared responsibility and continuous learning, the project ensured that improvements were not only sustained but also adaptable to future changes in workload or staffing patterns.

Limitations and Future Directions

Despite the success of the intervention, several limitations were identified during the implementation and evaluation phases. One of the primary limitations was the lack of real-time data tracking during the initial stages of the project. Baseline data were collected retrospectively, which may have introduced inaccuracies or incomplete data capture. The absence of real-time monitoring at the outset limited the ability to identify delays promptly and respond immediately to workflow inefficiencies.

Another significant limitation was the absence of an electronic laboratory information system. The reliance on manual registries, although effective for this intervention, posed challenges in terms of data accuracy, accessibility, and long-term scalability. Manual documentation is inherently prone to human error, including incomplete entries and inconsistencies in recording times. Furthermore, manual systems require additional staff effort and may not be sustainable in high-volume settings over extended periods.

The project also faced constraints related to limited quantitative data during the early implementation phase. While qualitative improvements in workflow and staff satisfaction were evident, the lack of comprehensive numerical data restricted the ability to perform detailed statistical analysis and quantify the full extent of improvements. This limitation highlights the importance of integrating robust data collection mechanisms at the outset of quality improvement initiatives.

Looking forward, several opportunities exist to enhance and build upon the success of this project. The integration of digital tracking systems and electronic laboratory information systems would represent a significant advancement. Such systems could automate the recording of request and report times, provide real-time alerts for delays, and generate comprehensive performance dashboards. Automation would reduce reliance on manual processes, improve data accuracy, and enable more sophisticated analysis of workflow efficiency.

Additionally, the implementation of automated workflows could further streamline laboratory operations by integrating investigation requests directly with laboratory processing systems. This would minimize delays caused by manual handling and improve coordination between clinical units and laboratory staff. Future initiatives may also explore the use of mobile or web-based applications to facilitate real-time communication and tracking of investigations.

In summary, while the project successfully addressed key inefficiencies in laboratory workflows, addressing these limitations through digital transformation and enhanced data systems will be essential for sustaining and scaling the improvements achieved. Continuous evaluation and adaptation will ensure that the system remains responsive to evolving healthcare demands and technological advancements.

6. CONCLUSION

The laboratory investigations optimization initiative at District General Hospital Nawalapitiya demonstrates that structured, low-cost interventions can substantially improve workflow efficiency, reduce inappropriate on-call investigations, and generate financial savings. Key success factors included color-coded forms, dual registries, interactive staff engagement, and continuous monitoring using the PDCA cycle.

This initiative provides a scalable model for other healthcare institutions seeking to enhance laboratory efficiency and patient care outcomes. The lessons learned highlight the importance of standardized processes, staff empowerment, and iterative quality improvement in achieving sustainable operational excellence.

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