



Increasing the Effectiveness in Critical Value Notifications in Chemical Pathology, Hospital Teluk Intan

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KEYWORDS

Critical value notification
Clinical audit
Laboratory quality
assurance

ARTICLE HISTORY

Received 19 Feb 2026
Received in revised form
17 Sep 2026
Accepted 20 Sep 2026
Available online 25 Sep 2026

ABSTRACT

This clinical audit aimed to improve the communication of critical laboratory results in the Chemical Pathology Unit, Hospital Teluk Intan. Timely communication of critical laboratory results is essential for timely clinical interventions to reduce patient morbidity and mortality. Method: The audit was conducted from November 2023 to August 2024 in the Integrated Laboratory, Hospital Teluk Intan. It focused on five critical test parameters— sodium, potassium, calcium, bilirubin (paediatrics) and ammonia (paediatrics)— according to Ministry of Health (MOH) guideline (Lampiran A). Data was extracted monthly from the Laboratory Information System (LIS) and analyzed using Microsoft Excel. Results: A baseline audit (October–November 2023) revealed the notification rates and the common causes of failures. Based on these findings, interventions were implemented, including issuing memos on the forms completeness, introducing standard notification procedures, continuous medical education (CME) and enhanced documentation. A re-audit from December 2023 to August 2024 evaluated the effectiveness of these changes. The initial data showed that only 70–71.6% of critical values were successfully notified. Key barriers included incomplete request forms, unanswered phone lines and lack of staff awareness. Post-intervention analysis demonstrated significant improvement, with notification rates consistently rising above 90%, reaching 98.8% by July 2024. Conclusion: These improvements showed that staff are more compliant and have better system efficiency. Structured interventions, including standardized procedures, education and improved communication protocols, have significantly increased notification rates for critical values. The audit underscores the importance of continuous monitoring, staff training and clear guidelines in ensuring patient safety and effective laboratory practices.

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1. INTRODUCTION

Critical value (CV) is defined as any test result that may require rapid clinical attention to avert significant patient morbidity and mortality [1]. According to De Gruyter (Oğuzhan Özcan et al.) published online January 20, 2017: Critical or panic values were first described by Lundberg as “potentially life-threatening test results unless necessary treatment is done promptly in clinical laboratories” [8]. Failure of timely communication and follow up of critical laboratory values (results) can lead to delay action being taken which may lead to morbidity or mortality. Critical Limit is defined as boundaries of low and high laboratory test results beyond which may cause imminent danger to the patient and /or

require immediate medical attention. Result Verification: Means results analysed, confirmed and ready to be reported. Notification: Any mode of communication e.g. telephone, SMS. All communication must be documented. The notification is timely as agreed/stated in the service objectives of the laboratory. LIS: Laboratory Information System (Schuynet & Schuylab) in HTI setting.

2. OBJECTIVE AND STANDARDS

2.1 Objectives

There has been increased concern about issues involved with enhancing the effectiveness of clinical laboratory critical

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<https://doi.org/10.56532/mjsat.v6i3.724>

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values notification since the publication of a report entitled “When to panic over abnormal values” by George Lundberg in the 1970s [6], [7]. Hence our aim of this audit is to improve communication of critical value of laboratory results in Chemical Pathology Unit, Hospital Teluk Intan.

2.2 Standards and Criteria

To improve effectiveness of critical value notifications.

MS ISO 15189 2022.

7.4.1.3 When examination results fall within established critical decision limits:

- The user or other authorized person is notified as soon as relevant, based on clinical information available;
- Actions taken are documented, including date, time, responsible person, person notified, results conveyed, verification of accuracy of communication and any difficulties encountered in notification”.

MSQH Service Standard 15 Pathology

Indicator 03: This is in line with the Malaysian Patient Safety Goal No. 8 which requires critical result to be notified within 30 minutes when it is ready to be reported”.

Malaysian Patient Safety Goal No. 8:

To Improve Clinical Communication by Implementing Critical Value Programme
(*Lampiran A, KKM/87/P3/10/8/1 (35), 2016*)

1. Percentage of Critical Values Notified within 30 minutes or less

$$\frac{a}{b} \times 100 = \% \quad (1)$$

a = Total number of critical value notified within 30 minutes (after result available)

b = Total number of critical value

2. For standardization of MPSG reporting, focused were given of 5 parameters due to their significant role to life-threatening complications when timely intervention is not initiated.

Sodium, Potassium, Calcium, Ammonia (Paeds), Bilirubin (Paeds)

Table 1. Parameters for Chemical Pathology critical value

Parameter	Critical Value	
	Threshold	Clinical Importance
Potassium	<2.8 or >6.0 mmol/L	Severe hypokalaemia may cause cardiac arrhythmias and respiratory muscle weakness, while hyperkalaemia can result in fatal cardiac conduction abnormalities and cardiac arrest.
Sodium	<125 or >155 mmol/L	Severe hyponatraemia may lead to cerebral oedema, seizures, and altered consciousness. Hypernatraemia may cause dehydration, neurological impairment, and intracranial haemorrhage.
Bilirubin	>300 umol/L	Severe neonatal hyperbilirubinaemia is associated with kernicterus and irreversible neurological damage.
Calcium	<1.5 or >3.0 mmol/L	Critically abnormal calcium levels may precipitate tetany, seizures, cardiac arrhythmias, or coma.

Parameter	Critical Value	
	Threshold	Clinical Importance
Ammonia	>100 umol/L	Hyperammonaemia may indicate metabolic disorders or liver dysfunction and can rapidly progress to encephalopathy and death if untreated.

3. METHODOLOGY

3.1 Location and Time

This project was conducted in Integrated Laboratory, Hospital Teluk Intan starting November 2023 until August 2024.

3.2 Inclusion Criteria

All critical laboratory values reported in Chemical Pathology based on *Lampiran A, KKM/87/P3/10/8/1 (35), 2016*.

3.3 Exclusion Criteria

The equations are an exception to the prescribed specifications of this template.

3.4 Data Collection

The laboratory utilised the Schuynet and Schuylab Laboratory Information Systems (LIS) for retrieval and monitoring of critical value data. These systems enabled monthly extraction of records including:

- Critical test parameters
- Time results became available
- Notification status
- Time of notification
- Documentation completeness

The LIS facilitated data analysis, audit monitoring and trend evaluation throughout the study period contributing to quality assurance and performance improvement activities within the Chemical Pathology Unit.

3.5 Data Analysis

Analysed using Microsoft Excel.

4. COMPARE PRACTICE WITH STANDARDS

4.1 Data Interpretation

There are several reasons for failure of critical value (CV) notification. Up to 37.90% of CVs were not informed for unspecified reasons with no explanation from laboratory personnel, indicating lack of awareness in complying with notification procedures. Unanswered calls and busy ward phone lines were also contributing factors. In keeping with previous study by Rensburgh et. al, “There appears to be a general lack of enthusiasm among clinical staff receiving critical results, despite their potentially serious impact on patient care and consequent medico-legal implications [11].”

To address this, notification workflows were standardised through continuous staff education, mandatory documentation of all notification attempts and closer supervision by senior laboratory personnel. Staff were also reminded to document reasons for unsuccessful notifications to improve traceability and accountability.

Additionally, incomplete laboratory request form without clear patient location made critical value notification more difficult.

4.2 Reasons for Shortfall in Quality

From the clinical audit, some of the limitations are:

- Incomplete laboratory request form.
- Unanswered phone calls after multiple attempts and busy wards' phone lines.
- Lack of awareness amongst laboratory personnel.

Accordingly, a standard procedure was established to ensure effective communication of this information and any issues encountered in the process were rectified.

Table 2. Critical Value reporting performances from October 2023 till November 2023

Critical Value	Month	
	October 2023 (n=366)	November 2023 (n=480)
Informed %	262 (71.6 %)	336 (70 %)
Not informed %	105 (28.7 %)	144 (30 %)

Table 3. Breakdown of uninformed Critical Value

Critical Value	Month		
	October 2023 (n = 104)	November 2023 (n = 144)	Percentage (%)
No location	35 (33.65 %)	30 (20.83 %)	26.21 %
Unanswered/ Engaged	49 (47.12 %)	40 (27.78 %)	35.89 %
Unspecified reasons (-)	20 (19.23 %)	74 (51.39 %)	37.90 %

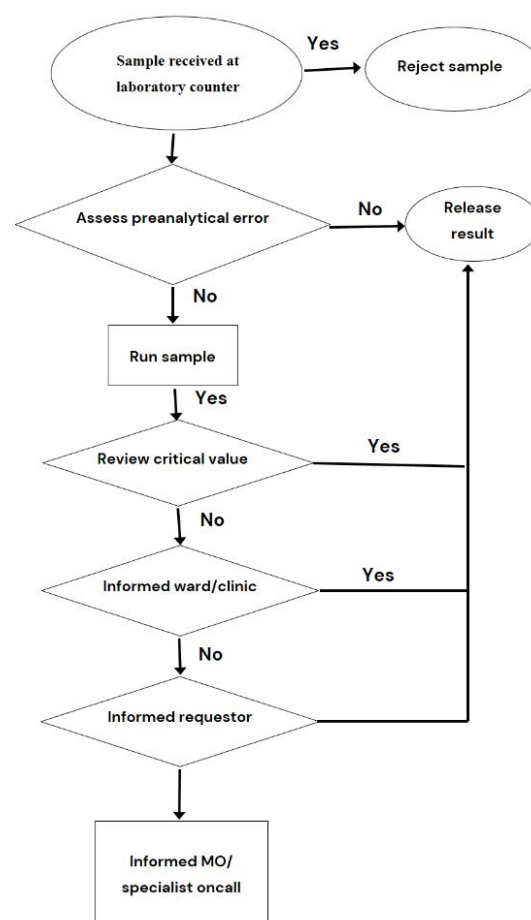


Fig. 1. Critical Value Notification Workflow

5. STRATEGIES FOR CHANGE

5.1 Strategies

A memo was issued to Head of Departments (HODs) addressing incomplete laboratory request forms, requiring compliance with the Pathology Service Handbook 3rd Edition 2023. Workflow among laboratory personnel was reinforced and all critical values must be communicated to the respective ward within 30 minutes as per mandated under Malaysian Patient Safety Goal (MPSG) No. 8 and supported by MSQH Service Standard 15 (Pathology). The 30-minute window is intended to ensure rapid clinical intervention for potentially life-threatening laboratory abnormalities.

Timely communication is essential because delays in informing clinicians may postpone urgent treatment decisions, increasing the risk of patient morbidity and mortality. Early notification enables immediate clinical assessment, medication adjustment, repeat testing or escalation of care when necessary.

CME sessions were conducted to strengthen implementation and monitor staff compliance with critical value notifications.

5.2 Implementation

A standard notification procedure for critical value notification was established and distributed to all wards and clinics in Hospital Teluk Intan. It outlines the notification process by laboratory staff including:

- Informer name
- Patient ID (name and RN/IC)
- Test parameter and critical result
- Sample date & time of notification
- Name of recipient and designation

This standardization improved traceability, reduced communication errors and ensured compliance with MS ISO 15189:2022 requirements.

Incomplete laboratory request forms was major barrier to timely notification. Essential details such as patient location, ward name or contact information were often missing. This caused delays in identifying and contacting the responsible healthcare team.

In December 2023, incomplete request forms began to be rejected in accordance with the *Pathology Services Handbook 3rd Edition 2023*. This improved documentation compliance, enabling faster patient identification and more efficient critical value notification.

When facing difficulties such as busy lines, unanswered phone calls or unknown patient location, staff contacted the requestor directly or informed the medical officer/ pathologist on-call.

Continuous Medical Education (CME) sessions played important role in reinforcing awareness and compliance among laboratory personnel. The sessions focused on:

- Importance of critical value communication for patient safety
- Standard operating procedures for notification
- Proper documentation requirements
- Troubleshooting communication difficulties
- Compliance with MS ISO 15189:2022 and MPSG No. 8

Monthly audit findings were also shared during CME sessions to provide feedback and encourage continuous quality improvement. These educational activities improved staff accountability and strengthened adherence to notification protocols.

6. REAUDIT

Table 4. Post audit Critical Value reporting performances

Critical Value (%)	Month								Aug 2024 (n= 561)
	Dec 2023 (n= 493)	Jan 2024 (n= 453)	Feb 2024 (n= 354)	Mar 2024 (n= 510)	Apr 2024 (n= 430)	May 2024 (n= 473)	Jun 2024 (n= 474)	Jul 2024 (n= 513)	
Informed	454 (92.1)	430 (94.1)	340 (96.1)	481 (94.3)	394 (91.6)	446 (94.3)	465 (98.1)	507 (98.8)	551 (98.2)
Not informed	39 (7.9)	23 (5.9)	14 (3.9)	29 (5.7)	36 (8.4)	27 (5.7)	9 (1.9)	6 (1.2)	10 (1.8)

6.1 Outcome

Following implementation of the corrective strategies, the re-audit showed significant improvement in critical value notification performance. Notification compliance increased from approximately 70% during the baseline audit (October–November 2023) to consistently above 90% from December 2023 onwards.

The best performance was recorded in July 2024 with 507 of 513 critical values successfully communicated achieving a notification rate of 98.8%. At the same time, uninformed critical values decreased markedly from 30% at baseline to 1.2% in July 2024.

These findings demonstrate the effectiveness of the interventions in enhancing communication efficiency and compliance with patient safety standards.

6.2 Dissemination of Findings and Information

To achieve our objective; to lower the percentage of CV not informed from 30% of cases (from Oct until Nov 2023), monthly data were collected and informed to all staff. As a result, significant reduction of uninformed CV percentage to less than 10% (from Dec 2023 until August 2024) is appreciated.

6.3 Monitoring and Surveillance

The critical value notification will continue to be monitored as an internal quality indicator for the purpose of service improvement as it is crucial for patients' safety.

Monthly data on uninformed critical values will be share with laboratory staff to ensure compliance. Laboratory request forms must also be complete and adequate as stated in distributed memo.

7. DISCUSSION

The marked improvement in critical value notification rates demonstrates the effectiveness of structures quality improvement approach. Initial challenges – including incomplete request forms, unresponsive phone lines and limited staff awareness – resulted in low notification rates (70–71.6%) posing risks to patient safety.

The audit identified poor responsiveness among some clinical staff receiving critical value notifications including unanswered calls and delayed acknowledgement of results. Similar issues have been reported in previous studies despite the serious clinical implications of critical results.

To mitigate this issue, formal memos were issued through memos to the Head of Department (HODs) to reinforce the importance of timely response to laboratory notifications and compliance with patient safety policies. Standardized procedures were also distributed to clinical units, alongside continuous engagement to strengthen communication between laboratory and clinical teams.

Following the standardized procedures, improved documentation, memos to clinical units and CME sessions, compliance steadily increased reaching 98.8% in July 2024 (re-audit: December 2023 – August 2024).

This audit shows that simple, well-planned interventions can significantly enhance laboratory service quality.

8. CONCLUSION

These improvements showed that staff are more compliant and have better system efficiency. Structured interventions, including standardized procedures, education and improved communication protocols have significantly increased notification rates for critical values. A complete

critical value notification and response process should be established in hospitals to provide safe and high-quality medical services [12]. The audit underscores the importance of continuous monitoring, staff training and clear guidelines in ensuring patient safety and effective laboratory practices.

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