Frequency, Causes and Economic Impact of Repeat Testing in a Clinical Biochemistry Laboratory of a University Hospital in Nepal

Puja Bhattarai[1], *Saroj Thapa*[2]

Affiliations:

[1]Department of Clinical Microbiology, Dhulikhel Hospital, Kathmandu University Hospital, Nepal

[2]Department of Clinical Biochemistry, Kathmandu University School of Medical Sciences, Nepal

Correspondence to:
Ms. Puja Bhattarai
Department of Clinical Microbiology
Dhulikhel Hospital, Kathmandu University Hospital, Kavre, Nepal
e-mail: bhtpooja@gmail.com

Received: 15 January 2026
Revised: 3 May 2026
Accepted: 15 May 2026
Published: 30 May 2026

How to cite this paper:
Bhattarai P & Thapa S. Frequency, Causes and Economic Impact of Repeat Testing in a clinical biochemistry laboratory of a university hospital in Nepal. *Ann. Clin. Chem. Lab. Med. 2026:* 5(1), 18-25. https://doi.org/10.3126/acclm.v5i1.94673

ABSTRACT

Background

Repeat testing is a common practice in clinical laboratories intended to confirm critical or unexpected values. Unnecessary repeat tests contribute to increased workload, increased turnaround time (TAT), and higher operational costs. However, there is a lack of standardized, evidence-based guidelines to govern repeat testing, particularly in resource-limited settings. This study aimed to analyze the frequency and patterns of repeat biochemical testing in a university hospital laboratory and to assess the associated reporting delay and economic burden.

Methods

A cross-sectional observational study was conducted in the Clinical Biochemistry Laboratory of Dhulikhel Hospital for a duration of one month. Biochemistry analyzer records were reviewed to identify repeated tests. The frequency of repeat per analyte, reasons for repetition, and concordance between initial and repeat results were assessed. The average delay in reporting due to repeat testing and the direct cost incurred were calculated.

Results

Out of 95,757 total tests, 701 (0.73%) were repeated across 43 analytes. Higher repeats occurred in low-volume tests, notably urine albumin (50%) and β-hCG (12.04%). Critical values were the most common reason for repetition (44.37%). For most of the analytes, no clinically significant difference was found between initial and repeat results. Repeat testing caused a mean reporting delay of 64 ± 41 minutes and incurred a total additional direct cost of NPR 153,188.

Conclusion

Although repeat testing plays an important role in confirming critical values and ensuring patient safety, a substantial proportion of repeated biochemical tests showed no meaningful change from the initial results. Reducing avoidable repeat testing through standardized guidelines and strengthened quality management practices may improve laboratory efficiency, reduce turnaround time, and optimize resource utilization without compromising patient care.

Keywords

Repeat testing, Critical Values, Turnaround time, Reproducibility of Result, Laboratory Cost

Introduction

Laboratory tests play a pivotal role in clinical decision making, influencing diagnosis, treatment, and monitoring of patients. In the past, repeat testing were routinely performed to confirm accuracy because analytical instruments during those days lacked adequate precision.[1] This practice remains common for critical values in many laboratories despite significant improvements in automation, precision, and quality control.[2]

The most common reason for repeat testing is often values beyond the critical result threshold. Critical values are laboratory results that indicate potentially life-threatening conditions requiring immediate clinical intervention. However, there is no standard protocols on the establishment of critical values, hence critical values may not be harmonized across laboratories.[3] Repeat testing is often intended to prevent the reporting of erroneous results and to enhance patient safety and at the same time, it may lead to prolonged turnaround time (TAT), increased laboratory workload, higher operational costs and delayed clinical decision-making.[1,4] In addition, it may lower diagnostic confidence with additional burden on healthcare systems.[5] Electrolyte panels (sodium, potassium) and renal function tests (urea, creatinine) are among the most frequently repeated tests, often due to their association with critical clinical states.[6] Similarly, metabolic tests like HbA1c are commonly repeated, sometimes due to analytical challenges or clinical doubt.[7,8] While repeat testing is justified in cases of suspected sample interference, analytical error or an implausible result, its routine application in the absence of a clear indication is difficult to defend.[9]

Evidence evaluating the utility, impact and cost implications of repeat testing in clinical biochemistry laboratories, especially in low and middle-income countries (LMICs) is limited. There is a paucity of data from LMICs evaluating the scale, rationale, and economic impact of repeat testing practices. Therefore, this study was conducted to systematically analyze the frequency and patterns of repeat biochemical testing, assess the concordance between initial and repeated results, and quantify the associated delays in TAT and direct laboratory costs in a tertiary care hospital in Nepal.

Methods

A quantitative, observational, cross-sectional study was conducted in the Clinical Biochemistry Laboratory of Dhulikhel Hospital-Kathmandu University Hospital (DH-KUH), a tertiary care teaching hospital. The study period spanned one month from 1st Jestha to 32nd Jestha 2081 (14 May to 14 June 2024). Ethical approval was obtained from the Institutional Review Committee of Kathmandu University School of Medical Sciences (IRC-KUSMS Approval No. 139/24). Patient identifiers were not collected and confidentiality of laboratory data was maintained throughout the study.

Data on all biochemical tests performed during the study period were extracted from the analyzer logs. A "repeat test" was defined as a re-analysis of the same analyte from the original sample aliquot performed before the initial result was reported. The different causes for the repeat tests that were included in the study were critical value (high or low), analytical error flag (e.g., sample insufficiency, instrument error), implausible or inconsistent result and quality control failure during the analytical run. Tests repeated on clinician's request after initial reporting or on a new sample were not included.

The different analytical methods employed for testing is shown in table 1.

Table 1. Different parameters and methods

S.N.	Test Name	Method / Principle	S.N.	Test Name	Method / Principle
1.	AFP	CLIA	23.	Serum Albumin	BCG
2.	ALP	AMP-IFCC	24.	Serum Amylase	Slide Method
3.	ALT	IFCC	25.	Serum Calcium	Slide Method

S.N.	Test Name	Method / Principle	S.N.	Test Name	Method / Principle
4.	AST	IFCC	26.	Serum Cortisol	CLIA
5.	CK- Total	Slide method	27.	Serum Creatinine	JAFFE (COMPENSATED)
6.	CK-MB	Slide method	28.	Serum Iron	Slide Method
7.	CRP	Immunoassay	29.	Serum LDH	Pyruvate
8.	D-dimer	Nephlometry	30.	Serum Lipase	Slide Method
9.	DHDL	Spectrophotometric	31.	Serum Magnesium	Slide Method
10.	Direct Bilirubin	Diazotized Sulfanilic	32.	Serum Sodium	ISE
11.	Drain Amylase	Direct substrate	33.	TAG	Spectrophotometric
12.	FBS	Slide Method	34.	Total Bilirubin	Diazotized Sulfanilic
13.	fT3	CLIA	35.	Total Cholesterol	Spectrophotometric
14.	fT4	CLIA	36.	Total Protein	Spectrophotometric
15.	GCT	Spectrophotometric	37.	TSH	CLIA
16.	HbA1c	HPLC	38.	Urea	Urease
17.	Phosphorous	Slide Method	39.	Uric Acid	Spectrophotometric
18.	Fluid ADA	Spectrophotometric	40.	Urine Albumin	Nephelometry
19.	Fluid LDH	IFCC	41.	Vitamin B12	CLIA
20.	Potassium	ISE	42.	Vitamin D3	CLIA
21.	PPBS	Spectrophotometric	43.	β-HCG	CLIA
22.	RBS	Spectrophotometric			

The frequency of repeat tests was defined as the proportion of repeated tests to total tests for each analyte. Similarly, the concordance of results was defined as the paired comparison of initial and repeat numerical results. The time difference between the availability of the initial result and the final verified result due to repetition was used for the calculation of test delay. The direct cost of repeat testing was calculated using test rates provided by the Nepal Health Insurance Board.10

Data was entered into Microsoft Excel and analyzed using STATA version 15. Descriptive statistics, including frequencies, percentages, means, medians, and interquartile ranges (IQR), were used to summarize data. Paired comparisons between initial and repeat test results were performed using appropriate statistical tests based on data distribution. A p-value <0.05 was considered statistically significant.

Results

During the study period of one month, a total of 95,757 biochemical tests (117 test types) were performed in the clinical biochemistry department of Dhulikhel Hospital. There was a total of 117 different parameters that were analyzed at that time. Of these, 701 tests (0.73%) representing 43 different parameters were repeated. The occurrence of repeat tests of various analytes is shown in Table 2. The distribution of repeats across major test categories is shown in Table 3.

Table 2. Occurrence of repeat tests of various analytes during the study period

S.N.	Test Name	Total Tests	No. of Repeat Tests	Frequency (%)
1.	AFP	13	1	7.69
2.	ALP	2631	4	0.15
3.	ALT	2996	17	0.57
4.	AST	2996	15	0.50
5.	CK- Total	57	1	1.75
6.	CK-MB	145	3	2.07
7.	CRP	3131	4	0.13
8.	D-dimer	86	1	1.16
9.	DHDL	2091	7	0.33
10.	Direct Bilirubin	2724	47	1.73
11.	Drain Amylase	14	1	7.14
12.	FBS	2716	5	0.18
13.	fT3	3262	3	0.09
14.	fT4	3271	1	0.03
15.	GCT	121	1	0.83
16.	HbA1c	1696	65	3.83
17.	Phosphorous	95	1	1.05
18.	Fluid ADA	67	1	1.49
19.	Fluid LDH	49	4	8.16
20.	Potassium	8403	71	0.84
21.	PPBS	2214	29	1.31
22.	RBS	4457	25	0.56
23.	Serum Albumin	2209	25	1.13
24.	Serum Amylase	453	5	1.10
25.	Serum Calcium	1111	16	1.44
26.	Serum Cortisol	31	1	3.23
27.	Serum Creatinine	8033	49	0.61
28.	Serum Iron	43	1	2.33
29.	Serum LDH	140	2	1.43
30.	Serum Lipase	442	13	2.94
31.	Serum Magnesium	555	5	0.90
32.	Serum Sodium	8195	72	0.88
33.	TAG	2116	16	0.76
34.	Total Bilirubin	2897	44	1.52
35.	Total Cholesterol	2092	2	0.10
36.	Total Protein	2632	23	0.87
37.	TSH	4055	10	0.25
38.	Urea	7814	76	0.97
39.	Uric Acid	869	11	1.27
40.	Urine Albumin	8	4	50.00
41.	Vitamin B12	723	2	0.28
42.	Vitamin D3	945	4	0.42
43.	β-hcg	108	13	12.04
	Total		**701**	

Table 3. Occurrence of repeat tests of analytes of different categories during the study period

S.N.	Category	Total Tests	No. of Repeat Tests	Frequency (%)
1.	Cardiac Markers & Inflammatory	3675	16	0.44
2.	Diabetic & Metabolic Panel	16402	158	0.96
3.	Hormones & Tumor Markers	152	15	9.87
4.	Liver Function Tests (LFTs) & Hepatobiliary	21297	183	0.86
5.	Pancreatic/Gastrointestinal Enzymes	909	19	2.09
6.	Renal Function & Electrolytes	33964	285	0.84
7.	Thyroid Function Tests	10588	14	0.13
8.	Urine Analysis	8	4	50.00
9.	Vitamins & Minerals	1711	7	0.41
	Total	**93706**	**701**	**0.75**

Most routine tests showed low repeat frequencies for high-volume parameters such as sodium (0.88%), potassium (0.84%), urea (0.97%), and creatinine (0.61%). Moderately higher repeat rates were observed in HbA1c (3.83%), cortisol (3.23%), lipase (2.94%), iron (2.33%), and CK-MB (2.07%). Markedly elevated repeat frequencies were noted in low-volume or special tests, particularly urine albumin (50%), β-hCG (12.04%), fluid LDH (8.16%), AFP (7.69%), and drain amylase (7.14%). Several parameters demonstrated excellent analytical stability, with repeat frequencies below 0.5%.

The most common reason for repeat testing was values falling beyond critical result threshold. Critical results accounted for 311 repeats (44.37%); of which 185 repeats for high value and 126 repeats for low value. It was followed by analyzer flags/errors (37.09%), out of linearity (9.55%) and inconclusive/inconsistent patterns (8.98%) as shown in figure 1.

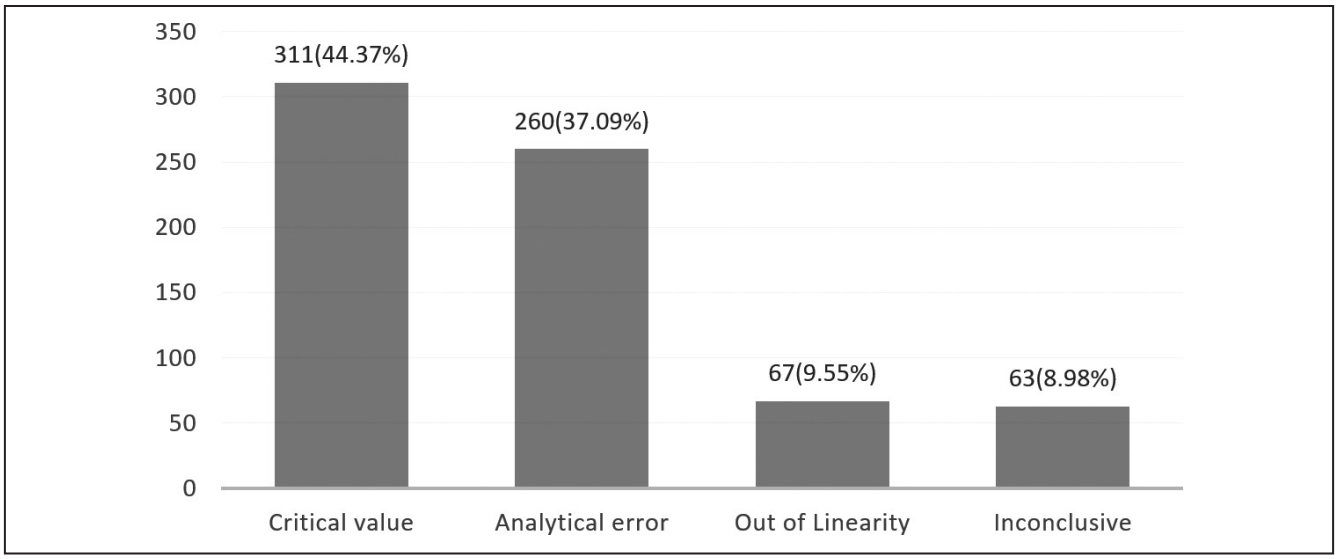

Figure 1. *Number of repeat tests performed due to various reasons.*

Comparison between initial and final test results revealed statistically significant differences in several analytes following repeat testing. Significant changes were observed in AST ($p = 0.02$), HbA1c ($p < 0.01$), PPBS ($p < 0.01$), serum albumin ($p = 0.02$), serum sodium ($p < 0.01$), urea ($p < 0.01$), β-hCG ($p < 0.01$), and triglycerides ($p < 0.01$). In contrast, ALT, direct bilirubin, FBS, potassium, RBS, serum calcium, serum creatinine, total bilirubin, total protein, and uric acid did not show statistically significant differences between initial and final measurements ($p > 0.05$).

Table 4. Comparison of initial and final test results of repeat tests

S.N	Analytes, conventional units	Initial Test Result Median (IQR) / Mean ± SD	Final Test Result Median (IQR) / Mean ± SD	p-value
1.	ALT, IU/L	4 (2, 1730.25)	13.5 (10, 1684.75)	0.25
2.	AST, IU/L	750 (19.1, 750)	1081 (22, 1402)	0.02
3.	Direct Bilirubin, mg/dL	0.5 (0.2, 3)	0.7 (0.5, 2.7)	0.17
4.	FBS, mg/dL	54 (51.5, 55.75)	51.5 (46, 57)	0.58
5.	HbA1c, %	6.3 (5.4, 7.3)	6.6 (5.9, 7.9)	<0.01
6.	Potassium, mEq/L	3.8 (3.4, 4.8)	3.8 (3.7, 4.5)	0.21
7.	PPBS, mg/dL	83 (64.5, 87.5)	89 (75, 97)	<0.01
8.	RBS, mg/dL	47 (37, 128.5)	45 (40, 130)	0.06
9.	Serum Albumin, g/dL	2.7 (2.3, 3.8)	2.9 (2.3, 5)	0.02
10.	Serum Calcium, mg/dL	10.1 (7.68, 11.83)	9.9 (7.88, 11.4)	0.51
11.	Serum Creatinine, mg/dL	5 (1.7, 8.17)	4.7 (1.1, 8.2)	0.84
12.	Serum Sodium, mEq/L	132.5 (127.75, 135)	137 (131, 138.25)	<0.01
13.	Total Bilirubin, mg/dL	3.2 (2, 6.05)	3.2 (1.78, 7.15)	0.39
14.	Total Protein, g/dL	6.9 (5, 8.95)	6.4 (5.08, 8.28)	0.28
15.	Urea, mg/dL	7.9 (4.9, 38)	22 (15, 46.5)	<0.01
16.	Uric Acid, mg/dL	9.65 (1.08, 14.23)	8.55 (1.98, 14.25)	0.44
17.	β-HCG, mIU/mL	10000 (1000, 1000)	36546 (28310, 82895)	<0.01
18.	TAG, mg/dL	540.85 ± 59.33	994.93 ± 386.06	<0.01

Note: Repeat tests done due to analytical error showing no initial test results are excluded.

Repeat testing caused a significant delay in reporting the test results. The mean reporting delay was 64 ± 41 minutes ranging from 7 minutes to 4 hours 52 minutes. The total direct cost incurred for the 701 repeated tests was NPR 153,188 (approximately USD 1064) in a month. HbA1c, due to its high unit cost and repeat rate, was the largest cost driver, accounting for about 25% of the total repeat testing expenditure.

Discussion

The present study assessed 701 repeat tests involving 43 routine biochemical analytes over one-month period. Electrolytes, renal function tests, liver enzymes, and glucose parameters demonstrated acceptable repeat rates despite high testing volumes, consistent with established laboratory quality benchmarks. Similarly, thyroid

function tests, CRP, lipid profile, and vitamin assays showed minimal repeats, suggesting stable reagents and reliable instrument performance. The highest repeat frequency was observed in urine albumin; however, this finding is influenced by a very small sample size and likely reflects pre-analytical issues such as improper sample collection or inadequate specimen quality. Elevated repeat frequencies in β-hCG and AFP may be attributed to mandatory verification of clinically critical or borderline results, dilutional reruns, and instrument flags, which are in line with good laboratory practice. Higher repeat rates in body fluid analyses, including fluid LDH and drain amylase, are likely related to sample heterogeneity and manual handling, which are known contributors to analytical variability. Overall, repeat testing was predominantly confined to low-volume, clinically critical, or special analytes, while routine parameters remained within acceptable limits. Continuous monitoring of repeat test can help identify process gaps and guide targeted corrective and preventive actions to further improve laboratory quality. Although repeated testing often showed statistically significant differences from the initial results, these differences were mainly due to analytical variation rather than true clinical change. Most repeat tests performed because of high or low initial values showed no meaningful difference from the first result, indicating that many of these repetitions were unnecessary. Critical values were the most common reason for repeating tests.

Repeat testing accounted for less than 1% of all biochemical investigations. However, it still caused delays in result reporting and increased laboratory costs. Similar to other studies, electrolyte and renal function tests were the most frequently repeated analytes. These tests are commonly linked to serious clinical conditions, which may explain the cautious approach taken by laboratory staff. This aligns with previous reports indicating that a substantial proportion of repeat testing does not improve diagnostic accuracy but contributes to increased workload and resource utilization.[1]

Despite numerous strategies to eliminate lab errors, they still occur.[7] Intelligent automation has improved reproducibility, reduced result variability and analysis errors, and significantly enhanced the quality of lab results.[8] Repeating tests to avoid false results is crucial when using instruments with poor precision.[11] This practice remains common for critical value measurements in many labs, even with significant advancements in automation, precision, and quality assurance.[2,11,12] Data from the College of American Pathologists (CAP) Q-Probes survey indicated that 61% of laboratories still repeat testing for critical values.[9] Typically, noncritical lab test results are not retested before being reported. Eliminating routine repeat testing can help lower costs and reduce turnaround time.[1]

Balancing patient safety with laboratory efficiency remains a challenge. While repeating critical results may reassure laboratory personnel, it can also delay urgent clinical decisions. Therefore, repeat testing should be based on clear protocols that consider analyzer performance, quality control status, and the patient's clinical condition.

This study provides a detailed snapshot of repeat testing practices in a busy tertiary care laboratory in Nepal. The overall repeat rate of 0.73% is comparable to or lower than rates reported in some studies from high-income settings, which can range from 0.5% to 5% depending on the test mix and protocols.[9,13] This relatively low rate may reflect efficient initial analytical processes. However, the associated cumulative delay of over 64 minutes on average and the significant additional cost highlight that even a low percentage has tangible operational impacts.

Electrolytes (Na+, K+) and renal markers (urea) were among the most repeated tests aligns with global patterns, as these are often linked to critical conditions like renal failure, cardiac arrhythmias, and diabetic emergencies.[11] The strikingly high repeat rate for HbA1c (3.83%) warrants specific attention. While HPLC is the gold-standard method, factors such as variant hemoglobins or poor chromatographic peaks may trigger technologist caution and repetition.[11,13] This suggests a need for better training and clearer testing guidelines.

Most critically, our data reinforce evidence from other studies that a large proportion of repeat testing, even for critical values, does not yield a clinically significant change in the result.[12,13] This questions the utility of a blanket repeat policy for all critical values when the analyzer is

functioning within control. The delay of over an hour, particularly for truly critical results, could paradoxically impede, rather than enhance, patient safety by slowing intervention. The economic burden of NPR 153,188 extrapolates to nearly NPR 1.84 million annually for this single laboratory a substantial sum in a resource-constrained system that could be redirected towards essential supplies or capacity building.

The one-month duration may not reflect annual variations. As a single-center study, findings may not be generalizable to laboratories with different instruments, volumes, or patient demographics. The cost analysis considered only direct costs; a full economic assessment including labor, overhead, and clinical impact of delays would be more comprehensive. Furthermore, the clinical outcomes associated with repeated tests were not tracked.

In conclusion, repeat testing remains a common laboratory safety practice but leads to increased costs and delays. In our setting, many repeat tests did not change clinical interpretation, suggesting that a large proportion of these tests may be avoided. Moving from routine to rational repeat testing, guided by analyzer performance, quality indicators, and clear institutional protocols, can improve laboratory efficiency while maintaining patient safety. This approach is especially important in resource-limited settings such as Nepal.

Acknowledgement

The authors extend their sincere gratitude to the technical and administrative staff of the Clinical Biochemistry Laboratory, Dhulikhel Hospital, for their unwavering cooperation and assistance in data collection.

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