Brief Report

Real world implementation of whole blood hemolysis indices on potassium results at the Point of Care

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Abstract

Introduction: Hemolysis is the most common preanalytical error in potassium testing due to release of intracellular potassium from disrupted blood cells. We have recently reported that the GEM Premier 7000 demonstrated strong agreement with central laboratory potassium measurements and reliable hemolysis detection. As the only POCT blood gas analyzer with integrated hemolysis indices, the GEM 7000 may reduce unnecessary repeat testing and improve efficiency. This follow-up study evaluated the impact of POCT implementation on potassium test utilization.

Methods: A retrospective analysis was conducted on all potassium tests (n=673) performed over one month using the GEM 7000 across multiple clinical units. Hemolysis status was assessed using the hemolysis index and repeat testing of potassium in the central laboratory (Vitros 7600) was evaluated for all samples, with subgroup analysis of hemolyzed specimens (HI 3–6). Results were compared with prior baseline data (January–April).

Results: A total of 673 potassium tests were performed, of which only 86 (12.78%) were repeated in the central laboratory. Among 247 hemolyzed samples (HI 3–6), only 20 (8.10%) underwent repeat testing, while 227 (91.90%) were not repeated. In contrast, prior baseline data showed a repeat rate of 95.05% in hemolyzed samples, representing a substantial reduction in unnecessary repeat testing for potassium.

Conclusion: Implementation of POCT hemolysis index significantly improved test utilization by reducing unnecessary repeat potassium testing, particularly in hemolyzed samples. This approach supports efficient laboratory workflows, reduces central laboratory burden, and enables timely clinical decision-making while maintaining appropriate result utilization.

Introduction

Hemolysis is the most common preanalytical error in clinical laboratory testing and remains a major challenge for accurate potassium measurement [1]. It results from disruption of red blood cell membranes, leading to the release of intracellular potassium into plasma and causing falsely elevated results (pseudohyperkalemia), which may lead to inappropriate diagnosis and/or treatment [2, 3]. Given that intracellular potassium concentrations are substantially higher than plasma levels, even minimal hemolysis can significantly impact measured values, particularly in whole blood samples [4]. The clinical implications are substantial, as both falsely elevated and masked potassium abnormalities can adversely affect patient management and outcomes [5].

Point-of-care testing (POCT) has become an essential component of modern laboratory medicine, particularly in acute care settings where rapid turnaround time is critical for timely clinical decision-making. Blood gas analyzers, such as the GEM Premier 7000, enable rapid measurement of potassium and other analytes directly from whole blood at the bedside [6]. However, the use of whole blood introduces unique preanalytical challenges, as hemolysis cannot be visually detected and has historically been difficult to measure in these systems [7]. As a result, potassium measurements obtained from POCT may be more susceptible to hemolysis-related interference, increasing uncertainty in result interpretation [8]. Recent technological advancements have addressed this limitation through the integration of hemolysis detection within blood gas analyzers. The GEM Premier 7000 incorporates an in-line hemolysis detection module capable of identifying and categorizing plasma free hemoglobin in whole blood samples, and we and others have previously demonstrated strong agreement with central laboratory methods [6,9]. Studies have shown that hemolysis is relatively common in whole blood testing, with reported rates ranging from approximately 8% to over 10% depending on clinical setting, and even higher in emergency or capillary samples [10]. Our group has previously demonstrated, in the pediatric setting, excellent agreement between potassium measurements obtained using the GEM 7000 and the central laboratory Vitros XT 7600, along with strong concordance in hemolysis detection across platforms, with most samples differing by no more than a single hemolysis grade level [6]. Importantly, these findings support the reliability of point-of-care whole blood hemolysis indices especially with regards to potassium testing. [11].

Despite improvements in hemolysis detection, the management of hemolyzed potassium results remains variable across institutions. In many settings, hemolyzed samples prompt repeat testing in the central laboratory to confirm results, leading to increased laboratory workload, additional blood draws, delayed turnaround times, and inefficient use of resources [12]. This practice is particularly impactful in high-volume or critical care environments, where the balance between rapid decision-making and result reliability is essential.

Optimizing test utilization in this context requires a careful balance between reliance on POCT results and appropriate use of confirmatory central laboratory testing [13]. While POCT offers clear advantages in turnaround time and workflow efficiency, its integration into clinical practice must be accompanied by strategies that minimize unnecessary repeat testing without compromising patient safety [14, 15].

In this study, we evaluate real-world potassium testing practices following implementation of GEM 7000 POCT across multiple clinical units. Specifically, we assess patterns of repeat testing in the central laboratory, examine the impact of hemolysis index on testing decisions, and compare current utilization practices with historical baseline data. Our goal is to identify opportunities to reduce unnecessary repeat testing and improve overall laboratory efficiency while maintaining appropriate clinical use of potassium results.

Methods

A retrospective observational study was conducted at Texas Children's Hospital to evaluate potassium test utilization following implementation of GEM 7000 point-of-care testing with hemolysis index, specifically assessing how availability of whole blood hemolysis indices influenced utilization of potassium results and reduced repeat central laboratory testing. All potassium results generated over a one-month period (November) using the GEM Premier 7000 blood gas analyzer (Werfen, Bedford, MA, USA) were included (n=673). The GEM 7000 provides whole blood potassium measurements with integrated hemolysis detection, categorizing samples by hemolysis index (HI) during routine analysis. Data were collected from multiple clinical units, including Operating Room Cardiovascular Service (ORCV), Cardiovascular Intensive Care Unit (CVICU), Adult Congenital Heart Disease Unit (24ACHD), and Pediatric Intensive Care Unit (PICU), with a smaller contribution from West Tower Emergency Center (WTEC). Following data extraction, each POCT result was cross-referenced in the electronic medical record (EPIC) to determine whether a corresponding potassium measurement was performed in the central laboratory using the Vitros 7600 chemistry analyzer (Ortho Clinical Diagnostics, USA). The GEM Premier 7000 utilizes an integrated iQM3 hemolysis detection system that categorizes specimens into hemolysis index (HI) levels 1–6 based on estimated free hemoglobin concentration: HI 1 (0–50 mg/dL), HI 2 (51–115 mg/dL), HI 3 (116–200 mg/dL), HI 4 (201–300 mg/dL), HI 5 (301–400 mg/dL), and HI 6 (≥401 mg/dL). At our institution, potassium results are reported for specimens with HI 1–5 and suppressed for specimens with HI 6. In the central laboratory, the Vitros 7600 categorizes hemolysis according to free hemoglobin concentration, and potassium results are not reported when free hemoglobin exceeds 500 mg/dL because of unacceptable analytical interference. Thus, the reporting thresholds for potassium are >401 mg/dL free hemoglobin for the GEM Premier 7000 and >500 mg/dL for the Vitros 7600. Repeat

testing was defined as a central laboratory potassium result obtained from the same patient within 2 hours of the initial GEM 7000 measurement. Hemolysis status was assessed using the GEM hemolysis index, with subgroup analysis focused on hemolyzed samples (HI 3–6). Test utilization was evaluated by calculating the proportion of POCT results repeated in the central laboratory overall and among hemolyzed specimens. Current utilization patterns were compared with previously collected baseline data (January–April) from multiple units, including TCH WTEC, PW NICU, and TCH WTNICU, to assess changes in repeat testing practices. Descriptive statistics were used to summarize test volumes and repeat rates.

Results

A total of 673 potassium tests were performed during the one-month study period using the GEM Premier 7000 point-of-care analyzer across multiple clinical units, including ORCV, CVICU, 24ACHD, and PICU, with a smaller contribution from WTEC. Of these, 86 tests (12.78%) had a corresponding repeat potassium measurement performed in the central laboratory using the Vitros 7600 analyzer within the defined 2-hour timeframe.

Hemolysis was common in the subset of samples preselected for electrolyte measurement, with 247 of 673 samples (36.7%) categorized as hemolyzed based on hemolysis index (HI) levels 3–6. In comparison, hemolysis was relatively uncommon in the overall blood gas specimen population (~1%), although higher rates were observed in the emergency department (up to 8.2%), as reported in our prior analysis [6]

Despite relatively high prevalence, repeat testing among hemolyzed samples was infrequent. Only 20 of the 247 hemolyzed samples (8.10%) were repeated in the central laboratory, while the majority, 227 samples (91.90%), were not repeated. These findings indicate that most hemolyzed POCT potassium results did not trigger confirmatory testing.

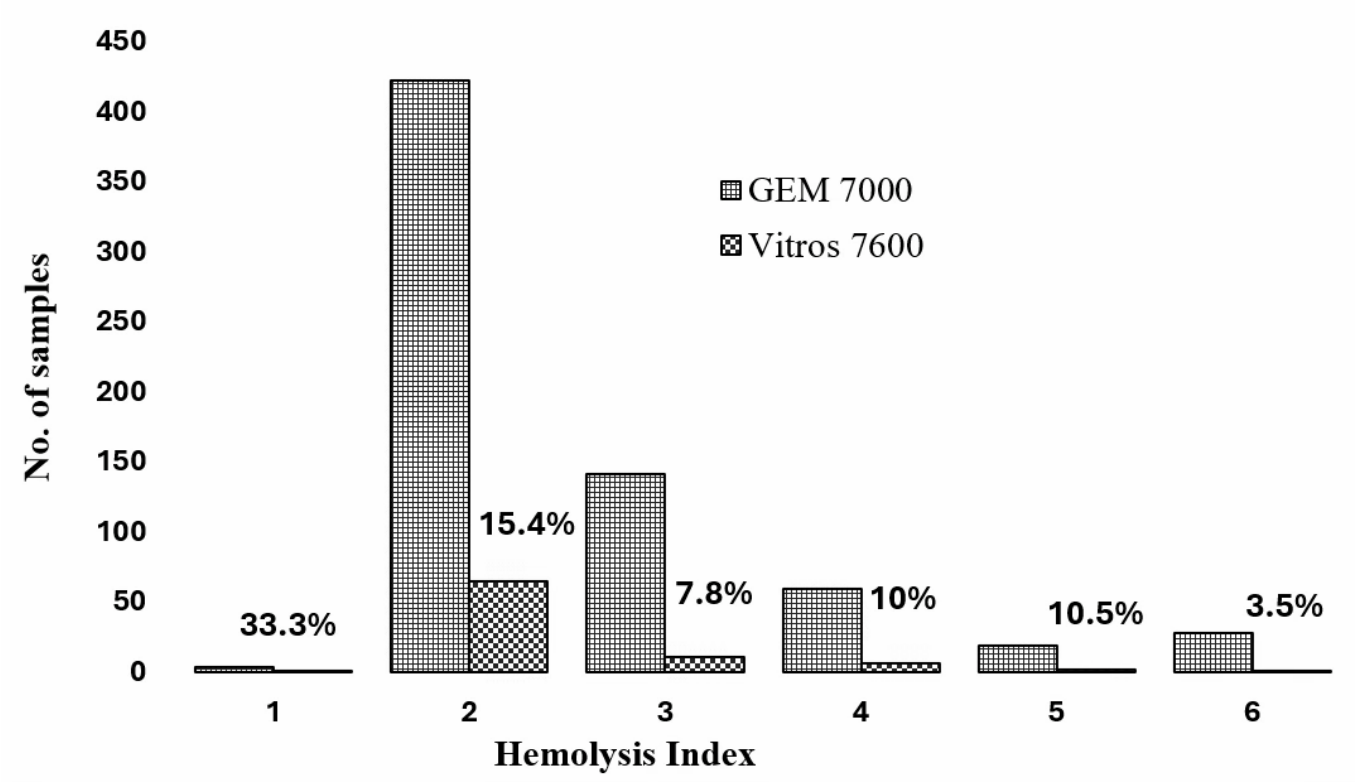
When stratified by clinical unit, variability in repeat testing rates was observed. The average reflex rate was highest in PICU (22.5%), followed by CVICU (13.6%) and OR (8.2%), indicating differences in utilization practices across care settings (Table1).

Table 1: Reflexed testing rates varied across units in relation to hemolysis index levels. Values represent the proportion of samples reflexed at each hemolysis level, with averages shown for each unit.

CVICU (n=117)		OR (n=350)		PICU (n=142)	
Hemolysis Index	**Reflexed Percentage (%)**	**Hemolysis Index**	**Reflexed Percentage (%)**	**Hemolysis Index**	**Reflexed Percentage (%)**
1	n/a	1	0	1	n/a
2	20	2	7	2	31
3	7	3	9	3	6
4	0	4	13	4	11
5	14	5	11	5	0
6	0	6	10	6	0
Avg	**13.6%**	**Avg**	**8.2%**	**Avg**	**22.5%**

Analysis by hemolysis index demonstrated that repeat testing was not uniformly distributed across HI levels. While moderate hemolysis categories (HI 2–4) accounted for the majority of repeated tests, relatively higher reflex percentages were observed in lower HI categories (HI 1–2) in some units, likely influenced by smaller sample sizes and case-specific clinical decision-making (Figure 1).

Figure 1: showing the number of total and reflexed samples across hemolysis index levels (1–6). Percent values indicate the proportion of samples reflexed at each hemolysis index relative to the total samples in that category.



Comparison between the two periods demonstrates a marked reduction in repeat testing for potassium in hemolyzed samples, decreasing from 95.05% in the baseline period to 8.10% in the current study. Additionally, overall central laboratory utilization remained low, with only 12.78% of all POCT potassium tests requiring repeat measurement. Together, these findings highlight a substantial shift in test utilization patterns following implementation of POCT across diverse clinical units.

Discussion

This study builds directly on our prior work [6] evaluating the analytical performance of the GEM Premier 7000 in a pediatric hospital setting. In that study, we demonstrated excellent agreement between GEM 7000 and central laboratory potassium measurements, along with strong concordance in hemolysis detection across platforms. While those findings established analytical reliability, the current study extends this work by examining how that reliability translates into real-world clinical practice and test utilization.

Prior study showed baseline data collected over a four-month period (January–April) from TCH WTEC, PW NICU, and TCH WTNICU identified 101 hemolyzed samples (HI 3–6), of which 96 (95.05%) underwent repeat testing in the central laboratory [6], reflecting a practice of near-universal confirmatory testing prior to POCT implementation. In the current study, repeat testing of hemolyzed samples decreased substantially from 95.05% during the baseline period to 8.10% following POCT implementation, representing a major shift from routine confirmatory testing toward a more selective and clinically driven utilization strategy.

Importantly, this change occurred despite a relatively high prevalence of hemolysis (36.7%), indicating that hemolyzed POCT potassium results were increasingly accepted without routine central laboratory confirmation.

Notably, analysis at the unit level revealed variability in repeat testing practices, with average reflex rates of 22.5% in PICU, 13.6% in CVICU, and 8.2% in OR. This heterogeneity suggests that, despite overall improvements in utilization, local clinical workflows, provider preferences, and patient acuity continue to influence repeat testing behavior. The higher reflex rate observed in PICU may reflect a more conservative approach in critically ill patients, whereas lower rates in OR settings may be driven by intraoperative workflow constraints and reliance on rapid decision-making.

This shift likely reflects increased institutional confidence in the GEM 7000 platform, particularly its ability to detect hemolysis in whole blood samples—an area that has historically limited reliance on POCT potassium testing. As previously demonstrated, the GEM 7000 provides reliable hemolysis detection with strong agreement to central laboratory systems and excellent potassium correlation. The current findings suggest that once this analytical confidence is established, it can meaningfully influence clinical behavior and reduce reliance on

redundant testing.

In addition, evaluation across hemolysis index levels demonstrated no consistent linear relationship between degree of hemolysis and likelihood of repeat testing. While moderate hemolysis (HI 2–4) accounted for the majority of repeat testing, relatively higher reflex rates were observed at lower hemolysis indices (HI 1–2) in some units. This pattern is likely influenced by smaller sample sizes in these categories and may reflect sporadic or case-specific clinical decision-making rather than a systematic response to hemolysis severity. These findings suggest that repeat testing behavior is not solely driven by hemolysis index but may be influenced by additional clinical factors such as patient condition, unexpected potassium values, or provider caution in borderline cases.

From an operational perspective, the observed reduction in repeat testing has important implications for laboratory efficiency and resource utilization. Unnecessary repeat testing contributes to increased workload, delayed turnaround times, and inefficient use of laboratory resources. In contrast, the low overall repeat rate observed in this study (12.78%) supports the role of POCT as a primary testing modality for potassium in acute care settings, with central laboratory testing reserved for selected cases where confirmation is clinically indicated. These findings are particularly relevant in pediatric and critical care environments, where minimizing blood draws and ensuring rapid availability of results are essential. Reducing unnecessary repeat testing may decrease patient discomfort, limit iatrogenic blood loss, and support more timely clinical decision-making. In this context, improved test utilization represents not only an operational benefit but also a meaningful patient-centered outcome.

The contrast between baseline and current data also highlights the importance of implementation maturity. The baseline cohort, derived from NICU-based units, demonstrated a highly conservative testing approach with near-universal repeat rates. In comparison, the current cohort, spanning multiple intensive care units, reflects a more integrated and confident use of POCT. This suggests that beyond analytical validation, factors such as user familiarity, ongoing training, and institutional trust play a critical role in shaping test utilization practices.

Taken together, these findings indicate that optimization of potassium test utilization depends not only on analytical performance, but also on appropriate interpretation and clinical use of whole blood hemolysis indices. Unit-specific variation and non-linear trends across hemolysis indices underscore the need for targeted education, standardized protocols, and ongoing monitoring to ensure consistent and appropriate use of POCT across settings.

This study has several limitations. It is a single-center retrospective analysis, and differences in patient populations and clinical units between the baseline and current cohorts may influence repeat testing behavior. Additionally, clinical outcomes were not directly assessed, and the appropriateness of individual repeat testing decisions was not evaluated. Therefore, while reduced repeat testing suggests improved efficiency, its direct impact on patient outcomes requires further study.

In summary, this study demonstrates that implementation of GEM 7000 POCT with hemolysis indices, supported by prior analytical validation, can lead to significant improvements in potassium test utilization. Together with our previous findings, these results illustrate a progression from analytical validation to operational optimization, highlighting the potential of POCT hemolysis indices to improve both laboratory efficiency and clinical workflow.

Conclusion

Implementation of point-of-care whole blood hemolysis indices improved reliance on POCT potassium results and reduced redundant potassium testing in the central laboratory, particularly for hemolyzed samples. This real-world analysis demonstrates that POCT can streamline laboratory workflows and optimize resource use while supporting timely clinical decision-making. Further studies are needed to evaluate the impact of these changes on clinical outcomes and to establish standardized approaches for managing hemolyzed POCT results.

CRediT authorship contribution statement

Nazmin Bithi: Visualization, Investigation, Formal analysis, Writing – original draft. Earnest J.P. Daniel: Writing – review & editing, Formal analysis. Michael D. Dowlin: Data Curation. Brandy Recio: Data Curation. Sridevi Devaraj:

Conceptualization

Writing – review & editing, Project administration.

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Data Availability

Will be sent on request.

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