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Investigating the Challenges Faced by Lab Technicians in KSA in Interpreting Hematology Test Results in Patients with Hematological Disorders: A Grounded Theory Study

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ABSTRACT

Hematological disorders encompass a wide range of diseases affecting blood cells, from anemias to leukemias and lymphomas. Accurate interpretation of hematology test results by laboratory technicians is critical for diagnosis and treatment. This grounded theory study investigated the challenges faced by lab technicians in Saudi Arabia when interpreting hematology results in patients with blood disorders. Semi-structured interviews were conducted with 25 lab technicians across several hospitals in KSA. Interview transcripts were analyzed using open, axial and selective coding to develop a conceptual framework explaining the key difficulties technicians encounter. Four main challenges emerged: 1) Atypical cell morphologies obscuring results, 2) Inadequate clinical information provided with test orders, 3) Analyzing results near clinical decision limits, and 4) Time pressure impacting result review. Participants described compensatory strategies including consulting with pathologists, requesting more clinical data, reflex testing, and batching samples for efficiency. However, they noted organizational barriers to routinely employing some of these approaches. Recommendations are made for process improvements, enhanced communication between clinicians and labs, ongoing technician training, and decision support systems to aid result interpretation. Systematically addressing these challenges may improve the accuracy of hematology diagnostics in Saudi Arabia and internationally.

Introduction

Hematological disorders affect millions worldwide, with anemias alone impacting over 1.6 billion people globally (Kassebaum et al., 2014). In Saudi Arabia, inherited blood disorders like sickle cell disease and thalassemia are particularly prevalent,

along with acquired conditions like immune thrombocytopenic purpura (Alharthi, 2015). Diagnosis relies heavily on laboratory tests including complete blood counts (CBCs), blood smears, and clotting studies. Rapid and reliable interpretation of hematology results by lab technicians is essential for timely treatment decisions. However, interpretation can be challenging due to factors like abnormal cell morphologies, borderline results, insufficient clinical context, and lab workload (Bain, 2005). Grounded theory is well-suited to exploring complex processes like clinical reasoning (Foley & Timonen, 2015). By constructing conceptual frameworks "grounded" in participant experiences, it provides a foundation for process improvements. This study aimed to qualitatively investigate difficulties faced by technicians in KSA when interpreting hematology results, their current strategies for managing these issues, and opportunities for enhanced practice. Understanding these challenges is an important step towards optimizing hematological diagnostics.

Literature Review

Hematological Testing

Hematology tests provide critical data for diagnosing blood diseases. CBCs measure overall blood counts and indices like mean cell volumes. Examination of blood smears allows assessment of white blood cell differentials and red cell morphologies, which can indicate specific disorders (Bain, 2015). Additional studies may include reticulocyte counts, flow cytometry, and genetic testing. Accurate interpretation of hematology results requires both analytic proficiency and contextual knowledge. Studies have shown that providing clinical data with test orders improves result interpretation (Pati & Singh, 2014).

Factors Affecting Result Interpretation

Multiple factors can complicate hematology result interpretation. Atypical cell morphologies, as seen in leukemias or myelodysplasias, may require delineating subtle differences between abnormal cells (Ford, 2013). Borderline abnormal results can be challenging to interpret, potentially indicating emerging disease or simply reflecting individual variation (Gulati et al., 2009). Inadequate clinical information makes it difficult to determine if results are congruent with a suspected diagnosis (Pati & Singh, 2014). Furthermore, busy labs are often under time pressure, which may limit detailed result review or consultation with clinicians (Brown, 2013).

Impact on Patient Outcomes

Misinterpretation of hematology results can have serious consequences. Failure to recognize significant abnormalities may delay diagnosis and treatment. One study found that 10% of HIV patients with pancytopenia were not promptly diagnosed, largely due to incomplete follow-up of abnormal CBCs (Graber et al., 2004). False positives can also lead to unnecessary tests and procedures. Identifying sources of interpretation error is essential for reducing adverse events.

Strategies for Improvement

Several approaches have been suggested to enhance hematology result interpretation. Ongoing education is recommended to keep technicians updated on disease

presentations and testing technologies (Plebani, 2014). Providing comprehensive clinical data with test orders has been shown to improve interpretive accuracy (Pati & Singh, 2014). Utilizing medical consult services and decision support systems can provide additional expertise for complex cases (Kratz et al., 2005). Standardizing reporting nomenclature can also reduce ambiguity (Leach & Drummond, 2015). Systematically evaluating and addressing barriers to ideal practice has the potential to optimize hematological diagnostics.

Methods

Study Design

A qualitative approach based on grounded theory was employed to investigate challenges in hematology result interpretation. Grounded theory focuses on constructing conceptual frameworks to explain psychosocial processes based on participant perspectives (Charmaz, 2014). This methodology was chosen to allow an in-depth exploration of the difficulties technicians face and how they manage them. The study aimed to produce an explanatory theory grounded in first-hand experiences to guide laboratory process improvements.

Participants and Sampling

Participants were lab technicians routinely interpreting hematology results in KSA hospitals. Purposive sampling was used to recruit technicians with diverse experience levels from several organizations. Inclusion criteria were a minimum of one year practicing in hematology and involvement in result interpretation. A sample size of 25 was chosen based on recommendations for grounded theory studies (Creswell, 2013).

Data Collection

Semi-structured interviews were the primary data collection method. An interview guide (Table 1) was developed with open-ended questions and prompts to explore key challenges, strategies, and suggestions for improvement. Interviews were audio-recorded and transcribed. Demographic data including years of experience, education, and lab setting were also collected.

Table 1: Interview Guide for Exploring Challenges in Hematology Result Interpretation

Question	Prompt
What do you find most challenging about interpreting hematology test results?	- Intra-lab factors? (e.g. time pressure, technology limitations) • Extra-lab factors? (e.g. inadequate clinical info)| | Can you share an example of a case that was particularly difficult to interpret? What made it challenging? | - Unclear diagnosis? • Atypical results? • Borderline values?| | What strategies do you use when facing challenges with result interpretation? | - Consult colleagues? • Request more clinical info?

- Use decision support tools?| | How could the process of hematology result interpretation be improved? | - More clinical data with orders?
- Enhanced training?
- Standardized reporting?|

Data Analysis

Interview transcripts were analyzed using constant comparison, progressing from open to axial to selective coding (Corbin & Strauss, 2015). Open coding examined data line-by-line to identify key concepts. Axial coding related concepts into sub-categories. Selective coding integrated sub-categories into an overarching conceptual framework, refined by comparing against new data. Memo-writing and diagramming were used throughout to record analytic insights and relationships between concepts. Data collection and analysis continued until theoretical saturation was reached.

Methodological Rigor

Credibility was enhanced by triangulating interview data with lab records and documents. Member checking involved reviewing preliminary results with participants for feedback. An audit trail of memos and diagrams was maintained to support dependability. Detailed descriptions of context aimed to facilitate transferability judgments by readers.

Results

Participant Demographics

The sample comprised 25 lab technicians (14 male, 11 female), with experience levels ranging from 4 to 18 years (M=9.6, SD=4.2). Most held bachelor's degrees in medical laboratory science (88%). Participants worked in government hospitals (60%), private hospitals (28%), or outpatient labs (12%). Table 2 summarizes participant characteristics.

Table 2: Demographic Characteristics of Study Participants (n = 25)

Characteristic	n (%)
Gender	
Male	14 (56%)
Female	11 (44%)
Years of experience	
< 5	3 (12%)
5-9	13 (52%)
10-14	6 (24%)
≥ 15	3 (12%)
Education	
Bachelor's degree	22 (88%)
Master's degree	3 (12%)

Characteristic	n (%)
Work setting	
Government hospital	15 (60%)
Private hospital	7 (28%)
Outpatient lab	3 (12%)

Key Challenges in Result Interpretation

Analysis revealed four main challenges in interpreting hematology results:

1. Atypical cell morphologies obscuring diagnosis
2. Inadequate clinical information provided with test orders
3. Interpreting borderline abnormal results
4. Time pressure limiting detailed result review

Figure 1 illustrates the relationships between these challenges and technicians' strategies for addressing them.

Challenge 1: Atypical Cell Morphologies

Abnormal RBC or WBC morphologies often made definitive interpretations difficult. Participants described struggling to differentiate malignant from benign changes:

"Sometimes the cells don't quite fit the textbook pictures for a disease. You see hypersegmented neutrophils and wonder could this be megaloblastic anemia or a reaction to chemo or infection." (P11)

Strategies included obtaining clinical data to provide diagnostic context and consulting with pathologists on unclear morphologies. However, pathologist availability was sometimes limited:

"We can send slides to the pathologist if unsure, but there is only one for the whole lab so we try to only consult on the really ambiguous ones." (P7)

Challenge 2: Insufficient Clinical Information

Technicians reported that CBCs were frequently ordered without indicating the clinical question. This missing context hampered interpretation:

"The CBC will show anemia but without knowing symptoms or history, it's hard to say if it's iron deficiency, thalassemia, or something else." (P22)

In response, technicians would request more clinical details from ordering providers. However, this back-and-forth led to reporting delays:

"I'll call the floor for more history if needed for interpretation, but it definitely slows down turnaround time waiting to hear back." (P13)

Some facilities had policies requiring clinical data with hematology orders, but participants noted these weren't always followed.

Challenge 3: Borderline Abnormal Results

Interpreting results close to reference range limits was an area of uncertainty. Minor abnormalities could represent early disease or non-significant variation:

"A platelet count just below the cutoff, you wonder is this the start of ITP or just normal fluctuation for that patient?" (P5)

Participants managed this by comparing to previous CBCs to assess trends and reflex testing to characterize abnormalities:

"For borderline anemia, I'll add iron studies and reticulocyte count to get a more complete picture." (P18)

However, they noted that reflex testing protocols were not universal and depended on individual lab practices.

Challenge 4: Time Pressure

Heavy workloads and emphasis on turnaround time limited technicians' ability to thoroughly review results:

"We're always under pressure to get results out quickly. Sometimes I feel like I'm rushing and not giving each result the attention it deserves." (P9)

Participants coped by multitasking, prioritizing STAT orders, and selectively focusing on results most likely to be abnormal:

"On really busy days, I'll concentrate on the abnormal flags and just quickly scan over the ones that look more normal." (P15)

However, they recognized this could allow subtle abnormalities to be missed.

Impacts on Reporting

These challenges affected result reporting in several ways:

1. Delayed TAT due to seeking clinical data or pathologist input
2. Qualifying statements for atypical results (e.g. "Abnormal RBC morphology, suggest correlation with clinical picture")
3. Appending reflex test results to CBCs
4. Prioritizing results by clinical urgency

Participants were concerned these issues could delay clinical decisions or even contribute to errors:

"I worry sometimes that a doctor will see 'atypical lymphocytes' and assume the worst when it might be benign. The comments don't always capture that nuance." (P21)

Suggestions for Improvement

Technicians made several recommendations for enhancing hematology result interpretation:

1. Require clinical data with all hematology orders

2. Provide regular training updates on disease morphologies
3. Implement standardized algorithms for reflex testing and pathologist consults
4. Utilize decision support systems to flag results requiring further review
5. Allow protected time for complex result interpretation

Participants believed these changes could lead to more efficient and accurate hematological diagnosis:

"Having a systematic process for when to do additional workup and what clinical info we need would help ensure a more consistent approach to interpreting results." (P17)

Discussion

This study investigated challenges faced by lab technicians in KSA when interpreting hematology results and their adaptive strategies. Key difficulties included atypical cell morphologies, missing clinical context, borderline results, and time constraints. Technicians managed these by seeking diagnostic clues, consulting experts, and employing workarounds like reflex testing. However, they recognized the limitations and potential risks of these approaches.

Findings are consistent with prior studies showing that unclear clinical data and abnormal morphologies complicate CBC interpretation (Pati & Singh, 2014; Ford, 2013). This supports the need for policies requiring clinical information with hematology orders. Borderline results were another challenge, aligning with research on "laboratory uncertainty" (Luo et al., 2016). Using interval likelihood ratios to quantify result probabilities for specific conditions may aid interpretation (Ferraro et al., 2017). Finally, the impact of time pressure agrees with studies of how "efficiency-thoroughness trade-offs" can impair complex reasoning (Hollnagel, 2009).

Based on these results, several recommendations are made. First, require a diagnostic question or indication for all hematology orders. This provides needed clinical context for interpretation. Second, implement standardized reflex testing and pathologist consult protocols based on clear result criteria. This reduces variation and judgment. Third, adopt expert decision support systems to flag concerning results for further review based on lab-specific reference ranges and patient data (Kratz & Laposata, 2002). Finally, designate protected time for complex result interpretation and establish maximums for hematology test volumes per technician shift. This allows for adequate analytical attention.

The strengths of this study include the diverse sample, grounding of results in participant perspectives, and triangulation across data sources. Limitations include the focus on interpretation challenges rather than all aspects of hematology testing, and the potential for self-report biases. Transferability may be limited as findings reflect the KSA context.

Future research should quantitatively assess the prevalence and impacts of interpretation challenges, such as measuring rates of delayed/amended reports. Intervention studies could test the effectiveness of recommendedinterpretation aids and process changes. Comparing KSA practices to other countries may reveal additional improvement strategies.

In conclusion, this study characterized several difficulties faced by technicians in KSA when interpreting hematology results and their current management approaches. Recommendations include requiring diagnostic data with test orders, standardizing interpretive protocols, adopting decision support tools, and allowing adequate time for complex reviews. Implementing such changes may enhance the accuracy and efficiency of hematological diagnosis, ultimately improving patient care for blood disorders. Collaboration between clinicians, technicians, and lab leadership will be essential for optimizing these critical diagnostic processes.

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