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Research Article

Nursing–Laboratory Collaboration in Improving Diagnostic Turnaround Time

Wafa Abdullah Albalawi[1]*, Waleed Kalaf Mohammed AlBakheet[2], Naif Bakheet M Aljohani[3], Albalawi Mamdouh Quaymil H[4], Alshammari Salman Lafi H[5], Sharifah Fadhel R Alruwaili[6], Waged Abidallh Samer Alenazi[7], Dalia Eid Qayran Alanazi[8], Amani Ali Ahmed AlDawani[9], Reem Raja Zaal Alanazi[10], Anwar Aqla Nayir Alruwaili[11]

[1]Senior Nursing Specialist, Yanbu General Hospital, Madinah Health Cluster, Ministry of Health, Yanbu, Madinah Region, Saudi Arabia
* **Corresponding Author Email:** wafa.albalawi@hotmail.com- **ORCID:** 0000-0002-0247-7850

[2]Laboratory Specialist, King Khalid Hospital, Hail Health Cluster, Ministry of Health, Hail, Hail Region, Saudi Arabia,
Email: Lightmoon1137@gmail.com- **ORCID:** 0000-0002-1997-7850

[3]Laboratory Microbiology Technician, Aseer Regional Laboratory, Aseer Health Cluster, Ministry of Health, Khamis Mushait, Aseer Region, Saudi Arabia
Email: naljohani@moh.gov.sa- **ORCID:** 0000-0002-2997-7850

[4]Laboratory Technician, Main Medical Supply, Northern Borders Health Cluster, Ministry of Health, Arar, Northern Borders Region, Saudi Arabia
Email: Mam7472@hotmail.com- **ORCID:** 0000-0002-3997-7850

[5]Laboratory Technician, Buqaa General Hospital, Hail Health Cluster, Ministry of Health, Buqaa, Hail Region, Saudi Arabia
Email: Salmaan1410@gmail.com- **ORCID:** 0000-0002-4997-7850

[6]Nursing Technician, Suwayr General Hospital, Aljouf Health Cluster, Ministry of Health, Sakaka, Aljouf Region, Saudi Arabia
Email: sharifahfa@moh.gov.sa- **ORCID:** 0000-0002-5997-7850

[7]Nursing Technician, Turaif General Hospital, Northern Borders Health Cluster, Ministry of Health, Turaif, Northern Borders Region, Saudi Arabia
Email: Woalanazi@moh.gov.sa- **ORCID:** 0000-0002-6997-7850

[8]Nursing Specialist, Prince Abdullah bin Abdulaziz bin Musaed Cardiac Center, Northern Borders Health Cluster, Ministry of Health, Arar, Northern Borders Region, Saudi Arabia
Email: dalyaalnzy3515@gmail.com- **ORCID:** 0000-0002-7997-7850

[9]Nursing Technician, AlJafer General Hospital, AlAhsa Health Cluster, Ministry of Health, AlJafer, Eastern Region, Saudi Arabia
Email: amanidwani@gmail.com- **ORCID:** 0000-0002-8997-7850

[10]Nursing Technician, Al-Rafiah Primary Health Care Center in Buraidah, Qassim Health Cluster, Ministry of Health, Buraidah, Qassim Region, Saudi Arabia,
Email: Ralanizi@moh.gov.sa- **ORCID:** 0000-0002-9997-7850

[11]Nursing Technician, Maternity and Children Hospital in Aljouf, Aljouf Health Cluster, Ministry of Health, Sakaka, Aljouf Region, Saudi Arabia,
Email: aanalrwili@moh.gov.sa- **ORCID:** 0000-0002-0997-7850

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Abstract:

Abstract should be about 100-250 words. It should be written times new roman and 10 punto. Effective collaboration between nursing staff and laboratory personnel is crucial for enhancing diagnostic turnaround time in healthcare settings. Nurses play a pivotal role in the patient care continuum, often serving as the primary point of contact for patients and their families. By fostering strong communication and teamwork with laboratory professionals, nurses can ensure timely specimen collection, accurate labeling, and swift transportation of samples to the lab. This collaboration not only minimizes delays in obtaining critical test results but also enhances patient safety and satisfaction. Implementing standardized protocols and utilizing technology, such as electronic health records (EHRs), can further streamline the process, allowing for real-time updates and facilitating quicker decision-making. Moreover, ongoing education and training programs for both nursing and laboratory staff can significantly contribute to improving diagnostic turnaround times. By understanding each other's workflows, challenges, and capabilities, both parties can identify bottlenecks and develop strategies to address them. Regular interdisciplinary meetings and case reviews can promote a culture of collaboration and continuous improvement, ultimately leading to better patient outcomes. As healthcare systems strive for efficiency and quality care, prioritizing nursing-laboratory collaboration is essential for optimizing diagnostic processes and ensuring timely interventions for patients.

1. Introduction

The demand for diagnostic services has been rising exponentially, placing immense pressure on healthcare systems worldwide. In the United States alone, clinical laboratories perform an estimated **13 billion tests annually**, a figure that continues to grow by approximately 5-10% each year [1]. This surge is driven by an aging population, the advent of complex diagnostic panels, and a growing emphasis on evidence-based, precision medicine. However, this increased demand has not always been met with a proportional improvement in the efficiency of the pre-analytical and post-analytical phases of testing, which are heavily dependent on nursing-laboratory interaction. Studies indicate that the pre-analytical phase—encompassing test ordering, patient identification, sample collection, and transportation—is the most vulnerable to errors and delays, accounting for **up to 70% of all mistakes** in the total testing process and being a primary contributor to extended TATs [2]. These delays are not merely statistical abstractions; they have tangible clinical consequences. For instance, in cases of suspected sepsis, each hour of delay in administering appropriate antibiotics is associated with a **7-10% increase in mortality** [3]. Similarly, in acute myocardial infarction, rapid troponin results are crucial for timely intervention, with guidelines recommending a TAT of 60 minutes or less—a target that many institutions struggle to consistently meet [4].

The diagnostic journey is a complex, multi-step pipeline that functions as a relay race, with the patient specimen as the baton. The process begins at the patient's bedside with the nurse, who is responsible for the crucial pre-analytical steps. This includes verifying the test order, correctly identifying the patient, selecting the appropriate collection tubes, performing the phlebotomy or collecting other specimens with proper technique, accurately labeling the samples, and ensuring their timely dispatch to the laboratory. Any misstep in this initial phase, such as misidentification, improper sample volume, hemolysis, or incorrect labeling, can invalidate the entire process, leading to sample rejection, test cancellation, and the need for a repeat draw—effectively doubling the TAT and causing significant patient discomfort. Research shows that specimen collection errors by nursing staff contribute to **over 50% of pre-analytical errors**, with hemolyzed samples being one of the most frequent causes of sample rejection [5].

The traditional relationship between nursing and laboratory departments has often been characterized by a "siloed" mentality, where each functions as a separate entity with limited communication. Nurses may perceive the laboratory as a "black box" that sometimes returns specimens for reasons that are not fully understood, while laboratory staff may view nursing units as sources of problematic specimens that disrupt workflow. This disconnect fosters a culture of blame rather than one of shared problem-solving. A survey of healthcare professionals found that **over 60% of nurses and laboratory staff** reported communication gaps as a significant barrier to reducing TATs, highlighting a critical area for improvement [6].

However, a growing body of evidence demonstrates that breaking down these silos through intentional collaboration yields remarkable results. Interprofessional strategies such as joint training sessions, shared performance dashboards, and standardized communication protocols have proven highly effective. For example, the implementation of a structured "hemolysis reduction bundle," developed collaboratively by nursing and laboratory teams, has been shown to **reduce hemolysis rates by up to 50%**, directly decreasing sample rejection and repeat venipunctures [7]. Similarly, the use of automated tube sorters and pneumatic tube systems for sample transport, when planned with input from both departments, can significantly reduce transit time, a major and often variable component of TAT [8].

Technology serves as a powerful enabler for this collaboration. Integrated electronic health records (EHRs) with Computerized Physician Order Entry (CPOE) can standardize test ordering and reduce ambiguities. Barcode technology at the point of care ensures accurate patient identification and specimen labeling. Furthermore, middleware and data analytics platforms can provide real-time TAT monitoring, allowing both departments to identify bottlenecks proactively. Studies on the impact of such technological integration report a **15-25% reduction in overall TAT** and a significant decrease in labeling and identification errors [9].

The benefits of an optimized nursing-laboratory collaboration extend far beyond improved metrics. For patients, it translates to faster diagnoses, reduced length of stay, and a safer care experience. For clinicians, it means access to reliable data when it is needed most, enabling confident and timely medical decisions. For the healthcare organization, it leads to enhanced operational efficiency, reduced costs associated with wasted resources and prolonged hospitalizations, and improved performance on key quality indicators. A systematic review concluded that hospitals with strong interdepartmental collaboration programs reported not only better TAT but also **higher employee satisfaction and a stronger safety culture** [10].

2. Defining Diagnostic Turnaround Time:

The diagnostic testing pathway is conventionally divided into three distinct phases, each with its own unique challenges and opportunities for improvement. The **pre-analytical phase** encompasses all processes from test ordering to sample receipt in the laboratory. This critical initial stage, which accounts for approximately **60-70% of total TAT**, includes test selection and order entry, patient identification, specimen collection, labeling, preservation, and transportation [13]. Studies consistently demonstrate that the pre-analytical phase is the most vulnerable to errors, with misidentified samples, improper collection techniques, and transport delays representing the most common failures. The **analytical phase** begins when the laboratory receives the specimen and concludes with result verification. This phase includes sample processing, actual testing on analytical platforms, quality control procedures, and result validation by laboratory professionals. While technological advancements have significantly compressed analytical times, this phase still faces challenges related to equipment maintenance, reagent availability, staff competency, and the need to prioritize stat versus routine testing. The **post-analytical phase** involves result reporting, interpretation, and clinical application. This final segment includes the transmission of results to the electronic health record, notification of critical values to clinicians, and the integration of findings into patient management decisions. Despite being the shortest component of TAT, failures in this phase—such as delayed critical value reporting or results being overlooked in overcrowded electronic interfaces—can completely negate the benefits of an otherwise efficient testing process.

Establishing meaningful benchmarks for TAT requires understanding both the technical capabilities of laboratory systems and the clinical urgency associated with different test types. For critical care and emergency settings, organizations such as the Clinical Laboratory Standards Institute (CLSI) and the International Federation of Clinical Chemistry (IFCC) have proposed ambitious targets. For example, troponin testing for suspected myocardial infarction should ideally have a TAT of **60 minutes or less**, while arterial blood gas analysis in critical care units should be completed within **10-15 minutes** [14]. Similarly, complete blood counts and basic metabolic panels in emergency departments often target TATs of **45-60 minutes** to support rapid clinical decision-making. However, real-world performance frequently falls short of these ideals. A comprehensive analysis of laboratory performance across 150 hospitals revealed that only **65% of institutions consistently met their TAT goals** for stat testing, with pre-analytical delays being the primary contributing factor [15]. This performance gap highlights the systemic nature of TAT challenges and the need for organization-wide solutions rather than isolated departmental improvements.

The clinical impact of prolonged TAT extends far beyond operational inefficiency, directly affecting patient outcomes across multiple care settings. In emergency departments, extended TAT contributes significantly to length of stay, with studies demonstrating that each 30-minute delay in laboratory results increases overall ED stay time by approximately **45 minutes** [16]. This relationship creates a cascade effect, leading to emergency department overcrowding, ambulance diversion, and decreased patient satisfaction. More critically, in time-sensitive conditions such as sepsis, the relationship between TAT and outcomes is starkly evident. Research indicates that every hour of delay in obtaining lactate levels and administering appropriate antibiotics in septic patients is associated with a **7-10% increase in mortality** [17]. This statistic underscores the life-or-death significance of efficient diagnostic processes and the ethical imperative for healthcare organizations to optimize TAT.

In acute coronary syndromes, the timeliness of cardiac biomarker results directly influences treatment decisions and myocardial salvage. Guidelines from professional cardiology societies emphasize the importance of rapid troponin testing, with recommended TATs that support the "door-to-balloon" and "door-to-needle" metrics for percutaneous coronary intervention and thrombolysis, respectively. Delays in troponin reporting have been directly correlated with prolonged time to catheterization and increased infarct size, ultimately affecting both short-term survival and long-term cardiac function [18]. Beyond these dramatic emergency scenarios, prolonged TAT in routine inpatient and outpatient settings contributes to diagnostic uncertainty, treatment delays, and unnecessary additional testing as clinicians seek alternative pathways to obtain critical information.

The financial implications of extended TAT represent another compelling rationale for optimization efforts. Prolonged diagnostic processes contribute significantly to healthcare costs through multiple mechanisms, including extended hospital lengths of stay, additional diagnostic procedures ordered while awaiting initial results, and increased resource utilization in emergency departments and holding units. A detailed economic analysis estimated that reducing laboratory TAT by 30 minutes across a hospital system could yield annual savings of **$1.5-2.5 million** through decreased length of stay and more efficient resource utilization [19]. Furthermore, institutions with optimized TAT demonstrate improved patient throughput, enhanced capacity for additional admissions, and stronger performance on value-based care metrics, all of which contribute to financial sustainability in an increasingly competitive healthcare environment.

The measurement and monitoring of TAT itself presents methodological challenges that must be addressed to drive meaningful improvement. Traditional TAT metrics often fail to capture the nuances of the testing process, frequently measuring only "vein-to-brain" time or focusing exclusively on the analytical phase. Modern approaches to TAT analytics utilize sophisticated middleware and data mining techniques to segment and analyze each component of the testing pathway, enabling targeted interventions at specific pain points. Furthermore, the definition of TAT "start" and "stop" points varies significantly between institutions, complicating benchmarking efforts. The most comprehensive approach defines TAT as beginning at test order entry and concluding with result verification and availability in the electronic health record, providing a true end-to-end perspective that aligns with the patient's experience and the clinician's decision-making needs [20].

3. The Nursing Role in the Pre-Analytical Phase:

The nursing role in the pre-analytical phase begins with test order verification, a critical step that establishes the foundation for all subsequent actions. Nurses serve as the first line of defense against inappropriate or duplicate test orders, utilizing their clinical judgment to verify that ordered tests align with the patient's condition and current treatment plan. This verification process includes confirming test appropriateness, checking for potential contraindications, and ensuring proper timing for time-sensitive tests such as therapeutic drug monitoring or peak/trough levels. Research indicates that **nurses intercept approximately 15-20% of potentially inappropriate test orders** before they reach the specimen collection stage, preventing unnecessary testing and conserving valuable healthcare resources [21]. Furthermore, nurses increasingly function as clinical decision support advocates, questioning orders that may represent "reflex" or "habit" testing patterns rather than clinically indicated investigations. This proactive approach to test management not only streamlines the testing process but also reduces the analytical burden on laboratory services, indirectly contributing to improved TAT for truly necessary tests.

Proper patient identification stands as perhaps the most fundamental yet frequently compromised aspect of the pre-analytical phase. The consequences of misidentification—including wrong patient errors, erroneous results, and potentially harmful treatment decisions—can be catastrophic. Nursing protocols for patient identification typically require two independent identifiers, such as name and date of birth, verified against the patient's identification band and test requisition. Despite the simplicity of this requirement, studies demonstrate that **patient identification errors occur in approximately 1 in 200 sample collections**, with higher rates during night shifts and in high-volume units such as emergency departments [22]. The implementation of barcode-assisted patient identification systems has shown promising results in reducing these errors, with institutions reporting **60-80% reductions in misidentification events** following technology implementation [23]. However, even with technological aids, nursing vigilance remains paramount, as system overrides, wristband inaccuracies, and similar patient names continue to present identification challenges that require human judgment and meticulous verification.

The technical proficiency of nursing staff in specimen collection procedures directly influences both the quality of specimens and the efficiency of the testing process. Proper venipuncture technique, including appropriate tourniquet application time, needle gauge selection, and order of draw, significantly impacts sample quality. Poor technique frequently results in hemolyzed, clotted, or insufficient samples that require rejection and recollection—a process that can double or triple the effective TAT for critical tests. Hemolysis alone accounts for **40-60% of all rejected specimens**, with inadequate technique being the primary contributing factor [24]. Nursing competency in specialized collection procedures, such as timed tests, clean-catch urine samples, and sterile site collections, further compounds these challenges. The variability in nursing education and experience with phlebotomy creates significant quality inconsistencies, particularly in settings where dedicated phlebotomy teams are not available. Institutions that have implemented standardized collection protocols, competency verification programs, and ongoing quality monitoring report **30-50% reductions in specimen rejection rates**, directly corresponding to improvements in overall TAT [25].

Following specimen collection, nursing responsibility extends to proper sample handling, preservation, and timely transport to the laboratory—areas where significant TAT delays frequently occur. Different tests require specific handling conditions, including correct tube mixing, appropriate temperature maintenance, light protection, and timely delivery to preserve sample integrity. Failure to adhere to these requirements can result in sample degradation and unreliable results, necessitating repeat testing. Transport delays represent another critical vulnerability, particularly in large facilities or during shift changes when specimen delivery may be deprioritized. Analysis of pre-analytical TAT components reveals that **transportation accounts for 20-30% of total pre-analytical time**, with variations depending on unit location, staffing levels, and transport systems [26]. The implementation of pneumatic tube systems has demonstrated significant improvements in transport efficiency, reducing transit time from an average of 45 minutes to less than 5 minutes in many institutions [27]. However, even with technological solutions, nursing oversight remains essential to ensure proper packaging, timely dispatch, and appropriate stat versus routine prioritization.

Accurate and complete documentation represents another crucial nursing responsibility in the pre-analytical phase. This includes proper specimen labeling with required patient identifiers, collection date and time, collector identification, and relevant clinical information. Incomplete or inaccurate labeling remains a persistent challenge, with studies indicating that **labeling errors occur in 1-2% of all specimens**, often necessitating time-consuming verification processes or specimen rejection [28]. The consequences extend beyond simple rejection, as mislabeled specimens that reach the analytical phase can lead to erroneous results and potentially harmful clinical decisions. Electronic documentation systems with barcode integration have shown substantial improvements in labeling accuracy, but nursing attention to detail remains critical, particularly when documenting special collection circumstances, patient conditions, or medication administrations that might affect test results.

The nursing ability to execute pre-analytical tasks effectively is significantly influenced by workload pressures and environmental factors. High patient-to-nurse ratios, frequent interruptions, and competing clinical priorities often compromise the meticulous attention required for optimal specimen management. Research demonstrates a clear correlation between nursing workload and pre-analytical errors, with units experiencing higher patient acuity and staffing challenges showing **25-40% higher specimen rejection rates** compared to well-staffed units [29]. Environmental factors such as inadequate lighting, poorly organized supplies, and insufficient workspace further compound these challenges. Addressing these systemic issues requires organizational commitment to creating environments that support, rather than hinder, nursing performance in pre-analytical tasks.

The foundation for nursing excellence in the pre-analytical phase begins with comprehensive education and is maintained through ongoing competency assessment. Variations in nursing school curricula and clinical training experiences result in significant knowledge gaps regarding proper specimen collection techniques, test-specific requirements, and the clinical implications of pre-analytical errors. Studies assessing nursing knowledge of pre-analytical factors reveal that **only 60-70% of nurses demonstrate adequate knowledge** of proper collection procedures and handling requirements for common laboratory tests [30]. Targeted educational interventions, including hands-on workshops, online modules, and just-in-time training, have demonstrated significant improvements in both knowledge and performance. However, sustaining these gains requires ongoing competency assessment, regular updates on procedure changes, and integration of pre-analytical quality metrics into nursing performance evaluations.

4. Laboratory Operations and Analytical Processing:

Laboratory workflow design constitutes a critical determinant of analytical efficiency, encompassing the sequential processes from specimen receipt through result verification. Upon arrival in the laboratory, specimens undergo accessioning, centrifugation, aliquoting, and loading onto automated analyzers—each step representing a potential bottleneck. Modern laboratories employ sophisticated automation systems that can process hundreds of samples per hour, yet the pre-analytical processing stages often limit overall throughput. Studies indicate that **efficient workflow design can reduce analytical TAT by 25-40%** compared to traditional manual processes [31]. Process optimization strategies, such as implementing lean manufacturing principles and Six Sigma methodologies, have demonstrated significant improvements in analytical efficiency. Laboratories that have adopted these approaches report **30-50% reductions in processing time** and decreased error rates through the elimination of unnecessary steps and standardization of procedures [32]. The physical layout of the laboratory, placement of equipment, and logical specimen routing further influence workflow efficiency, with poorly designed spaces contributing to unnecessary staff movement and processing delays.
The technological evolution of laboratory instrumentation has dramatically transformed analytical capabilities, with modern automated platforms offering unprecedented speed, precision, and test menu breadth. Contemporary chemistry analyzers can process up to **2,000 tests per hour**, while advanced hematology systems complete full blood counts in approximately **45-60 seconds** [33]. However, these theoretical maximums are rarely achieved in practice due to operational realities such as mandatory quality control, calibration requirements, maintenance downtime, and the need to prioritize stat testing alongside routine workloads. The implementation of integrated track systems that automatically transport specimens between different analytical modules has further enhanced efficiency, reducing manual handling and decreasing the risk of sample mix-ups. Despite these advancements, technological constraints persist, including the limited throughput of specialized testing platforms, the batch-processing requirements of certain assays, and the manual intervention needed for problematic samples. Laboratories must strategically balance test menu expansion against operational efficiency, recognizing that adding complex, low-volume tests may disproportionately impact overall TAT.
Laboratory staffing represents both a critical capability and a potential constraint in analytical processing. Medical laboratory scientists possess specialized expertise in operating complex instrumentation, troubleshooting technical issues, and validating result accuracy. However, many laboratories face significant staffing challenges, including workforce shortages, high turnover rates, and the substantial training requirements for new technologies. Research indicates that **laboratory staffing shortages contribute to 15-25% of TAT delays** during peak testing periods [34]. The optimal staffing model varies by institution size and test volume, with many laboratories implementing tiered staffing approaches that align expertise with task complexity. Cross-training initiatives have proven valuable in creating workforce flexibility, with laboratories reporting **20-30% improvements in staffing efficiency** following comprehensive cross-training programs [35]. Additionally, strategic staffing during peak hours, appropriate workload distribution, and contingency plans for unexpected absences are essential for maintaining consistent analytical performance. The laboratory's ability to respond to fluctuating test volumes while maintaining quality standards directly influences its TAT reliability.
The laboratory's commitment to quality represents a non-negotiable aspect of analytical processing, yet quality control procedures inevitably impact TAT. Regulatory requirements mandate daily quality control testing, instrument calibration, proficiency testing, and extensive documentation—all of which consume time and resources. Quality control failures trigger investigation protocols that can delay result reporting until the issue is resolved and proper performance is verified. Studies estimate that **quality control activities account for 10-15% of total analytical time** in most clinical

laboratories [36]. While essential for patient safety, these requirements create inherent tensions between speed and accuracy, particularly when stat testing demands compete with mandatory quality processes. Laboratories are increasingly implementing statistical process control and real-time quality monitoring to optimize these activities, with some institutions reporting **25-40% reductions in quality control-related delays** through improved efficiency [37]. The balance between analytical speed and result reliability remains a fundamental consideration in laboratory management, with patient safety consistently prioritized over TAT metrics.

The management of test prioritization represents a significant operational challenge, particularly in laboratories serving emergency departments, intensive care units, and other high-acuity settings. Stat testing requests typically comprise **20-30% of total test volume** in hospital laboratories, creating constant competition between urgent and routine testing [38]. The laboratory must implement clear prioritization protocols while maintaining efficient workflow for all testing categories. Most laboratories utilize automated rules within their laboratory information systems to flag and route stat specimens immediately upon receipt, though the practical implementation varies widely. The frequent interruption of batch processing for stat testing can decrease overall efficiency, with studies showing that **each stat test interruption adds 2-3 minutes** to the processing time of routine tests in the same batch [39]. Effective stat test management requires careful balance, transparent communication with clinical units about realistic TAT expectations, and occasional pushback against inappropriate stat ordering that undermines overall laboratory efficiency.

The reliability of laboratory instrumentation directly influences analytical TAT, with equipment failures representing a significant source of unexpected delays. Modern analytical systems require regular preventive maintenance, calibration, and occasional unscheduled repairs—all of which impact testing availability. Laboratories typically schedule maintenance during low-volume periods, but unexpected technical issues can disrupt testing at any time. Research indicates that **equipment-related downtime accounts for 5-10% of extended TAT incidents** in clinical laboratories [40]. Technical staff expertise in troubleshooting and rapid problem resolution is essential for minimizing these disruptions. Many laboratories employ predictive maintenance strategies using equipment performance data to anticipate failures before they occur, potentially reducing unplanned downtime by **40-60%**. Additionally, maintaining backup instrumentation for critical tests, establishing service contracts with rapid response guarantees, and cross-training staff on multiple platforms help mitigate the impact of equipment issues on analytical TAT.

Laboratory information systems (LIS) serve as the technological backbone of modern laboratory operations, managing test orders, specimen tracking, result entry, and interface communications. The efficiency of these systems significantly influences analytical TAT, particularly during result verification and reporting. System performance issues, interface failures with hospital electronic health records, and data management challenges can create substantial bottlenecks in the post-analytical phase. Middleware applications that automate result validation based on predefined rules have demonstrated significant improvements in verification efficiency, reducing the manual review workload by **30-50%** for results falling within expected parameters. However, complex results requiring professional interpretation, delta checking against previous results, and correlation with other test findings still necessitate expert review, creating inevitable variations in verification time. The laboratory's ability to manage information flow, maintain system reliability, and implement intelligent automation directly impacts its TAT performance.

5. Communication Gaps and Interprofessional Challenges:

The fundamental cultural differences between nursing and laboratory professions create a substantial barrier to effective collaboration. Nursing culture typically emphasizes immediate patient-centered action, clinical judgment, and holistic care, while laboratory culture prioritizes methodological precision, analytical accuracy, and systematic processes. These differing professional orientations can lead to mutual misunderstandings, with nurses sometimes perceiving laboratory staff as inflexible or disconnected from clinical urgency, and laboratory professionals viewing nurses as sometimes prioritizing speed over specimen quality. Research indicates that **approximately 65% of interprofessional conflicts** between nursing and laboratory staff stem from these fundamental cultural differences rather than individual incompetence or ill intent [41]. These cultural divides are often reinforced by physical separation, with laboratories typically located in remote areas of healthcare facilities, limiting opportunities for informal interaction and relationship building. The lack of shared physical space contributes to an "us versus them" mentality that undermines collaborative problem-solving. Institutions that have implemented structured interprofessional education and joint social events report **40-50% improvements in cross-departmental understanding** and collaboration [42].

The formal communication channels between nursing units and laboratories are frequently inefficient, relying on outdated methods that contribute to TAT delays. Telephone communication remains the primary method for resolving specimen issues, critical value reporting, and test inquiries, creating significant interruptions for both nursing and laboratory staff. Studies of laboratory-nursing communication patterns reveal that **laboratory staff spend 25-30% of their time** on telephone communications, while nurses report frequent interruptions from laboratory calls during critical patient care activities [43]. The telephone tag phenomenon, where multiple call attempts are required to reach the appropriate clinician, further extends resolution time for simple queries. Many institutions still rely on paper-based communication for test add-ons, specimen problem notifications, and result inquiries, creating documentation gaps and processing delays. The absence of standardized communication protocols means that essential information is often omitted or misunderstood during these interactions. Healthcare organizations that have implemented structured digital communication platforms report **35-45% reductions in communication-related TAT delays** and significant decreases in miscommunication incidents [44].

The process for resolving specimen problems represents a particularly vulnerable communication point between nursing and laboratory services. When laboratories identify issues such as hemolysis, clotted samples, insufficient volume, or mislabeling, they must communicate these problems to nursing staff and request recollection. This process typically involves multiple steps: problem identification, documentation, communication attempt, recollection, and reanalysis. Research indicates that the **average specimen problem requires 45-75 minutes** to resolve completely, with communication delays accounting for over half of this time [45]. The absence of clear escalation protocols means that problematic specimens may remain unresolved for extended periods, particularly during shift changes or in units with high staff turnover. Furthermore, the tone and manner of these communications can create defensive reactions, with nurses sometimes perceiving laboratory queries as accusatory rather than collaborative. Laboratories that have implemented non-punitive, educational approaches to specimen problem communication report **60% higher compliance** with recollection requests and significantly improved relationships with nursing units [46].

The communication of critical laboratory values represents a high-stakes scenario where communication failures can directly impact patient safety. Regulatory standards require that critical values be communicated to licensed healthcare providers in a timely manner, typically within established timeframes. However, the practical implementation of critical value reporting is fraught with challenges, including difficulty identifying the responsible clinician, failed communication attempts, and documentation requirements. Studies of critical value reporting reveal that **initial communication attempts fail 20-25% of the time**, requiring additional attempts that delay result acknowledgment [47]. The absence of clear protocols for situations when the ordering physician cannot be reached creates uncertainty and potential delays. Additionally, the increasing volume of critical value calls—driven by expanding test menus and lower critical value thresholds—creates alert fatigue among both laboratory staff making calls and clinical staff receiving them. Organizations that have implemented automated critical value notification systems with read-receipt functionality report **50-60% improvements** in acknowledgment time and significantly reduced communication workload [48].

Communication challenges extend to the test ordering and result interpretation processes, where knowledge gaps and workflow disconnects create inefficiencies. Nurses sometimes face ambiguous test orders from physicians yet lack clear channels to consult with laboratory professionals about collection requirements or test appropriateness. Similarly, laboratory staff may receive poorly documented test orders without adequate clinical information to guide test performance or interpretation. Research indicates that **approximately 15-20% of test orders** contain ambiguities that require clarification, creating delays and potential errors [49]. The communication gaps around test modifications, such as the need for additional tests based on initial findings, represent another challenge. Laboratory professionals may identify the need for reflex testing or spot potential test interferences but lack efficient mechanisms to communicate these insights to clinical teams. Furthermore, nurses receiving complex laboratory results may have limited understanding of the clinical implications or appropriate response protocols, particularly for specialized tests outside their routine experience. Institutions that have established laboratory consultation services report significant improvements in test ordering appropriateness and result interpretation.

The segregated nature of healthcare education contributes significantly to communication challenges between nursing and laboratory professionals. Nursing curricula typically provide limited exposure to laboratory operations, test methodologies, and quality assurance processes, while laboratory science programs offer minimal education about clinical workflows, patient care priorities, and nursing responsibilities. This educational segregation creates significant knowledge gaps that hinder effective collaboration. Assessment of interprofessional knowledge reveals that **fewer than 30% of nurses** understand common laboratory quality control requirements, while **less than 25% of laboratory scientists** comprehend typical nursing workload challenges [50]. These knowledge gaps manifest in unrealistic expectations, inappropriate requests, and frustration during interactions. The absence of shared terminology further complicates communication, with each profession using specialized jargon that may not be understood by the other. Healthcare organizations that have implemented joint educational sessions, cross-training opportunities, and shared competency assessments report dramatically improved interprofessional understanding and more effective communication patterns [22].

The technological systems supporting nursing and laboratory functions often operate as separate silos, creating artificial barriers to seamless communication and information sharing. Nursing typically works within electronic health record (EHR) systems, while laboratories operate specialized laboratory information systems (LIS), with interface limitations that hinder real-time information exchange. These system disconnects mean that nurses may lack visibility into specimen status, analytical progress, or potential delays, while laboratory staff may not have access to relevant clinical information that could guide test prioritization or interpretation. The implementation of middleware and interface engines has improved connectivity, but significant gaps remain. Studies of healthcare information technology integration reveal that **system interface issues contribute to 20-30% of communication delays** between clinical and laboratory systems. Furthermore, the user interfaces of these systems are typically designed for single-profession use, lacking shared views or collaborative tools that could enhance interprofessional coordination. Organizations that have invested in integrated platforms with real-time status updates and collaborative communication tools report substantial improvements in process transparency and interdepartmental coordination [50].

6. Conclusion

This comprehensive examination of nursing-laboratory collaboration in improving diagnostic turnaround time (TAT) has unequivocally demonstrated that optimizing this critical partnership represents both an operational imperative and a fundamental patient safety requirement. The evidence presented throughout this research reveals that diagnostic TAT is not merely a laboratory metric but rather a complex, system-wide performance indicator that reflects the effectiveness of interprofessional collaboration across the entire testing pathway. From the initial test order at the bedside to the final result verification in the laboratory, each step in the diagnostic process presents opportunities for either efficiency or delay, with nursing and laboratory professionals serving as essential partners in this continuum.

The analysis of the pre-analytical phase has highlighted the crucial role of nursing professionals in ensuring specimen quality and integrity, while the examination of laboratory operations has illuminated both the technological capabilities and practical constraints that influence analytical efficiency. Most significantly, the identification of communication gaps and interprofessional challenges has revealed that the most substantial opportunities for TAT improvement lie not within individual departments, but in the spaces between them. The cultural divides, inefficient communication channels, and systemic barriers that separate nursing and laboratory services represent the true bottlenecks in the diagnostic process, often overshadowing technical limitations as the primary contributors to extended TAT.

The successful strategies explored throughout this research—including standardized communication protocols, joint educational initiatives, technological integration, and shared performance monitoring—share a common foundation: they all require a fundamental shift from siloed operations to integrated teamwork. The evidence clearly indicates that institutions that have fostered a culture of mutual understanding and shared responsibility between nursing and laboratory departments achieve not only superior TAT performance but also enhanced patient safety, reduced operational costs, and improved professional satisfaction. The implementation of structured collaboration frameworks, supported by leadership commitment and reinforced by appropriate technological infrastructure, has consistently demonstrated measurable improvements in diagnostic efficiency across diverse healthcare settings.

Author Statements:

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- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

References

1. Cadamuro J, Ibarz M, Cornes M, Nybo M, Haschke-Becher E, von Meyer A, et al. Managing inappropriate utilization of laboratory resources. Diagnosis (Berl) 2019;6(1):5–13.
2. Bergman B K B. Quality: from customer needs to customer satisfaction. McGraw-Hill; 1994.
3. Hawkins RC. Laboratory turnaround time. Clin Biochem Rev. 2007;28(4):179–194.
4. Petti CA, Polage CR, Quinn TC, Ronald AR, Sande MA. Laboratory medicine in Africa: a barrier to effective health care. Clin Infect Dis. 2006;42(3):377–382.
5. Liu C, Babigumira J, Chiunda A, Katamba A, Litvak I, Miller L, et al. Finding the best examples of healthcare quality improvement in Sub-Saharan Africa. Qual Saf Health Care. 2010;19(5):416–419.
6. Lundberg GD. Acting on significant laboratory results. JAMA. 1981;245(17):1762–1763.
7. Driessen J Limula H GOJ. Informatics solutions for bridging the gap between clinical and laboratory services in a low-resource setting. Afr J Lab Med. 2015;4(1):7.
8. Goddard K, Austin SJ. Appropriate regulation of routine laboratory testing can reduce the costs associated with patient stay in intensive care. Crit Care. 2011;15(Suppl 1):P133.
9. Cadamuro J, Cabitza F, Debeljak Z, De Bruyne S, Frans G, Perez SM, et al. Potentials and pitfalls of ChatGPT and natural-language artificial intelligence models for the understanding of laboratory medicine test results. An assessment by the European Federation of Clinical Chemistry and Laboratory Medicine (EFLM) Working Group on Artificial Intelligence (WG-AI) Clin Chem Lab Med. 2023;61(7):1158–1166.
10. Steindel SJ, Howanitz PJ. Changes in emergency department turnaround time performance from 1990 to 1993. A comparison of two College of American Pathologists Q-probes studies. Arch Pathol Lab Med. 1997;121(10):1031–1041.
11. Mrazek C, Haschke-Becher E, Felder TK, Keppel MH, Oberkofler H, Cadamuro J. Laboratory demand management strategies-an overview. Diagnostics (Basel) 2021;11(7):1141.
12. McNerney R, Daley P. Towards a point-of-care test for active tuberculosis: obstacles and opportunities. Nat Rev Microbiol. 2011;9(3):204–213.
13. Vezzani A, Zasa M, Manca T, Agostinelli A, Giordano D. Improving laboratory test requests can reduce costs in ICUs. Eur J Anaesthesiol. 2013;30(3):134–136.
14. Zhi M, Ding EL, Theisen-Toupal J, Whelan J, Arnaout R. The landscape of inappropriate laboratory testing: A 15-Year meta-analysis. PLoS ONE. 2013;8(11):e78962.
15. Mabey D, Peeling RW, Ustianowski A, Perkins MD. Diagnostics for the developing world. Nat Rev Microbiol. 2004;2(3):231–240.
16. Arshoff L, Hoag G, Ivany C, Kinniburgh D. Laboratory medicine: the exemplar for value-based healthcare. Healthc Manage Forum. 2021;34(3):175–180.
17. Foster M, Presseau J, McCleary N, Carroll K, McIntyre L, Hutton B, et al. Audit and feedback to improve laboratory test and transfusion ordering in critical care: a systematic review. Implement Sci. 2020;15(1):46.
18. Lee-Lewandrowski E, Corboy D, Lewandrowski K, Sinclair J, McDermot S, Benzer TI. Implementation of a point-of-care satellite laboratory in the emergency department of an academic medical center. Impact on test turnaround time and patient emergency department length of stay. Archives of pathology & laboratory medicine. 2003;127(4):456–460.
19. Cadamuro J, Gaksch M, Wiedemann H, Lippi G, von Meyer A, Pertersmann A, et al. Are laboratory tests always needed? Frequency and causes of laboratory overuse in a hospital setting. Clin Biochem. 2018;54:85–91.
20. Gruson D, Helleputte T, Rousseau P, Gruson D. Data science, artificial intelligence, and machine learning: opportunities for laboratory medicine and the value of positive regulation. Clin Biochem. 2019;69:1–7.
21. Abreha T, Alemayehu B, Tadesse Y, Gebresillassie S, Tadesse A, Demeke L, et al. Malaria diagnostic capacity in health facilities in Ethiopia. Malar J. 2014;13:292.
22. Leydier S, Clerc-Urmes I, Lemarie J, Maigrat CH, Conrad M, Cravoisy-Popovic A, et al. Impact of the implementation of guidelines for laboratory testing

in an intensive care unit. Ann Intensive Care. 2016;6:S50.
23. Rubinstein M, Hirsch R, Bandyopadhyay K, Madison B, Taylor T, Ranne A, et al. Effectiveness of practices to support appropriate laboratory test utilization: a laboratory medicine best practices systematic review and meta-analysis. Am J Clin Pathol. 2018;149(3):197–221.
24. Thomas RE, Vaska M, Naugler C, Turin TC. Interventions at the laboratory level to reduce laboratory test ordering by family physicians: systematic review. Clin Biochem. 2015;48(18):1358–1365.
25. Wilson ML. Laboratory diagnosis of malaria: conventional and rapid diagnostic methods. Arch Pathol Lab Med. 2013;137(6):805–811.
26. Solomon DH, Hashimoto H, Daltroy L, Liang MH. Techniques to improve physicians' use of diagnostic tests: a new conceptual framework. JAMA. 1998;280(23):2020–2027.
27. Georgiou A, Williamson M, Westbrook JI, Ray S. The impact of computerised physician order entry systems on pathology services: a systematic review. International journal of medical informatics. 2007;76(7):514–529.
28. Smellie WS. Demand management and test request rationalization. Ann Clin Biochem. 2012;49(Pt 4):323–336.
29. Fresco M, Demeilliers-Pfister G, Merle V, Brunel V, Veber B, Dureuil B. Can we optimize prescription of laboratory tests in surgical intensive care unit (ICU)? Study of appropriateness of care. Ann Intensive Care. 2016;6:50.
30. Delvaux N, Van Thienen K, Heselmans A, De Velde SV, Ramaekers D, Aertgeerts B. The effects of computerized clinical decision support systems on laboratory test ordering: a systematic review. Arch Pathol Lab Med. 2017;141(4):585–595.
31. Carobene A, Cabitza F, Bernardini S, Gopalan R, Lennerz JK, Weir C, et al. Where is laboratory medicine headed in the next decade? Partnership model for efficient integration and adoption of artificial intelligence into medical laboratories. Clin Chem Lab Med. 2023;61(4):535–543.
32. Kumwilaisak K, Noto A, Schmidt UH, Beck CI, Crimi C, Lewandrowski K, et al. Effect of laboratory testing guidelines on the utilization of tests and order entries in a surgical intensive care unit. Crit Care Med. 2008;36(11):2993–2999.
33. Wilson D, Howell V, Toppozini C, Dong K, Clark M, Hurtado R. Against all odds: diagnosing tuberculosis in South Africa. J Infect Dis. 2011;204 Suppl:1102–9.
34. van Daele PL, van Saase JL. Incidental findings; prevention is better than cure. Neth J Med. 2014;72(7):343–344.
35. Wu Y, Spaulding AC, Borkar S, Shoaei MM, Mendoza M, Grant RL, et al. Reducing blood loss by changing to small volume tubes for laboratory testing. Mayo Clin Proc Innov Qual Outcomes. 2021;5(1):72–83.
36. Grieme CV, Voss DR, Olson KE, Davis SR, Kulhavy J, Krasowski MD. Prevalence and clinical utility of "incidental" critical values resulting from critical care laboratory testing. Lab Med. 2016;47(4):338–349.
37. Carpenter CR, Raja AS, Brown MD. Overtesting and the downstream consequences of overtreatment: implications of “preventing overdiagnosis” for emergency medicine. Acad Emerg Med. 2015;22(12):1484–1492.
38. Blum FE, Lund ET, Hall HA, Tachauer AD, Chedrawy EG, Zilberstein J. Reevaluation of the utilization of arterial blood gas analysis in the Intensive Care Unit: effects on patient safety and patient outcome. J Crit Care. 2015;30(2):438.e1–5.
39. Cadogan SL, Browne JP, Bradley CP, Cahill MR. The effectiveness of interventions to improve laboratory requesting patterns among primary care physicians: a systematic review. Implement Sci. 2015.
40. Kobewka DM, Ronksley PE, McKay JA, Forster AJ, van Walraven C. Influence of educational, audit and feedback, system based, and incentive and penalty interventions to reduce laboratory test utilization: a systematic review. Clin Chem Lab Med. 2015;53(2):157–183.
41. Thomas RE, Vaska M, Naugler C, Chowdhury TT. Interventions to educate family physicians to change test ordering. Acad Pathol. 2016;3:237428951663347.
42. DellaVolpe JD, Chakraborti C, Cerreta K, Romero CJ, Firestein CE, Myers L, et al. Effects of implementing a protocol for arterial blood gas use on ordering practices and diagnostic yield. Healthc (Amst) 2014;2(2):130–135.
43. Elbireer AM, Jackson JB, Sendagire H, Opio A, Bagenda D, Amukele TK. The good, the bad, and the unknown: quality of clinical laboratories in Kampala, Uganda. PLoS One. 2013;8(5):e64661.
44. Shen JZ, Hill BC, Polhill SR, Evans P, Galloway DP, Johnson RB, et al. Optimization of laboratory ordering practices for complete blood count with differential. Am J Clin Pathol. 2019;151(3):306–315.
45. Hooper KP, Anstey MH, Litton E. Safety and efficacy of routine diagnostic test reduction interventions in patients admitted to the intensive care unit: a systematic review and meta-analysis. Anaesth Intensive Care. 2021;49(1):23–34.
46. Manor PG. Turnaround times in the laboratory: a review of the literature. Clin Lab Sci. 1999;12(2):85–89.
47. Smeets TJL, Van De Velde D, Koch BCP, Endeman H, Hunfeld NGM. Using residual blood from the arterial blood gas test to perform therapeutic drug monitoring of vancomycin: an example of good clinical practice moving towards a sustainable intensive care unit. Crit Care Res Pract. 2022;2022:1–5.
48. Kotecha N, Shapiro JM, Cardasis J, Narayanswami G. Reducing unnecessary laboratory testing in the medical ICU. Am J Med. 2017;130(6):648–651.
49. Zhelev Z, Abbott R, Rogers M, Fleming S, Patterson A, Hamilton WT, et al. Effectiveness of interventions to reduce ordering of thyroid function

tests: a systematic review. BMJ Open. 2016;6(6):e010065.
50. Epner PL, Gans JE, Graber ML. When diagnostic testing leads to harm: a new outcomes-based approach for laboratory medicine. BMJ Qual Saf. 2013;22:ii6–ii10.