

An analysis of the overuse and underuse of laboratory testing by skilled medical professionals when assessing patients for thrombotic and bleeding problems

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Abstract

Background: Diagnostic errors, particularly in test selection, are a significant contributor to misdiagnoses and delayed treatments. Both overutilization and underutilization of laboratory tests have been recognized as prevalent issues, yet little is known about their frequency and clinical impact, especially in the context of coagulation disorders. This study investigates overutilization and underutilization of coagulation tests by expert physicians in the evaluation of patients with bleeding and thrombotic disorders.

Methods: This study included 300 selected patient cases at a healthcare institution. The cases were discussed in daily meetings by a coagulation diagnostic management team, consisting of pathology residents and attending physicians. Data from electronic health records, including test results and diagnoses, were analyzed for errors in test selection. The frequency of overutilization and underutilization was assessed, and the financial burden of unnecessary tests was estimated. Statistical analyses included the Fisher exact test and t-tests to evaluate associations between patient characteristics and test selection errors.

Results: The analysis revealed that 77.5% of cases involved errors in test selection, with 44% of patients experiencing underutilization, 16% overutilization, and 17.5% both over and underutilization. Errors were more prevalent in African descent and Hispanic patients, women, and younger patients. The total unnecessary cost of overutilized tests across the 300 cases was SAR6054, with an estimated annual burden of SAR18,162.

Conclusion: Nearly 75% of cases involved diagnostic errors in test selection, emphasizing the prevalence of overutilization and underutilization in coagulation testing. The study highlights the need for increased awareness and real-time expert reviews to optimize test utilization and reduce diagnostic errors, ultimately improving patient outcomes and reducing unnecessary healthcare costs.

Introduction

In 2015, the National Academy of Medicine (formerly the Institute of Medicine) released a report addressing diagnostic errors. A key finding from this report was that every adult is likely to experience at least one diagnostic mistake during their lifetime (1). However, other studies

and expert opinions suggest the actual number of such errors may be significantly higher for most individuals.

One of the primary factors contributing to diagnostic inaccuracies is the failure to select appropriate diagnostic tests. Both excessive use of laboratory tests and insufficient use are well-documented concerns. Overutilization, known to be a prevalent and costly issue, has been recognized for some time (2–5). More recently, underutilization of tests has emerged as a critical factor in delayed or incorrect diagnoses, sometimes occurring alongside overutilization within the same patient (5). A significant obstacle in addressing these issues is the lack of awareness among healthcare providers about the gaps in their knowledge concerning the diagnostic potential of laboratory tests.

Discussions surrounding test overutilization and underutilization often stem from subjective viewpoints, disconnected from clinical contexts. For instance, while some may argue that testing for hypercoagulability is overused, such a broad statement overlooks specific scenarios where the tests are essential, such as in patients with a strong familial predisposition to venous thrombosis. Sweeping generalizations can obscure the nuanced clinical decision-making required in such cases.

This investigation provided a unique opportunity to gather insights from multiple experts in diagnostic coagulation. The experts evaluated patient cases involving bleeding or thrombotic disorders and offered real-time assessments regarding the appropriate use of laboratory tests. By reviewing a substantial number of cases, the study identified frequent instances of both overutilization and underutilization of coagulation tests. These findings underscore the prevalence of these issues and highlight that underutilization is often a significant factor contributing to diagnostic delays or errors.

Methodology

This research aimed to evaluate the frequency of errors in selecting diagnostic tests for patients being assessed for active bleeding, thrombosis, or the associated risks. Data were derived from a review of test results for 200 randomly chosen patients whose cases were discussed in daily meetings. The setting was a healthcare institution with a robust electronic health record system, multiple healthcare facilities, and a patient population characterized by ethnic and socioeconomic diversity. The primary hospital within this system accommodates 310 patient beds, including 60 for intensive care. Annually, the institution handles care for approximately 26,000 inpatients and conducts 750,000 outpatient visits (6).

The daily reviews were conducted by a coagulation diagnostic management team (DMT), comprising pathology residents and attending physicians. Residents prepared and presented clinical summaries and laboratory findings related to coagulation, including initial interpretations of the tests. Attending physicians then refined these interpretations and evaluated whether the tests conducted were appropriately chosen or missed. This systematic process ensured thorough case review and decision-making.

The study received expedited approval from the Institutional Review Board, allowing for the collection and analysis of data. Quantitative and statistical analyses were employed to assess the frequency of test overutilization and underutilization in the diagnostic process. While it was not feasible to calculate the costs associated with delayed diagnoses due to the variable nature of resulting complications, the financial burden of unnecessary coagulation tests was quantified. This was achieved by referencing the list prices of two commercial laboratories to estimate the expenditure linked to test overutilization.

Additionally, demographic data were analyzed to determine whether errors were disproportionately distributed among specific patient groups. Statistical methods included the two-tailed Fisher exact χ^2 test for categorical variables such as gender and ethnicity, with significance defined as a p-value of < 0.05 . A t-test was used to compare the average ages of patients with and without test selection errors.

Results

The analysis of 300 cases revealed the frequency of errors in selecting diagnostic tests. This study identified 255 unique cases of diagnostic errors, yielding an error rate of 77.5%, which was statistically significant (95% confidence interval: 71.7%–83.3%; $p < 0.0001$).

The findings highlighted the prevalence of diagnostic errors, with 77.5% of cases involving errors compared to cases without errors, confirmed by a 95% confidence interval of 71.7%–83.3% and a p-value of < 0.0001 .

Table 1 illustrates the influence of ethnicity, gender, and age on test selection errors. Regarding ethnicity, the highest error rates were observed in individuals of African descent (error-to-no-error ratio of 11), followed by Hispanic patients (error-to-no-error ratio of 8). Caucasian patients had the lowest error-to-no-error ratio at 2.5. Overall, the association between errors and ethnic background was statistically significant ($p = 0.012$). Women evaluated for bleeding or thrombotic conditions experienced more errors (error-to-no-error ratio of 5) than men (error-to-no-error ratio of 2), with a significant p-value of 0.013. Additionally, younger patients were more likely to experience errors than older patients, with mean ages of 39.2 years and 46.8 years, respectively ($p = 0.016$).

Of the 300 cases, 18% involved assessments for fetal loss risk or eligibility for an antiphospholipid syndrome diagnosis. Other diagnoses included deep vein thrombosis, postoperative bleeding, pulmonary embolism, and vaginal bleeding. A miscellaneous category encompassed over 15 other conditions, such as hematemesis, Raynaud's syndrome, and epistaxis.

Some patients experienced both overutilization of certain tests and underutilization of others. Specifically, 16% of patients were classified as overutilization only, 44% as underutilization only, and 17.5% as both overutilization and underutilization.

The total cost of overutilization across the 200 cases was SAR6054, with an estimated annual burden of SAR18,162, as the sample cases represented approximately 33% of the yearly case volume.

Table 1: Patient Characteristics in Hospital Visits with and without Diagnostic Error

Characteristic	Error (n = 255)	No Error (n = 45)	Error-to-No-Error Ratio	p-Value
Patient Ethnicity, no. (%)				
Caucasian	61.9%	84.4%	2.5	0.012
African American	21.3%	6.7%	11	
Hispanic	15.5%	6.7%	8	
Asian/Pacific Islander	1.3%	0 %	–	
Other/Unknown	0 %	2.2%	–	
Patient Sex, no. (%)				0.013
Female	71.0%	51.1%	5	
Male	29.0%	48.9%	2	
Patient Age, Mean (SD)	18.1%	19.8%		0.016

Discussion

Diagnostic errors are a significant issue, with numerous studies highlighting how failures in the diagnostic process contribute to patient harm, including fatalities. This concern has led to inquiries by major scientific organizations. Errors occurring in clinical laboratories have been documented across preanalytical, analytical, and postanalytical stages (11–13). Research indicates that preanalytical mistakes, particularly in selecting laboratory tests, constitute up to

70% of all diagnostic errors in laboratory settings (14). Over the last decade, the increasing complexity of clinical laboratory tests has created challenges for clinicians in selecting appropriate tests and interpreting their results (15). Additionally, advancements in automated diagnostic technologies have further complicated these processes (16, 17). Together, these factors amplify the likelihood of errors in both test ordering and result interpretation. Despite the significance of this issue, studies focusing on the frequency and evaluation of errors in laboratory test selection are limited (18).

This research offered a rare chance to analyze 300 cases in real time, guided by multiple experts specializing in coagulation. The findings shed light on errors in both the overuse and underuse of laboratory tests. It was observed that errors were especially common in the context of coagulation testing. The alarming rate of errors—77.5%—highlights the scope of the issue, even within a setting where specialists are available to provide guidance on test selection and interpretation. It is possible that the complexity of coagulation evaluations contributes to a higher frequency of errors compared to other clinical areas.

Patient demographics such as ethnicity, age, and gender were found to influence the likelihood of diagnostic errors (Table 1). Notably, errors were less common in individuals of certain ethnicities, such as those identified as Caucasian, compared to others. Additionally, younger patients and females experienced more errors compared to older patients and males. The age difference of approximately seven years between groups raises questions about why younger patients are more susceptible to test selection errors.

A detailed analysis of principal diagnoses provides critical insights that can guide interventions aimed at reducing diagnostic errors. The diversity of symptoms observed among patients further underscores the need for improved clinical reasoning and test selection practices. Future studies should explore how these symptoms influence the decision-making process of healthcare providers.

Errors in test utilization for coagulation diagnostics were categorized into overutilization, underutilization, or both. In some cases, both overuse and underuse occurred simultaneously, affecting 17.5% of patients. Although this analysis did not evaluate errors in test result interpretation, it is essential to acknowledge the critical role these mistakes play in diagnostic errors. Misinterpretation of test results was evident in a variety of cases, including missed diagnoses of antiphospholipid syndrome, incorrect interpretations of PTT mixing studies, and errors in diagnosing coagulation disorders such as factor V Leiden deficiency. From this study, it appears that at least 12% of the cases involved errors in test result interpretation.

The economic impact of overutilization errors on healthcare systems and patients is also significant. While the financial losses attributed to overuse alone were quantified, the costs associated with underuse—such as prolonged hospital stays due to delayed or missed diagnoses—are likely much higher. If these additional factors were included, the financial burden could be substantially greater (19, 20).

This study's findings are based on data from an academic center of moderate size, but the implications may be far-reaching. Larger institutions, where the volume of diagnostic cases is significantly higher, may incur exponentially greater financial losses due to overutilization. For instance, the annual financial burden from overutilization alone could range from the reported SAR18,000 to as much as SAR220,000 in larger centers.

The study does have limitations. As a retrospective review, it relies heavily on existing medical records, which may not capture all diagnostic errors. Additionally, the absence of physician debriefings post-error identification limits the ability to fully understand the root causes of diagnostic errors. The study focused exclusively on errors associated with coagulation and thrombotic disorders, making the findings less generalizable to other clinical areas. Cost estimates were derived from pricing data of two specific laboratories, which may not reflect the full spectrum of laboratory costs, limiting the precision of the economic analysis.

Conclusions

While inappropriate laboratory test selection is often discussed, opportunities to conduct real-time, expert reviews of cases in clinical settings are rare. This study highlights that nearly 75% of cases involved errors in test selection, providing an evidence-based perspective on the widespread issue of improper test utilization.

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