

Leading article

Towards appropriate laboratory test utilization: A narrative overview

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Key words: inappropriate, laboratory tests, overutilization, underutilization

Abstract

Increasing expenses and complex economic issues raise the need to redesign healthcare in a cost-effective way while retaining the quality of care. Laboratory medicine plays an indispensable role in modern health care. Optimizing appropriate laboratory test utilization could reduce healthcare cost while enhancing quality of care. Literature search was done using pub-med electronic database among the studies published between January 1975 and April 2024 with search words 'inappropriate', 'utilization' and 'laboratory tests'. Manual search of journal services and textbooks as well as reference articles were also done. Among them, studies on the landscape of inappropriate laboratory testing, possible causes, consequences, rationale for appropriate laboratory testing, strategies to improve appropriateness and the effectiveness of the interventions were included by screening the title and abstract. Studies on imaging and blood products requests were excluded. The proportion of inappropriate tests among studies varied extensively ranging from 4.5% to 95%. Based on a meta-analysis and systematic review published in 2013, overall mean rates of over and underutilization were 20.6% and 44.8% respectively. Numerous strategies have been employed both independently and in combination to overcome inappropriate utilization of laboratory resources. Laboratory diagnostic algorithms, clinical decision support systems/tools

(CDSS/CDST), interventions within computerized provider order entry (CPOE), education and guidance, audits and feedback, gate keeping strategies, harmonization of test panels and request form design, and review of offered tests are some of them. Laboratory professionals can raise awareness of the need to change practice towards more appropriate requesting behavior.

Introduction

Modern healthcare shows increasing complexity with a marked rise in expenditure. On the other hand, in recent years governments are facing challenges to address extremely complex economic issues. It will be unsustainable if the trend continues at the present rate. Hence there is a need to redesign the healthcare system to be safe, effective, timely, equitable, patient-centered and particularly efficient.

Laboratory medicine has become an indispensable discipline in modern healthcare. Laboratory test results are utilized in screening, diagnosis and assessing prognosis. They are also used for risk stratification of disease, treatment selection and monitoring of disease progression or treatment response. They serve as a guide for both hospital discharges and admissions, while laboratory testing takes up a significant portion of healthcare budgets it also serves as the core element for more expensive downstream care. Thus, laboratory professionals are in a good position to help reduce healthcare expenditures through cooperation with clinicians and other healthcare providers.

Increased utilization of laboratory tests in the recent past could be explained in several ways. Technology advancement results in a wide array

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of test repertoire, improved turnaround time, electronic order entry systems and panels/profiles of investigations. Hence ordering tests and receiving reliable results on time has become easy and comfortable. Availability creates demand. Practice of defensive medicine due to the threat of malpractice liability is identified as a contributor in the recent past. Lack of adequate knowledge on appropriate selection of tests for a clinical setting and incorrect interpretation of test results causes overutilization of laboratory tests. Sometimes tests are ordered merely to satisfy or impress the patients, peers or supervisors. Innate curiosity, research habits, reduced tolerance to errors, financial rewards, practice inertia, and reliance on technology rather than rational cognitive problem solving also can contribute to this problem. Use of more than one confirmatory test, ordering of secondary or tertiary laboratory tests without considering primary test results and mass screening further compound the problem. Insurance cover for the cost of investigations, overreliance of tests to deal with uncertainty (inability to establish the diagnosis), and increased demand for care due to aging population and growing number of people with chronic disease, prolonged stay in hospital, unfavorable outcome are some other identified factors. Duplication of testing (within 12 hours) is another important factor causing overloading of laboratory services. Inaccessibility of paper records or incomplete electronic record transfer among incompatible electronic medical record system when patients are transferred between care facilities leads to duplicate testing behavior. It can also happen when more than one clinician is involved in the patient's care and fragmentation of care resulting from sub specialization. Recurring tests that are automatically redone at a specific interval are another cause of over testing particularly when clinicians forget to cancel standing orders for those tests. Laboratory requests flagged as urgent have also increased in the recent past. Many laboratories are facing an annual increase in workload of 8-10%. Rise in absolute test volume outpaces the most obvious confounders such as population growth or greater proportion of older patients. Demand for laboratory testing is increasing faster than medical activity. As the rate of test utilization grows there is increased scrutiny over the appro-

priateness of testing. It is questionable whether all these tests are appropriate and utilized for clinical decision making. Systematic evidence of the laboratory contribution to the overall process of diagnosis and management of patient is hard to produce.

Appropriateness in testing remains a complex, multidimensional, multi-perspective concept. Laboratory testing is considered appropriate only if it supports the standard of care which in turn is defined according to patient outcome. It will allow accurate diagnosis to be made, ideal therapy to be identified and monitored and accurate prognosis to be established. The right test must be ordered for the right patient at the right time and for the right reason with the intension of producing the right outcome in a cost-efficient manner. Test results should be interpreted in the correct way and appropriate action should be taken. Testing should be in accordance with the current subject-specific expert knowledge or evidence-based standards for usage. Re-testing intervals should be appropriate. Utilizing the laboratory services appropriately is very important in optimal medical practice.

Though several articles are published on various aspects of inappropriate utilization of laboratory investigations at various settings individually and in various combinations, a complete review article covering the entire aspect of this issue is lacking. This narrative overview will summarize the relevant literature and present the

- Prevalence of inappropriate utilization of laboratory investigations.
- Possible consequences.
- Interventions focused to improve test appropriateness based on the possible causes.
- Effectiveness of various interventions.

Methods

Literature search was done using pub-med electronic database among the studies published between January 1975 and April 2024 with search words 'inappropriate', 'utilization' and 'laboratory tests'. Seven hundred and eighty-eight results

were found. Among them those relevant to the focused purpose of the study by screening the title and abstract were included. Studies on the landscape of inappropriate laboratory testing, possible causes, consequences, rationale for appropriate laboratory testing, strategies to improve appropriateness and the effectiveness of the interventions were included. Studies on imaging and blood products requests were excluded. Manual searching of journal services and textbooks and searching through reference articles that are retrieved was also done.

Discussion

Inappropriate utilization of laboratory investigations and possible consequences

– Inappropriate underutilization of laboratory investigations

Failure to order a test when indicated may lead to failure of diagnosis or inaccurate diagnosis or delayed diagnosis which can lead to greater patient suffering, adverse health outcomes and higher costs over the long haul associated with treating advanced diseases. Failure to review and follow-up on patient test result in a timely manner also can cause serious adverse outcome. In a retrospective review of 307 closed malpractice claims in which patients alleged a missed or delayed diagnosis in the ambulatory settings, 59% of claims involved diagnostic errors that harmed patient and 30% resulted in death. For 59% of the errors, cancer was the diagnosis involved¹.

– Inappropriate overutilization of laboratory investigations

Tests that are ordered but not indicated carries a risk of unnecessary follow-up tests due to increasing likelihood of generating a false positive result, incorrect diagnosis and treatment, increased length of hospital-stay, unnecessary blood loss and unnecessary mental stress for the patient. In laboratory investigations, the upper and lower 2.5% of the results are not included in the normal range. Thus, even though there is nothing wrong with 5% of the normal population, they will be classified as abnormal. These false positive results can happen not only in laboratory investigations but also in imaging studies. In literature, there are many

examples of “Ulysses syndrome”. Patients with Ulysses syndrome find themselves caught in a web of further investigations, referrals and sometimes treatment before they are finally recognized as healthy, which they were in the first place. It is a side effect of unnecessary or inappropriate investigations or wrong interpretation of results. An example is described in the following patient vignette: Jason fell and hurt his leg. Mother thought that it could be just a bruise, but grandma advised her to take him to the hospital. The doctor thought a fracture was unlikely but just to be on the safe side had a radiograph taken. There was no fracture but on the corner of the film, well away from the site of injury there is an area of abnormal bone. After several unhelpful blood tests, the worried parents take Jason to an orthopedic surgeon who thinks it is probably a normal variant. But the family have worried themselves into a belief that Jason has cancer, he biopsies the lesion. The pathologist makes a confident diagnosis of fibrous cortical defect. The child falls on the slippery hospital floor and fractures his leg through the area that was weakened by the operation and spends six weeks in a cast while it heals².

In addition to the negative impact on the patient, inappropriate laboratory overutilization causes draining of laboratory resources including supplies and human resources and derangement of laboratory efficiency. It also causes delays in the completion of priority laboratory tests.

There are no publications with reliable information to address to which extent laboratory results are really used for patient care. Many strategies have been used in the literature to investigate inappropriate utilization of laboratory resources. Comparing the number of tests per patient, overall ordering habits, feedback forms administered before and after intervention, consideration of clinical context and checking for medically justifiable re-testing intervals are some of them.

Several studies have been conducted to estimate inappropriate use of laboratory investigations. Reported inappropriateness in laboratory tests ordering varies widely depending on the criteria used for establishing inappropriateness. It includes both underutilization and overutilization.

The objective criteria are independent of the investigator and precisely stated. Subjective criteria are based on expert review. There should be a clear indication for ordering a test to consider it as appropriate if restrictive criteria are used. No contraindication is enough for ordering a test to consider it as appropriate if permissive criteria are used. Inappropriate test ordering can happen during the initial evaluation of the patient (initial testing) or in response to new signs and symptoms (repeat testing).

A systematic review of published studies between 1965 and 1995 on inappropriate use of laboratory investigations was published in 1998. Among 44 eligible studies 11 used implicit criteria for inappropriate laboratory utilization and 33 used explicit criteria. Most of the studies originated from the United States (70%). The proportion of inappropriate tests among studies included in this systematic review varied extensively ranging from 4.5% to 95%³.

In another 15-year (1997-2012) meta-analysis and systematic review published in 2013 forty-two studies were included. Among them 38 investigated overutilization of laboratory investigations and 8 investigated underutilizations. Four studies investigated both. Thirty-one studies used objective criteria for measuring appropriateness while 11 used subjective criteria. Seven studies employed both permissive and restrictive criteria, while sixteen studies exclusively utilized restrictive criteria and nineteen only utilized permissive criteria. Based on this meta-analysis and systematic review, overall mean rates of over and underutilization were 20.6% (95%CI 16.2-24.9%) and 44.8% (95%CI 33.8-55.8%) respectively⁴.

Interventions to overcome inappropriate laboratory utilization

In the literature several interventions have been used to overcome inappropriate laboratory utilization. However, all strategies might not be suitable for each laboratory and for each medical condition. Therefore, each laboratory should select appropriate strategies according to the local scenario in close collaboration with clinicians. Influencing clinical practice and implementing

changes, especially those that involve restrictions, are challenging. Every modification to a procedure that impacts the quantity of tests performed, the staff's workload, or the laboratory budget needs to be approved by the local healthcare facility's executive board, the medical director, and the head of the department. Changes should always be made in collaboration with clinicians. A physician's clinical judgement should not be replaced by any clinical scoring systems and or clinical decision system. Developing and implementing these strategies need precise planning, clear communication and intense collaboration between healthcare professionals and other potential stakeholders⁵.

1. Laboratory diagnostic algorithms or reflexive testing algorithms

These are pathways based on clinical setting like anaemia, jaundice, etc. Clinicians refer the patients to the laboratory professionals for a laboratory diagnostic work-up of the respective clinical setting. Laboratory specialists may be able to select the right reflex tests and to interpret results in combination with clinical signs and symptoms based on current evidence and guidelines. Clinicians receive a narrative interpretation that would enable them to make diagnoses and treat the patients more efficiently⁵.

2. Clinical decision support systems/tools (CDSS/CDST)

These are interactive decision support tools that integrate patient information with current medical knowledge and assist healthcare professionals to make clinical decisions with explanations. These tools can be utilized in the laboratory as well.

Human resources are usually allocated to the laboratories according to the number of tests requested by the clinicians. Additional work of reflex testing and interpretation increases the workload. These tasks can be automated using artificial intelligence and machine learning. However, for patients with complex disease or non-specific symptoms or test results with possible gray zones, it is not straightforward. Lack of suitable IT tools is a limiting factor⁵.

3. Interventions within the computerized provider order entry (CPOE)

Computerized provider order entry (CPOE) in laboratory medicine refers to the process of providers entering and sending laboratory test requests via a computer application rather than paper, fax, or telephone. Interventions within CPOE include reshaping electronic request forms, redundant test alerts, display of test costs, and limitation of availability of tests in the COPE user interface.

4. Education and guidance

Education and guidance are intended to raise awareness of the need to change practice towards more appropriate requesting behavior. Applying it consistently and with effort is necessary to bring about a significant shift in requesting behavior. The focus of the laboratory quality performance has been on optimizing analytical performance and to some extent improving the pre-analytical and post-analytical phases of testing. Test demand management and diagnostic validation of the tests (pre-pre-analytical phase) and receiving, interpretation of laboratory results and subsequent appropriate actions for best patient outcome (post-post-analytical phase) did not get much attention. These activities happening at clinical-laboratory interphase remains a crucial issue and more error prone. As responsibility for these activities falls in the boundaries of clinical-laboratory interphase, they are poorly evaluated and monitored. The complexity of modern healthcare environment and ever-expanding test repertoire increases the need for more integration between clinical information and laboratory data.

Several ways have been used to disseminate information in literature such as formal sessions, staff meetings, peer group discussions, e-mails, posters, educational flyers, bed side reminders, content in the intranet, and educational contents in electronic devices such as tablets. There are several online platforms aimed to enhance education on the appropriateness in laboratory testing. These include choosing wisely project⁶, the lap test online project⁷ and the Australian quality use of pathology program⁸.

5. Audit and feed back

This involves an audit of tests requested with feedback provided on the tests' selection practice. It can be collective or individual. It is effective when it is used in combination with other interventions⁵.

6. Gate-keeping strategies

These are implemented by laboratories to impose on clinicians. These strategies must be developed and implemented in very close collaboration and in accordance with clinicians. They are usually active once the order is placed. Implementing minimum retesting intervals (time limit within which no additional testing of same parameter from the same patient is clinically justified and hence allowed) or limiting a test to a particular appropriate patient population are few examples⁵.

7. Harmonization of test panels/profiles and request form design

Laboratory test panels/profiles can be source of overutilization of laboratory tests if that is not used appropriately. Hence, revising/restructuring test panels/profiles on a regular basis in collaboration with relevant clinicians would be an efficient strategy⁵.

8. Review of offered tests

Laboratories should screen their repertoire periodically for obsolete tests and remove them ⁵.

Effectiveness of interventions

A systematic review and meta-analysis published in 2018 based on 83 studies published between 1980 and 2016 evaluated the effectiveness of above-mentioned practices used to support appropriate clinical laboratory tests utilization either alone or in combination⁹. Fifty-one of these studies were meta-analyzed. The available evidence base demonstrated considerable variability in terms of targeted test-ordering clinicians, targeted testing, patient setting, patient inclusion/exclusion criteria, facility type and size, study design, the specific intervention used within a practice category and author affiliation (46% laboratory professionals). Methodological flaws hamper drawing strong

conclusions from literature. Based on this systematic review and meta-analysis, the strength of evidence ratings for each practice ranged from high to insufficient. Laboratory diagnostic algorithms/reflex testing, combined practices, and interventions within CPOE are recommended as to support appropriate laboratory test utilization. For other interventions additional studies are needed to evaluate the effectiveness on appropriate laboratory test utilization.

Limitations

Though numerous studies have been conducted on estimation of inappropriate utilization and evaluation of effectiveness on practices used to support appropriate test utilization, results are not generalizable or comparable due to variability in study settings, methodology and the criteria used to determine the inappropriateness. Potential publication errors or selective reporting is also a limitation. There are insufficient audits on how test results affect patient care and clinical outcomes, including whether results were reviewed, and appropriate action was taken. Performing audits to estimate the prevalence of inappropriate laboratory tests utilization locally with adherence to the guidelines including the use of standard appropriateness criteria is the way forward. Audits on the impact of tests results on patient pathways and outcome also need to be done.

Conclusions

Improving the laboratory cost-effectiveness profile through appropriate utilization of laboratory investigations without declining obtainable improvement in healthcare is a challenge. Designing, implementing, evaluating and maintaining interventions focused to improve the appropriateness are important steps in achieving this goal. Laboratory professionals are in a good position to help in achieving this goal through close collaboration with clinicians and other healthcare providers. Readily accessible and genuinely helpful laboratory professionals can create an atmosphere for better communication with the clinicians. Creating awareness on inappropriate utilization of laboratory tests among the end users would be the initial step. A multidisciplinary

laboratory stewardship steering committee consisting of laboratory professionals, clinicians, administrators, and health informatics professionals shall be responsible for making decisions that promote and ensure appropriate laboratory testing. Implementing comprehensive digital health solution in healthcare institutions shall be the way forward in resource limited countries. Laboratory diagnostic algorithms, education, audit, feedback and selected gate-keeping strategies individually or in combinations would be beneficial locally.

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