

# Frequency that Laboratory Tests Influence Medical Decisions

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**Background:** Among the variables that influence medical decisions, laboratory tests are considered to be among the most important and frequently used. The influence of laboratory tests on medical decisions has been difficult to estimate. The goal of this study was to estimate the number of patient encounters that included a laboratory test.

**Methods:** We extracted information for 72 196 patient encounters from 1-week intervals each quarter of a year from our comprehensive academic medical center electronic medical record. The patients examined represent a comprehensive range of clinical conditions and medical services. We determined for which encounters laboratory and other orders existed.

**Results:** Overall 35% of encounters had 1 or more laboratory tests ordered. However, the percent varied markedly with patient care areas. For inpatient, emergency department, and outpatient populations, 98%, 56%, and 29%, respectively, had 1 or more laboratory tests ordered.

**Conclusions:** Our observations support that it is not possible to use a single number to categorize the frequency with which laboratory tests occur in patient encounters. Utilization of laboratory tests varied with type of medical service with almost all inpatients, approximately half of emergency department patients, and nearly one-third of outpatients having laboratory tests during their healthcare visit.

## IMPACT STATEMENT

This investigation examined how frequently laboratory tests were included in the medical records of a large number of patients with a large mix of different clinical conditions. In addition, differences in frequency of ordering laboratory and other diagnostic tests in inpatient, outpatient, and emergency department care areas were examined. Consequently, the conclusions represent a comprehensive examination of how frequently laboratory and other diagnostic tests were available to inform medical decisions.

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<sup>2</sup> **Nonstandard abbreviations:** EMR, electronic medical record; VCU, Virginia Commonwealth University.

Since the beginning of modern medicine, the clinical laboratory has been essential to patient care and diagnosis. However, it has been difficult to quantitatively assess the number of medical decisions that are informed by laboratory results. The longstanding claim that laboratory tests inform 70% of medical decisions was originally based on anecdotal observations and never substantiated (1). An assessment of oncology and cardiology practitioners reported that *in vitro* diagnostic testing was used 75% of the time, but substantial clinical decisions only occurred in 66% of those patients (2). Other investigators have reported that laboratory testing was used in 41% of emergency department visits (3), 38% of general internist visits, 29% of family physician visits (4), and 31% of primary care physician visits (5). The IFCC Task Force on the Impact of Laboratory Medicine on Clinical Management and Outcomes reviewed the complexity of laboratory medicine and how it affects clinical medicine and healthcare (6). The task force examined the role of laboratory testing for screening, risk assessment, diagnosis, treatment selection, and monitoring treatment response. Their overall assessment was that laboratory testing is an essential part of many clinical care scenarios, that improvement in appropriate use of laboratory testing is needed, and that laboratory specialists need to collaborate with clinical providers to optimize the value of laboratory testing.

The widespread use of electronic medical records (EMRs)<sup>2</sup> makes it possible to examine the EMR to determine the fraction of patients for whom laboratory test results exist for a given healthcare encounter. Despite the completeness of an EMR, it remains difficult to elucidate the relationship between a laboratory test result and its role in a medical decision or how many medical decisions were directly influenced by laboratory tests. Although it is not possible to know if a laboratory test was actually reviewed and used as the basis for a medical decision, for this investigation, we made the assumption that if a laboratory test

was ordered, it played a role in managing a patient's encounter. We examined the records in the EMR for the Virginia Commonwealth University (VCU) Medical Center to determine the number of medical encounters for which laboratory tests were ordered.

The study took place at VCU Health System, a comprehensive academic medical center with 1125 beds, 7 intensive care units, 36 operating rooms, and a large range of outpatient services. Every major specialty of medicine is offered, including the only level I trauma center in the region, a comprehensive cancer center, a transplant center, and a burn center. In 2015, the medical center admitted close to 50 000 inpatients, served 112 000 people in the emergency department, and served 640 000 people in outpatient clinics.

## MATERIALS AND METHODS

The EMR was from Cerner Millennium implemented in 2004 and was expanded over several years. Now, paper records have been eliminated and the EMR includes records of all physician, nursing, and ancillary transactions that occur for a patient. In any medical system, there are many clinical decisions made that are documented by progress notes, consultation notes, nursing notes, etc., that are text-based and difficult to search and relate to specific laboratory test results. Consequently, our examination of data was restricted to what could be extracted as discrete elements and categorized to estimate the influence of laboratory information on a patient's healthcare encounter.

One-week intervals that avoided holidays were sampled during the months of December 2014 and March, June, and September 2015 to represent typical patient encounters throughout the year. A patient encounter was defined as a unique patient visit that began during the date ranges examined. A patient visit that started and ended that was followed by a second visit initiated during the same 1-week sampling interval was counted as 2

encounters. Patient encounters that extended from 1 sampling interval to another were only included once. Cerner Command Language was used for the EMR query, and data were examined using Excel 2013. The query included the type of patient visit, the location the patient visited, the name of all completed orders, and the hospital service area that fulfilled an order. The project was approved by the VCU Institutional Review Board.

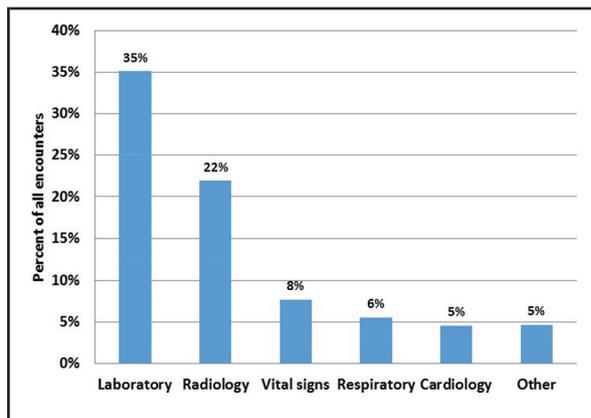
All diagnostic tests were included, and all non-diagnostic tests were excluded. A “diagnostic test” was defined as a procedure that represented an investigation of physiologic condition. Results from such tests are used by a physician to make a decision on diagnosis or treatment. For example, radiology, vital signs, respiratory testing, invasive cardiology, vascular laboratory, or pathology laboratory testing were considered diagnostic tests. Laboratory tests included clinical and anatomic procedures provided by central laboratory services or at the point of care. Nondiagnostic tests were those that did not influence a clinicians' diagnosis or medical decision. For example, medication orders, dietary orders, or physical rehabilitation orders are important for managing a patient's condition but do not provide diagnostic information for decisions regarding a diagnosis or treatment.

**RESULTS**

Fig. 1 shows that laboratory tests were the most frequently ordered diagnostic procedure (25334 of 72197 [35.0%] patient encounters) followed by radiology, vital signs, respiratory, cardiology, and other.

Fig. 2 shows that 98% of inpatients, 56% of emergency department patients, and 29% of outpatients, respectively, had at least 1 laboratory test ordered.

Fig. 3 shows the distribution of the total number of laboratory test orders by patient care area. The figure shows that 50% of all laboratory orders were

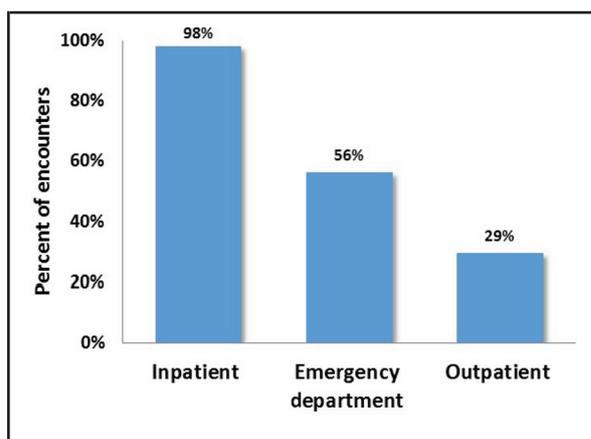


**Fig. 1. Percent of all patient encounters during which diagnostic tests were performed.**

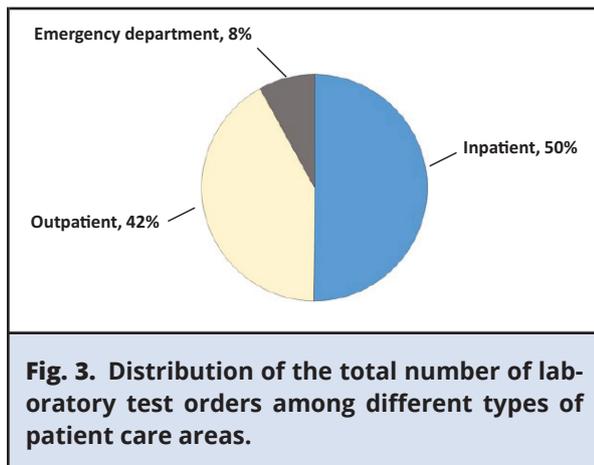
Note that a single patient encounter may have more than one type of diagnostic test procedure.

placed by inpatient areas, 42% of all laboratory orders were placed by outpatient areas, and 8% of all laboratory orders were placed by the emergency department.

Fig. 4 shows that the most common diagnostic orders placed for inpatients were vital signs (53%), laboratory (26%), and respiratory (18%); for outpatients, the most common orders were for laboratory (70%), vital signs (18%), and radiology (7%); and for



**Fig. 2. Percent of different types of patient care areas for which at least 1 laboratory test was ordered.**

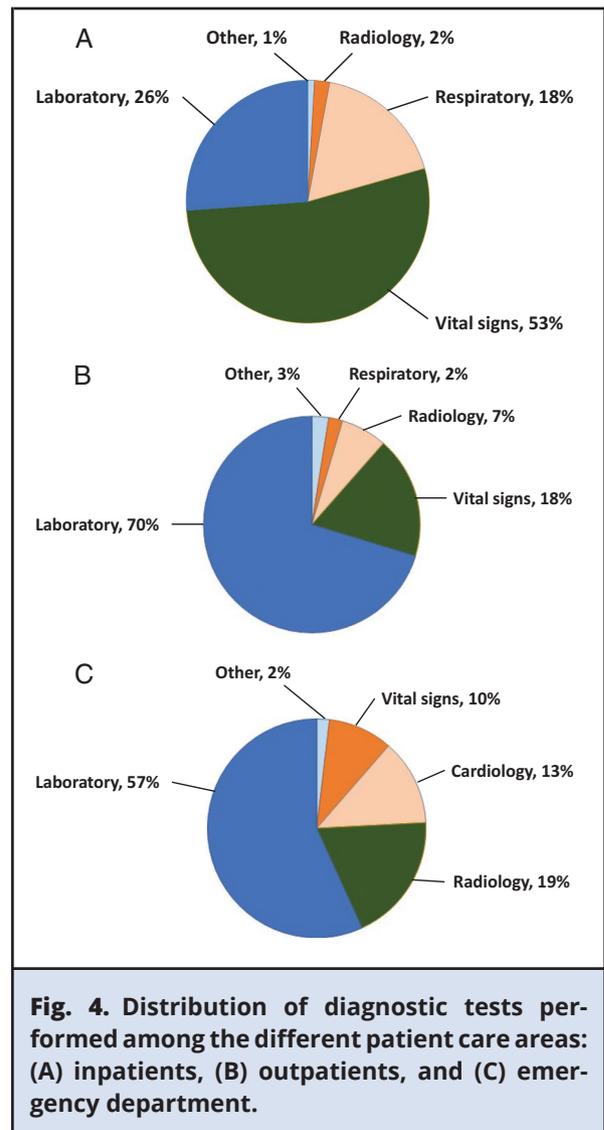


the emergency department, the most common orders were for laboratory (57%), radiology (19%), and cardiology (13%).

**DISCUSSION**

We observed that laboratory use varied depending on treatment areas. The greater the acuity of a patient population, the more likely the laboratory was used, which explains why almost all inpatients used laboratory testing. The illnesses in an inpatient population are typically more severe and require frequent monitoring of pathophysiologic biomarkers and therapeutic drugs and need laboratory support for infection management and blood products.

The inpatient service ordered more laboratory tests (218134) than the outpatient service (181434), despite having fewer numbers of patients (2981 and 63001, respectively). An interesting observation was that vital signs were the most frequently ordered inpatient diagnostic tests, whereas laboratory tests were the most frequently ordered for outpatients. This discrepancy may be explained by the need for multiple vital signs ordered frequently for many inpatient situations. In contrast, outpatient encounters would need only one vital sign order per encounter, while multiple laboratory tests may be needed.



The emergency department's laboratory utilization rate was lower than for inpatients. The emergency department's patient population is composed of patients with problems such as minor injuries and infectious conditions, but also patients with serious acute illness and severe trauma. The range of illnesses from the simple to life threatening explains why laboratory utilization was less in the emergency department than for inpatient services. Our observation that 56% of emergency department visits included laboratory

tests is somewhat higher than a report that laboratory testing was used in 41% of emergency department visits (3); this is most likely due to differences in populations served.

Outpatient services' laboratory utilization rate was the lowest of all 3 categories of patient care services. The outpatient population typically suffers from a range of chronic diseases and cancers that require laboratory testing. However, services such as physical checkups, outpatient follow-up, and elective procedures frequently do not require laboratory testing. Our observation that 29% of outpatient encounters had laboratory tests is consistent with reports of 29%–38% for primary care physicians consisting mainly of general internists and family physicians (4, 5).

Strengths of our study were the completeness of the EMR, the comprehensive range of medical services offered at the medical center, and the

large number of patients with a varied mix of clinical conditions. The observations were limited to the medical practices at our institution that may not be the same at other healthcare systems. In addition, it is not possible to know if a laboratory test was actually reviewed and used as the basis for a medical decision. However, for this investigation, we made the assumption that if a laboratory test was ordered, it played a role in managing a patient's encounter.

In summary, our observations support that it is not possible to use a single number to categorize the frequency with which laboratory tests occur in patient encounters. Use of laboratory tests varied with type of care service with almost all inpatients, approximately half of emergency department patients, and nearly one-third of outpatients having laboratory tests during their healthcare visit.

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**Author Contributions:** All authors confirmed they have contributed to the intellectual content of this paper and have met the following 4 requirements: (a) significant contributions to the conception and design, acquisition of data, or analysis and interpretation of data; (b) drafting or revising the article for intellectual content; (c) final approval of the published article; and (d) agreement to be accountable for all aspects of the article thus ensuring that questions related to the accuracy or integrity of any part of the article are appropriately investigated and resolved.

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## REFERENCES

- Hallworth MJ. The "70% claim": what is the evidence base? *Ann Clin Biochem* 2011;48:487–8.
- Rohr U-P, Binder C, Dieterle T, Giusti F, Messina CGM, Toerien E, et al. The value of in vitro diagnostic testing in medical practice: a status report. *PLoS One* 2016;11:e0149856. doi:10.1371/journal.pone.0149856.
- Centers for Disease Control and Prevention. National hospital ambulatory medical care survey. 2010. [http://www.cdc.gov/nchs/data/ahcd/nhamcs\\_emergency/2010\\_ed\\_web\\_tables.pdf](http://www.cdc.gov/nchs/data/ahcd/nhamcs_emergency/2010_ed_web_tables.pdf) (Accessed November 2016).
- Hickner JM, Fernald DH, Harris DM, Poon EG, Elder NC, Mold JW. Issues and initiatives in the testing process in primary care physician offices. *Jt Comm J Qual Patient Saf* 2005;31:81–9.
- 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.
- Hallworth MJ, Epner PL, Ebert C, Fantz CR, Faye SA, Higgins TN, et al. for the IFCC Task Force on the Impact of Laboratory Medicine on Clinical Management and Outcomes. Current evidence and future perspectives on the effective practice of patient-centered laboratory medicine. *Clin Chem* 2015;61:589–99.