

# Excess Cost of Routine Daily Laboratory Tests among Internal Medicine Departments at Jordan University Hospital: a Pilot Study

*Hussein H. Alhawari<sup>1\*</sup>, Khaled Al Oweidat<sup>2</sup>,  
Hana Makhamreh<sup>3</sup>, Saif Aldeen AlRyalat<sup>4</sup>, Wesam Abu Zaid<sup>5</sup>,  
Muayad Azzam<sup>6</sup>, Lara Al-Abdallat<sup>6</sup>, Emad Al-Abdallat<sup>7</sup>*

## Abstract

**Introduction:** Laboratory tests have become the single highest-volume medical activity; this is a result of physicians' dependence on them. They order them even in cases where they are deemed unnecessary clinically and have no impact on patient care and treatment. One of the practices that lead to "over-investigation" in terms of these tests is "routine testing", which yields to an excess cost both monetarily as well as in other aspects. Thus, the purpose of this study is to investigate routine laboratory ordering practices among internal medicine departments at Jordan University Hospital to determine the amount and cost of unnecessary routine lab tests ordered.

**Methods:** We reviewed the data of 30 patients that were admitted for a minimum of 5 days, aged over 18 years old, and not pregnant in various internal medicine departments (respiratory, hematology, gastroenterology, infectious diseases, neurology, nephrology and cardiology). Through criteria set by previously published studies, and the experience of internal medical consultants we calculated the cost of excess labs for all the patients that met aforementioned criteria during a time span of 1 month.

**Results:** The average age of the sample was 57.3 years, spread out among the different departments. The mean average excess cost per patient per day was \$43.1 ( $\pm$  25.8) ranging from 0 to \$103.3, with no significant difference between age and department.

**Conclusion:** A potential to lower hospital admission cost lies in these unnecessary excess laboratory tests, however further studies with a larger sample sizes are needed, as well as studies assessing the non-monetary cost caused by over-investigation.

**Keywords:** Blood test; Cost; Over-investigation; Routine testing

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1 Department of Internal Medicine, The University of Jordan.

2 Department of Internal Medicine, Respiratory and Sleep medicine, The University of Jordan.

3 Department of Internal Medicine, Cardiology, The University of Jordan.

4 Department of Ophthalmology, The University of Jordan

5 Head of medical education office, Jordan University Hospital, The University of Jordan

6 Faculty of Medicine, The University of Jordan.

7 Professor of Forensic Medicine, The University of Jordan

\* Correspondence should be addressed to:

Department of Internal Medicine, Nephrology, The University of Jordan.

Queen Rania Street, Amman 11942, Jordan.

email: [Hussein\\_hawari@hotmail.com](mailto:Hussein_hawari@hotmail.com)

## Introduction

Clinical Laboratory Tests have been essential diagnostic tools since they became a standard fixture at the beginning of the 20<sup>th</sup> century. These tests, which started out as simple but unreliable, were developed throughout the years to reach the level of sophistication and accuracy as they are now. [Berger, 1999] This advancement was accompanied by an increase in their usage as well as the increase in their dependency. Lewin Group for the Centers for Disease Control and Prevention described laboratory tests as “an essential element of the health care system ... and integral to many clinical decisions”. [Hallworth, 2011] In addition to this, an increase in total hospital admissions has occurred; according to the Jordan Health System Profile, hospital admissions in Jordan increased from 13.0 to 14.5 percent between the years 2006 and 2010. [Musa, 2011] As a result, to manage the high quantity of tests required, many hospitals adopted “routine laboratory testing”, which can be best described as a set group of common laboratory tests that are performed at regular intervals to all hospital patients, regardless of their clinical picture. Like many hospitals, JUH (Jordan University Hospital) adopts this technique, in which routine lab tests are ordered daily during morning rounds.

A significant factor that led to this adaptation is the technological advancements in the field of medicine, where laboratory tests have become a quick and effective option that yields results almost instantly at a relatively low cost. As a consequence, healthcare professionals no longer carefully consider the order of these blood tests, to the extent that it became the single highest-volume medical activity. [Faulkner, 2017; Alexaner, 2012] A study also attributed the use of routine testing to

being “a psychological comfort zone for clinicians, masking an over-reliance on investigations or a lack of confidence in clinical judgment . Ordering unnecessary tests is driven by the fear of missing any important clinical details.” [Faulkner, 2017] Although various literatures have explored the benefits and conveniences of routine testing [Grady, 2017; Zhou, 2010], it has been associated with over-investigation [Tabriz, 2004] which has many significant adverse effects and costs, both on the patient and on the hospital, and as we know that this contradict as well as having negative impacts on the healthcare system.

First of all, for patients, the excess blood withdrawal causes unnecessary discomfort. Moreover, there is an additional risk of generating false-positive results, due to more tests being performed, doctors might fall in misdiagnosis. On the other hand, for hospitals, over-investigation leads to the overloading of the diagnostic services, as well as wasting valuable healthcare resources, leading to inefficiency in providing healthcare. Most notably is that over-investigation presents an additional excess cost for hospitals. [Zhi, 2013]

Over-investigation forms a problem to healthcare systems worldwide; to diminish that, international campaigns such as “Choosing Wisely” have been created to resolve or at least lessen the impact over-investigation has on patients, particularly in terms of “the value of care and potential risks”. [Levinson, 2014] Therefore, in this study, we aim to investigate routine lab ordering practice among internal medicine departments to determine the amount and cost of unnecessary ordered routine lab tests. Various papers have described the effects of over-utilization as well as probable strategies and experiments to solve it [Schubart, 2001; May, 2006]; however, according to our search,

no paper to date has focused on the excess cost caused solely by criteria set on redundant routine laboratory tests in Jordan.

### Materials and methods

This mono-centric cross-sectional study was approved by our institutional review board IRB committee, and conducted in accordance with the latest update (2013) of the declaration of Helsinki. The treating team was blinded for any the existence of such study. The reviewers are from the quality office, management office, or from the departments which their patients were not included in this study. They were educated by internal medicine specialist about the laboratory tests included in this study, their normal limits, and the criteria for the normal test.

### Participants

This study was done in the period from November 1<sup>st</sup>, 2017 to November 30<sup>th</sup>, 2017 in the internal medicine department at Jordan University Hospital (JUH). We included patients who will be discharged after an admission of at least five days. We also adopted the following inclusion and exclusion criteria:

Admitted at any of the following internal medicine department; Respiratory, Hematology, Gastroenterology, Infectious diseases, Neurology, Nephrology and Cardiology departments. Regarding our included sample, we did not include pregnant ladies, we did not include patients who are less than 18 years old, and we did not include any patient who required transfer to the ICU or other departments.

All the included patients were followed up daily for the duration of their stay, and any event that required additional testing (e.g. medical complication, drug complication etc.). None of the patients died during the study

period.

We included a total of 30 patients in this study with a mean age of 57.3 years ( $\pm 15.6$ ). They were 14 males (46.7%) and 16 females (53.3%). Nine patients (30%) were admitted to hematology department, five patients (16.7%) to each of respiratory and neurology, three patients (10%) to each of GI, ID, and cardiology, and two patients (6.7%) to nephrology departments. No admissions for more than five days were found for other internal medicine departments.

### Study design

We reviewed the data of the previous admission for each patient in details including the period of admission, reason for admission, clinical data and progress notes, past history and all the laboratory tests that were done during that admission, including the routine lab tests that were ordered daily as the "cycle labs" to be reviewed during the morning rounds. Our search included the main lab tests that are most commonly ordered on the daily cycle by the aforementioned departments by team residents, including; Complete Blood Count (CBC), Liver Function Test (LFT), Kidney Function Test (KFT), and Electrolytes. These tests are available as "panels" on the JUH computer system; i.e. each one is composed of more than one test that can be ordered as a "package".

Two internal medicine consultants reviewed clinical data, progress note, and lab tests ordered for each patient, or if there were any lab tests that were repeated unreasonably. According to their experience and previously published studies [Schubart, 2001; May, 2006], they determined if there were any unnecessary lab tests that were not justified, based on the following guidelines and their clinical judgment if they were not covered by the guidelines:

- Admission investigation are not considered over-investigation.

- Routine labs which were conducted and not only showing normal results but also no clinical need to conduct them according to progress notes are considered over-investigation.

- If there was a clinical justification on the progress note, or if a lab result is abnormal, then it will not be considered over-investigation.

- A one-time normal investigation after any abnormal investigation is justified, any other normal labs subsequently is considered over-investigation.

We calculated the total cost of the unnecessary lab tests for each patient, according to the price of each test in JUH laboratory (number of unnecessary lab tests\*cost of the test), and then we calculated the total cost of unnecessary lab tests of each patient. After that, we calculated the average cost of the excess labs per day for each patient (Total cost of the unnecessary lab tests for each patient/period of admission in days). Finally we calculated the average cost of excess labs per day for all patients of each department (Total cost of unnecessary lab tests for all patients of each department/total duration of admission of all patients of that department).

### Statistical analysis

We used SPSS 21.0 (Chicago, USA) for our analysis. We described the variables in term of count (frequency) for ordinal and nominal variables, and used either mean ( $\pm$  standard deviation) for normally distributed continuous variables, and via median (25 to 75 percentiles) for not-normally distributed variables.

We used independent sample t-test and one-way ANOVA to analyze the mean difference in

gender or department and the cost. We used non-parametric tests (Mann-Whitney and Kruskal-Wallis) to analyze the gender and departmental difference in investigations that were done. A p value of less than 0.05 was our significant threshold.

### Results

The mean total excess cost per patient was \$625.7 ( $\pm 556.3$ ) ranging from none to \$2634.2. The mean excess cost per patient per day was \$43.1 ( $\pm 25.8$ ) ranging from none to \$103.3. Table 1 details the average excess cost per day and total excess cost for each gender and for each group of duration. Table 2 details the average excess cost per day and total excess cost for each department. We did not find any significant difference between age or department and the cost.

The median number (25-75 percentiles) of excess investigation for CBC was four (two to six), for LFT none (none to four), for KFT five (two to eight), for electrolytes six (three to nine). We only found significant difference in median LFT done between departments, as median number of LFT done in hematology department was five (four to six),  $p=0.021$ .

### Discussion

Among patients admitted to internal medicine departments for various indications, we showed that the mean average excess cost per patient per day was \$43.10 ( $\pm 25.78$ ), a cost that is an excess to what a patient would need based on his/her clinical data. This comes in compliance with a previous study also done on an academic internal medical department, where they found that a mean of 2.01 tests per patient per day could be avoidable, considering that the average price of tests we studied is \$31.83. [Miyakis, 2006] Although doing

department specific analysis would be limited by the small sample size, we found that patients admitted to hematology department have significantly more LFT orders than other departments. These findings are supported by previous studies which also showed that over-investigation is a common practice which was done by residents in teaching hospitals. [Fung, 2015] A study investigated Inappropriate Laboratory Testing concluded that high-volume tests, such as those which were ordered during routine testing, are more likely a source of over-investigation than other low-volume tests. [Zhi, 2013]

CBC is the most commonly ordered lab test in our included sample from internal medicine departments. A recent review showed that neither CBC nor any of its components should be ordered routinely in asymptomatic, non-pregnant adults, as it does not reduce mortality. [Allan, 2017] In a previous study that was done to measure the usefulness of routine CBC in a university hospital, they found that up to 11% of routinely ordered CBC results are abnormal but less than 1% of results require management change. [Ruttimann, 1992] In another study which was done on internal medicine department in a university hospital, where routine CBC was ordered in almost 55% of patients admitted, results changed the management plan in only 0.6% of all patients. [Frye, 1987]

Although insurance companies cover most of the costs on behalf of patients, we found that an excess cost of around \$43.1 per patient per day from routine over-investigation, a cost that would be preventable if a wiser approach of test ordering is adopted. This excess cost also acts as an unnecessary burden on national health care budget. [Khalifa, 2014] According to the World Bank report in 2013 about Jordan, 9.13

% of the governmental spending went to the healthcare system. [Tamimi, 2014] Therefore; a potential for better utilization of the budget lies in reducing the unnecessary routine laboratory tests. Previous studies also showed that over-investigation can induce anemia and can increase mortality, [Vincent, 2002] where a previous study showed that iatrogenic anemia can occur to patients from routine labs orders during their period of admission. [Thavendiranathan, 2004] Another study analyzed investigations that were done among internal medicine inpatients and found that almost two thirds of investigations were ordered after the first day of admission did not contribute to the diagnosis. [Miyakis, 2006]

There are several practices that can reduce over-investigation, firstly, e by increasing the awareness of residents and other trainees and alerting them about the value of investigations , also the harms of over investigations, an intervention that need to be repeated continuously to observe a sustained effect. [Rhyne, 1979] Secondly, by executing a weekly review of medical records to develop a specific guideline for medical conditions, where trainees should adhere with the guidelines. This intervention is shown to be effective in lowering the excess cost, but it causes an increase in labour demanding. [Fowkes, 1986] And Finally, by displaying computer alerts with tests that were ordered repetitively, a message that can be as simple as a notice of repetition, to display the cost burden on the patient from repetitive testing. [Tierney, 1990] This intervention is shown to be effective in reducing over-investigation by a constant fraction, and it should be implemented in almost every university hospital.

This study has several limitations. First, as a pilot study, it only included a small sample size,

although this helped us in following daily clinical data for all patients included. Moreover, we did not assess the adverse effect of over-investigation. The lack of agreement about what is considered appropriate laboratory testing between literatures is an additional complication. [May, 2006]

### Conclusion

According to our definition to over-investigation, we found a large cost of over-investigation in several internal medicine

departments. We also found a significant variation in the type of test that can be considered as over-investigation. Future studies should consider assessing other investigations were done routinely, including chest X-ray, electrocardiogram among others, and compare these investigations between departments.

### Conflict of interest:

The authors declare that there are no conflicts of interest.

**Table 1:** Details regarding the average excess cost per day and the total excess cost for each gender and for each group of duration are in Dollars.

		Average cost per Day (\$)		Total cost (\$)	
		Mean	Standard Deviation	Mean	Standard Deviation
Gender	Male	39.43	17.71	696.07	694.60
	Female	46.26	31.36	564.16	413.90
Duration (days)	<10	37.85	28.14	279.42	204.23
	11-20	61.26	22.17	815.26	265.33
	>21	34.03	15.83	1042.23	809.13

**Table 2:** Details regarding the average excess cost per day and the total excess cost for each department are in Dollars.

		Average cost per Day (\$)		Total cost (\$)	
		Mean	Standard Deviation	Mean	Standard Deviation
Department	Hematology	63.45	32.20	660.97	390.13
	GI	30.47	20.02	634.84	309.34
	Neurology	29.82	19.82	363.15	447.54
	Respiratory	42.99	18.21	854.77	1002.59
	ID	33.62	8.24	711.37	604.37
	Nephrology	33.53	7.37	864.21	861.60
	Cardiology	32.64	23.71	322.12	344.58

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## التكلفة الزائدة للفحوصات المخبرية اليومية الروتينية بين أقسام الطب الباطني في مستشفى الجامعة الأردنية: دراسة تجريبية

حسين حمدان الحوري<sup>1\*</sup>، خالد العويدات<sup>2</sup>، حنا مخامرة<sup>3</sup>، سيف الدين الريالات<sup>4</sup>، وسام ابو زيد<sup>5</sup>، مؤيد عزام<sup>6</sup>، لارا العبدلات<sup>6</sup>،  
عماد العبدلات<sup>7</sup>

1. قسم الباطنية العامة، كلية الطب، الجامعة الاردنية.
2. استشاري الأمراض الصدرية، قسم الباطنية العامة، كلية الطب، الجامعة الاردنية.
3. استشاري أمراض القلب، قسم الباطنية العامة، كلية الطب، الجامعة الاردنية، عمان، الاردن.
4. مقيم في قسم طب العيون، كلية الطب، الجامعة الاردنية.
5. مستشفى الجامعة الأردنية، عمان، الاردن.
6. كلية الطب، الجامعة الاردنية، عمان، الاردن.
7. استشاري الطب الشرعي، كلية الطب، الجامعة الاردنية، عمان، الاردن.

### الملخص

**المقدمة:** أصبحت الفحوصات المخبرية النشاط الطبي الأعلى حجمًا، وهذا نتيجة لاعتماد الأطباء عليها. يطلبونها حتى في الحالات التي تعتبر فيها غير ضرورية سريريًا وليس لها أي تأثير على رعاية المرضى وعلاجهم. احد الممارسات التي تؤدي إلى "الإفراط في طلب الفحوصات" هي "الفحوصات الروتينية"، والتي تؤدي إلى تكلفة زائدة سواء ماليًا أو في جوانب أخرى. وبالتالي، فإن الغرض من هذه الدراسة هو التحقيق في ممارسات طلب الفحوصات المخبرية الروتينية بين أقسام الطب الباطني في مستشفى الجامعة الأردنية، لتحديد مقدار وتكلفة الفحوصات المخبرية الروتينية غير الضرورية المطلوبة.

**أساليب:** قمنا بمراجعة بيانات 30 مريضاً تم قبولهم لمدة 5 أيام على الأقل، ممن تزيد أعمارهم عن 18 عامًا، وغير الحامل من النساء في أقسام الطب الباطني المختلفة (الجهاز التنفسي، أمراض الدم، الجهاز الهضمي، الأمراض المعدية، أمراض الأعصاب، أمراض الكلى وأمراض القلب). من خلال المعايير التي وضعتها الدراسات المنشورة مسبقًا، و تخبر الاطباء الاستشاريين في قسم الباطنية العامة، قمنا بحساب تكلفة الفحوصات المخبرية الزائدة لجميع المرضى الذين استوفوا المعايير المذكورة أعلاه خلال فترة زمنية مدتها شهر واحد.

**النتائج:** كان متوسط عمر العينة 57.3 سنة، موزعة بين الاقسام المختلفة. كان متوسط التكلفة الزائدة لكل مريض في اليوم 43.1 دولار (25.8±). يتراوح من 0 إلى 103.3 دولار، مع عدم وجود فرق بناء على العمر او القسم  
استنتاج: هناك إمكانية لخفض تكلفة الدخول إلى المستشفى من خلال التقليل من هذه الفحوصات المخبرية الزائدة و غير الضرورية، ولكن هناك حاجة إلى مزيد من الدراسات ذات أحجام عينة أكبر، فضلاً عن دراسات لتقييم التكلفة غير النقدية الناتجة عن الإفراط في الفحوصات المخبرية.

الكلمات الدالة: فحص الدم، التكلفة، اجراء روتيني