



# Changing the electronic request form proves to be an effective tool for optimizing laboratory test utilization in the emergency department



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## ABSTRACT

**Objectives:** Appropriate laboratory utilization more often than not needs to be initiated by the laboratory. This study was performed to analyze the impact on test ordering patterns in the emergency department obtained by omitting certain tests from the electronic tick box request form. The tests could still be ordered by writing the full name of the test or by a phone call.

**Methods:** Erythrocyte sedimentation rate (ESR), fibrinogen, aspartate aminotransferase (AST), calcium and lipase were omitted from the electronic request form and could subsequently be ordered either by phone or a typed-in request. A reflex testing protocol was elaborated for reduction of creatine kinase (CK) and CK-MB analyses. All interventions were introduced with prior consultation with clinical staff and according to current guidelines. The reduction of test orders and costs in the post-intervention period was assessed. All data were retrieved retrospectively from the laboratory information system (LIS).

**Results:** Disappearance from the tick box request form resulted in a significant decrease in the number of requests for targeted tests in the post-intervention year, mostly affecting AST and fibrinogen (83% and 79% reduction of ordering, respectively), followed by a 58% reduction in calcium orders, and 54% and 43% reductions in ESR and lipase requests, respectively. A substantial reduction in CK requests was also observed, while CK-MB requests almost disappeared. Annual cost savings that emerged from all implemented interventions were estimated to be 19,445€.

**Conclusion:** Significant reduction in ordering of selected tests was achieved simply by limiting their availability in hospital computerized order entry (COE) system. The present data suggest that removal of laboratory tests from the electronic request form can be an effective tool for changing physicians' test ordering behavior.

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## 1. Introduction

Appropriate utilization of laboratory testing is considered to be the key issue of the pre-preanalytical phase [1]. Due to increasing pressure on reducing healthcare costs while continuously improving the quality of service and patient management, optimal laboratory utilization is becoming an ever-growing concern among

laboratory experts [2]. Although overutilization is most common, optimization of laboratory testing does not necessarily mean reduction in the number of tests ordered but rather orientation toward justified and adequate test requisition [3,4]. Selective and patient-oriented laboratory testing is the prerequisite not only for efficient patient management but also laboratory cost-effectiveness [4–6]. It is clear that involvement of laboratory experts in this process is essential. In the so called 'volume to value' transition era, laboratories no longer serve just as a nameless silent service but are becoming increasingly involved in the proper selection of laboratory tests, thus contributing to the quality of patient care [7–9].

In an effort to rationalize, it is of utmost importance to get active real time insight into physicians' ordering practices and identify the key problems. This information serves as the cornerstone for implementation of demand management strategies which might include various educational and administrative interventions [3,9,10]. These tools are classified as weak, moderate and strong, depending on the strength of their impact on the reduc-

**Abbreviations:** ESR, erythrocyte sedimentation rate; AST, aspartate aminotransferase; CK, creatine kinase; CK-MB, creatine-kinase MB; LIS, laboratory information system; COE, computerized order entry; IT, information technology; ED, emergency department; ALT, alanine aminotransferase; GGT, gammaglutamyl transferase; LD, lactate dehydrogenase; CRP, C-reactive protein; CBC, complete blood count; PT, prothrombin time; aPTT, activated partial thromboplastin time; NTproBNP, N-terminal pro-brain natriuretic peptide; HIS, hospital information system; hs-Tn, high-sensitive troponin; ULRR, upper limit of the reference range; TAT, turnaround time.

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tion of inappropriate testing [3]. Education-based approach, which includes informative lectures referring to relevant and evidence-based guidelines, is considered a weak but crucial tool in an ongoing maintenance of a successful laboratory–clinician cooperation. However, it inevitably needs to be coupled with other interventions. On the other hand, interventions of moderate and strong effectiveness imply a more rigorous approach and are usually incorporated in the laboratory and/or hospital information system. Possibilities are different and depend on the nature of the problem. They include various restrictions in the test ordering process such as ordering algorithms and reflex testing, privilege ordering principles and limitation or complete removal of test availability. Despite the variability of intervention principles, they all have the same ultimate goal of systematic guidance toward a more appropriate laboratory patient management [3,4,6,11,12]. There is evidence that application of various interventions simultaneously is more effective than a single one [3].

Emergency laboratory is a unique entity in the laboratory setting where a selection of urgent tests is available for fast, reliable and accurate management of critically ill patients. According to available data, inappropriate and excessive laboratory ordering practices are especially common in the emergency department (ED) [1,13–15]. The underlying causes mostly speculated are defensive medicine, scarce knowledge of diagnostic accuracy of laboratory tests and lack of cost-awareness among physicians [1,3,6,13,15,16]. Due to all these factors, it seems well worth the effort to introduce utilization restrictions in the emergency laboratory.

We hypothesized that ready availability of all tests on the request form at our institution enhances the use of laboratory testing, both in routine and in emergencies. We identified the emergency laboratory setting as an area for optimizing laboratory test utilization given the persistent, rather uniform traditional ordering habits present among physicians in our ED.

The focus of our intervention were mainly obsolete tests that are nowadays replaced by more specific ones and/or the ones that are crucial only in a limited number of conditions in critically ill patient management.

To specify, erythrocyte sedimentation rate (ESR) is a test of limited utility nowadays according to published data, remaining helpful in the diagnosis and management of a few specific conditions usually not being treated within the ED [17]. Similarly, CK and CK-MB are severely outdated tests in the management of suspected acute coronary syndrome, especially since the introduction of high-sensitive troponin tests [18].

Alanine aminotransferase (ALT) and aspartate aminotransferase (AST) are traditionally and de facto incorrectly called 'liver function tests' and are usually ordered together [19]. Although their utility is often intertwined, ALT is known to be a more specific indicator of liver disease [19–21]. Therefore, we deemed it justified to limit AST availability on the request form.

Fibrinogen analysis in the ED is important in a few specific clinical conditions, the most significant being management of trauma hemorrhage. Its widespread determination in the ED is, therefore, of questionable clinical utility and not recommended [22,23].

Calcium is another test we believed reasonable to focus our efforts on. Although hypocalcemia is known to be a common finding in critically ill patients [24,25], it was demonstrated that its levels rarely affect treatment in the ED [26]. Furthermore, replacement therapy has not demonstrated to improve patient outcome [24].

Finally, although lipase appears to be a more specific test than amylase for diagnosis of acute pancreatitis [27], we considered it justifiable to reduce its tick box availability in our laboratory setting due to almost uniformly coupled ordering with amylase and its higher price.

In this study, we presumed that omitting selected tests in the electronic request form and thus introducing the obligation of

ordering those tests by phone or by writing the name of the test in the field for comments at the bottom of the request form will significantly reduce their utilization. This type of soft approach appeared feasible both from our point of view and after discussing it with lead physicians in charge of the ED. It was jointly assumed that it might be an efficient way of discouraging mindless test requesting but still obtaining all the test results if necessary.

The aim of the present study was to assess the impact of restrictive changes in the electronic request form on ordering selected tests and the appropriate cost reductions achieved.

## 2. Materials and methods

### 2.1. Setting

This study was conducted at the emergency laboratory of the Department of Laboratory Diagnostics, University Hospital Center Zagreb. This emergency laboratory operates within the premises of the Department of Emergency Medicine and provides laboratory diagnostics for outpatients admitted to the ED. The laboratory operates on 24/7 basis, performing approximately 0.5 million tests/year, which corresponds to about 200 patients per day. The laboratory test panel includes routine biochemistry (glucose, creatinine, urea, aspartate aminotransferase (AST), alanine aminotransferase (ALT), gamma glutamyltransferase (GGT), lactate dehydrogenase (LD), total and direct bilirubin, sodium, potassium, chlorides, calcium, ethanol, creatine kinase (CK), CK-MB, C-reactive protein (CRP), alpha amylase in plasma and urine, lipase), hematology (complete blood count (CBC), erythrocyte sedimentation rate (ESR)), coagulation (prothrombin time (PT), activated partial thromboplastin time (aPTT), fibrinogen, D-dimers), immunochemistry tests (troponin T and NTproBNP) and urinalysis.

Laboratory tests are ordered through an electronic tick box request form in the hospital information system (HIS). After sample delivery to the laboratory, the request is transferred to the laboratory information system (LIS).

### 2.2. Study design

This study represents a retrospective analysis of test requests in the emergency laboratory over a period of three years (from 2013 to 2015), compared to the year before interventions were made (2012). IT-based interventions were, as explained previously, implemented in the computerized order entry (COE) form. The tests that were omitted from the electronic request form were ESR, AST, calcium, lipase, fibrinogen, CK and its cardiac isoenzyme (CK-MB). All interventions were introduced after thorough discussion and in agreement with key physicians in charge of the ED. An informative notification was disseminated to the entire clinical staff prior to introduction of each intervention.

The course of implementation of interventions and the type of interventions are outlined in Table 1.

Specifically, the ready availability on the electronic request form was limited for ESR, fibrinogen, AST, lipase and calcium but all these tests remained available by phone call from physicians to the laboratory staff or by writing the name of the test in the field for comments at the bottom of the request form. Furthermore, an automatic IT-based reflex testing protocol within the laboratory was elaborated for reduction of CK and CK-MB testing, as shown in Fig. 1. Nevertheless, these tests could also be requested regardless of the reflex testing protocol if urged by physician.

### 2.3. Data collection and analysis

The following data were obtained for the studied years (2012, 2013, 2014, 2015): the number of patients admitted to the emer-

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