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Original article

Improving laboratory test ordering can reduce costs in surgical wards

Davide Giordano[1], Michele Zasa[2], Corrado Iaccarino[3], Vincenzo Vincenti[4], Isabella Dascola[5], Bruno Carlo Brevi[6], Tiziano Gherli[7], Maria Gabriella Raso[8], Giovanna Campaniello[9], Patrizia Bonelli[10], Antonella Vezzani[11]

[1] Surgery Department, Otorhinolaryngology Unit, Arcispedale Santa Maria Nuova-IRCCS, Reggio Emilia, Italy; [2] Clinica Mobile nel Mondo, World Motorbike Championship (Moto GP & WBSK) Medical Division, Parma, Italy; [3] Emergence-Urgency Department, Neurosurgery-Neurotrauma Unit, University Hospital of Parma, Parma, Italy; [4] Head and Neck Department, Otorhinolaryngology Unit, University Hospital of Parma, Parma, Italy; [5] Neuroscience Department, Neurosurgery Unit, University Hospital of Parma, Parma, Italy; [6] Head and Neck Department, Maxillofacial Surgery Unit, University Hospital of Parma, Parma, Italy; [7] Cardio-Nephro-Pulmonary Department, Cardiac Surgery Unit, University Hospital of Parma, Parma, Italy; [8] Surgery Department, Anaesthesiology, Critical Care and Pain Medicine, University Hospital of Parma, Parma, Italy; [9] Hospital Governance Department, University Hospital of Parma, Parma, Italy; [10] Pathology and Laboratory Medicine Department, University Hospital of Parma, Parma, Italy; [11] Cardio-Nephro-Pulmonary Department, Cardiac Surgery Intensive Care Unit, University Hospital of Parma, Parma, Italy

Summary. *Background and Aim* Laboratory blood tests for hospitalized patients are often overused. Excessive costs and no proof of benefit suggest re-evaluating the current approach to laboratory test ordering. The aim of the study is to improve the decision-making process of test ordering and to investigate what effect a rational, evidence-based use of laboratory test ordering in surgical wards would have on costs and healthcare resources. *Methods* Three-phase experimental prospective study carried out at the tertiary referral teaching hospital of Parma. Phase 1 (baseline status). The baseline status of laboratory test ordering was evaluated by recording the number of biochemical tests requested for patients undergoing elective surgery. Laboratory tests were grouped in "recommended" (RT) and "non recommended" (nRT) tests on the basis of pertinent literature. Phase 2 (improvement action): new guidelines were introduced into clinical practice. Phase 3 (feedback): Prospective data collection for first and second feedback was performed with no advance notice. *Results* A highly significant reduction in test ordering was found on occasion of the phases 2 and 3 of the study. The overall number of tests decreased, largely due to a decrease in the use of nRT. *Conclusions* Analysis was justified by the fact that most test requests proved not to be supported by clinical evidence. Inappropriate ordering of laboratory tests results in an unnecessarily high number of requests, which do not in turn improve patient management. Moreover, more appropriate, evidence-based laboratory test ordering for patients undergoing elective surgery may produce a significant reduction in costs, particularly in high-cost settings. (www.actabiomedica.it)

Key words: healthcare costs, laboratory test ordering, surgical wards

Introduction

Laboratory blood tests for hospitalized patients are often overordered. In high-cost settings such as intensive care units, patients undergo an even greater number of tests, which accounts for 10% - 25% of total hospital bills in the United States (1). Some authors have suggested that laboratory blood tests are overused (2,3). Multiple strategies have been proposed in an effort to improve appropriateness in laboratory test

ordering in order to reduce the number of unnecessary tests. Moreover, effects of evidence-based laboratory test ordering on healthcare costs are not yet fully understood.

There is ongoing debate regarding the appropriateness of laboratory test ordering in surgical wards. According to the National Institute for Clinical Excellence (NICE), a more accurate clinical evaluation of patients undergoing elective surgery may contribute to decreasing the number of unnecessary tests, thus reducing healthcare costs (4). On the other hand, it must be noted that a relevant portion of healthcare costs may be caused by cancellation or postponement of scheduled surgical interventions on the day of surgery itself because the preoperative clinical evaluation is incorrect due to the lack of tests (5). Moreover, an inappropriately high number of tests may result in an increased number of reports for each patient often requiring additional preoperative specialist consults. This may potentially increase the time from the patient's preoperative evaluation to surgery thereby potentially increasing the number of postponed patients at the time of surgery.

There may be large differences in an intensive care unit concerning the amount of resources available to each physician for managing critically ill patients. However, more resources may not be associated with a shorter length of hospital stay or a lower mortality rate (6). Excessive costs, potential risks, and no proof of benefit suggest re-evaluating the current approach to laboratory test ordering in surgical wards. We performed an experimental prospective study whose aim was to improve the decision-making process of test ordering and to investigate the effect of a rational, evidence-based use of laboratory test in surgical wards on laboratory test ordering and healthcare costs.

Patients and Methods

The study was approved by the Unified Human Research Committee of Parma. Written informed consent was waived because the guidelines were construed as part of the quality assurance process in surgical wards. Data were analysed in an anonymous form.

This study is a three-phase (baseline status, improvement action, feedback) experimental prospective study carried out at the tertiary referral teaching hospital of Parma, Italy, from June 2009 to June 2010. Surgical wards enrolled in the study were divided into four classes, on the basis of the grade of surgery according to the classification of the NICE guidelines (4), as follows:

- Minor and intermediate surgery wards: otorhinolaryngology, maxillofacial surgery.
- Major and major plus surgery wards: neurosurgery, neurotrauma, cardiac surgery.

All these wards share the same anaesthesiology service. General surgery units of our hospital were not included in the study because they have a different anaesthesiology unit, which did not participate in the study.

Before the month of June 2009, laboratory tests had been requested by surgeons, anaesthesiologists, and consultants according to their best judgment. In surgical wards there were no clear indications regarding the request of laboratory biochemical tests to be requested for patients undergoing elective surgery. Moreover, physicians had been in the habit of ordering multiple laboratory tests bundled together as "biochemical organ profiles" (i.e. renal, hepatic, metabolic, cardiac, and/or nutritional profile), without indicating the name of the single test. When nurses inserted the order into the hospital electronic database they checked all the groups of tests exploring a specific function, thus causing a potentially inappropriately high number of requests.

Phase 1 (baseline status). The baseline status of laboratory test ordering was evaluated by recording the number of biochemical tests requested to the laboratory by each surgical ward included in the study during the month of June 2009 for patients undergone elective surgery. For each ward the number of exams considered has been calculated as the sum of preoperative tests performed as outpatient prior to admission and postoperative tests requested during the hospital stay. During the same month, pertinent literature was identified through a computerized search of MEDLINE database. Then, new local guidelines for laboratory biochemical tests ordering were written by a local ten-member consensus working group composed of two anaesthesiologists, one biochemist, six surgeons, and one medical administrator.

New local guidelines included the following main points:

- The practice of bundling multiple laboratory tests together was strongly discouraged.
- It was emphasized that each test should be ordered only in the context of probabilities of disease rather than as a generic search of abnormal values to be corrected.
- Each ward should examine its own laboratory test ordering practice yearly in order to monitor and highlight inappropriate prescriptions that may be targeted for improvement actions.

Preoperative laboratory biochemical tests for patients undergoing elective surgery were grouped in "recommended" (RT) and "non recommended" (nRT) tests, assessing for each test the reimbursement cost to the hospital by the Public Health System (Table 1). The choice of considering the single test as RT or nRT was made on the basis of the pertinent literature (4,5,7). Laboratory tests not included in guidelines were considered RT on the basis of consensus of the working group. Laboratory tests identified as RT were considered always appropriate, while nRT should be requested on the basis of a specific clinical query.

Phase 2 (improvement action): new guidelines were introduced into clinical practice in wards included in the study starting in July 2009.

Phase 3 (feedback): Prospective data collection for first and second feedback was performed with no advance notice by the medical administrator of the hospital during the months of December 2009 (first feedback) and June 2010 (second feedback).

The effects of improvement action were evaluated by comparing the number and the cost of RT and nRT ordered before and after the introduction of the new guidelines in each group of wards enrolled in the study. The control group was represented by the number of biochemical tests ordered in each ward during the month of June 2009, before the introduction of new guidelines. For each phase of the study, data reviewed were the number of surgical procedures performed and the number of postponed patients at the time of surgery.

Results were expressed as the difference in the mean per-patient number and cost of RT and nRT, before and after improvement action, in the two groups of wards identified above.

Analysis of data was performed using the chi square test or the ANOVA test, as appropriate.

Statistical significance was defined as a $p < 0.05$.

Results

The number of elective interventions in surgical wards included in the study during the period of the study is reported in Table 2.

Table 1. Laboratory tests with the relative cost calculated as the charge reimbursed to the hospital by the Public Health System

RT		nRT			
Test (n)	Reimbursement (€)	Test (n)	Reimbursement (€)	Test (n)	Reimbursement (€)
Complete Blood Count	4.00	Creatine kinase-myoglobin	3.70	Creatine kinase	1.95
Glucose	1.30	Myoglobin	7.60	Inorganic phosphorus	1.60
Blood urea nitrogen	1.25	Troponin	16.35	Iron	1.55
Creatinine	1.25	HDL Cholesterol	1.85	Transferrin	5.15
Sodium	1.25	Uric acid	1.25	Magnesium	1.70
Potassium	1.25	Bilirubin, direct	1.55	Chloride	1.25
Bilirubin, total	1.25	Proteins	1.25	Amylase	2.45
Aspartate aminotransferase	1.15	Albumin	2.60	Lipase	3.20
Alanine aminotransferase	1.15	Gamma glutamyltransferase	1.25	Ferritin	9,10
Pseudocholinesterase	1.55	Alkaline phosphatase	1.40	Cholesterol, total	1.15
		Lactate dehydrogenase	1.25	Triglycerides	1.30
				Calcium	1.25

RT: Recommended Test; nRT: non Recommended Test

Table 2. Number of elective interventions in surgical wards during the months of June 2009, December 2009, and June 2010

Minor and Intermediate surgery				Major and Major plus surgery			
	June 2009	December 2009	June 2010		June 2009	December 2009	June 2010
Maxillo-facial surgery	42	45	48	Neurosurgery	44	53	52
Otorhinolaryngology	84	113	85	Neurotrauma	35	29	25
				Cardiac surgery	37	68	55
Total	126	158	133		116	150	132

Table 3. Number and cost of preoperative laboratory biochemical tests ordered during the months of June 2009, December 2009, and June 2010

		Test (n)			Cost (€)		
		June 2009	December 2009	June 2010	June 2009	December 2009	June 2010
Minor-Intermediate	RT	1,917	2,042	1,678	2,960	3,178	2,577
Surgery	nRT	2,110	1,676	1,332	3,923	3,332	2,369
	Total	4,027	3,718	3,010	6,883	6,510	4,946
Major-Major plus	RT	2,861	3,294	2,815	4,396	5,073	4,252
Surgery	nRT	3,460	1,629	1,442	6,925	3,420	2,575
	Total	6,321	4,923	4,257	11,321	8,493	6,827

RT: Recommended Test; nRT: non Recommended Test

Number and cost of RT and nRT laboratory biochemical tests ordered in each surgical ward during the months of June 2009, December 2009, and June 2010 are shown in Table 3.

Per-patient number and cost of RT and nRT laboratory biochemical tests ordered in the surgical wards included in the study during the months of June 2009, December 2009, and June 2010 are shown in the Tables 4 and 5.

A highly statistically significant reduction in the mean per-patient number and cost of RT and nRT, compared to the month of June 2009, was observed in December 2009 and in June 2010 in all a surgical wards included in the study. The overall number of tests decreased, largely due to a decrease in the use of nRT. It must be made clear that, while not recommended, they may have been indicated on a case by case basis. The number of postponed patients at time of surgery was: one in June 2009, one in December 2009, and none in June 2010. Statistical significances are shown in Tables 4 and 5.

Discussion

In the present study the introduction of local guidelines in clinical practice for the preoperative evaluation of patients undergoing elective surgery pro-

Table 4. Per-patient number and cost of laboratory biochemical tests ordered in Minor and Intermediate surgery wards during the months of June 2009, December 2009, and June 2010

	June 2009		December 2009		June 2010	
	Tests (n)	Cost (€)	Tests (n)	Cost (€)	Tests (n)	Cost (€)
RT	15.21 (47.6%)	23.49 (43.0%)	12.92 (54.9%)*	20.11 (48.8%)*	12.62 (55.7%)*	19.38 (52.1%)†
nRT	16.75 (52.4%)	31.13 (57.0%)	10.61 (45.1%)*	21.09 (51.2%)†	10.02 (44.3%)*	17.81 (47.9%)*
Total	31.96	54.62	23.53	41.20	22.64	37.19

RT: Recommended Test; nRT: non Recommended Test;* $p \leq 0.001$ vs June 2009; † $p < 0.005$ vs June 2009

Table 5. Per-patient number and cost of laboratory biochemical tests ordered in Major and Major plus surgery wards during the months of June 2009, December 2009, and June 2010

	June 2009		December 2009		June 2010	
	Tests (n)	Cost (€)	Tests (n)	Cost (€)	Tests (n)	Cost (€)
RT	24.66 (45.3%)	37.89 (38.8%)	21.96 (66.9%)*	33.82 (59.7%)†	21.33 (66.1%)†	32.21 (62.3%)†
nRT	29.83 (54.7%)	59.70 (61.2%)	10.86 (33.1%)*	22.80 (40.3%)†	10.92 (33.9%)*	19.50 (37.7%)*
Total	54.49	97.59	32.82	56.62	32.25	51.71

RT: Recommended Test; nRT: non Recommended Test;* $p \leq 0.001$ vs June 2009; † $p < 0.005$ vs June 2009

duced a significant reduction in costs for RT and nRT in all the wards considered. Moreover, this reduction was achieved without increasing the number of postponed patients at time of surgery. Other authors have reported an excessive use of laboratory testing, with a potentially negative effect on the quality and costs of patient care (2,3,8).

A greater reduction of costs was registered in major and major plus surgery wards. This may be due to an earlier more casual attitude towards prescribing examinations based more on surgical complexity than on the clinical severity of the patient.

Enhancing the appropriateness of biochemical test ordering is a major goal of quality improvement, with many strategies available that can be used in order to promote quality and reduce costs of patient care (9,10). As reported by Ezzie (7), many practitioners in our study as well proved to be unaware of the cost of each biochemical test. We believe that providing such cost data to clinicians may promote a change in behaviour towards test ordering. However, the major concern of clinicians in reducing nRT ordering was the reduced ability to detect physiologic abnormalities.

We performed the present analysis on the basis of the results of a clinical audit that was performed at the Intensive Care Unit of the tertiary referral teaching hospital of Parma, Italy, in 2007 (11). As reported by others (12), that clinical audit allowed us to detect the problem easily and to asses its dimension.

Guidelines developed on the basis of the published literature allow us to stay abreast of the most effective testing strategies and to critically estimate test performance characteristics. Various studies have reported that a marked reduction in test ordering occurring soon after an improvement action has not lasted over time, with test ordering often returning to higher preintervention levels over a short period (13,14).

In our study, a sharp reduction in test ordering occurred three months after the introduction of local guidelines; this reduction was still present at the time of the second feedback ten months later. The overall number of tests decreased, largely due to a decrease in the use of nRT. This suggests that behaviour towards laboratory test ordering might have been structurally modified as a result of the intervention. Despite the fact that this significant reduction in the number of RT and nRT tests was registered after the amelioration actions, the number of RT tests remained high. This suggests inappropriate or overuse of these tests on a per-patient basis. We explain this finding by the fact that it is hard to change physicians' prescription attitudes. Some physicians think that more tests may have a protective effect with regard to legal issues. Some authors have suggested that the most effective program in facilitating long-term changes should involve interventions addressed to a range of behavioural factors and incorporate an environmental or administrative intervention (14-16).

Our intervention, implemented in order to reduce unnecessary laboratory tests, was developed as part of the quality process in surgical wards. Although it required the participation of physicians and nurses and the support of administrators, our improvement action did not incur any additional costs to the hospital because all the data were derived from the hospital database. This study has some limitations. We conducted the analysis on biochemical tests only, blood gas analysis, and blood coagulation tests were not considered. Moreover, we cannot rule out that some physiologic abnormalities may not have been detected due to re-

ductions of tests although we did not find any major clinical adverse effects on preoperative evaluation in patients undergoing elective surgery.

Laboratory test ordering activity was analysed on a per-patient basis rather than a per-case as the initial aim of the study was to investigate the effect of a rational, evidence-based use of preoperative laboratory test in surgical wards on laboratory test ordering and healthcare costs, regardless of the type of surgical procedure.

We introduced local guidelines in our setting on the basis of the pertinent literature.

Nevertheless, practitioners should bear in mind that each setting has its own characteristics. This implies not only that guidelines have to be adapted to each setting, but that each institution should adopt any tool that can better achieve and maintain laboratory test ordering appropriateness over time.

In conclusion, the analysis performed in this study was justified by the fact that most test requests proved not to be supported by the clinical evidence. Inappropriate ordering of laboratory biochemical tests results in an unnecessarily high number of requests, which do not in turn improve patient management. Moreover, more appropriate, evidence-based laboratory test ordering for patients undergoing elective surgery may produce a significant reduction in costs, particularly in high-cost settings such as major and major plus surgery wards.

Repeated audits, continuing education, and awareness of physicians should be promoted in each setting in order to achieve a stable and significant reduction in the number of unnecessary biochemical test requested.

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Correspondance:
Davide Giordano MD,
Otorhinolaryngology Unit, Surgery Department,
Arcispedale Santa Maria Nuova-IRCCS,
viale Risorgimento 80, 42100 Reggio Emilia, Italy
Tel. 0039 0522 296273;
Fax: 0039 0522 295839
E-mail: Davide.Giordano@asmn.re.it