In Reply to The Environmental Impact of Inappropriate Clinical Laboratory Testing: What's New?

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TO THE EDITOR:

We thank Dr. Valdenassi and colleagues for their interest in the intriguing subject of appropriateness in laboratory medicine. We appreciate the opportunity to delve deeper into the main objective of our review, namely the limitless exploration of (in)appropriateness outcomes at the levels of the "3Ps" resources (i.e., patient, planet, and profit). As highlighted by Valdenassi et al. in their letter, we focused on the benefits of reducing unnecessary testing, as underuse is less extensively addressed in the current literature and there is an inherent challenge in quantifying the consequences of unprescribed tests. A recent analysis of 7379 diagnosis errors associated with serious harms (53.0% death) showed clinical judgment factors as the main driver (85.7%) (1). These factors include 5 items, including failure or delay to order a diagnostic test and misinterpretation of diagnostic studies (1). Moreover, a comprehensive meta-analysis revealed that underuse was twice as prevalent as overuse (2), a rate later confirmed by hemostasis-focused studies (3). Some typical examples of underuse in hemostasis testing include lack of D-dimer testing in patients with low clinical probability of venous thromboembolism (which may lead to unnecessary pulmonary angiography), underuse of lupus anticoagulant testing (which may generate a missed diagnosis of antiphospholipid syndrome), and underuse of anti-PF4/heparin antibodies (which may lead to a missed diagnosis of heparin-induced thrombocytopenia).

We basically agree with Valdenassi et al. in stating that a clear definition of inappropriate testing is essential. In our view, the appropriateness of testing must be established on evidence-based guidelines, which are unfortunately lacking in specific tests or clinical situations. Some evidence-based expert opinions are emerging in the literature, representing a reliable basis for defining appropriateness (3) and for implementing guidelines-based interventions (4). By reviewing interventions to reduce inappropriate testing in the intensive

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Table 1. Proposed quality indicators for evaluating the performance of interventions to improve appropriateness in laboratory medicine, classified by level of feasibility.

Output	Quality indicator	Measurement	Unit	Level of feasibility	Level of relevance	Remarks
Environmental	Consumables management	Number of tubes spared per year	Plastic mass/year or €/year → eCO_2	High	High	Either theoretical or data from logistics software
Environmental	Reagents management	Number of reagents spared per year	€/year → eCO_2	High	High	Either theoretical or data from logistics software
Economic	Consumables management	Number of tubes ordered	€/year	High	High	
Economic	Reagents management	Number of reagents ordered	€/year	High	High	
Patient care	Hospital-acquired anemia	Blood volume harvested by patient	mL/patient	High	High	Theoretical
Patient care	Rate of transfusion	Blood volume transfused per year	L/year	High	Moderate	Influenced by other variables
Methods	Ordering panel use	Number of analyses prescribed through ordering panels	Number/defined time interval	Moderate	High	Depends on the computerized order entry software
Methods	Ordering panels review	Number of analyses prescribed before and after panels review	Number/defined time interval	Moderate	High	Depends on the laboratory information system Expressed by analysis, by department, or by clinician
Methods	Gatekeeping	Number of analyses prescribed before and after implementation	Number/defined time interval	Moderate	High	Depends on the laboratory information system
Environmental	Energy management	Energy use	kwh/year → eCO_2	Moderate	Moderate	Depends on institutional management, i.e., the granularity of institutional consumption to focus on the laboratory
Environmental	Water management	Water use	m3/year → eCO_2	Moderate	Moderate	Depends on institutional management, i.e., the granularity of institutional consumption to focus on the laboratory

(continued)

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Table 1. Continued

Output	Quality indicator	Measurement	Unit	Level of feasibility	Level of relevance	Remarks
Economic	Energy management	Energy use	kwh/year → €/year	Moderate	Moderate	Depends on institutional management, i.e., the granularity of institutional consumption to focus on the laboratory
Economic	Water management	Water use	m^3/year → €/year	Moderate	Moderate	Depends on institutional management, i.e., the granularity of institutional consumption to focus on the laboratory
Patient care	Length of stay	Average length of hospitalization in days	Days/patient/year	Moderate	Low	Often available at a later time point; influenced by too many other variables
Patient care	Rate of rehospitalization	Rehospitalization rate	% of patients/year	Moderate	Low	Often available at a later time point; influenced by too many other variables
Patient care	Mortality	Yearly death rate	% of death/year	Moderate	Low	Often available at a later time point; influenced by too many other variables
Staff well-being	Staff workload	Hands-on time	Hours/year	Low	High	No optimal method for precise evaluation
Economic	Staff workload	Hands-on time	Hours/year → €/year	Low	Moderate	No optimal method for precise evaluation

care unit, we found that half mentioned a guidance-based strategy rooted in local expert consensus (4). However, a closer examination of the different guidance revealed significant discrepancies, highlighting that it is time for more evidence and harmonization in laboratory tests decision-making. A better understanding of this underuse of existing guidelines would be valuable for improving their quality and strengthening the supporting evidence. To this end, we call for a better multidisciplinary collaboration between clinicians and laboratory specialists in designing guidelines. Diagnostic workup could be more patient-valuable when the laboratory receives clinical information (e.g., development of demand-management strategies such as laboratory diagnostic algorithms), and interpretation of test results could be more accurate with the skills of laboratory specialists (3, 5). Regarding the comment on our intersection of safety, financial costs, and environmental impact

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of inappropriateness, clear boundaries cannot be defined as these dimensions are deeply interconnected, needing a holistic approach to fully assess their combined effects.

In terms of environmental impact, Valdenassi et al. highlight the oversimplification of comparing laboratory test CO_2 emissions with car travel distance. However, this enables the visualization of the carbon impact of some laboratory tests at a glance, even if obtaining more accurate analyses would certainly be interesting. The 2024 overall emissions of our 936-bed academic center were recently estimated using the Bilan Carbone® method of the French Agency for Ecological Transition. Greenhouse gas emissions have been mainly assessed on the basis of monetary conversion factors. The scope of the evaluation excludes inbound and outbound freight, travel and fugitive emissions, and analysis sent to referral laboratories. According to this evaluation, the laboratory is responsible for the production of 4260 tons of CO_2 (4% of total emissions), divided into reagents (54.8%), medical devices (8.3%), drugs (0.1%), waste management (0.5%), services purchases (14.4%), goods purchases (1.5%), energy (4%), and fixed assets (16.3%). The average CO_2 emission per test (n = 15 321 041) and per year is estimated at 279 g in our academic center.

Finally, although quantitative quality indicators are essential for assessing the effectiveness of any intervention, they remain underrepresented in the literature. Table 1 outlines several quantitative key performance indicators based on their outcomes, feasibility, and relevance. Their specific objectives and monitoring frequency should be defined according to each local policy of quality policy.

In summary, appropriateness is a current challenge for laboratory specialists, supported by official bodies such as the European Federation of Clinical Chemistry and Laboratory Medicine. The team of authors of our original review highlights the multistakeholder process to promote value-based healthcare. We hope that these clarifications will serve as a basis for further investigation into (in)appropriate laboratory testing.

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