Opinion Paper

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Point-of-care testing, near-patient testing and patient self-testing: warning points

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Abstract: Point-of-care testing (POCT), near-patient testing (NPT) and patient self-tests (PST) are diagnostic examinations performed at the time and place of patient care. While POCT and NPT are performed and analyzed by medical professionals, PST are based on samples and parameters directly collected and analyzed by lay users. These tests are spreading both in high income countries and in low to middle income countries as they are expected to improve healthcare efficiency and equity, by saving resources, releasing pressure from hospitals and reducing logistical barriers. However, accurate multidisciplinary assessment is mandatory to ensure that what they promise is real. We reviewed some important ethical aspects, international standards and regulations. The current risks associated with alternative ways of testing are explained by the principles of respect for patient autonomy and non-maleficence. Further evidence from multidisciplinary assessment is needed to evaluate pros and cons in light of the principles of beneficence and justice. Although POCT or NPT need common regulation and accurate provider training to ensure safe and appropriate interpretation of results, PST needs even more attention as they are subject to direct patient use. Randomized controlled trails including patient education should be conducted in order to provide reliable evidence on clinical outcomes, patient acceptance and cost-effectiveness. Mandatory regulation is needed to avoid harm and EU regulation should help different countries maintain a safe use of devices in a global population of producers and users.

Keywords: ethics; near-patient testing; patient self-testing; point of care testing; quality; safety

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Introduction

Point-of-care testing (POCT), near-patient testing (NPT) and patient self-tests (PST) are diagnostic examinations performed at the time and place of patient care. While POCT and NPT are performed and analyzed by medical professionals, PST are based on samples and parameters directly collected and analyzed by lay users. POCT and NPT differ from traditional diagnostic procedures as they employ basic devices able to provide results without traditional laboratory mediation, in order to spare time and/or cover underserved healthcare areas (i.e., rapid antigen tests, infectious disease testing, finger-prick samples or rapid cardiac marker diagnostics). PST differs from traditional diagnostic procedures, POCT and NPT as they provide results to patients or care givers used to know some basic parameters of a certain disease they have to monitor without recurring every time to a medical professional or a healthcare facility again. In doing so, basic devices (i.e., a pulse oximeter, a blood pressure monitor or flash glucose monitoring) can be employed in ordinary settings (at home, at work, at school, or on vacation).

These tests are spreading both in high income countries and in low to middle income countries as they are expected to improve healthcare efficiency and equity, by saving resources, releasing pressure from hospitals and reducing logistical barriers. One of the first randomized controlled trials comparing PST to traditional, hospital-based diagnostics dates back to 2005, showing positive evidence in support of the former and acceptance in the majority of trained patients [1], soon followed by consensus guidelines [2]. Additional boost was given by the COVID pandemic on these methodologies [3, 4], requiring a systematic evaluation of their use in ordinary conditions [5].

In this paper, we review some important ethical aspects intertwined with technical, clinical, economic, organizational, and societal issues in order to support dedicated procedures of Health Technology Assessment (HTA) and warn investors, payers, policymakers and final users of the few but meaningful risks they need to be aware of. These aspects are focused under the lens of the four classical principles of biomedical ethics [6] and current international standards and regulations.

Respect for patient autonomy

PST technically offers the highest level of patient autonomy, as patients can check their parameters wherever they are, increase therapy compliance, keep their status monitored, and minimize the rate of adverse events and complications. The experience of diabetics self-controlling glucose concentration is a clear example of how these technologies completely change the healthcare journey and the ordinary lives of patients. Patients are freed from continuous healthcare facilities and are allowed to comply with therapy while performing the activities they consider more relevant, which is a direct way of increasing autonomy. Considering the high functional value of attending school, work, and possibly leisure and sport activities to the psychophysical and social wellbeing of individuals, these technologies offer a further, indirect opportunity to enhance patient autonomy. Considering how many chronic patients need ongoing help by formal or informal caregivers (i.e., relatives of elderly patients or parents of younger patients) just to move to the healthcare facilities and be texted, the societal value of these procedures becomes even higher.

However, proper training of direct users (PST) is crucial in making these benefits possible and avoiding harm, as there is no autonomy without the ability to understand information correctly [7]. Indeed, the inaccurate interpretation of test results (either when directly accessible to the patient, or when made available by operators with low-to-no expertise on instruments and characteristics of laboratory tests) can cause several problems:

- Anxiety concerning single abnormal values, regardless of an overall assessment of patient health status and history;
- Inappropriate use of instrumentation, possibly inducing abnormal and/or incorrect values;
- Inappropriate preparation of the patient and/or the specimen, possibly inducing abnormal and/or incorrect values;
- Inappropriate preparation of the patient in sensitive circumstances, such as communicating the diagnosis of a severe disease, as not all operators could have the skills and experience doctors should have in front of patients and caregivers;
- Wrong interpretation of data, possibly inducing inappropriate additional investigations and treatments (the diagnostic cascade);
- Inappropriate recommendation towards users' relatives to undergo certain examinations in turn (e.g., because of their biological linkage): this is particularly dangerous in the case of genetic tests (including the so-called genetical predictors) and infectious disease antibodies;
- Inappropriate neglect of pathological values, which may happen more easily in absence of systematic database reporting; this again is particularly dangerous in case of genetic tests and sexually-transmitted disease antibodies;
- Clinical waste in charge of the payer;
- Additional pressure on the healthcare system, causing implicit rationing mechanisms in turn.

Misunderstandings among clinicians, patients, and caregivers should also be prevented by sharing clear and binding chronic care pathways, as patients may think they are more independent than they actually are. For instance, Continuous Glucose Monitoring devices (CGM) entered routine clinical monitoring of type 1 diabetic patients, minimizing hypoglycemic episodes, complying with insulin therapy, and sparing finger pricking capillary blood [8, 9]. The confidence in CGM is very high, but clear agreements are needed to maintain as much as possible autonomous use within a safe and monitored pathway, involving the patient, his/her parent or caregiver (consider minor patients, unprepared patients, and patients with cognitive limitations), the physician and/or the healthcare organization.

Beneficence

PST enables patients to seek care before acute episodes occur, and POCT also reduces the time between data collection and release, potentially enhancing compliance with outpatient therapy and reducing the length of hospital stay (e.g., when reaching a certain parameter is necessary to allow patient discharge). These hypotheses foster the perception of a clear beneficial use.

However, such potential benefits need be carefully balanced against the risks of lay users taking decisions on their own, in case of PST. In case of POCT, the real impact on the healthcare process is not sufficiently studied when implemented into a medical pathway or surgical procedure, while a complete HTA should be performed, including the

dimensions of safety across the pathway (inpatient or outpatient), efficacy in clinical trials, and effectiveness in context [10]. Therefore, the real beneficence of these technologies and procedures depends on the specific settings in which they are employed, either because safe professional monitoring supports them, or because they provide a better alternative to the absence or impracticality of traditional diagnostic instruments. For instance, when the latter need too much time to provide life-saving information, in presence of possible heart attacks [11], drug abuse [12], allergens, infections [13], blood clotting and ischemia [14]. Other general occasions, which make POCT appropriate to use, include:

- Absence or unavailability of a central laboratory performing traditional tests;
- Absence of tests consistent with the instrumentation available in the clinical laboratory;
- Unavailability of preanalytical recommended procedures needed to store biological material correctly.

Non-maleficence

Instruments quality, use, and proper collection of biological material require technical control to minimize unintended outcomes, imprudent decisions, clinical management, variation or neglect of at-risky conditions. This is why lay persons should be careful to rely on them for medical decision-making [15]. Moreover, unnecessary testing and treatment could be encouraged by doctors, healthcare services or industrial producers, including commercial purposes, despite data safety is lacking and proper patient follow-up in case of abnormal results is not yet warranted [16].

Performing diagnostic tests without the intervention of a laboratory expert can put clinicians in the position of prescribing the repetition of examinations, incrementing preventable iatrogenic harm (i.e., blood losses) [17], costs (either at the expense of patients or third parties) and healthcare attendance to patients and caregivers. Professional laboratory control of tests should be made mandatory even in outpatient settings, adopting open, common databases for experts and practitioners.

Laboratory experts should also verify the input and output of artificial intelligence programs developed to help interpret POCT-resulting data in order to minimize patient harm and reduce analytical errors [18, 19].

Justice

POCT, or self-tests, are expected to improve access for the whole population, especially in underserved areas such as low- and middle-income countries (LMIC), developing countries, rural areas, and areas served by underqualified professionals [20, 21]. Therefore, it is reasonable to infer that these procedures can improve justice.

However, there are several aspects to consider:

- POCT and self-tests are not necessarily cheaper than traditional centralized testing in clinical laboratories [22];
- more accessible tests to the population lead to greater costs in charge of the third payer, which means in turn more opportunity costs to consider, namely other treatments denied or provided later to other patients in National Health Services;
- the cost of maintenance of technology and of continuous supply of reagents, which is probably higher in low- and middle-income countries or remote areas in wealthier countries.

Once alternative methods prove as effective as traditional tests, more economic, and better access will be granted, and allocative justice evaluations will become more reliable and precise [23, 24].

In particular, chronic patient self-testing needs robust evidence in support of efficacy and cost-effectiveness, O'Kane et al. concluded in their review on diabetes (type 1 and 2), kidney function, thrombosis prevention and further developments (chemotherapy, rheumathoid arthritis and gestational diabetes) [9]:

(a) preferably obtained from randomized controlled trials than from observational studies,
(b) including patient education in the intervention.

Meanwhile, alternative testing should be proposed only when central clinical laboratory testing is not possible, it is not available, or it is not able to face a sudden increase in some tests [25].

Standard and regulations

There are different applications in different countries for patient-self testing. Listing all of them is beyond the scope of this work and could be the topic for a systematic review.

Common standards and regulations have been introduced by international institutions to minimize risks at the moment of writing. The International Organization for Standardization (ISO) set two guidelines to cover the application of POCT/NPT while further information was released by the European Union to cover *In Vitro* Diagnostic Regulation (IVDR) and PST procedures.

For what concerns POCT

- ISO 22870:2016 required these tests to be applied in hospitals, clinics and by a healthcare organization providing outpatient care, excluding patient self-testing in a home or community setting [26]; ISO 15189:2022 included, confirmed and replaced the standard beforementioned, foreseeing gradual implementation of the updated measures within December 2025 [27];
- ISO/TS 22583 provided guidance for supervisors and operators where POCT is performed without medical laboratory training, supervision, or support, including the key components that should be considered to provide safe and reliable results, describing qualified supervisor requirements, training operator requirements, and excluding self-testing [28].

For what concerns patient self-testing, EU Regulation 2017/746 [29] stated in

- Annex I, Chapter II rules about "protection against the risks posed by devices intended for self-testing or near-patient testing", requiring
  - These devices "shall be designed and manufactured in such a way that they perform appropriately for their intended purpose", taking into account the skills and the means available to the intended user;
  - The information and instructions provided by the manufacturer shall be easy for the intended user to understand and apply in order to correctly interpret the result provided by the device and to avoid misleading information;
  - In the case of near-patient testing, the information and instructions provided by the manufacturer shall make clear the level of training, qualification, and/or experience of the user:
- Annex I, Chapter III distinguishes among three groups of users, each of whom needs specific instructions for use, namely
  - Patients for self-testing;
  - Laboratory personnel;
  - Healthcare professionals.

Conclusions

The current risks associated with alternative ways of testing are explained by the principles of respect for patient autonomy and non-maleficence. Further evidence from multidisciplinary assessment is needed to evaluate pros and cons in light of the principles of beneficence and justice.

POCT needs appropriate professional training to interpret the results and communicate them to patients. In case these results are interpreted with the support of artificial intelligence, laboratory experts should verify the input and output. Common EU regulation should be adopted at this purpose, along with eligibility criteria being established by the healthcare authority on which procedures can be performed outside hospitals, with or without the involvement of laboratory professional, and to what extent.

PST need even more attention as direct patient use substantially increases risks. Patients need accurate training to use the devices they are given correctly, and healthcare professionals in turn need training to train patients accurately. Moreover, maintaining the autonomous use of these devices within a safe and monitored pathway may be more difficult to achieve in practice than to recommend in theory.

Randomized controlled trails including patient education should be conducted in order to provide reliable evidence on clinical outcomes, patient acceptance and cost-effectiveness. Mandatory regulation is needed to avoid harm and EU regulation should help different countries maintain a safe use of devices in an increasingly global population of producers and users.

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