Short Communication

Preanalytical mistakes in samples from primary care patients

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Abstract

Background: Preanalytical mistakes (PAMs) in samples usually led to rejection upon arrival to the clinical laboratory. However, PAMs might not always be detected and result in clinical problems. Thus, PAMs should be minimized. We detected PAMs in samples from Primary Health Care Centres (PHCC) served by our central laboratory. Thus, the goal of this study was to describe the number and types of PAMs, and to suggest some strategies for improvement.

Methods: The presence of PAMs, as sample rejection criteria, in samples submitted from PHCC to our laboratory during October and November 2007 was retrospectively analysed.

Results: Overall, 3885 PAMs (7.4%) were detected from 52,669 samples for blood analyses. This included missed samples (n = 1763; 45.4% of all PAMs, 3.3% of all samples), haemolysed samples (n = 1408; 36.2% and 2.7%, respectively), coagulated samples (n = 391; 10% and 0.7%, respectively), incorrect sample volume (n = 110; 2.8% and 0.2%, respectively), and others (n = 213; 5.5% and 0.4%, respectively). For urine samples (n = 18,852), 1567 of the samples were missing (8.3%).

Conclusions: We found the proportion of PAMs in blood and urine samples to be 3-fold higher than that reported in the literature. Therefore, strategies for improvement directed towards the staff involved, as well as an exhaustive audit of preanalytical process are needed. To attain this goal, we first implemented a continued education programme, financed by our Regional Health Service and focused in Primary Care Nurses.


Keywords: blood sampling; mistake detection; preanalytical mistakes; primary health care.

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At present, all issues related to patient safety are considered to be “hot” topics. From the publication of the 1999 report by the US Institute of Medicine "To err is human: building a safer health system", both the mass media and scientific community have paid increasing attention to these issues (1, 2). In this context, detection of problems such as preanalytical mistakes (PAMs) that might cause misdiagnosis, must be given high priority, as these mistakes may greatly influence clinical decision-making (3). Within the different stages of the analytical process (preanalytical, analytical and post-analytical), it is necessary to stress the importance of the preanalytical stage, since PAMs may account for 46%–68% of all laboratory errors seen in routine samples (4–6), and in up to 93% in samples coming from emergency areas (7).

We detected a high number of PAMs in samples received from Primary Health Care Centres (PHCC) served by our central laboratory, most of these resulting in rejection of the sample by the laboratory staff. Therefore, the development of corrective strategies to reduce PAMs must be given priority, and the very first step should be an understanding of the actual magnitude of the problem.

The goal of this research was to perform a retrospective analysis of a prospectively built database to assess the number and types of PAMs in samples from PHCC (both blood and urine samples) arriving at the general laboratory of the University Hospital “Virgen de la Victoria”. This laboratory serves a total of 14 PHCC (8 at the Sanitary District of Málaga Centre, and 6 at the Sanitary District of Guadalhorce), providing primary health care to 300,000 people.

This laboratory receives an average of 25,800 blood samples and 9100 urine samples per month. Samples are obtained by the attending nurses at the PHCC and processed at one of the following laboratory sections: Haematology (complete blood count, basic coagulation, and length of sedimentation reaction in blood (LSRB)), Clinical Analyses (serum biochemistry, protein electrophoresis and urine analyses) and Clinical Biochemistry (immunology, tumour markers and hormones). For simplicity, PAMs detected in blood samples were grouped into Haematology (blood counts, LSRB and coagulation) and Biochemistry (remaining analytical determinations).

After approval by the Institutional Ethics and Clinical Research Review Board, all samples and laboratory request forms received at the laboratory from PHCC during October and November 2007 were checked for preanalytical errors. The study period was considered suitable since it did not include holiday periods (Summer, Christmas, Easter) where the presence of covering staff might influence the study...
results. Identified PAMs were expressed as incidence and the percentage of total samples, and classified as follows: 1) Missed sample (MS): any specimen not enclosed with the physician’s order (because patient did not attend the appointment, the sample was not drawn, or it was missed during transportation); 2) Haemolysed sample (HS): any blood sample showing haemolysis; 3) Inappropriate volume of sample (IVS): any blood sample with an excess or deficit of the exact requested volume (e.g., more blood than needed in samples for coagulation tests or blood counts when test tubes are filled with a syringe instead of a vacuum system); 4) Coagulated sample (CS): samples with clotting detected before or during the analytical process; and 5) Other errors (OE): any other cause of sample rejection not included in above categories (e.g., lipaemic samples, choloric samples, broken test tube, wrong test tube for the requested parameter, etc.). The presence of free haemoglobin in serum was detected automatically by spectral absorbance (405 nm), together with lipids (700 nm) and bilirubin (452 nm), and rated 1–6 according to Haemolysis-Icteric-Lipaemic (HIL) index in samples for biochemistry (information provided by the manufacturer, Dimension RXL Max, Siemens, Newark, IL, USA). An if-then value comparison of erythrocyte counts and mean concentration of corpuscular haemoglobin level was used for automatic detection of HS in the haematological cell counters (information provided by the manufacturer; Pentra 120 Retic, Horiba-ABX, Montpellier, France). Haemolysis was also detected visually following centrifugation of samples for coagulation testing, and after sedimentation in samples for LSRB. Slightly HS were not rejected, but the presence of haemolysis was indicated in the laboratory report. Samples were rejected whenever they presented one or more PAMs.

Overall, there were 3885 PAMs causing sample rejection detected in 52,669 laboratory request forms and/or blood samples from the PHCC received in the central laboratory during the study period (7.5%). With respect to laboratory sections, 2480 (9.9%) errors were detected in 24,958 samples for Biochemistry, while 1405 (5.1%) errors were detected in 27,711 samples for Haematology. These 3885 PAMs correspond to samples from 3534 patients; i.e., PAMs affected more than one sample from some patients. However, only six samples were rejected because of double errors.

During the study period, 1567 PAMs were detected in 18,852 laboratory request forms and/or urine samples (8.31%), all of them corresponding to MS. The distribution of the different types of errors for each section is shown in Table 1.

Most PAMs were attributable to human error (6, 8), implying that its origin should be detected and the correcting activity should be structured accordingly. This fact accounts for the high proportion of MS for urine tests. The rejection of a sample in the laboratory involves a number of inconveniences, including the collection of a new sample from the patient and the delay in patient care, resulting in both patient and staff disappointment (9). One serious error regarding patient safety that is due to the release of test results to wrong patient (10). Fortunately, such an error (typically post-analytical) was not detected during the study period at our institution.

These issues, which are crucial for the management of clinical laboratories, are considered as key issues for achieving our laboratory targets. For this purpose, it is essential that clinical managers in the laboratory and PHCC develop strategies for the detection of PAMs and implement appropriate corrective measures. In addition, a large number of samples are collected from PHCC in rural areas. Thus, there is the possibility that samples are rejected because the transportation time exceeds analyte stability for some tests (e.g., coagulation tests and LSRB). Although this was not a primary objective of our study, we did not detect problems with respect to delays in sample transportation to the laboratory (<2 h according to the transportation protocol) or with incorrect storage conditions (6°C–8°C).

Some experts have highlighted the importance of evaluating these areas in order to improve the quality of medical care, with special emphasis in the collaboration between PHCC and the hospital laboratories (11). Therefore, detection of errors at an early stage helps prevent unnecessary health risks, and avoids repeat visits to the healthcare facility (12–14). Both

<table>
<thead>
<tr>
<th>Blood samples</th>
<th>Urine samples</th>
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<tbody>
<tr>
<td><strong>Samples, n</strong></td>
<td><strong>Total</strong></td>
</tr>
<tr>
<td><strong>Error type, n (%)</strong></td>
<td></td>
</tr>
<tr>
<td>MS</td>
<td>755 (3.02)</td>
</tr>
<tr>
<td>HS</td>
<td>1407 (5.64)</td>
</tr>
<tr>
<td>IVS</td>
<td>98 (0.39)</td>
</tr>
<tr>
<td>CS</td>
<td>7 (0.03)</td>
</tr>
<tr>
<td>Others</td>
<td>213 (0.85)</td>
</tr>
<tr>
<td><strong>Total errors</strong></td>
<td>2480 (9.93)</td>
</tr>
</tbody>
</table>

Values are given as numbers (% of all samples). MS, missed samples; HS, haemolysed samples; IVS, incorrect volume sample; CS, coagulated sample; others, lipaemic sample (n = 153), choluric sample (n = 42), broken test tube (n = 5), wrong test tube (n = 13).
aspects adversely affect the patients’ welfare. With this aim, we studied the incidence and types of errors resulting in sample rejection by the laboratory. We observed that, as for blood samples from the hospital areas (15–17), it is the section of clinical biochemistry where the higher number of PAMs were detected (Table 1). In addition to MS, HS was the most frequent PAM in biochemistry. In contrast, CS was the most frequent PAM in haematology. In addition, PAMs related to urine samples were frequent (all of them MS), and as urine samples are analysed in the biochemistry section, this obviously contributes to the higher rate of PAMS in this section (Table 1).

As stated above, the rate of PAMs observed in this study is in agreement with those reported by us and others for urgent samples from different hospital areas (15,16), for which the effectiveness of a strategy for correction was seen (17). Thus, the following query was derived from this research: Which was the cause for such a high number of PAMs? The answer to this apparently simple question is complex indeed. A number of different professionals with different education and training, interest, and work habits are involved in the preanalytical stage (3, 15, 16, 18). Therefore, it is necessary to deal with this situation integrally, and with the correct structure involving different professional disciplines.

For the purpose of attempting to solve this problem, we have developed an educational programme. Since more than half of PAMs were MS, the first stage consists of a number of clinical sessions directed towards the PHCC nurses who are responsible for collecting samples. The topics covered by these sessions include 1) general aspects of blood sample collection, 2) sources of errors in blood samples for haematological and pre-transfusion tests, 3) most frequent problems in samples for clinical biochemistry tests, 4) consideration for special laboratory tests: clinical pharmacology, microbiology and genetics, and 5) collection of microbiological samples: problems and solutions. This strategy has proven to be useful when applied to hospital nursing staff (17). In addition, the recognition of the importance of quality control in the preanalytical phase of venous blood sampling has been reported before (19).

However, our aim is to involve other professional staff in order to more easily resolve this problem. We are now working in this direction. Among other measures, we intend to make an analysis in terms of errors and their consequences. This might allow us to determine the most critical steps of the total testing process, and redesign those activities that would provide correction or minimisation of mistakes. It is necessary to keep working to involve professionals from the laboratory and other areas in order to adopt a culture of safety that is implemented at all levels of the organisation (11, 20).

Conflict of interest statement

The authors declare that neither they have received or will receive funding or support nor they have been employed by an organisation that may in any way gain or lose financially from the results of their study. The authors also declare that they do not have any conflict of interest in regard to the content of this paper.

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