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Knowledge, attitudes and practices of caregivers and laboratory agents on the pre-analytical phase of haematological analyses in Burkina Faso

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ABSTRACT

The pre-analytical phase of biological analyses is critical as it registers the most errors encountered within the testing process. This study aimed at assessing the knowledge, attitudes and practices of healthcare workers on the pre-analytical phase in haematological laboratory. A cross-sectional study using an auto-administered questionnaire and direct observations of haematological analyses' prescribers, blood samples and laboratory staff were conducted from June to August 2020. The questionnaires were designed to gather the socio-professional characteristics, knowledge and attitudes of participants. The observation grids were focused on their practices in haematological analyses requesting, blood samples drawing, transportation and reception at the laboratory. A total of 388 respondents were included. Their average seniority in the profession were 11.4 ± 3.8 years and 13.6% received refreshing training in the last three years. All the laboratory agents, 94.1% of analyses' prescribers and 76% of blood samplers had good knowledge and attitudes. Moreover, 83% of the request forms, 29.2% of blood samples collection, transportation and 74.8% of blood specimens' reception at the laboratory were rated good. This study reported some inadequate knowledge, attitudes and practices in the pre-analytical phase that call for reinforcement of basic and continuing trainings and implementation of rigorous technical procedures.

Keywords: Haematological analyses, laboratory request form, blood specimen sampling, Ouagadougou.

INTRODUCTION

Medical biology is an essential diagnostic aid-tool in modern medicine, as it provides reliable and accurate results. Indeed, clinician counts sometimes on the laboratory results for proper diagnosis and treatment of patient (Shoaib et al., 2020). For a long time, laboratories have focused their efforts on eliminating or reducing errors in the analytical phase before realizing that the quality of laboratory analyses do not only depends on the analytical procedures. Indeed, it is demonstrated that the pre-analytical phase is critical as it registers the most errors (up to 84.5% according to studies) encountered within the total testing process (Wiwanitkit, 2001; Sharma, 2009; Shoaib et al., 2020). The pre-analytical phase refers to the physiological

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conditions of the patient and the management of its specimen from their collection to the time of analysis. This phase consists of several stages beginning with the request of medical laboratory diagnostic by the physician and including patient preparation, sample collection, handling, transportation, processing and storage until the analysis (Magnette et al., 2016). This phase is specific and complex. It includes procedures that are not totally under the control of the laboratory personnel staff and are mostly performed outside the laboratory (Green, 2013). In addition, it comprises many manual procedures that cannot be fully automated. Problems can arise in the clinical ward or in the specimen sampling area (this is the external pre-analytical phase) or within the laboratory (the internal pre-analytical phase).

The main issues of the pre-analytical phase may consist in sample misidentification, use of inadequate container, incorrect order of draw, prolonged tourniquet placing, incorrect use of additive solutions, collection of unsuitable samples for quality (e.g. contaminated, haemolysed, clotted, leaked, … samples) or quantity (e.g. insufficient volume, inappropriate blood-to-anticoagulant ratio), inappropriate mixing of a sample, inadequate temperature or delay in transportation, inadequate sample preparation (e.g. delay in centrifugation, inappropriate speed and centrifugation duration) or storage (Magnette et al., 2016; Alavi et al., 2020). The consequences on patient care could be important such as incorrect diagnostic and therapeutic decisions, since clinical laboratory results affect up to 60–70% of clinical decisions (Rattan et Lippi, 2008). Delay in treatment or additional health costs can occur in 13-25% of cases or severe impact on patient care in another 5-25% of cases. In terms of cost, pre-analytical specimen errors represent 0.23 to 1.2% of total hospital operating costs (Green, 2013). In the United States, medical errors are considered to be the 8th cause of death, higher than motor vehicle accidents, cancer and AIDS (Nichols, 2005). In haematology laboratory and transfusion medicine, comprehensive statistics reported a rate of "wrong blood in tube" in 337 per million of specimens and the overall chance that a patient might receive a blood product intended for another patient is approximately 1/20,000 (Lippi et al., 2009). Globally, 40-50% of blood transfusion morbidities result of patient or blood component misidentifications (Green, 2013).

In view of the above, the skills of all parties involved in the process of the medical biology are crucial for the quality of the medical laboratory results. To date, no study has covered the whole process of the pre-analytical phase in haematology in Burkina Faso. Also, this study aimed at assessing the knowledge, attitudes and practices of caregivers and laboratory staff on the pre-analytical phase of haematological analyses in three teaching hospitals in Ouagadougou, Burkina Faso.

MATERIALS AND METHODS

Study settings

The study was conducted in the Yalgado Ouedraogo University Hospital Centre (CHUYO), the Charles De Gaulle Paediatric University Hospital Centre (CHUP-CDG) and the Bogodogo University Hospital Centre (CHUB), all located in Ouagadougou, the capital of Burkina Faso. A combined cross-sectional study using an auto-administered questionnaire and direct observations of the healthcare workers practices was performed from June to August 2020.

Questionnaire survey concerned three groups of healthcare workers i.e. the biological analyses' prescribers (physicians and medical students), blood samplers (nurses, medical and nursing students, laboratory technicians) and laboratory staff (Pharmaceutical and biological students, laboratory technicians). At least 100 participants were expected per group. Three auto-administered questionnaires (one questionnaire for each group) were designed to gather data on study participants' socio-professional characteristics (professional qualification, seniority in the position and in the profession) and their knowledge and attitudes. The questions were structured around the prescription of haematological exams, blood sampling, blood specimens handling,

transportation and reception at the laboratory. The questionnaires were distributed hand-to-hand to the healthcare workers present on the day of the survey and they answered and rendered the completed questionnaire on site.

An observation grid was used to appreciate healthcare workers' practices, with focus on haematological analyses request forms, the procedure of blood sampling at the patient bed or in the laboratory and the quality of samples received at the laboratory.

Each correct answer or practice, was scored 1 point and 0 if not. Thus, auto-administered questionnaires were scored of 23, 19 and 17 points and the observation grids 10, 9 and 6 points respectively for biological analyses' prescribers, blood samples and laboratory agents. Knowledge, attitudes and practices were considered to be "poor" for a score under 50%, "fair" for 50% to 75% and "good" for a score over 75%.

Statistical analysis

The data was entered on Epi-info 7 and exported to Stata 15 software for cleaning and analysis. Knowledge, attitudes and practices of each category of healthcare workers were described using mean ± standard deviation of the score obtained and the frequency of responses.

Ethical considerations

The anonymity, confidentiality and integrity of the study participants were respected. They all gave informed consent prior to the survey. A restitution of the results of the study was made to the managers of the concerned departments for corrective actions.

RESULTS

Baseline characteristics of questionnaire respondents

Out of the 450 questionnaires distributed, responses from 388 healthcare workers were received, represented a participation rate of 86.2%. The majority of respondents were female and the sex ratio (male/female) was 0.88. The study population consisted of physicians, biologists, nurses, laboratory technicians, and medical, pharmaceutical, biological and nursing students involved in the pre-analytical phase of laboratory analyses. The average seniorities were 11.4 ± 3.8 years in the profession and 2.9 ± 1.4 years in the position. Table 1 reports the baseline characteristics of study respondents.

Knowledge, attitudes and practices of the study participants

The average score of knowledge and attitudes of the healthcare workers was 11.3 ± 3.3 for blood specimens' samplers, 12.8 ± 2.3 for laboratory agents and 17.2 ± 3.7 for biological analyses' prescribers. The majority of agents (100% of laboratory agents, 94.1% of biological analyses' prescribers and 76% of blood specimens' samplers) had fair to good knowledge and attitudes on the pre-analytical phase of haematological analyses (Table 2). Correct knowledge and attitudes of healthcare workers on the critical stages of the pre-analytical phase varied from 98.3% to 36.8%. The proportion of correct and incorrect responses of study participants are recorded on the Table 3.

Concerning healthcare workers' practices, 83% of request forms for haematological analyses were rated good, 53.2% of blood sample collections and their handling and transportation were rated poor and 74.8% of blood specimens' controls upon receipt at the laboratory were correctly done. The main items that missed on request forms were patients' clinical information, the nature of the sample, the prescriber identity and the service that issuing the request for biological analyse. During the blood drawing, samplers failed to perform correct hand disinfection in 94.2%, to place the tourniquet correctly in 80.7%, and to respect the tubes' drawing order in 75.4%. The sample drawing hour was not mentioned in 100%. Laboratory agents correctly verified the patients' identity on the request forms and sample labels, the blood samples' quality in the majority of cases (Table 4).

Table 1: Baseline characteristics of questionnaire respondents.

Parameters	Number	Proportion (%)
Hospital		
CHUYO	172	44.3
CHUP-CDG	101	26.0
CHUB	115	29.6
Category		
Laboratory analyses' prescribers	101	26.0
Blood specimens' samplers	171	44.1
Laboratory agents	116	29.9
Gender		
Female	206	53.1
Male	182	46.9
Qualification of analyses prescribers (n = 101)		
Physicians	71	70.3
Medical students	30	29.7
Qualification of blood samplers (n = 171)		
Nurses	97	56.7
Medical and nursing students	57	33.3
Laboratory technicians	17	9.9
Qualification of laboratory agents (n = 116)		
Pharmaceutical and biological students	57	49.1
Laboratory technicians	59	50.9
Professional seniority (years)		
< 5	119	30.7
5 – 10	114	29.4
> 10	155	39.9
Seniority in the position (years)		
< 5	262	67.5
5 – 10	75	19.3
> 10	51	13.1
Training on the topic during the three last years		
Yes	53	13.6
No	335	86.4

CHUYO: Yalgado Ouedraogo University hospital; CHUP-CDG: Charles de Gaulle Paediatric University hospital; CHUB: Bogodogo University hospital.

Table 2: Overall level of knowledge, attitudes and practices on the pre-analytical phase of haematological analyses.

Agent category	Score	Knowledge and attitudes and practices level		
	Mean ± 2 SD	Bad (< 50%)	Fair (50 -75%)	Good (> 75%)
Knowledge and attitudes (n = 388)				
Prescribers	17.2 ± 3.7	6 (5.9)	34 (33.7)	61 (60.4)
Blood samplers	11.3 ± 3.3	41 (24.0)	84 (49.1)	46 (26.9)
Laboratory agents	12.8 ± 2.3	0 (0.0)	20 (17.2)	96 (82.8)
Practices of healthcare agents (n = 171)				
Prescribers	8 ± 0.7	9 (5.3)	20 (11.7)	142 (83.0)
Blood samplers	5 ± 2.0	91 (53.2)	30 (17.5)	50 (29.2)
Laboratory agents	4 ± 1.2	8 (4.7)	35 (20.5)	128 (74.8)

SD: Standard deviation.

Table 3: Some responses of the study participants about the pre-analytical phase of haematological analyses.

	Questions	Correct (n; %)	Incorrect (n; %)
Prescribers (n =101)	What are the different steps of the pre-analytical phase items?	40 (39.6)	61 (60.4)
	What are the items of the laboratory request forms?	70 (69.3)	31 (30.7)
	Indications of the common haematological analyses	57 (56.4)	34 (33.6)
	Preparation of patient for haemostasis analyses	63 (62.4)	38 (37.6)
Samplers (n =171)	How to perform the verification of patient identity	136 (79.5)	35 (20.5)
	What are the mandatory items on the patient sample label?	139 (81.3)	32 (18.7)
	Describe the technique to perform the asepsis of phlebotomy site	74 (43.3)	97 (56.7)
	Describe the conditions of blood samples handling and transportation	63 (36.8)	108 (63.2)
	How important is it to respect the required filling volume?	140 (81.9)	31(18.1)
	How do perform sample homogenization?	139 (81.3)	32 (18.7)
	What is the main difference between purple cap and red cap collection tubes?	134 (78.4)	37 (21.6)
Lab agents (n =116)	Describe the procedure for identity match verification	114 (98.3)	2 (1.7)
	Describe the procedure for checking for samples' nonconformities?	53 (45.7)	63 (54.3)
	What are the nonconformities leading to sample rejection?	68 (58.6)	48 (41.4)

Table 4: Quality of laboratory request forms, blood sampling and samples received in the laboratory.

	Parameters	Existing item or act performed	
		Yes (n; %)	No (n; %)
Prescription	Patient's identity	170 (99.4)	1 (0.6)
	Patient gender	154 (90.0)	17 (10.0)
	Patient age	151 (88.3)	20 (11.7)
	Nature of tests	161 (94.2)	10 (5.8)
	Patient clinical information	125 (73.1)	46 (26.9)
	Date of demand	142 (83.0)	29 (17.0)
	Nature of the sample	132 (77.2)	39 (22.8)
	Prescriber signature	161 (94.2)	10 (5.8)
	Prescriber identity	141 (82.5)	30 (17.5)
	Identification of health care unit	59 (34.5)	112 (65.5)
Sampling	Hand disinfection	10 (5.8)	161 (94.2)
	Compliant tourniquet placement	33 (19.3)	138 (80.7)
	Compliant tube	167 (97.7)	4 (2.3)
	Respect of the order of draw	42 (24.6)	129 (75.4)
	Sample homogenization	129 (75.4)	42 (24.6)
	Insufficient withdrawal	15 (8.8)	156 (91.2)
	Haemolysed sample	7 (4.1)	164 (95.9)
	Coagulated Sample	5 (2.9)	166 (97.1)
	Mention of sampling hour	0 (0.0)	171 (100)
Reception	Verification of samples label	166 (97.1)	5 (2.9)
	Verification of the quality of the sample	146 (85.4)	25 (14.6)
	Verification of key information on request form	156 (91,8)	15 (8.8)
	Notification of sampling receipt hour	0 (0.0)	171 (100)

DISCUSSION

The study aimed at assessing knowledge, attitudes and practices of healthcare workers in the management of the pre-analytical phase of haematology laboratory. A cross-sectional study that combined auto-administered questionnaire and direct observation surveys was conducted. Haematological analyses' prescribers, blood samples and laboratory agents from three teaching hospitals of Ouagadougou were included in the study. Less than 2/3 of haematological analyses' prescribers, 1/4 of blood samples and more than 3/4 the laboratory workers had a good level of knowledge and attitudes on the pre-analytical phase of haematological exams.

A few previous studies had already examined some aspects of biomedical analyses in Burkina Faso. Indeed, in 2019, a study reported the non-conformities encountered on laboratory request forms (Yacouba et al., 2020). Moreover, two studies on the results of the national External Quality Assessment program implemented since 2006, raised some insufficiencies of medical laboratories in Burkina Faso (Sakande et al., 2010; Sakandé et al., 2014). However, these quality assessments are more focused on the analytical phase than the pre- and post-analytical ones. Also, our study is the first to explore the entire pre-analytical phase in haematological analyses.

The limitations of the study are related to its design (auto-administered questionnaire and direct observation). In order to mitigate bias in the responses of study participants, on-site completion of the study questionnaire was applied; anything that limited the risk that participants would consult documents or the Internet to respond. But it remains possible that some agents interacted with each other when working together on the same bench or at the same position. In addition, the physical presence of the interviewer for direct observation may also influenced the behaviour of some respondents.

In order to effectively contribute to the diagnosis and treatment of patients, the medical laboratory is expected to render accurate and reliable results. Therefore, at all phases of the biological analyses, all stakeholders should be made aware, trained and adhere to the requirements. This is all the more necessary as the results of several studies shown that pre-analytical errors are closely connected to the behaviours of caregivers and laboratory agents (Adcock et al., 2018; Chavan et al., 2019). In this study, the proportion of laboratory analyses' prescribers and blood samples collectors (those in charge with the external pre-analytical phase) that had knowledge and attitudes compatible with the objective of precision and reliability of biological results were not high (60.4% for prescribers and 26.9% for samplers). Such a situation could be explained by the insufficiencies of the laboratory aspects in the training curricula of physicians and nurses in Sub-Saharan Africa. In addition, there is hardly any continuing training on this topic for these staff. Indeed, it is known that the clinical laboratory was among the weakest components of the health systems in Africa (Marinucci et al., 2011). They acquired most of their knowledge, attitudes and practices about the laboratory on the job. Only 13.6% of respondents had received refreshing training over the past 3 years and the majority (67.5%) had less than 5 years of seniority in their position.

The majority (82.9%) of the laboratory agents had good knowledge and attitudes about the pre-analytical phase. Tadesse et al. (2018) in Addis Ababa found similar results, with 36% of blood samples and 72.6% of laboratory agents which had good knowledge. Such a result probably reflects a good basic and continuing trainings of laboratory agents. A recent combined narrative review and cross-sectional study reported the existence of training curricula (initial and continuing trainings) on medical biology intended for laboratory staff; which was not the case for nurses and physicians (Koster et al., 2021). The knowledge and attitudes of blood samples and laboratory staff about the pre-analytical phase of haematological analyses were more or less in line with their practices that were rated as good in 29.2% and 74.8% respectively. Which makes sense, knowing that "*adequate practices or not on a phenomenon result from correct or erroneous attitudes that derive from good or poor knowledge on this phenomenon*" (José et Oudou, 2013).

According to ISO 15189: 2012 standards and the good medical biology practice guidelines, the request of laboratory analyses must be made by authorized and qualified personnel (Ministère de la santé, 2009; Szymanowicz, 2010). The haematological analyses' prescribers were mainly physicians (70.3%) and medical students (29.7%). They were respectively 69.3% and 56.4% to know the basic items of laboratory request form and the main haematology analyses and their indications. However, only 39.6% were able to enumerate the steps comprising of the pre-analytical

phase. This low level of knowledge on the pre-analytical phase can seriously compromises the preparation of the patient for blood sampling and hence the quality and reliability of the biological results.

The haematological analyses request forms received at the laboratory were mostly incomplete. They did not include the patient's clinical information (clinical symptoms, current treatment, specimen collection conditions …) in 26.9% of cases. A previous study conducted three years earlier in Burkina Faso found that these information were missing in 45.1% of laboratory request forms (Yacouba et al., 2020). Other studies reported missing information in 29.9% in Ethiopia (Tadesse et al., 2018), 22.7% in Ghana (Olayemi et Asiamah-Broni, 2011), 6.4 and 6.8% in Nigeria (Oladeinde et al., 2012; Adegoke et al., 2021), 19.1% in South Africa (Nutt et al., 2008) and 26.2% in Tanzania (Makubi et al., 2012). The current clinical and therapeutic information allow biologists to properly interpret the results obtained, and also to act by carrying out, if necessary, additional analyses that can provide more precision for the clinician. For 17.5% of request forms, the prescriber identity (name and contact) was not indicated and in 65.5% the requesting service was not specified. These non-conformities were higher than in those noted by Yacouba et al. (2020) (5.9% and 17.3% respectively). Some authors have also noted significant proportions of bulletins that lack this information (Oladeinde et al., 2012; Makubi et al., 2012). These shortcomings hardly allow communication between the biologist and the prescriber in order to improve the properly use of the biological results for patient care. The patient identification key information, namely patient name, gender and age were absent respectively in 0.6%, 10.0% and 11.7%. Compared to the previous study (Yacouba et al., 2020), these types of non-conformities have increased. Patients' misidentifications on the request forms or blood sample labels can lead to errors in attribution of laboratory test results with potential safety concerns for patients. For example, errors in attribution of blood group typing or problems in identifying patients can lead to transfusion accidents. Multi-centric studies on the performance of sample collection reported the proportion of wrong blood in tube about 1 per 550 to 1986 specimens (Dzik et al., 2003; Murphy et al., 2004). In addition, the absence of the age and sex of the patients on the laboratory request forms could err the interpretation of the biological results, given that the reference values depend on these anthropometric parameters. These elements are not always well understood by prescribers and they are not often made aware of their importance.

Blood sample collection and handling are critical for the quality of biological analyses. The samples must be collected by trained and authorized persons. In this study, the samplers was mainly nurses, medical and nursing students (90.1%) or laboratory technicians (9.9%). A significant knowledge, attitudes and practices gaps was noted in blood samples collection and handling. The principle of positive patient identification was not known by 20.5% of blood samplers. The procedures of hand disinfection, tourniquet placement and the tubes' drawing order were noted known in 94.2%, 80.7% and in 75.4% respectively. This could err analyses. Moreover, poor hands disinfection constitutes a source of infections associated with care and services. In Niger, Degbey et al. (2019) noted that only 27.3% of compliance for minimal hand hygiene. In addition, mirror discrepancies (absence of marital or maiden name or nickname) between the tube label and the laboratory request form in 2.3% of the samples were noted. Patient's age and sex missed on the tube label in 98.8%.

The technique of homogenization of the tubes with anticoagulant was not known by 18% of the samplers interviewed and had not been correctly carried out by 24.6% of those who were observed. The consequence of these skill shortages was manifested by the presence of coagulated (2.9%) and haemolysed (4.1%) samples. Like the homogenization of samples by successive inversion of the tube, the blood-to-anticoagulant ratio is also critical to avoid haemolysis and blood clots in samples. In the study, 18.1% of samplers interviewed had

incorrect knowledge on the importance of the blood to anticoagulant ratio and abnormal volume (insufficient or excessive) is reported in 8.8% of the samples checked. Another cause of haemolysis is poor handling and transport conditions for blood samples. Only 36.8% of the agents interviewed had correct knowledge about these conditions. Blood clot and haemolysis are major reasons for rejecting specimens in the haematology laboratory. In Ethiopia, Tadesse et al. (2018) found that haemolysis and clotting counted for 34.5% and 2.3% of blood samples rejection. For all samples received at the laboratory, the time of collection was not specified. This information is however essential for the reliability of analyses, particularly for haemostasis tests. Indeed, blood samples undergo degradation, especially when they are not stored at the right temperature. This can err the biological results (Tadesse et al., 2018; Tóth et al., 2020).

Of the 116 laboratory agents included, 49.1% were pharmaceutical and biological students and 50.9% laboratory technicians. They are authorized to receive requests and samples for biological analyses. The procedure for verifying the patient's identity on the specimen label and the request form was known by 98.3% of the agents; 54.3% did not know the elements of compliance of the samples to be checked and 41.1% did not know the main reasons for rejecting the samples. In practice, 2.9% did not check the consistency of the patient identification information, 14.6% did not check the quality of the sample and none reported the sample reception time. Such shortcomings can inevitably lead to the acceptance of nonconforming samples. If the presence of haemolysis or clot is not detected, the results of laboratory tests, especially haemostasis tests, will be completely skewed and lead to unfounded treatment decisions. The non-respect of deadlines or the use of unsuitable container for the blood collection could lead to the same results (Tóth et al., 2020).

Conclusion

The study aimed at assessing the knowledge, attitudes and practices of caregivers and laboratory staff on the pre-analytical phase of haematology analyses. This phase of the biological analyses is complex because it involves a diversity of actors and comprises many manual procedures. This study reported inadequacies of healthcare workers' knowledge, attitudes and practices for a proper management of the pre-analytical phase in haematological analyses. Indeed, deviations from good practices of laboratory analyses prescriptions, blood sampling and reception of biological samples were noted. These insufficiencies call for reinforcement of basic and continuing training of all stakeholders and the implementation of rigorous procedures to which the concerned persons adhere.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

SS, BAD and EK designated the study. SS and BAD collected and analysed the data. SS, KN, DBA, MNM and DK interpreted the results SS, NK, NMM and KD wrote the manuscript. EK supervised the entire study. All the authors approved the manuscript.

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