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The Role of Medical Laboratory Specialists and Phlebotomists in Reducing Errors and Enhancing Patient Safety

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Abstract

1. Introduction

Every phlebotomy event is an opportunity for errors. The phlebotomist is the only medical professional present during these events. The laboratory's constant goal is comprehensive services that maximize clinical utility while minimizing turnaround time. The challenge for a laboratory in today's rapid-fire environment is to proactively reduce the likelihood of errors during these events through cooperation with the healthcare units' staff, in particular, the phlebotomists.

Patient specimen collection is a delicate part of laboratory diagnosis. The importance of identification, collection and specimen processing is reinforced. While the nurse often

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plays this active role in a healthcare unit's lab orders, it is usually the phlebotomist who is actually responsible for the collection process. Some of the most common errors made during the pre-analytical phase by phlebotomists concern errors in patient preparation, collection and transport, or non-collection or insufficient volumes. However, even when these are pre-established as policy by a healthcare unit, a common mistake by nursing staff in clinical practice is adding, or misinterpreting, details different from those on the original order. The label inevitably becomes the sole means of patient identification after the collection process. Under current practice, it is quite possible to collect patient samples that are, in essence, completely unidentifiable, especially when not collected at a healthcare unit that has a patient healthcare unit number encoded on the bar code. However, these cannot completely eliminate ID errors. Just over 17% of errors weren't detected until the QA process. The study concludes that patient specimen identification errors are common but preventable.

Methods

To evaluate efforts to reduce WBIT, SCNMCL's decade-long focus on minimizing ID errors was reviewed. A significant incident involving two patients with the same last name highlighted the issue of misidentification. In response, SCNMCL mandated the use of national health insurance cards at collection sites to eliminate previous manual recording errors. Although a bar code identification system was introduced as one of three safety measures, workflow inefficiencies remained. Directors analyzed procedures in OPD and ED with flowcharts, requiring health insurance cards for verification. It was found that 480 (80%) of hospital OP codes were accurately logged, with a seven-step OPD process communicated to other hospitals. Stamp execution inefficiencies were noted in 40% of cases, indicating a need for reform. Recommendations included reorganizing requisition forms by medical record numbers and updating phelobotomists on UCCS. An automatic labeling system at phlebotomy stations decreased specimen mismatches, identifying 16 mismatches over two years. Out of 13 tests, 10 were consistent and three had discrepancies, with 29 samples from different patients. A proposed auto-verification delta check system aims to identify mismatches, recording 2,779 mismatches or unlabeled specimens after implementation

Conclusion

Patient specimen ID errors are common but preventable. A variety of process interventions was undertaken, mainly increasing automated labeling of patient specimens, and the impact of those interventions was evaluated.

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The national health insurance card was modified to contain healthcare provider and patient identification information. Phlebotomy station terminals with barcode scanners were used to scan the healthcare provider's and patient's ID cards. After sample collection, a barcode label printed automatically was attached to an empty tube. Patient demographic information and barcode labels were scanned by barcode scanner linked to the laboratory information system. Each tube's barcode corresponded to the patient requisition. As a result, patient requisition errors in clinics, a major type of error, could be checked by this system. Automated labeling systems connected to the hospital information system were gradually expanded to all phlebotomy stations in the outpatient department and emergency department. Most specimen mismatch or entirely unlabeled specimens were easily detected during laboratory receiving or accessioning, and those information errors were then corrected. The remainder of the specific/loosely unlabeled specimens would be created as what's called wrong blood in tube specimen errors. These errors are usually undetectable unless discrepancies between requisitions and test results are noticed; consequently, the computer-based delta check autoverification system for certain test items was put into use in the clinical laboratory. Inconsistent results, such as different white blood cell counts for the same patient obtained from two specimens, could often be detected. Most phlebotomy procedures were carried out by medical laboratory specialists or trained phlebotomists, and they knew that unlabeled tubes' specimens would not be accepted. The modified and automated phlebotomy tube labeling system could avoid writing errors. After a series of interventions, the most frequent kind of ID error found was unlabeled specimens, followed by specimen/requisition mismatch error and then wrong blood in tube specimens. After these interventions, the first two kinds of ID error were dramatically reduced. Currently, the national health insurance system has already been modified as described above. Swift barcode scanners are equipped with barcode printers in all medical buildings. With this barcode-assisted system, a total 22% of wrong blood in tube errors were identified in the clinical laboratory before reporting. The remaining 78% of these errors were identified by other healthcare staff, and then requests for noncoagulated blood were cancelled, prompting high-powered antibiotics for critical patients.

2. Importance of Accuracy in Laboratory Testing

To be effective and safe, medical decisions must be based on reliable information. Laboratory testing is very important in providing this information. The information quality is affected by many factors such as the test request: well formulated, correctly ordered, test results: correct, obtained by analysing an appropriate biological sample,

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analytical quality, but also related to pre-analytical (e.g., patient preparation), and post-analytical activities (e.g., reporting, interpretation, and action after the delivery of test results) and these can generate errors and poor information, which can have a serious impact on patient safety. One study has suggested that 70% of the information needed by a health care provider is made available by data generated by the laboratory. Unfortunately, not all laboratory data are correct. Laboratory medicine is currently the cornerstone of clinical diagnosis and management of patients, with significant impact on patient care, and is a high technology scientific discipline, with clinical utility for 70% of information in patient episodes. Therefore, quality concerns must be addressed carefully to ensure the appropriate use of laboratory information. To achieve this goal, it is absolutely necessary to have closed-loop monitoring, starting from the choice of the biological sample to submit to the laboratory, in order to avoid inappropriate requests, and up to the timely therapeutic actions, thanks to appropriate and timely reporting test results (Plebani, 2015).

2.1. Impact of Errors on Patient Safety

Errors in medical practice, including laboratory medicine, will inevitably result in unsatisfactory and mismanagement of patient condition. In best case, errors may go unobserved because they cause no harm. Medical laboratory specialists and phlebotomists ask to be played a crucial role in the health-care services to reduce the error and improve patient safety as it occurs at the interface between the patient and health professional. Improper method of ordering laboratory test, mishandling and wrongly labeling the patient samples are three major sources that improve chances of laboratory error and it reduces patient safety by prefers to misdiagnosis, wrong drug prescription, unrequested surgical operations, or unnecessary repeated laboratory tests (Assegu Fenta & Mohammed Ali, 2020). It is estimated that about 40–70% clinical decision are base laboratory assay results and patient laboratory testing now-a-day's drastically increasing. However, about 93% of medical actions are depending on the results of test. So, it should be quality laboratory service to the patient which is free from error in-side the laboratory or in pre and post-analytical process. Generally, the main function of the test is to provide a rapid and clinically relevant the result with regard to reasonable looking tests including the blood compatibility in medical units in relation to patient symptoms and treatment current clinical repeated lab test had long been deployed as a gold standard for each patient care routine. Of every period spent on various clinical conditions, 70-90% are instructed on the findings of laboratory tests because the different test results are anticipated to a great advantage medical support reduction and enhance up

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service. There are two major healthcare providing information and healthcare treatment services that are directly broadcasted of the patient based on laboratory support and patient are outports - they took the test of illness in order them tests word such a way that the necessarily requested tests would not be neglected (Nordin et al., 2024). Blood samples are taken as the input and the requested test type is determined from the sample image and the input image. On the other hand, the treatment of a particular patient is made predominantly basing on the results of the laboratory test and therefore, reduction and instrumental treatment including hospitals and clinics are provided. If a particular patient comes to the test with a certain symptom for the physician to be taken a refined laboratory request need to be checked which test is needed for the patient. Almost all laboratory tests of an experiment is to require some laboratory, the request will be checked to see if proper tests are requested are according to the condition of the patient. Once add-mission and discharge of a patient's sample then another professional an on their interested tests is one the for the laboratory personnel to performed the test and before performing the test the patient's sample will be checked on its label to make a sure for its unreadiness. Because label mistake of the blood samples from the patient apparently seriously affects the can work process of unneeded test repeat, missed final report, and a chance of to be mismarked of the label with other patient during the test processing, and it may also be a chance for a patient's mismarked change of drug prescription when done with the incorrect test result or final report unfounded since there was not any test performed for and this patient. Generally the label mistake by the laboratories, it's due to technician responsible personals careless ness; or unluckily, it's unlabeled the-patient finiale.

2.2. Role of Medical Laboratory Specialists in Ensuring Accuracy

The role of medical laboratory specialists has a large and essential part in the medical service provided. Their tasks begin from the draw order performed by phlebotomists to the interpretation of results based on the influence of diseases and drugs. In the preanalytical phase, the activities of phlebotomists and laboratory processors becomes vital to ensure the safety and accuracy of the examination results. Upon awareness of the lack of standardization in many processes in the preanalytical phase, efforts at various levels have been initiated to close the gap of patient treatment safety. Meanwhile, the watchful prevention efforts by the laboratory can effectively reduce the number of errors in the analytical and postanalytical testing phase. Broad multidisciplinary and interdisciplinary collaboration covering all healthcare professionals is important not to

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overlook declining performance as reflected by a complex structure of errors. Subtle errors would be identified by task-focused competency assessment (Nordin et al., 2024).

Chronic kidney disease (CKD), dialysis treatment, and kidney transplantation patients commonly require the monitoring of the concentration of numerous analytes. For the majority of clinical chemistry analytes, the number and stability of processing instructions were adequate for correct serum or plasma sample preparation in all original manufacturers' routine-primary test-tubes. Since no analyte was completely stable or separated during the blood clotting process, serum separator tubes should ideally provide an additional time delay before centrifugation. However, this approximation could not resolve either the inadequate number of processing instructions regarding the appropriate timing of sample centrifugation to allow serum or plasma clotting and/or the stability of glucose and ammonia analytes after venipuncture for the original manufacturers' standard-primary test-tubes. Furthermore, different manufacturers' nonstandardized color coding of routine-primary test-tube closures and tube stoppers has been associated with both the preparation and processing of blood tubes yielding rejected samples, mismanaged or lost request forms, and labelling problems which consequently may lead to the wrong draw order.

3. Phlebotomy Procedures and Best Practices

This review states that accurate and precise laboratory test results are dependent on properly performed phlebotomy. Phlebotomy falls within the realm of the pre-pre-analytical phase in the testing process of the laboratory. The pre-pre-analytical, pre-analytical, analytical and the post-analytical phases of laboratory medicine are described. There are pre-analytical steps that may not be performed in the laboratory and are also unlikely to be performed by laboratory personnel. Studies suggest errors mostly occur during the pre-analytical (46%-70%), followed by the post-analytical phases (4.8%-8.9%), with the fewest errors occurring in the analytical phase (21%-41.6%) of laboratory testing. The most frequent pre-analytical errors in laboratory medicine are identified as: (i) missing sample and/or test request; (ii) incorrect or missing identification; (iii) in vitro haemolysis; (iv) undue clotting; (v) use of the wrong container; and (vi) contamination from the infusion route (A. Mbah, 2014). Traditionally, the process of testing in the laboratory is divided into three contrasting yet dictionary phases: the pre-analytical, analytical and post-analytical phases. The procedure used for laboratory testing is the result of the phlebotomist, who usually draws blood. However, in current laboratory medicine, the introduction of venous collection systems by scientific apparatus makes

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phlebotomy the most automatic step in the deeply complex range of processes that comprise the laboratory testing process. As a result, any error occurring during phlebotomy prospects directly to errors in laboratory diagnosis. Phlebotomy, known as apoptome or apometome, is the cut or puncture of vein(s) by snipping or nicking. The functionality of the vein incision is to invade a vein or vein(s) in order to pull out blood, which is in the main vein system that carry on circulation venously. After drawn out, the blood may be used for various purposes, among others of which are those that could be categorized as: clinical examination technique, diagnosis, transfusion, research, and/or for treatment. Major vein(s) specifically cupped, receiving the blood into a closed-vessel served with anticoagulant/coagulant activator, and transfer it in a sealable open-vessel, therefrom could be collected in various quantities of samples differentiation and then stored up under specific condition during its requirement.

3.1. Importance of Proper Phlebotomy Techniques

Introduction: Phlebotomy and quality in the African laboratory

Phlebotomy, also called venesection or venotomy, is the incision into a vein for the purpose of drawing blood for laboratory analysis, diagnosis, transfusions and research (A. Mbah, 2014). The person who performs phlebotomy is called a phlebotomist. Accurate and precise laboratory test results depend on properly-performed phlebotomy in order to obtain high-quality specimens. Traditionally, the laboratory testing process is divided into three phases: pre-analytical, analytical, and post-analytical. Phlebotomy falls within the realm of the pre-analytical phase, and includes steps that may neither be performed in the laboratory nor undertaken by laboratory personnel.

In addition, the prevalence and rate of errors in the pre-analytical phase suggest that current health care practices inadequately address these issues. Africa's underperforming health services, characterised by unacceptably high prevalence and rate of errors, also address the quality of medical service in both the private and public sectors.

3.2. Common Errors in Phlebotomy and Their Consequences

It is known that errors in laboratory medicine occur most frequently in the extra-analytical phase of laboratory testing. The preanalytical phase, subjected to the highest vulnerability, is a major source of laboratory errors, even from 60% to 70% of laboratory errors. Phlebotomy, defined as a collection of biological specimen for analysis, is considered a process of patient diagnosis and care, in spite of being the widest surgery process. A fundamental invasive method in disease diagnosis is requested by all patients

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attending health services. The phlebotomy procedure comprises lots of steps from formulating the demand for laboratory examination to dispatch it to a laboratory. Any small variance occurring at different levels of the process cannot be without adverse effects. These adverse consequences would affect the patient, person who will make the phlebotomy process or at minimum the clinical practitioner. The introduction of the variability into the system would have direct detrimental result on the quality of the system (Nordin et al., 2024). It is a fact that the process is carried out by medical staffers owning diverse educational background including specialist doctor, emergency medical technician, intern, midwife and nurse. Aside from these, sedulous attendants, nursing lumberjacks and health technicians, in facilities where these medical personnel are not available, would have phlebotomy too, albeit infrequently. Thus, in order to reduce phlebotomy errors, phlebotomy should be delivered into the system in a standardized fashion with written instructions distributed and attainable for use in every phlebotomy unit. Moreover, it should be well-documented by being confirmed by necessitated consent. There are two key phlebotomy guidelines documents which are widely used in the whole world. One of them is "Collection of Diagnostic Venous Blood Specimens" and the other one is "WHO Guidelines on Drawing Blood: Best Practices in Phlebotomy". Some countries in Europe have drawn these principles up and either adopted those from other countries or modified and nationalized those guidelines. But, seven European countries have these guidelines. The reasons for the insufficiency of National Phlebotomy Guidelines are described variously as the existence of enough guidelines time-consuming, leadership inadequacy, or else the insufficiency of expertise in the decision drift away. In the face of the fact that the studies have showed less than optimal compatibility rate, it is necessity that the training and education activities should be performed continuously.

4. Quality Control Measures in the Laboratory

Due to the simplicity of venipuncture procedure and the accessibility of a large vein, the procedure usually leads to underestimation of the inherent risks. However, obtaining an adequate blood sample also requires familiarity with aspects of the technique, such as choosing a suitable vein, the proper positioning of the tourniquet, and the angle at which to insert the needle. These are some examples of the considerations needed in obtaining a suitable blood specimen. Standardization of the venipuncture procedure is important to ensure patient safety and that samples are suitable for medical laboratory analysis. The quality of laboratory testing has been drawn into question by the increasing adoption of important quality elements of laboratory testing.

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Participants have begun to scrutinize the problem of potentially erroneous results. It has been shown that many of the significant errors that are found can be traced back to before the analytical process begins. The implementation of apparent quality control measures in the preanalytical phase must be improved to ensure the quality of the primary specimen and reduce the risk of patient harm. Medical laboratory specialist and phlebotomist duties play an important role in this respect as they ensure that all aspects of laboratory work related specifically to preanalytical requirements are met. Major aspects of pursuing standardization of venipuncture procedure and of creating a consequent technical standard are examined.

4.1. Types of Quality Control

To diagnose, treat, cure, and help prevent diseases, health care providers need accurate patient test results. False positive results which are also known as arbitrary test results, can create safety issues for the patient. These patients will not get correct treatment from the doctor and finally, these patients may be sent to a different hospital or even the patients will loss their life. False negative results which are also known as patient-rejectable test results can also create a medical malpractice lawsuit. To address this need for accurate test results, much attention is given to establishing proper laboratory quality control procedures. QC can be defined as that part of testing which is intended to monitor the analysis, the individual and combined effects of systems that influence the results of an analysis and the health and safety of diagnostic service providers. QC is based on two standards which are: reactive maintenance and preventive maintenance. Reactive maintenance is time-wasting and also does not give coordinate maintenance, whereas preventive maintenance reduces down time, increases implementation efficiency, maintains a fixed working level, and works on a percentage from the manufacturer (W Njoroge & H Nichols, 2014).

4.2. Implementation of Quality Control in Laboratory Settings

4.2.1. Overview

Quality control refers to the measures taken to ensure that laboratory testing is accurate and reliable, and the results generated are precise. Unlike others in the health care discipline, those who work in the clinical laboratory do not usually interact directly with patients. However, the laboratory specialist or phlebotomist plays an important role in a patient's health by selecting, obtaining, and processing blood samples for analysis. Most diseases are diagnosed by testing blood in a laboratory; therefore, there is a great need for

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the information to be accurate. It has been estimated that laboratory test results account for 70-80% of a patient's medical record .

4.2.2. Preanalytical

It is the process which occurs between the time a physician orders a test and the time a laboratory specialist processes the sample for analysis. Preanalytical variables across laboratory testing are largely uncontrolled and can introduce error. As much as 75% of all laboratory errors in clinical diagnostic testing are attributed to preanalytical variables. Of those errors, 60-70% occur in blood collection and handling, while 10% occur in the processing of the samples once they arrive in the laboratory. Preanalytical variables in the laboratory setting include: incorrect preparation and fasting, stressful environment, exercise, not at rest, fist clenching, release of band, flushing the IV line, and incorrect tourniquet application. Discarding the first tube, drawing below an IV line, running a line, clotting, liquid or K2EDTA tubes, drawing above an IV line, and under-filling tubes.

5. Collaboration and Communication Between Medical Laboratory Specialists and Phlebotomists

5.1. Improved Communication Between Medical Laboratory Specialists and Phlebotomists Error reduction occurs when communication occurs between medical laboratory specialists and phlebotomists. Phlebotomists collect blood samples, which are then analyzed by medical laboratory specialists. However, various problems have prevented proper collaboration and communication, which is why error prevention measures are urgently needed. It is necessary to improve the information given to the phlebotomists in order to prevent sample rejection. Medical laboratory specialists should be given the name of the type of the sample that they cannot process, a shortened version of the cause of the rejection. The pre-phlebotomy information that needs to be known by the phlebotomists is the size of the vacuum tube and the type of the anticoagulant in the vacuum tube. The phlebotomists should expect a decline in the stability of blood gas analytes, such as PO2, PCO2, and pH, when the sample is not received at the laboratory soon after collection. Consequently, the sample analysis they order could be a waste, as they can be rejected or invalid. This will motivate phlebotomists to be responsible for maintaining the sample integrity during transportation to the laboratory. Pellet Heparin and Na Citrate are not recommended for the blood gas test as the anticoagulant in the vacuum tube. Pellet Heparin causes the sample for serum or plasma to consist of blood

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and gel. Na Citrate causes the sample for serum or plasma to contain white blood cells (WBC) and hemolysis.

Different manufacturers are using non-standardized colors of the tube closure. The same color of the clot activator tube is used by different manufacturers for different tube material. The same color of the tube closure is used by different manufacturers for different tube material. A non-standardized color of the tube closure of blood clotting tube has caused the phlebotomists to confuse the order of the draw. An incorrect drawing order results in hemolysis.

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