

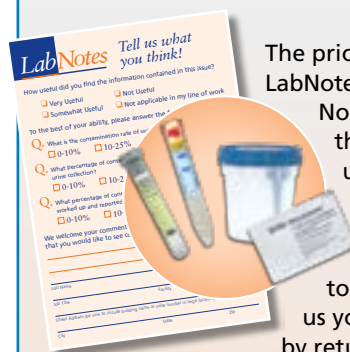
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Thanks for the Feedback!



The prior issue of **LabNotes (Volume 16, No.3)** focused on the subject of **urine specimen collection and testing.**

Thank you to all who sent us your opinions by return postcard or email. The results* of that combined survey are as follows:

The overwhelming majority of respondents found the subject matter contained in that issue to be useful in their line of work. Thirty percent of respondents estimated that urine cultures in their facilities became contaminated 10-25% of the time and 5% said contamination occurred 25-50% of the time.

* This survey was intended to gain insight on how some clinical laboratorians view the problem of urine culture contamination in their work experience. BD does not claim this to be representative of all clinical laboratorians or the state of urine culture testing in healthcare facilities industry-wide. A total of 75 individuals from US healthcare institutions participated in this survey.

Twenty percent of respondents said that 10-25% of contaminated urine samples required repeat collection and 8% of respondents estimated that repeat collections were needed for 25-50% of urine specimens.

When asked what percentage of contaminated, false-positive urine cultures were worked up and reported to physicians, 10% estimated that it occurs with 10-25% of them and 3% of respondents thought it happened with 25-50% of the cultures.

In general, proper sample collection, handling, transport, and storage will minimize urine culture contamination rates. BD Vacutainer® Urine Collection Products offer all the advantages of a closed system. Patients receive more reliable results, as there are fewer chances of false positives with decreased handling and/or proper preservation of the urine specimen.

LabNotes®

A Newsletter from
BD Diagnostics –
Preanalytical Systems

Volume 17, No.1, 2007

INSIDE: read about the new safety-engineered finger lancet



INDUSTRY NEWS

BD (Becton, Dickinson and Company) (NYSE: BDX) has announced the purchase of Burlington, NC-based TriPath Imaging (Nasdaq: TPTH), makers of an automated diagnostic test for cervical cancer screening (Pap smear). TriPath develops and markets innovative solutions for the clinical management of cancer, including detection, diagnosis, staging, and treatment. As cancer remains a leading worldwide health concern, this acquisition expands the BD scope of expertise in the areas of cancer diagnostics, disease-state management, and next-generation medical technologies.

Preanalytical Errors in the Emergency Department



Modern clinical laboratories around the world are now enjoying the benefit of decades of development in analytical hardware, assay methodology and reagent systems.

Technologies currently employed on many modern instrument platforms in clinical chemistry and hematology laboratories were restricted to the research environment just a few years ago. These advances have delivered significant gains in analytical performance in terms of precision, accuracy, sensitivity

and specificity. Complementing these gains has been a steady improvement in quality control and quality assurance programs within clinical laboratories.

Concurrently, there has been an increase in the level of participation in external quality assurance programs. In the developed world and in much of

the developing world, all of this has combined to deliver high standards of analytical performance – within the laboratory walls.

Workload pressures in ED often lead to collection of sub-optimal quality specimens

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New!

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2007 Scholarship Recipients pictured at CLMA ThinkLab Conference, Houston, TX



LabNotes

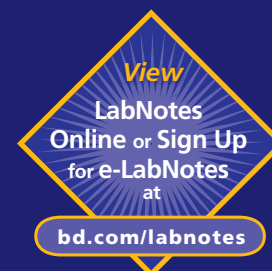
A Newsletter from
BD Diagnostics –
Preanalytical Systems

Volume 17, No.1, 2007

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- ◆ Venous vs. Capillary Blood Specimens
- ◆ New Independent Studies on Safety-Engineered Blood Collection Sets
- ◆ New Safety-Engineered Finger Lancet

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Dr. Ana Stankovic

Letter from the editor

In this issue of *LabNotes*, we focus on an area of the hospital that is often prone to preanalytical variables when blood is being drawn—the Emergency Department. Our feature article highlights several of these variables and offers suggestions on how to address these concerns. We hope you will find this information useful in your facility.

We are pleased to provide an overview of one of our newest products, the BD Microtainer® Contact-Activated Lancet. This unique new device activates when pressed against the patient's skin, giving you a more accurate incision when performing a skin puncture.

Also in this issue, we share the results of our last reader survey regarding urine culture contamination. Take a look—you may find some of the responses surprising. Please find the attached business reply postcard where we ask for your opinions on capillary blood collection. We look forward to receiving your responses. Thank you to all who have participated in these past surveys as we greatly value the opinions of our readers.

Regards,

Dr. Ana Stankovic

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Preanalytical Errors

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For many years however, there has been increasing recognition that the situation is less favourable in the preanalytical phase of the testing process such that there is now general acceptance of the need to focus on improvements in this area. Because up to 60% of the testing process is centered around the preanalytical phase and preanalytical errors have been reported to account for more than two thirds of all laboratory errors^{1,2}, it is clear that improvements in this area will deliver the greatest incremental gains in the overall quality of clinical laboratory services. Quality improvement in the preanalytical phase helps laboratories to provide more timely and accurate test results for clinicians – crucial factors in terms of patient outcome and healthcare institution operating costs. When we look at this in the context of the high pressure environment of the Emergency Department (ED), we see a paradox. Whilst the ED is an area that has, arguably, the greatest need for accurate test results, workload pressures often lead to the collection of specimens of sub-optimal quality – the heartland of preanalytical error. As well, the pressured environment in the ED can lead to increased risk of needlestick injury (NSI) and exposure to potentially infectious specimens. In this article, we examine common causes of sub-optimal specimen quality, the implications for test result error and the steps that can be taken to overcome these problems whilst achieving consistently safe and efficient specimen collection with good test turn around time (TAT). We have not tried to encompass all aspects of preanalytical error. Rather, we have focused on problem areas most commonly encountered in a busy ED environment.

Sub-optimal Specimen Quality – the ‘big five’

Before moving to a discussion on sub-optimal specimens, we should define what we mean by a ‘quality specimen’. Simply, this is a specimen which accurately reflects the *in vivo* situation of the patient at the time of collection. Because blood is a ‘living fluid’, collection of a quality specimen and delivery of this to the laboratory is far from easy. Many factors can combine to bring about significant change in the specimen from the point of collection through to the time of analysis. The most common causes of sub-optimal specimens in an ED environment and their rejection by the laboratory are:

- 1 incorrect patient identity (ID) or incomplete ID details
- 2 incorrect procedures for intravenous (IV) ‘line draws’
- 3 incorrect order in which evacuated tubes are filled (incorrect order of draw)
- 4 trauma to the specimen leading to hemolysis
- 5 inadequate mixing leading to clotting of anticoagulated specimens

- A mismatch of patient ID details between specimen tube and the test request form is a common occurrence
- Specimens collected from IV lines are often contaminated with IV fluid, hemolyzed or both
- The correct order of draw is often not followed in ED
- Hemolysis arises most commonly from mechanical trauma to the specimen (e.g., use of inappropriate size syringe with IV line collections, use of very small gauge needles, improper transfer of specimens from syringe to an evacuated tube or improper line collection procedures)
- Clotting of anticoagulated specimens arises from inadequate mixing

Hemolyzed and clotted specimens, ID error and poor quality specimens arising from IV line draws are commonly seen in the ED

Of course, the above five sources of sub-optimal specimens are not restricted to the ED. However, hemolysis, clotted specimens, ID error and poor quality specimens arising from IV line collections are commonly seen in this setting. When we consider some of the techniques and workplace situations that can lead to sub-optimal specimen quality, it is easy to understand how specimen collection performed ‘in haste’ can lead to these issues.

1 Incorrect Patient ID

The worst type of preanalytical error is when the physician receives and acts on test results from the wrong patient. Even a very low ID error rate can lead to serious medical errors involving significant adverse events for the patient and costly increased length of hospital stay. A ‘failure mode and effect analysis’ study at the University of Kansas Hospital in 2003³ showed that careful attention to all aspects of the specimen procurement process can lead to tangible improvements in the error rate. As for other forms of preanalytical error however, many errors can go undetected. A trend towards automated systems that integrate barcoding of patient ID wristbands with a well defined and rigid specimen collection procedure will certainly help to reduce all errors of this type. Allied to this is the increasing use of computerized physician order entry which can deliver clear benefits in what may be described as the ‘Pre- Preanalytical Phase’. That is, a reduction in the number of errors in test types ordered.

2 IV ‘Line Draws’ – a common source of poor quality specimens

Protocols for IV line collection for blood specimens vary among healthcare institutions. In general, blood collection from peripheral lines is deemed to be acceptable only with newly placed lines – before these are used for administration of fluids. Blood collection from peripherally inserted central catheters and other central lines is commonplace. Regardless of the regulations in this area, certain steps must be taken to ensure a quality specimen (as per the definition above) is obtained. The two most common problems with ‘line draw’ specimens are hemolysis and contamination with infusion fluids. As with the discussion on hemolysis below, this occurs as a result of mechanical trauma caused, mainly, by excessively high flow rates of blood from the catheter to the syringe or the evacuated tube. For syringe collections, the use of large (e.g. 10 mL) sizes may be convenient but these can easily generate excessive negative pressure leading to high flow rates (and thus high ‘shear’ forces) which result in cell rupture. Smaller size syringes (3 to 5 mL) are recommended along with a slow rate of draw on the plunger. The use of an evacuated collection technique is recommended as this provides all the benefits of a closed system collection. Where this technique is employed, the use of an extension tubing set is recommended as a means of reducing the flow rate. The use of partial draw tubes will also assist in reducing the flow rate. Partial draw tubes (e.g. 2 mL draw in 13 mm x 75 mm, 5 mL capacity tube) have a reduced vacuum or more correctly, a higher internal pressure compared to ‘full draw’ tubes.

Inadequate flushing of the IV line is a common cause of contamination of specimens with electrolytes, glucose or other substances causing laboratory error. If we consider a typical ‘5% glucose’ infusion containing approximately 280mmol/L of glucose, it is easy to see how a very small level of contamination of the blood specimen with this fluid could greatly impact a test result commonly of the order of 5mmol/L. Similar examples can be found for other infusion fluids such as those used for total parenteral nutrition. In addition to contamination leading to errors in results for glucose and electrolytes, the presence of infusion fluid in the specimen will of course introduce a dilution error which will affect all test results.

Regardless of whether the specimen is acquired via syringe collection or direct evacuated collection, the line should first be flushed using sterile saline with a minimum of 2.5 times the ‘dead space’ of the catheter. Note that the actual dead space may vary considerably according to the device type.

After flushing, a discard syringe (minimum 3 - 5 mL) or discard evacuated tube (again minimum 3 - 5 mL) should be obtained prior to collecting blood for analysis. When a tube is going to be drawn for discard, a non-additive tube is suggested. This tube can precede all other tube types without concern of contamination (from carry-over of additive) leading to laboratory test result error.

Following blood collection, the line must be flushed again with a suitable solution (e.g. saline or heparinized saline) according to the healthcare institution’s policy⁵.

3 Incorrect Order of Draw

When the closed evacuated collection system is used for collection of a variety of tubes (with different additives) from one patient, it is important to fill the tubes in an order which minimizes any adverse effect on specimen quality due to the additive from the preceding tube. The CLSI recommends the order as shown.

Order of Draw for Multiple Tube Collections

Reflects change in NCCLS recommended Order of Draw (NCCLS H3-A5, Vol 23, No 32, 8.10.2)

Closure Color	Collection Tube	Mix by Inverting
BD Vacutainer® Blood Collection Tubes (glass or plastic)		
	• Blood Cultures - SPS	8 to 10 times
	• Citrate Tube*	3 to 4 times
	• BD Vacutainer® SST™ Gel Separator Tube	5 times
	• Serum Tube (glass or plastic)	5 times (plastic) none (glass)
	• Heparin Tube	8 to 10 times
	• BD Vacutainer® PST™ Gel Separator Tube With Heparin	8 to 10 times
	• EDTA Tube	8 to 10 times
	• Fluoride (glucose) Tube	8 to 10 times

*When using a winged blood collection set for venipuncture and a coagulation (citrate) tube is the first specimen tube to be drawn, a discard tube should be drawn first. The discard tube must be used to fill the blood collection set tubing’s “dead space” with blood but the discard tube does not need to be completely filled. This important step will ensure maintenance of the proper blood-to-additive ratio of the blood specimen. The discard tube should be a nonadditive or coagulation tube.

NOTE: Always follow your facility’s protocol for order of draw

It is recommended that the tourniquet be removed when blood begins to flow into the first tube. Additive carryover can also be prevented by ensuring the base of the tube is always below the top of the tube during the blood collection process. Examples of carryover include potassium from EDTA tubes contaminating tubes required for electrolyte analysis in the

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Preanalytical Errors

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clinical chemistry laboratory or carryover of clot activators used in plain serum and serum gel tubes into sodium citrate tubes used for blood coagulation testing.

4 Trauma to the specimen – leading to hemolysis (Handle with care! Blood cells are fragile!)

Blood cells in general and red blood cells in particular are fragile and susceptible to rupture due to mechanical trauma (as above), osmotic shock (exposure to non-isotonic fluids) and exposure to temperature extremes (e.g. during transportation to the laboratory). Hemolysis is one of the most common causes of sub-optimal specimens leading to laboratory error⁶. Because some of the constituents of red blood cells (notably potassium and lactate dehydrogenase) are present in the cells at significantly higher concentrations than in serum or plasma, a small amount of hemolysis can lead to significant error if this is not detected. Fortunately, many modern analyzers automatically screen for hemolysis. Nevertheless, this remains as a significant source of error. Whilst gross hemolysis is rarely missed, clinically meaningful variations of some laboratory tests have been observed in specimens where hemolysis is mild or almost undetectable^{7,8}. An example of this would be the production of a normal potassium result for a hypokalemic specimen. For many laboratories, the ED contributes disproportionately to the tally of hemolyzed specimens.

For many laboratories, the ED contributes disproportionately to the tally of hemolyzed specimens

Care, therefore, needs to be taken when collecting specimens to avoid mechanical trauma to the cells. A recent study⁹ showed that the use of small gauge needles (25 G or smaller) is associated with increased variability in potassium levels compared to those in specimens collected using 23 G or 21 G needles – leading the authors to conclude that 25 G needles cannot be recommended for collection of venous blood. Whilst a statistically significant difference between results obtained in specimens collected with 21 G and 23 G needles was not demonstrated, a bias was evident in free hemoglobin, potassium, calcium, chloride and sodium results obtained on specimens collected in the smaller, 23 G needles. Use of large bore syringes in conjunction with small gauge needles adds to the mechanical trauma placed on the blood cells. Lysis of red cells due to

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New Information

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University of Nebraska:
Effect of a Safety-Engineered Phlebotomy Device on Activation Compliance and Sharps Injury

The Point-of-Care Path

POCT more accurately describes a testing delivery option, rather than a specific analytical test. Performing lab testing at the patient's location or bedside is a method of testing widely used in hospital and physician office laboratories, nursing homes, clinics and even patients' homes. Bringing testing to the patient's location generally offers the advantage of a shorter turnaround time for reporting over standard lab testing collected by venipuncture. The result is faster patient treatment and recovery, which ultimately can lower healthcare costs through faster discharges.

— Donna R. Kirven,
BPPVE, CPTI(CA), PBT(ASCP), NCPT(NCCT)

Advance for Medical Laboratory Professionals,
February 2007 issue

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exposure to liquid skin antiseptic agent is also common when insufficient time is allowed for the skin preparation agent to dry. Apart from errors arising from contamination of serum and plasma with intracellular contents of red cells, it should be noted that hemolysis can also lead to significant errors in coagulation testing. Levels of hemolysis less than 1% have been shown to impact significantly on test result accuracy for routine coagulation tests such as INR, and aPTT⁷. Adverse handling of the specimen leading to red cell rupture is also likely to damage platelets and facilitate increased activation of the latter.

Hemolysis is least likely to occur in specimens drawn via venipuncture using a closed, evacuated collection system

Hemolysis is least likely to occur in specimens collected via venipuncture using a closed, evacuated collection system. Whilst this method remains the one of choice from the perspectives of specimen quality and safety, blood collection using syringe collection methods (venipuncture or 'line draw') remain common in the ED setting. First and foremost, healthcare professionals working in the ED should ensure that compliance with a correctly performed closed evacuated method for blood collection is maximized through education and training. The nature of the patient care process in ED, however, does mean that there will be a justifiable need, in some circumstances, to collect blood using a syringe based method. Education and training is critical in these circumstances to ensure that healthcare professionals follow the correct procedures to minimise the potential for hemolysis. Apart from the choice of needle gauge (above), another key consideration is the way in which the specimen is transferred from the syringe to the blood collection tube. Devices are now available that facilitate 'closed transfer' from the syringe to the tube without the need to remove the tube cap. Where these are used, it is important that the blood is allowed to be drawn into the tube by the vacuum in the tube. Pressure must not be applied to the syringe plunger to accelerate the rate of transfer as this is a certain recipe for hemolysis and may also lead to over-filling of the tube (a potential source of preanalytical error for many tests where the ratio of blood to additive is critical). If a needle is used (e.g. with syringe-based venipuncture), the first and most important step in the transfer process is the safe-disposal of the needle into an approved sharps container.

5 Inadequate Mixing – Leading to Clotting of Anticoagulated Specimens

As for hemolyzed specimens, overtly clotted specimens and those with micro-clots are, unfortunately, commonplace in the clinical laboratory. Again, this specimen quality issue is often disproportionately represented by specimens originating from the ED. Whilst anticoagulants differ in terms of their solubility in blood, all specimen tubes with anticoagulant additives require thorough mixing. This mixing must be performed by gentle inversion of the tube. Inversion should be slow enough to allow the air bubble in the tube to completely traverse the length of the tube. Of all the anticoagulant additives, EDTA is easily the least soluble. Lavender top EDTA tubes therefore deserve particular attention. Whilst overt clotting is easily detected, micro-clots in whole blood EDTA specimens used for hematology testing may go undetected even though most modern analyzers have systems to detect clots and platelet clumps. Inadequate mixing of EDTA specimens therefore remains as a potential source of platelet count (and other) errors and instrument sample probe occlusion. At the very least, micro-clots and platelet clumps will adversely affect TAT for the ED because of the need to re-collect the specimen. In the clinical chemistry laboratory, undetected clots in heparin plasma specimens can also occlude sample aspiration probes. Perhaps more significant is the potential for very small clots (micro-fibrin) to be aspirated with the plasma sample and adversely affect test result accuracy (e.g. some immunoassays). It is worth noting that assay problems mediated by fibrin are not restricted to plasma specimens obtained from anticoagulated whole blood. Mixing is just as important for serum and serum gel tube specimens containing a clot activator. Inadequate mixing can lead to a reduced speed of coagulation in the specimen because of poor distribution of the clot activator throughout the specimen. Depending on the time between specimen collection and centrifugation, the slow rate of coagulation may lead to the formation of fibrin particles and strands in the serum during or after centrifugation and before analysis.

The Need for Speed in ED!

Clearly, rapid TAT is a key issue in the ED. But at what price? It makes no sense whatsoever to obtain a result a few minutes earlier if corners are cut that lead to a poor quality specimen and preanalytical error. It is important to emphasise that many preanalytical errors are very difficult to detect. We have mentioned hemolysis and clotted specimens above but there are many other aspects of sub-optimal specimen

quality that may go undetected in the laboratory. One example is falsely elevated troponin results caused by the presence of microfibrin particles in the specimen¹⁰. Another example is erroneous aPTT results arising from specimens where there is a significant degree of platelet activation leading to platelet factor 4 mediated heparin neutralization (e.g. platelet activation arising from 'partial draw' tubes with excessive headspace). Consistent procurement of quality specimens with the lowest possible rate of rejection by the laboratory will deliver the best quality results and significantly assist with average TAT by reducing the need to re-collect specimens.

The single most effective way to reduce TAT for clinical chemistry results is the use of heparin plasma specimens *in lieu* of serum. This eliminates the clotting time component in the TAT (typically 30 minutes). Some laboratories further decrease TAT by reducing centrifugation times and increasing relative centrifugal force (rcf). Data are now available to support this strategy using centrifugation times of less than four minutes (with rcf values of 3000 g) with certain plasma separation tubes¹¹. Laboratories must validate such data prior to adopting centrifugation conditions different to those recommended by the tube manufacturer. A decision to use heparin plasma specimens in lieu of serum entails a number of considerations, including:

- Reduced analyte stability in plasma gel specimens (compared to serum gel specimens)
- Different test results for some tests (e.g. total protein, potassium, some immunochemistry assays) – necessitating different reference ranges
- Heparin plasma is not validated for use with some assays

Apart from the five most common problem areas we have covered above, three other frequent sources of sub-optimal specimen quality seen in ED are those associated with blood gas analysis, blood culture and urine specimens.

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Preanalytical Errors

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Blood Gas Specimens

Whilst the concentration of heparin in most blood gas syringes is much higher than in evacuated blood collection tubes, clotted specimens are a key issue and lead to increased TAT and increased blood gas analyzer downtime. Mixing of these specimens is difficult due to the absence of an air bubble in the syringe (maintaining an anaerobic state with an absence of air bubbles is of course a critical requirement for a quality specimen). Mixing by inversion alone is simply inadequate. Once filled to the correct level, the syringe must be 'rolled' between the palms of the hands for at least 5 seconds to ensure adequate mixing of the heparin anticoagulant. Mixing by inversion as well is also recommended. The pressured environment in ED also presents a significant risk of NSI in this situation. Safety devices designed to encapsulate the needle are strongly recommended. Whatever device is used, care must be taken to prevent NSI whether the specimen is to be analyzed at the 'point of care' or forwarded to a remote laboratory.

Most modern syringes contain an electrolyte balanced heparin additive designed to be compatible with all electrolyte assays (including ionized calcium and ionized magnesium). This is important given the prevalence of electrolyte (and other) testing now performed on arterial blood gas specimens (and so-called 'venous' blood gas specimens obtained mainly for stat chemistry results including electrolytes). Because metal cations are susceptible to binding to regular, pharmaceutical grade heparin, use of this type of anticoagulant presents a source of preanalytical error (electrolyte results are reduced with excessive concentrations of heparin). Whilst the modern balanced formulations allow higher concentrations of heparin to be used in blood gas syringes, recommended fill levels should be observed – even the balanced formulations have their limits!

Blood Culture Specimens

As for blood gas specimens, collection of blood culture specimens presents a significant risk of NSI in ED. The other key issue with these specimens is contamination with skin flora resulting in falsely positive culture results. With regard to NSI, the use of a closed blood collection system using a winged butterfly set to draw directly into the blood culture vials is recommended. When using this procedure, it is important to note that blood culture bottle(s) from the major manufacturers do not have a 'calibrated draw volume'. Unlike evacuated blood collection tubes, blood culture bottle(s) will generally draw beyond their optimal fill level. For this reason, a target

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1. BD Clinical Documentation V57499
2. BD Clinical Study



continued from page 6

fill level should be marked on the label of the bottle(s) (with reference to the fill level gradations). Note also that the bottle can be removed during the blood collection process to check the fill level on a flat surface if required. If additional blood is required, the bottle can then be re-engaged in the holder assembly attached to the winged collection set. Thorough skin preparation is essential in minimizing contamination of blood cultures with skin flora. The key to success is the use of a radial swabbing action (moving outwards from the intended puncture site). This process must not be rushed and the use of multiple swabs should be considered in situations where it is clear the site is heavily soiled. Collection of specimens for blood culture through IV lines (of any type) is not recommended.

Urine Specimens

Whilst urine specimen quality issues are not confined to the ED, the pressured environment and the 'need for speed' (as above) certainly increase the potential for preanalytical error. Similarly, the ED environment can lead to increased safety risks to healthcare workers arising from exposure to these specimens. The use of urine containers with leak-resistant caps is clearly an important preventative measure. Containers with integral fittings to allow closed transfer of a calibrated volume of the specimen to evacuated urine collection tubes also assist with minimizing exposure and providing a sealed, high quality specimen. Where delays are anticipated

between specimen collection and analysis, tubes with preservatives for chemistry urinalysis and micro culture and sensitivity testing are also available.

Improvement Through Education

We hope the information presented above helps to provide an understanding of the key issues pertaining to specimen quality (and therefore test result accuracy), safety and TAT in the ED. To say that education is required to ensure these issues are understood and addressed is to state the obvious. To be truly effective, education programs need to focus on the clinical impact – that is, exactly what sub-optimal quality means in terms of potential test result errors and patient outcome.

Because physicians and nurses are the predominant stakeholders when it comes to preservation of the *in vivo* quality of a sample, education programs focusing on the causes and impact of sub-optimal sample quality are more likely to be effective in changing undesirable practices.

Physicians and nurses are also instrumental when it comes to healthcare worker safety. Again, education needs to be targeted at specific NSI issues in ED such as the need to use safety engineered sharps protection

Doctors and nurses in ED
are key stakeholders in
specimen quality and safety

devices and the need to understand and follow best practices in high risk areas such as blood gas and blood culture collections (above). An adjunct to this should be an underlying theme of improved efficiency (in terms of TAT, patient stay in ED) that adherence to best practices can deliver.

Whatever the nature of any formal training, we strongly recommend that a member of the ED staff is nominated as an on-site educational resource with responsibility to provide on-going training and to monitor improvements. ♦

Brian Smith is Clinical Director for Asia Pacific and Japan, BD Diagnostics – Preanalytical Systems in Australia.

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Differences in Composition of Capillary and Venous Blood Specimen

Blood obtained through skin puncture (capillary blood) differs from blood that is obtained through venipuncture. When analyzing the major characteristics of capillary blood, such as pH, PCO₂, PO₂ and oxygen saturation, freely flowing capillary blood is actually more similar to arterial than to venous blood. On the other hand, due to the method of collection, capillary blood is contaminated with interstitial and intracellular fluids, which will influence the analytic values obtained from these samples. It is for this reason that capillary blood is not recommended for coagulation testing. Differences also exist between venous and capillary blood analyte concentrations (see table at right). This is by no means an exhaustive list, and since the data were taken from two different studies, does not include identical analytes for both specimen types, i.e. plasma and serum.

Capillary Blood Collection

SPECIMEN	Capillary Value Greater Than Venous Value (%)	No Difference between Capillary and Venous Values	Capillary Value Less Than Venous Value	These differences between capillary and venous samples are important for laboratorians to keep in mind because the analyte reference ranges for one may not be reliably applied to the other. In order to insure the quality and accuracy of their results, laboratories should determine separate and capillary and venous analyte reference ranges where applicable.
SERUM ¹	Glucose 1.4 Potassium 0.9	Phosphate Urea	Bilirubin 5.0 Calcium 4.6 Chloride 1.8 Sodium 2.3 Total Protein 3.3	
PLASMA ²	Alanine Aminotransferase 32.8 Albumin 5.4 Amylase 19.6 Aspartate Aminotransferase 5.0 Calcium 1.2 Chloride 4.5 Creatinine Kinase 24.6 Total Protein 13.2	Glutanyl Transferase	Alanine Phosphatase 5.4 Creatinine 8.3 Potassium 2.6 Sodium 0.7 Urea Nitrogen 24.0 UricAcid 2.5	

¹ From: Kupke 1R, Kather B, Zeugner S. On the composition of Capillary and Venous Blood Serum. CIIN, CHIM, ACT, 1981; 112: 177-85.

² From Rommel K, Koch C-D, Spilker D. Einfluss Der Material Ewinnung AUF Clinisch-Chemische Paarameter in Blut, Plasma UND Serum BEI PATHEN MIT STABILEM AND ZENTRAUSIERTEM KREISLAUF. J CLIN CHEM BIOCHEM 1978,16:373-80.