CHEMICAL PATHOLOGY TESTS REQUESTING & SPECIMEN COLLECTION

DR NADZIMAH MOHD NASIR

Head of Chemical Pathology Unit

Department of Pathology, HUiTM

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Chemical Pathology Unit
Department of Pathology
Faculty of Medicine, UiTM

PATHOLOGY
Faculty of Medicine. UiTM

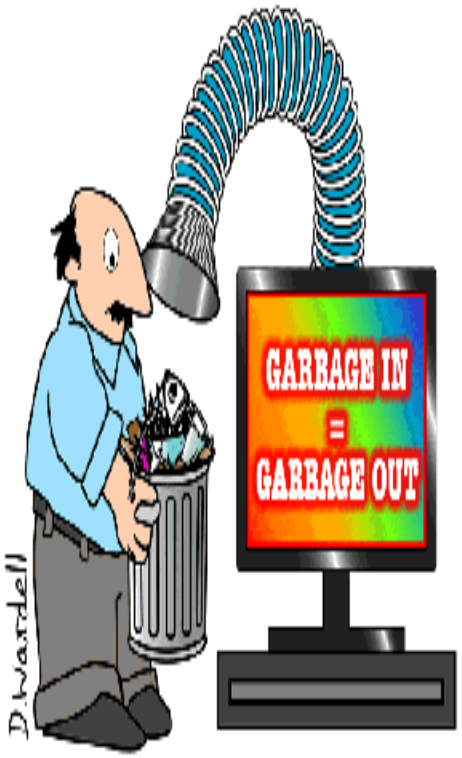
INTRODUCTION

- Chemical Pathology deals with analyzing a wide range of substances (e.g. electrolytes, blood gases, enzymes, glucose, proteins, lipids, hormones, etc.) in the blood and body fluids.
- ~70% of clinical decisions are made based on laboratory tests.[1]
- The result of any laboratory test is only as good as the specimens received in the laboratory.

[1]*Rohr UP, Binder C, Dieterle T, Giusti F, Messina CGM, Toerien E, et al. The value of in vitro diagnostic testing in medical practice: a status report. PLoSOne 2016;11(3): e0149856.*

EFFECTS OF UNSUITABLE SPECIMENS

- Compromise the validity of test results → misdiagnosis, improper treatment, malpractice.
- Requires a repeat collection from the patient - ? Precious sample.
- Delay in diagnosis/ treatment/ patient care.
- Patient discomfort and dissatisfaction.
- Additional expenses.

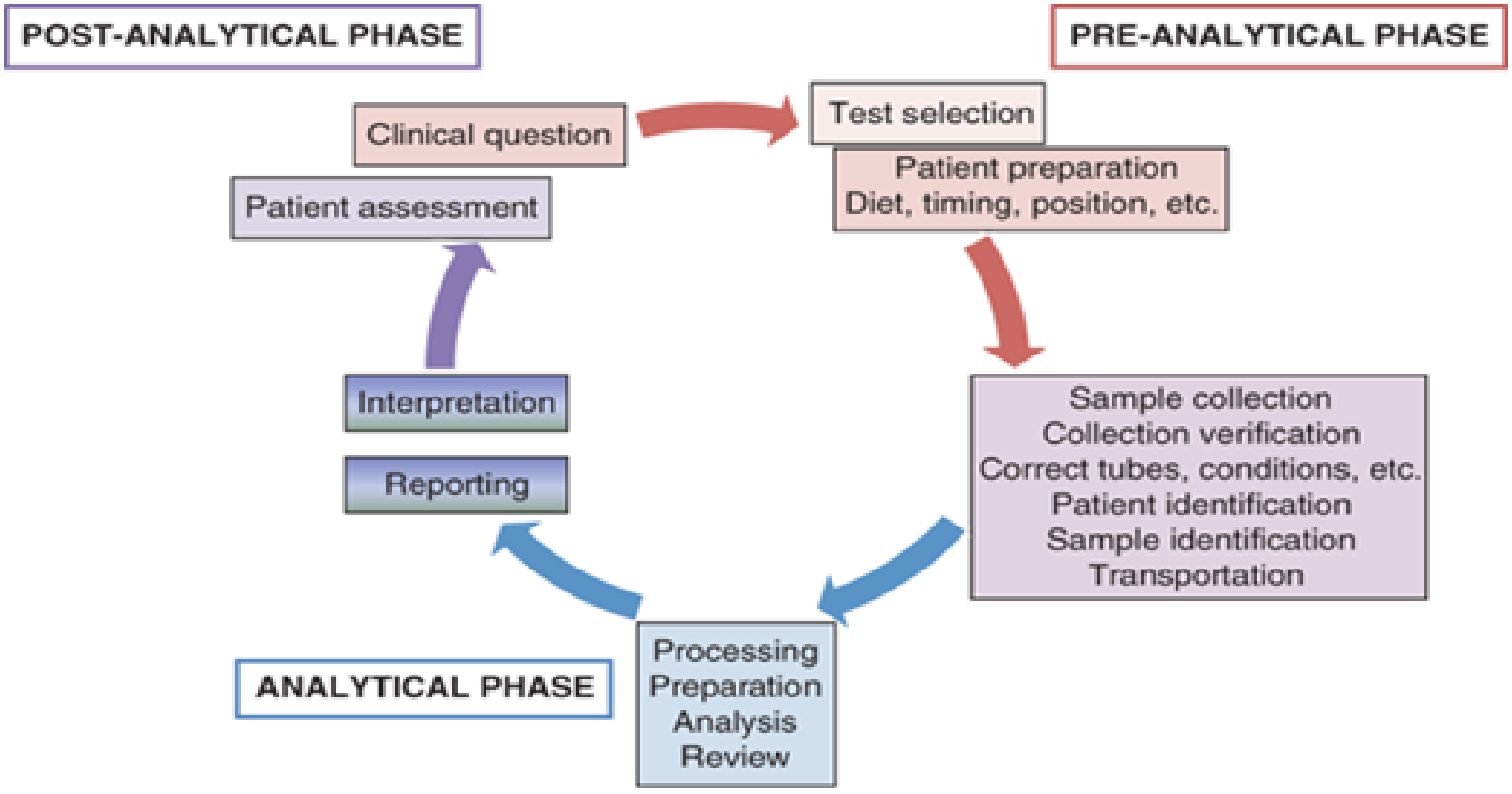


FREQUENCY & TYPE OF LABORATORY ERRORS

	Absolute frequency (ppm)		Relative frequency (%)	
	1996	2006	1996	2006
Total errors	4667	3092		
Preanalytic	3186	1913	68.2	61.9
Analytic	617	646	13.3	15.0
Postanalytic	864	715	18.5	23.1

Plebani M. The detection and prevention of errors in laboratory medicine. Annals of Clinical Biochemistry. 2010;47(2):101-110.

preanalytical error
ˌ ˈpriːænəˈlɪtɪkəl ˈɛrə
noun
Preanalytical errors are errors in test results that occur as a consequence of actions or events preceding the test or analysis itself.



Source: Howard M. Reisner: Pathology: A Modern Case Study
www.accessmedicine.com

SPECIMEN REJECTION CRITERIA

- Defective / Missing / Wrong **label**
- Incomplete Request **Form**
- **No specimen** received
  (only request form received)
- **Haemolysed** / **clotted** sample
- **Lipaemic** / **Icteric** sample
- **Insufficient** specimen
- Wrong / Expired / Broken / Leaking collection **containers**
- **Improper** Specimen **Collection**
  (e.g. Wrong order of draw)
- **Repetitive** test requests
  (e.g. HbA1c request is < 8 weeks from previous testing)
- Improper **transportation** method / temperature not maintained
- Out of sample **stability** / Delayed sample arrival
- Test is **not** clinically **indicated**
  (e.g. Free PSA is rejected when total PSA result is not within 2.5 – 10 ng/ml)
- Test is **not offered**

Clinical Laboratory Handbook 1st edition, page 5. Downloadable from https://pathologyuitm.weebly.com/

CHEMICAL PATHOLOGY SPECIMEN REJECTION (JAN – JUNE 2020)

Rejection rate (SG BULOH)	**506 out of 25,751 specimens (1.96%)** MSQH MALAYSIAN SOCIETY FOR QUALITY IN HEALTH *Target: < 1%*		
Top 3 Reasons for Rejection	**No. 1**	**No. 2**	**No. 3**
	REPETITIVE REQUEST	**HAEMOLYSIS**	**CLOTTED SAMPLE**
Percentage of rejection	35.1%	24.1%	19.2%

CHEMICAL PATHOLOGY SPECIMEN REJECTION (JAN – JUNE 2020)

Rejection rate (SELAYANG)	**42 out of 13,465 specimens (0.31%)** MSQH MALAYSIAN SOCIETY FOR QUALITY IN HEALTH *Target: < 1%*		
Top 3 Reasons for Rejection	**No. 1**	**No. 2**	**No. 3**
	NO SPECIMEN RECEIVED	**REPETITVE REQUEST**	**HAEMOLYSIS**
Percentage of rejection	52.4%	21.4%	11.9%

REPETITIVE REQUESTS

- Waste of resources
  (e.g. materials, reagents, lab staff time)
- Increases laboratory's workload
- Delay in turnaround time of other genuinely necessary tests
- Increases the rate of specimen rejection
- Increase in costs
- Patient discomfort and dissatisfaction

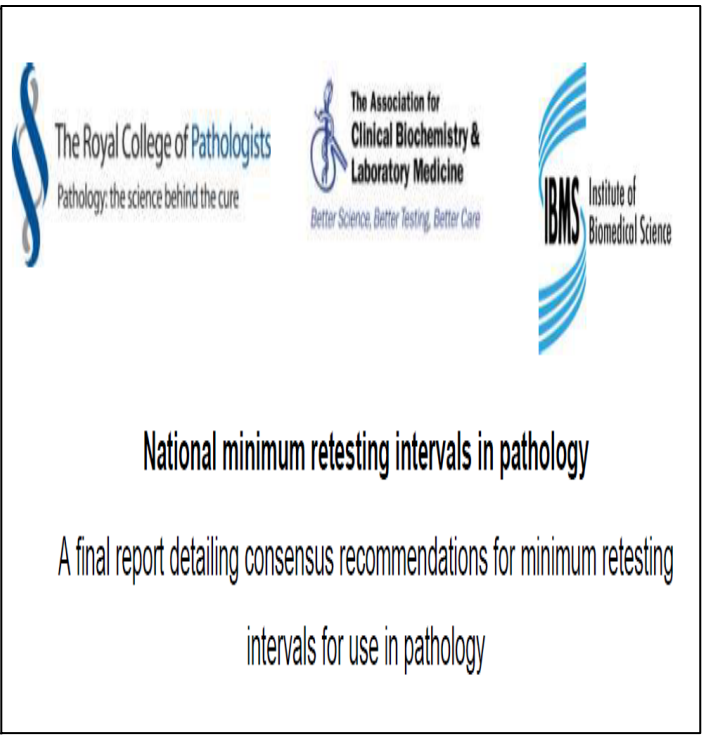
COMMONLY AFFECTED TESTS:

- **HbA1c** requested < 8 weeks from the previous testing
- **Lipid profile (FSL)** requested repetitively during out of office hours.

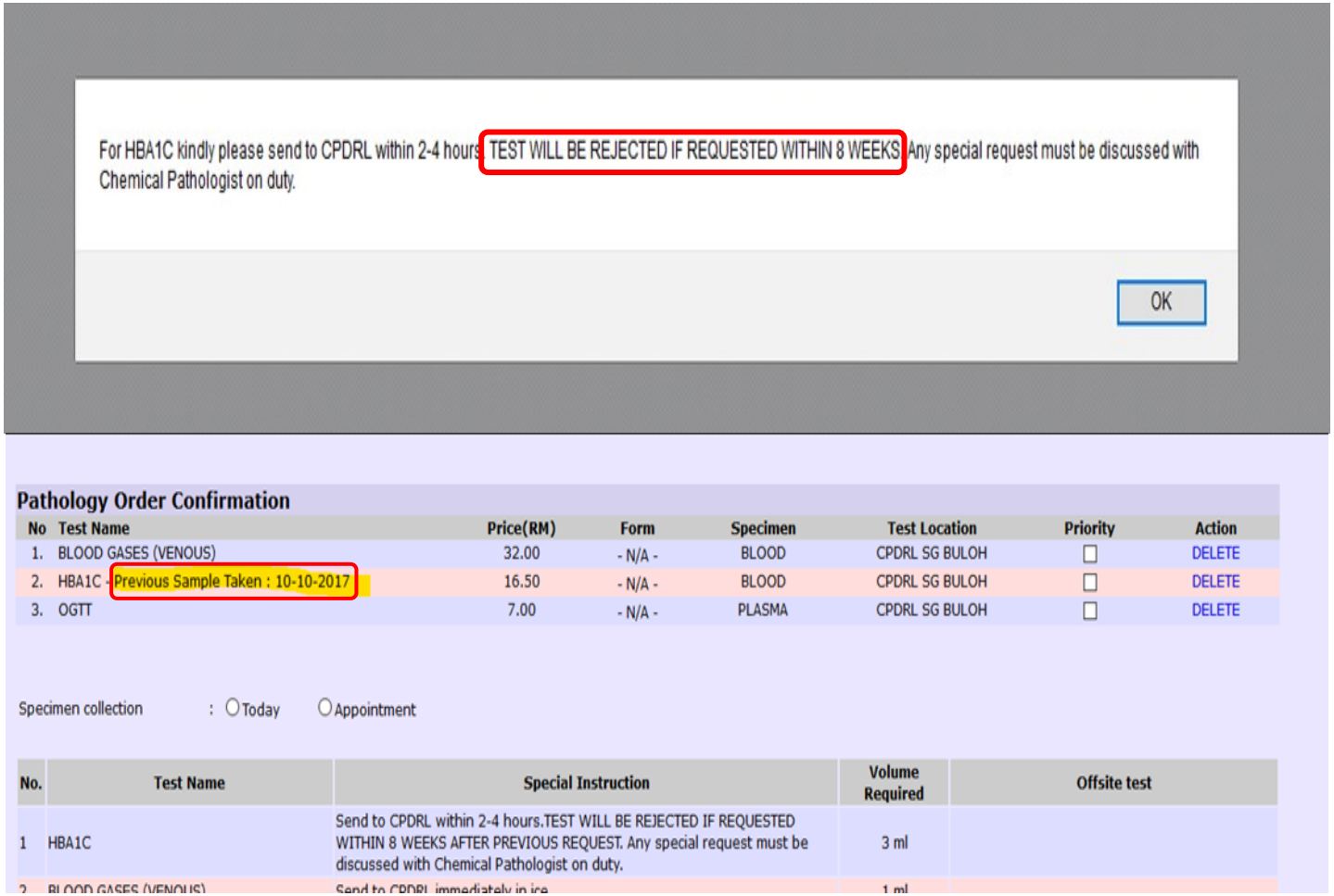
HbA1c requests < 8 weeks from previous testing

- HbA1c represents the average rate of glycation over the lifespan of HbA (120 days), particularly in the previous **6-8 weeks**.
- Glycation is a **SLOW**, irreversible process.

HbA_{1C} monitoring of patients with type 2 diabetes	2–6 monthly intervals (tailored to individual needs), until the blood glucose concentration is stable on unchanging therapy; use a measurement made at an interval of less than 3 months as an indicator of direction of change, rather than as a new steady state Six monthly intervals once the blood glucose concentration and blood glucose lowering therapy are stable



Reminders in UniMEDS for HbA1c requests



List of 24-hour (on-call) tests

- Blood Gases
- hs Troponin T
- Renal Profile
- Liver Function Test
- Bone Profile
- Glucose
- Calcium
- Magnesium
- Phosphate
- Bilirubin
- Creatine Kinase
- Amylase
- AST
- CRP
- Urine FEME (dipstick only)
- Urine Pregnancy Test
- Body Fluids Biochemistry

FSL is not part of the 24-hour / On-call tests. Specimens received out of office hours will be kept and analyzed on the next working day.

Clinical Laboratory Handbook 1st edition, page 11. Downloadable from https://pathologyuitm.weebly.com/

HAEMOLYSIS

- **Effects of haemolysis**:
  - Overestimation of **K**, ALT, AST, creatinine, CK, iron, LDH, lipase, Mg, PO_4, urea.
  - Significantly decreased Na, albumin, ALP, Cl, GGT and glucose.
  - A hemolysis index of ~150 (Hb 1.9 g/L) caused > 20% change in cardiac **troponins** (the direction of change depends on assay).
  - Clinically significant variations of AST, Cl, LDH, K and Na were observed in specimens displaying mild or almost undetectable hemolysis by visual inspection (Hb < 0.6 g/L).

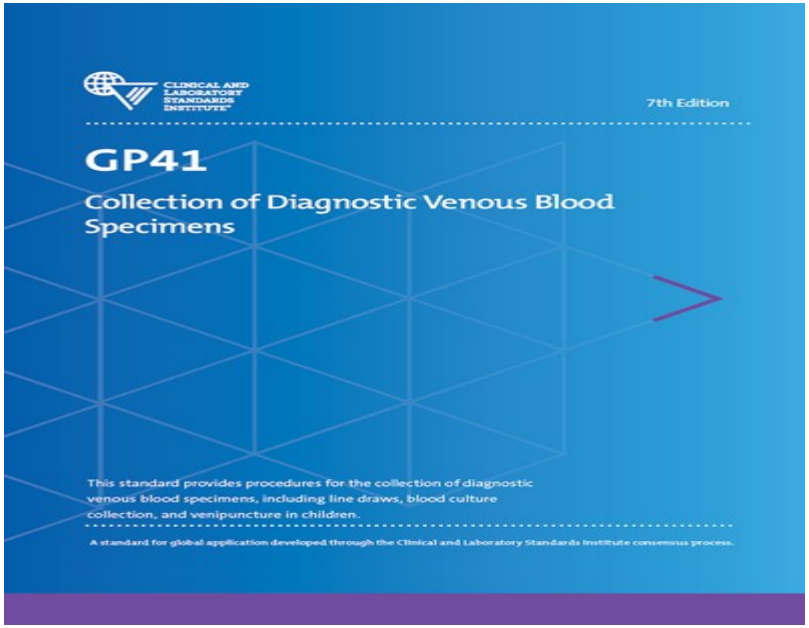
Lippi G et al. Influence of hemolysis on routine clinical chemistry testing. Clin Chem Lab Med 2006;44(3):311–316
Renze Bais, The Effect of Sample Hemolysis on Cardiac Troponin I and T Assays, Clinical Chemistry 2010; 56(8), 1357–1359

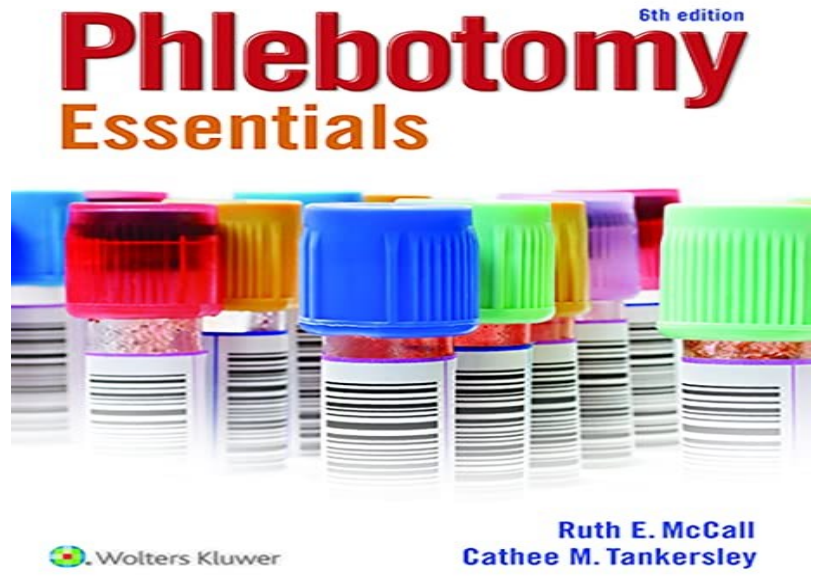
PREVENTION OF HAEMOLYSIS

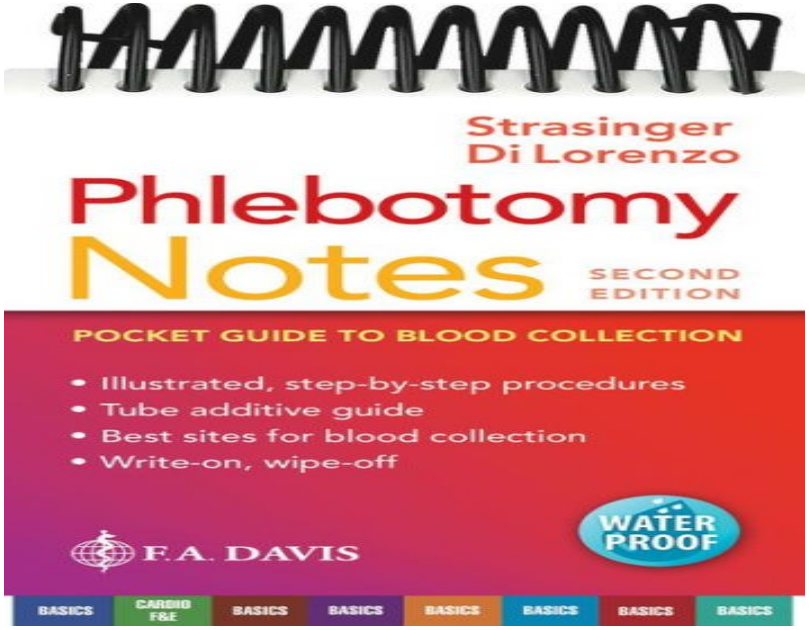
GOOD PHLEBOTOMY PRACTICE

- Use suitable needle gauge (20-22 G for routine collection). Too small a needle results in excess vacuum force, too large a needle cause shear stress on the cell walls.
- Draw sample from antecubital region of the arm. Drawing from other sites has been shown to result in a higher degree of hemolysis.
- Warm up the puncture site to increase blood flow and prevents the need to “milk” the site.
- Do not leave the tourniquet on for > 1 minute. Prolonged tourniquet time causes the interstitial fluid to leak into the tissue, promoting hemolysis.
- Allow venipuncture site to completely air dry after cleaning with alcohol. Alcohol damages cell walls.
- Place the needle correctly in the vein. Partial occlusion by the inner wall of the vein exerts shear force on the cells.
- Pull the plunger of syringe gently when drawing blood. Pulling too quickly exerts excess pressure and shear the cell walls.
- Pushing hard on the syringe plunger while transferring blood to a tube exerts a destructive level of pressure
- Avoid drawing from catheters and lines - involve shear forces and turbulence cause hemolysis.
- Fill tubes to correct volume. Under-filling of tubes containing anticoagulant results in a higher than recommended concentration of the additive, which promotes hemolysis.
- Mix additives with the specimens by inverting tubes gently. Vigorous mixing or shaking can break the cells.
- Protect the specimens during transport. Exposure to inappropriate temperatures and significant jarring will cause hemolysis in transit.


World Health Organization
WHO guidelines on drawing blood: best practices in phlebotomy


CLINICAL AND LABORATORY STANDARDS INSTITUTE
7th Edition
GP41
Collection of Diagnostic Venous Blood Specimens
This standard provides procedures for the collection of diagnostic venous blood specimens, including line draws, blood culture collection, and venipuncture in children.
A standard for global application developed through the Clinical and Laboratory Standards Institute consensus process.


6th edition
Phlebotomy Essentials
Ruth E. McCall
Cathee M. Tankersley
Wolters Kluwer


Strasinger
Di Lorenzo
Phlebotomy Notes
SECOND EDITION
POCKET GUIDE TO BLOOD COLLECTION
• Illustrated, step-by-step procedures
• Tube additive guide
• Best sites for blood collection
• Write-on, wipe-off
WATER PROOF
F.A. DAVIS
BASICS
CARDIO F&E
BASICS
BASICS
BASICS
BASICS
BASICS
BASICS

CLOTTED SAMPLES

EFFECTS OF CLOTTED SAMPLES:

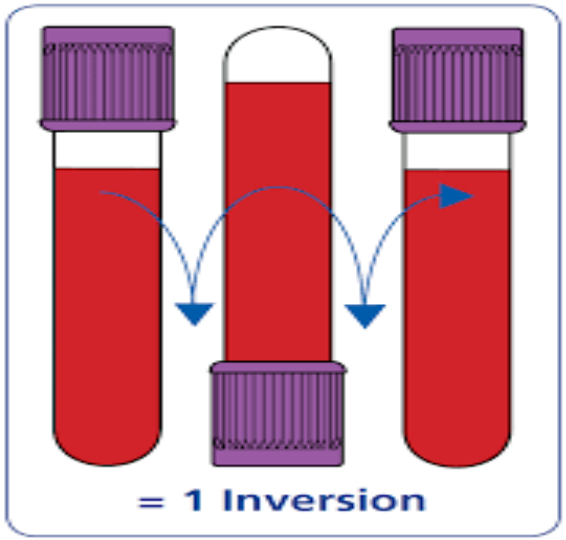
- Clots may alter composition of the specimens, producing inaccurate results.
- Clots can block the systems inside the analyzer, leading to analyzer breakdown and downtime → delay in turnaround time of test results and patient care.

CAUSES OF CLOTTED SAMPLES

- Delay of placing blood in tubes with additives e.g. leaving blood in a syringe too long before transferring to the tube.
- Improper mixing of blood with anti-coagulants in tubes or syringes (for blood gases).
- Over-filled tubes, leaving too little or no air-space that will enable proper mixing with anti-coagulants.

PREVENTION OF CLOTTED SAMPLES

- Transfer blood into the appropriate blood tubes immediately after collection.
- Fill the tubes with the recommended sample volume (as indicated on the tube).
- Gently invert the tubes to properly mix the blood with the anti-coagulants (depends on type of tubes, usually 8-10 times).
- For blood gases, ensure the syringe is free of air bubbles and roll the syringe between your palms.



- Blood sample from a 60-year-old male taken in the outpatient setting revealed the following:
  - K^+ 10.3 mmol/L
  - Na^+ and Cl^- normal
  - Total calcium 0.63 mmol/L
  - ALP 8 IU/L
  - Mg^{2+} 0.3 mmol/L
- Sample is not haemolysed. Patient is well.
- Cause?
  - **K_2-EDTA contamination**
- Important to know the **ORDER OF DRAW** to avoid cross-contamination of additives between blood tubes.

Order of Draw	Tube Stopper Colour	Tube Inversion	Rationale for the Collection Order
Blood culture (sterile collections)		8-10X	Minimise microbial contamination
Coagulation tubes	Light blue 	4 X	The first additive tube in order because all other additives affect coagulation tests
Glass plain tubes	Red 	Nil	Prevent contamination by other additives in other tubes. Plain glass tube should be drawn before the plastic serum tube with SST.
Clot activator, silicon coated (plastic) tubes	Red 	5 X	Filled after coagulation tests because silica particles in the plastic tubes activate clotting and affect coagulation tests (carry-over of silica into subsequent tubes can be overridden by anticoagulant in them)
SST clot activator, gel separator tubes	Gold 	5 X	
Heparin tubes	Green 	8 X	Causes the least interference in tests other than coagulation tests
EDTA tubes	Lavender 	8 X	Responsible for more carry-over problems than any additive. It elevated Na^{+} and K^{+} levels, chelates and decreases Ca^{++} and Fe levels, elevates PT and APTT results.
Oxalate / fluoride tubes	Gray 	8 X	Oxalate is used after haematology tube (lavender stopper) because oxalate interferes in enzyme reaction, damages cell membranes and causes abnormal RBC morphology.

DELAYED SAMPLE PROCESSING

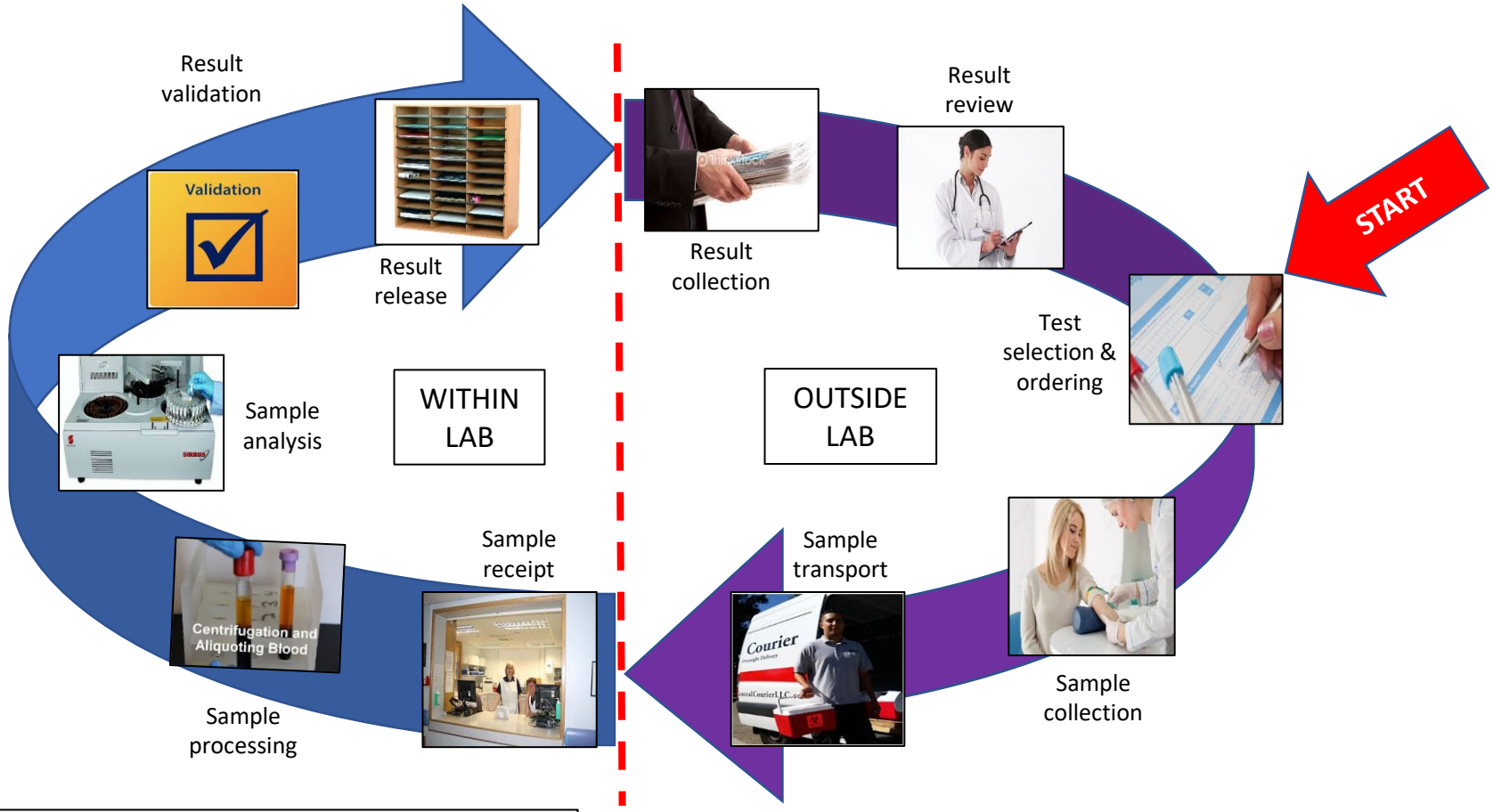
- The Clinical and Laboratory Standards Institute (CLSI) recommends that serum samples are separated **within 2 hours of collection** for most analytes.
- Some analytes are significantly affected by delayed separation because of:
  - Prolonged contact of plasma/serum with cells and leakage of intracellular constituents e.g. **potassium**, inorganic **phosphorus**, **magnesium**, **LDH**.
  - Glycolysis in cells which consumes **glucose** and produces **lactate**.
  - Degradation of **proteins** and **peptides** by blood enzymes.
- **Urine** samples stored at room temperature for > 2 hours will have:
  - Bacterial overgrowth
  - Lysis of RBCs, WBCs and casts
- Specimens need to be sent to the laboratory within the recommended time interval to ensure validity of test results.

LABORATORY TURNAROUND TIME (TAT)

= Total time taken from **sample arrival at the lab** to the **release of validated result.**

Type of request	TAT
Blood gases	45 minutes
hsTroponin T Urgent requests	1 hour
Inpatient but non-urgent requests	4 hours
Outpatient requests	5 working days
Special tests (run in batches) e.g. HbA1c, endocrine tests	5 working days
Outsourced tests	Depends on referral lab

LABORATORY TESTING PROCESS



LABORATORY TURNAROUND TIME

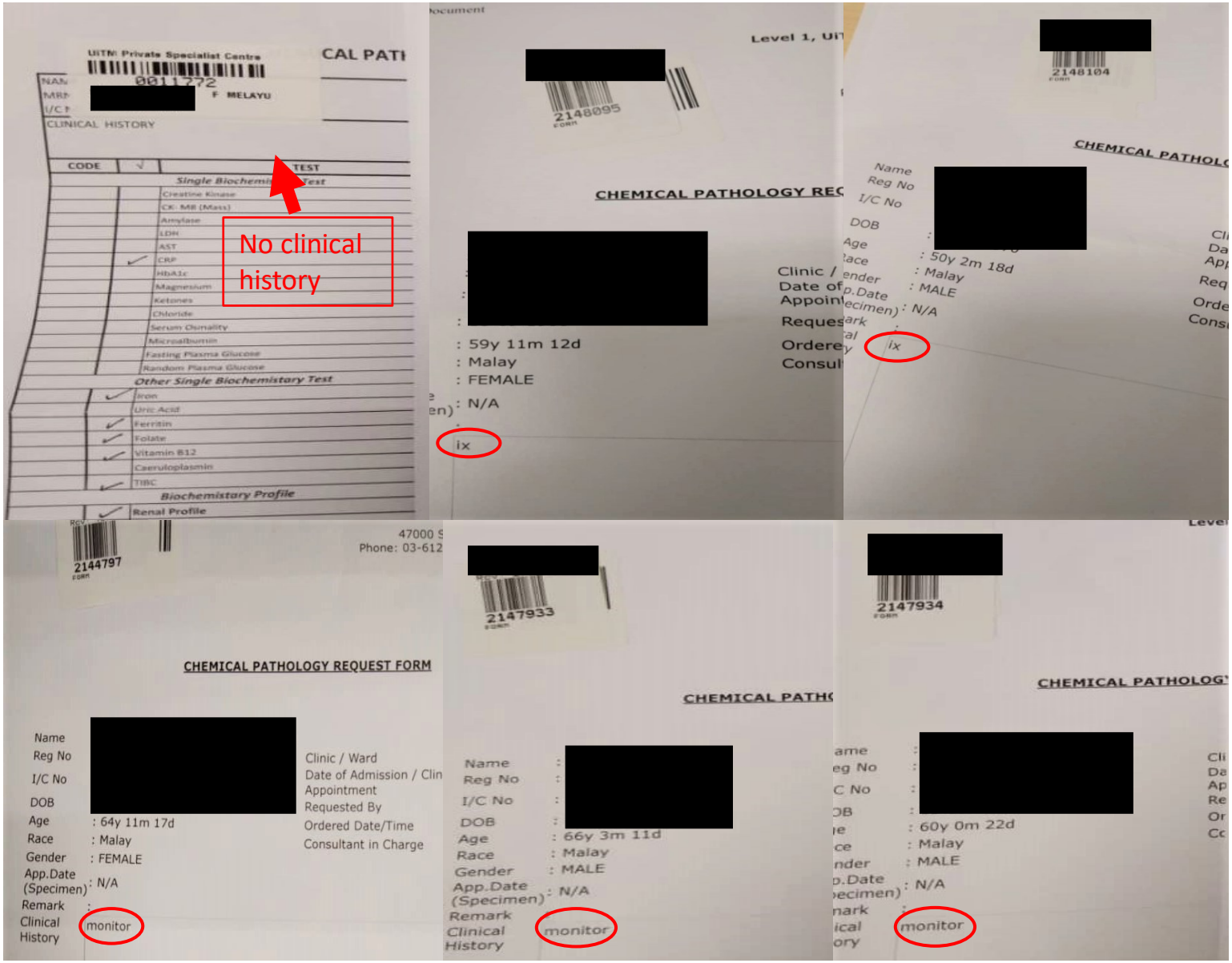
RESPONSIBLE REQUESTING

DO

- Write relevant meaningful clinical history that may assist in interpretation of results.
- Know the indication when consulting the Pathologist for urgent / rare / expensive tests.
- Accept responsibility when notified about critical values (including from outpatients).
- Complete the required forms (e.g. PER PAT) when requesting for outsourced tests.

DO NOT

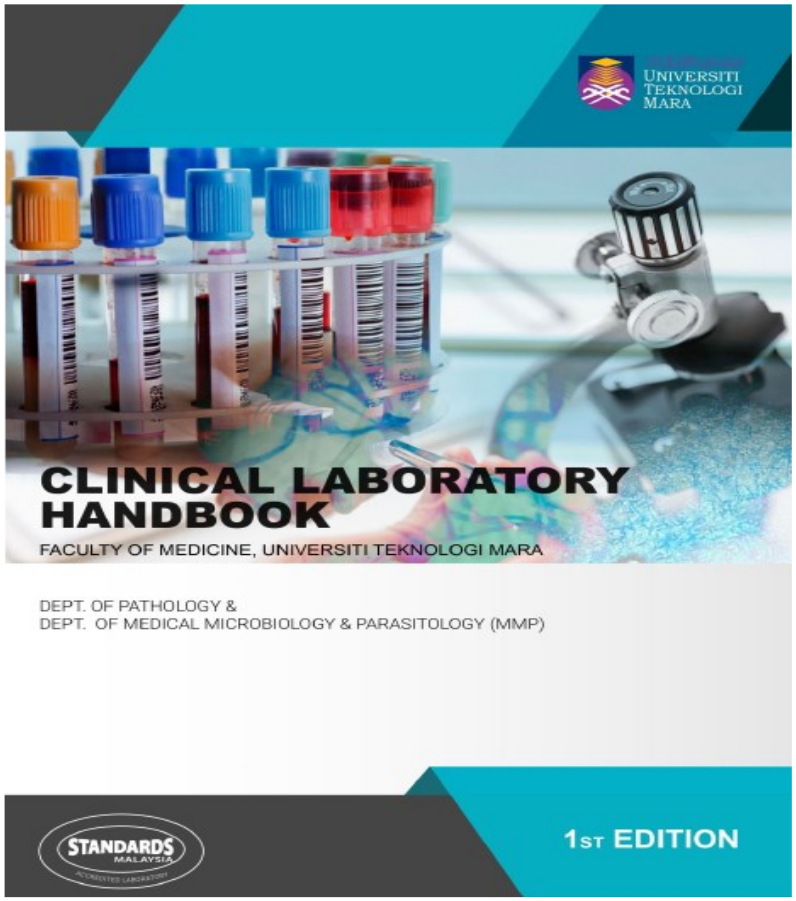
- Abuse urgent requests e.g. urgent request for health screening.
- Order tests without indication e.g. every single hormone or tumour marker on the list.
- Harass the lab staff to report results verbally. The policy of the lab is **NO verbal reporting** except for critical values.


UiTM Private Specialist Centre
CAL PATI
F MELAYU
CLINICAL HISTORY
CODE
TEST
Single Biochemistry Test
Creatine Kinase
CK-MB (Mass)
Amylase
LDH
AST
CRP
HbA1c
Magnesium
Ketones
Chloride
Serum Osmality
Microalbumin
Fasting Plasma Glucose
Random Plasma Glucose
Other Single Biochemistary Test
Iron
Uric Acid
Ferritin
Folate
Vitamin B12
Caeruloplasmin
TIBC
Biochemistary Profile
Renal Profile
No clinical history
2148095
CHEMICAL PATHOLOGY REQ
: 59y 11m 12d
: Malay
: FEMALE
: N/A
ix
2148104
CHEMICAL PATHOLO
: 50y 2m 18d
: Malay
: MALE
: N/A
ix
2144797
Phone: 03-612
CHEMICAL PATHOLOGY REQUEST FORM
Name
Reg No
I/C No
DOB
Age : 64y 11m 17d
Race : Malay
Gender : FEMALE
App.Date (Specimen) : N/A
Remark :
Clinical History
monitor
Clinic / Ward
Date of Admission / Clin
Appointment
Requested By
Ordered Date/Time
Consultant in Charge
2147933
CHEMICAL PATH
Name :
Reg No :
I/C No :
DOB :
Age : 66y 3m 11d
Race : Malay
Gender : MALE
App.Date (Specimen) : N/A
Remark :
Clinical History
monitor
2147934
CHEMICAL PATHOLOG
: 60y 0m 22d
: Malay
: MALE
: N/A
monitor

MISC.

- Add-on tests can be requested for samples that has been sent to the lab, provided:
  - ✓ adequate sample volume remains after the initial tests have been completed
  - ✓ stability of the analyte(s) requested are still acceptable.
- Please check with the lab staff first before ordering add-on tests via UniMEDS. A new request form should be sent to the lab for the add-on tests.
- For dynamic function tests, please inform the lab at least 1 day before performing the test and sending samples.

For further information, please refer to



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thank you