

CUSTOMER EDUCATION SERIES 2021



PRE-ANALYTICAL ERRORS IN CHEMICAL PATHOLOGY LAB

Dr Arjoanna Farra Azizi
Chemical Pathologist & Quality Manager
Dept of Clinical Diagnostic Laboratories (CDL)

9th December 2021

The Department of Clinical Diagnostic Laboratories (CDL)

- Its operation began in October 2010 (*previously known as Centre for Diagnostic Pathology and Research Laboratories (CPDRL)*).
- The main laboratory is located at Level 1, Block A, Hospital UiTM, Puncak Alam and two other locations are in Sg. Buloh and Selayang campuses.
- CDL provides diagnostic, research and consultancy services in the following disciplines:
 - **Chemical Pathology**
 - **Hematology & Transfusion Medicine**
 - **Anatomic Pathology**
 - **Medical Microbiology & Parasitology**
- CDL has been certified with **MS ISO 15189** accreditation by the Dept of Standards Malaysia since 2014.

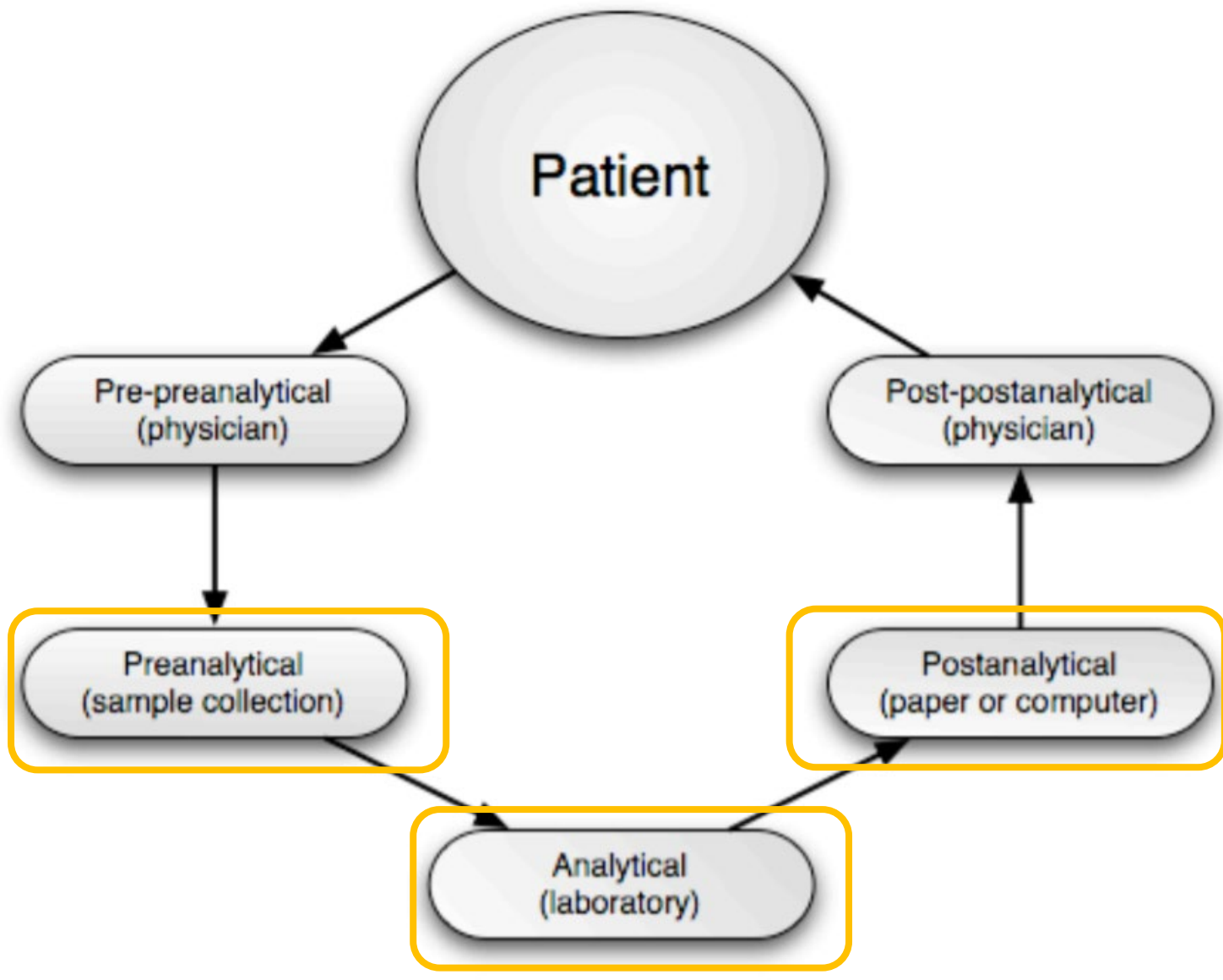


OUTLINES

- **Total Testing Process & Pre-analytical Errors**
 - **Specimen Rejection Criteria**
 - **Chemical Pathology Specimen Rejection Rate**
 - **Issues in Chemical Pathology testing**
 - **Quizzes**
 - **Q&A**
-

INTRODUCTION

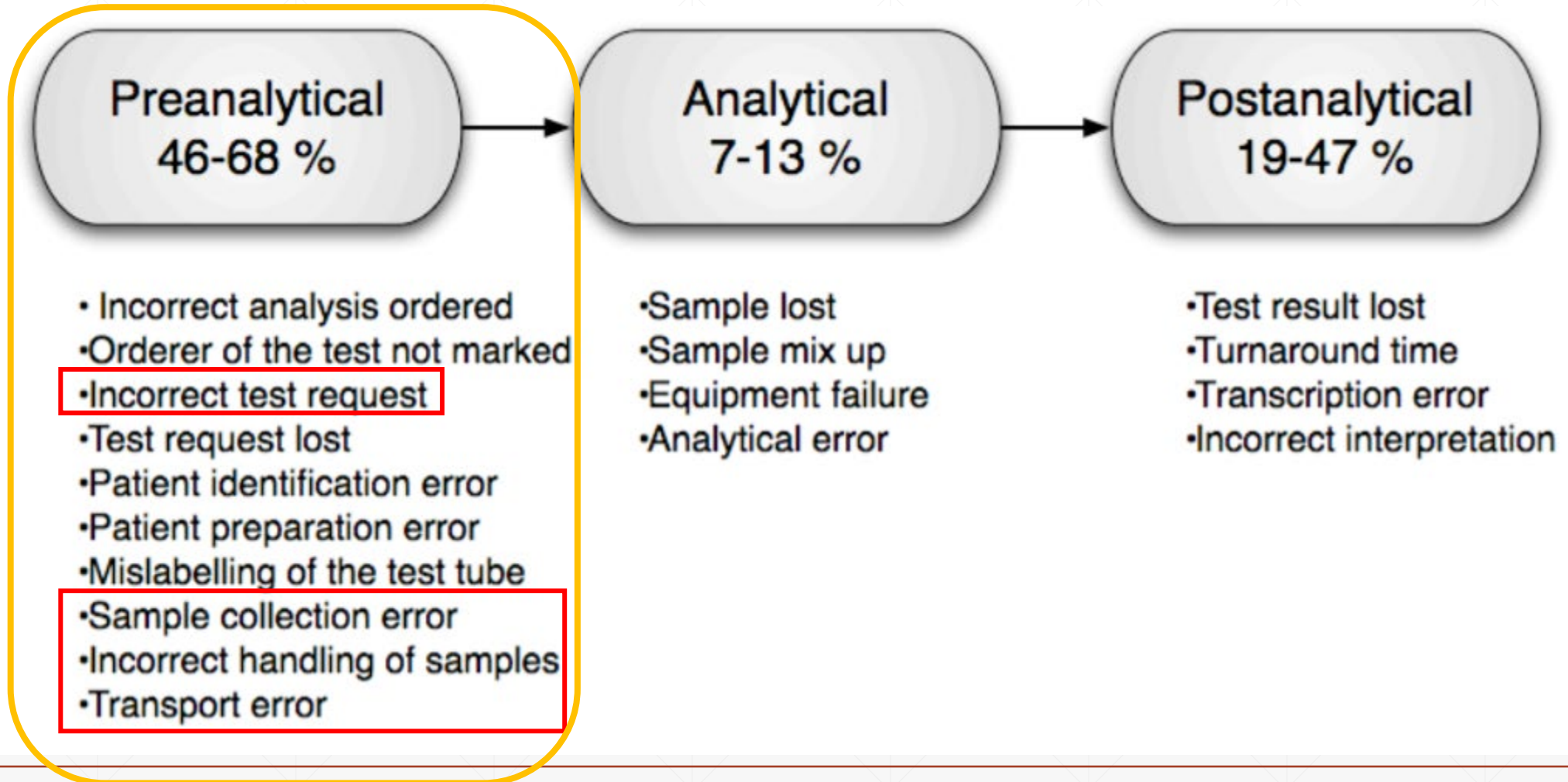
- A patient's diagnosis & treatment are often based on laboratory test results - this is why accurate results are critical
 - Incorrect test results could lead to misdiagnosis which could have potentially fatal consequences
 - Proper specimen collection and handling is a critical part of obtaining a **valid** laboratory result.
-



TOTAL TESTING PROCESS (TTP)

TTP is the total process from the ordering of a test to the interpretation of a test result.




ERRORS WITHIN THE TOTAL TESTING PROCESS



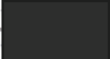
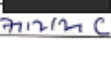
SPECIMEN REJECTION CRITERIA IN CHEMICAL PATHOLOGY

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

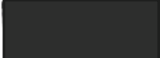

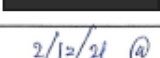
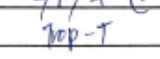
SPECIMEN REJECTION FORM

Patient Name : 
 Registration No. : 
 Lab ID : 
 Requester (Clinic/Ward) : P10
 Date & Time of Reception : 7/12/21 10:00am
 Test Request : HbA1c
 Reason for Rejection :


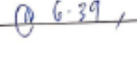
<input type="checkbox"/>	Defective label
<input type="checkbox"/>	Missing label
<input type="checkbox"/>	Wrong label
<input type="checkbox"/>	Incomplete Request form
<input type="checkbox"/>	Hemolyzed sample
<input type="checkbox"/>	Lipaemic sample
<input type="checkbox"/>	Icteric sample
<input type="checkbox"/>	Clotted sample
<input type="checkbox"/>	Expired collection containers
<input type="checkbox"/>	Wrong collection containers
<input type="checkbox"/>	Broken or cracked collection containers
<input type="checkbox"/>	Insufficient specimen
<input type="checkbox"/>	No specimen received (only request form received)
<input type="checkbox"/>	Improper transportation method (specify:)
<input type="checkbox"/>	Temperature not maintained
<input type="checkbox"/>	Delayed specimen received
<input checked="" type="checkbox"/>	Repetitive test order/double request 8/11/2021
<input type="checkbox"/>	Test is not clinically indicated
<input type="checkbox"/>	Out of sample stability
<input type="checkbox"/>	Test is not offered
<input type="checkbox"/>	Improper Specimen Collection
<input type="checkbox"/>	Others (specify:)

Informed by : 
 Received by : 
 Date & Time informed : 7/12/21 10:39am

SPECIMEN REJECTION FORM

Patient Name : 
 Registration No. : 
 Lab ID : 
 Requester (Clinic/Ward) : 
 Date & Time of Reception : 2/12/21 @ 6-10am
 Test Request : Top-T
 Reason for Rejection :

<input type="checkbox"/>	Defective label
<input type="checkbox"/>	Missing label
<input type="checkbox"/>	Wrong label
<input type="checkbox"/>	Incomplete Request form
<input checked="" type="checkbox"/>	Hemolyzed sample H: 130
<input type="checkbox"/>	Lipaemic sample
<input type="checkbox"/>	Icteric sample
<input type="checkbox"/>	Clotted sample
<input type="checkbox"/>	Expired collection containers
<input type="checkbox"/>	Wrong collection containers
<input type="checkbox"/>	Broken or cracked collection containers
<input type="checkbox"/>	Insufficient specimen
<input type="checkbox"/>	No specimen received (only request form received)
<input type="checkbox"/>	Improper transportation method (specify:)
<input type="checkbox"/>	Temperature not maintained
<input type="checkbox"/>	Delayed specimen received
<input type="checkbox"/>	Repetitive test order/double request
<input type="checkbox"/>	Test is not clinically indicated
<input type="checkbox"/>	Out of sample stability
<input type="checkbox"/>	Test is not offered
<input type="checkbox"/>	Improper Specimen Collection
<input type="checkbox"/>	Others (specify:)

Informed by : 
 Received by : 
 Date & Time informed : 6:39, 2/12/21

Requesters will be notified as soon as possible should the test request be unacceptable for any of the above reasons.

CHEMICAL PATHOLOGY SPECIMEN REJECTION (JULY – DEC 2020)

Rejection Rate (SG BULOH)	547 out of 28,059 specimens (1.95%)			Target MSQH: <1%
Top 3 Reasons for Rejection (with % rejection)	No. 1	No. 2	No. 3	
	Double/repetitive order	Haemolysis	Clotted	
	37.1%	24.1%	19.2%	

Rejection Rate (SELAYANG)	47 out of 15,562 specimens (0.3%)			Target MSQH: <1%
Top 3 Reasons for Rejection (with % rejection)	No. 1	No. 2	No. 3	
	Double/repetitive order	No sample received	Clotted	
	46.8%	14.9%	12.8%	

CHEMICAL PATHOLOGY SPECIMEN REJECTION (JAN – JUNE 2021)

Rejection Rate (SG BULOH)	512 out of 28,396 specimens (1.8%)			Target MSQH: <1%
Top 3 Reasons for Rejection (with % rejection)	No. 1	No. 2	No. 3	
	Double/repetitive order	Haemolysis	Clotted	
	42.6%	30.5%	8.8%	

Rejection Rate (SELAYANG)	32 out of 15,643 specimens (0.2%)			Target MSQH: <1%
Top 3 Reasons for Rejection (with % rejection)	No. 1	No. 2	No. 3	
	Double/repetitive order	Clotted	Insufficient sample	
	32.3%	25.8%	16.1%	

DOUBLE/ REPETITIVE ORDER

WHY WE NEED TO PREVENT DOUBLE REQUEST/ REPETITIVE ORDER ?



Financial efficiency
Optimising Patient Care

- INCREASE UNNECESSARY PHLEBOTOMY
- DECREASED PATIENT SATISFACTION
- INCREASED HEALTHCARE COSTS

COMMON TESTS WITH REPETITIVE ORDER

1. Haemoglobin A1c (HbA1c)

- Blood test that is used to help diagnose and monitor people with diabetes
- Sample is **NOT** processed during **Non-Office hours** (but not rejected)
- However, sample will be **rejected** if previous request is **less than 8 weeks interval**

2. Fasting Serum Lipid (FSL)

- Blood test that measures the amount of cholesterol & fats in the body as well as predicts the risk of developing cardiovascular disease
 - Sample is **NOT** processed during **Non-Office hours** (but not rejected)
-



UNIVERSITI
TEKNOLOGI
MARA

CLINICAL DIAGNOSTIC LABORATORIES DEPARTMENT
LEVEL 1, PUSAT PAKAR PERUBATAN UiTM (PPUiTM)
UNIVERSITI TEKNOLOGI MARA
CAWANGAN SELANGOR, SUNGAI BULOH CAMPUS
 Jalan Hospital, 47000 Sungai Buloh, Selangor Darul Ehsan.
 Tel: 03-6126 5215 Faks: 03-6126 5212



Name : [REDACTED]
 Order No : [REDACTED]
 Order Date : 10-11-2021
 Location : [REDACTED]
 Requester : [REDACTED]
 Collection Date : 07-12-2021 08:01

MRN : [REDACTED]
 DOB : [REDACTED]
 Gender : [REDACTED]
 Order From : [REDACTED]
 NIRC : [REDACTED]
 Received Date : 07-12-2021 10:01

Analyte	Results	Unit	Flag	Reference	Methodology
---------	---------	------	------	-----------	-------------

BLOOD

HbA1c(%)	REJECTED	%		<= 5.7	HPLC (Ion Exchange)
HbA1c(mmol/mol)	REJECTED	mmol/mol		<= 39	HPLC (Ion Exchange)

REJECTED: HbA1c was rejected due to repetitive order (previous request is less than 8 weeks interval). Please refer to request on date (08/11/2021) of previous request. Informed to [REDACTED] on 07/12/2021, at 10:39am.

Verified by [REDACTED]
 Validated by [REDACTED]
 Reported Date : 07-12-2021 10:52

Note: Test indicated with (*) are not Skim Akreditasi Makmal Malaysia (SAMM) accredited



HOW TO PREVENT REPETITIVE ORDERS?

- **Follow recommendations of Minimum Retesting Intervals (MRI)**
 - ✓ The minimum time before a test should be repeated (based on the properties of the test and the clinical situation in which it is used).
 - ✓ Determined by consensus recommendations.
- **Know the lab Turn Around Time (TAT) for urgent, routine and specialised tests**



The Association for
**Clinical Biochemistry &
Laboratory Medicine**



The Royal College of Pathologists
Pathology: the science behind the cure

National Minimum Re-testing Interval Project:

A final report detailing consensus recommendations for
minimum re-testing intervals for use in Clinical Biochemistry

Prepared for the Clinical Practice Group of the
Association for Clinical Biochemistry and Laboratory Medicine and
supported by the Royal College of Pathologists.

Report Author: Dr Tim Lang – Project Lead

LAB TURN AROUND TIME (TAT)

Defined as the time interval between sample arrival at the lab to the release of validated result

Type of request	TAT
Blood gases	45 minutes
hs Troponin 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

- 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

LIST OF 24 HR (ONCALL) TESTS

FSL & HbA1c are not part of 24hr/
oncall tests

Specimens received out-of-office hrs
will be kept an analyzed on the next
working day.

Tests that are run in batches:

- **Thyroid function tests (TFT)**
- **Iron profile, Folate & vit B12**
 - Every Wednesdays
- **Other endocrine (hormone) tests: LH, FSH, E2, PROG, TESTO, PRL, CORTISOL**
 - Every Thursdays

**Turn-Around Time
(TAT)**

5 working days

HAEMOLYSIS

HAEMOLYSIS

What is haemolysis?

- Hemolysis is the breakdown of RBC and the release of intracellular contents into surrounding fluid (e.g. blood plasma)

How do you know when a blood specimen has been hemolyzed?

- Hemolysis cannot be detected until after the tubes have been spun.

How many types of haemolysis?

- **In-vivo (in the patient):** Due to medical conditions e.g. such as autoimmune hemolytic anemia or transfusion reaction.
 - **In-vitro (in the collection tube):** Due to improper specimen **collection**, specimen **processing** or specimen **transport**.
-

HAEMOLYSIS

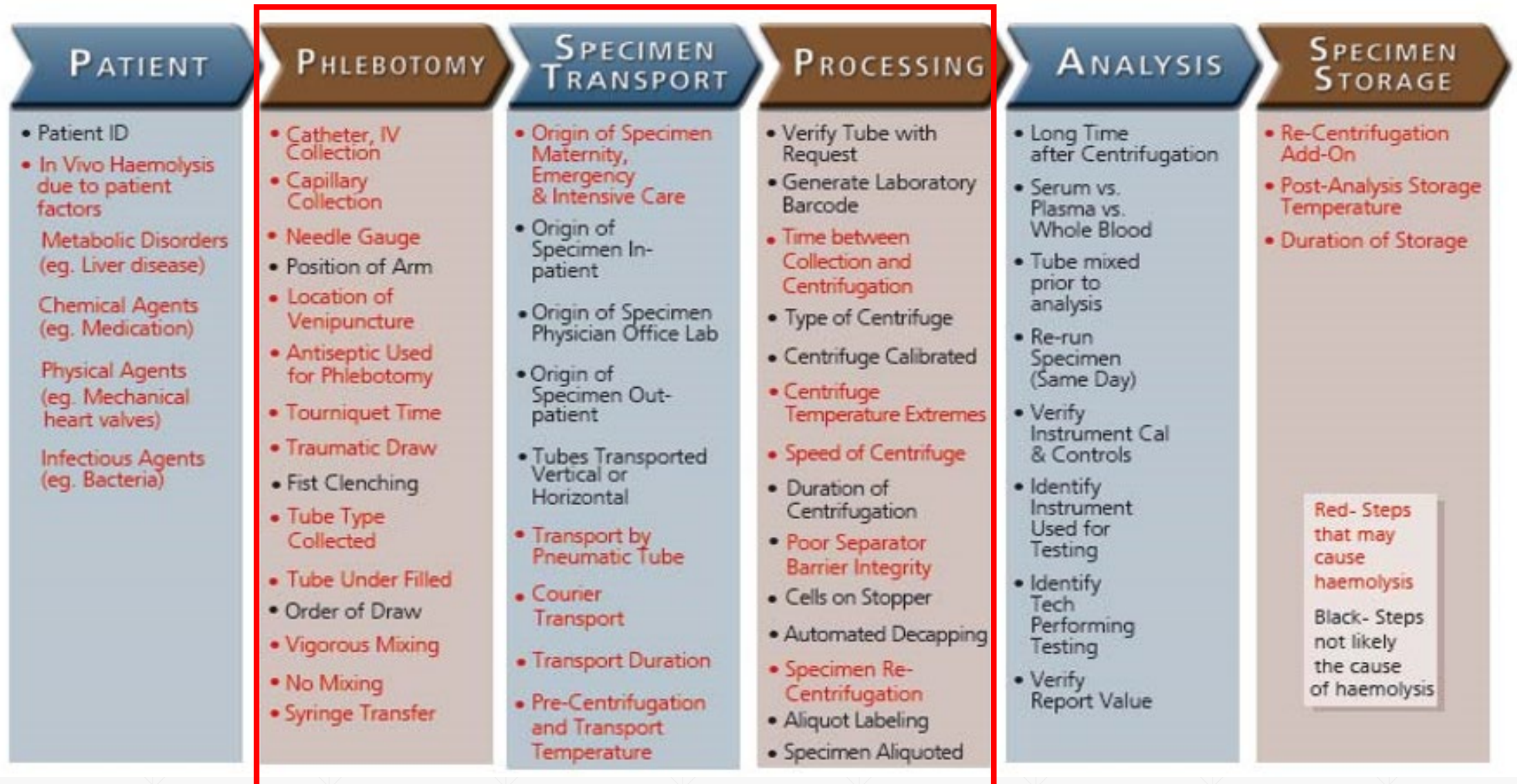
The first tube is not hemolyzed.
This sample is acceptable.



Tube number 2 is slightly hemolyzed, and may or may not be acceptable depending on the test.

Tubes 3 and 4 are grossly hemolyzed and will need to be recollected.

FACTORS AFFECTING HAEMOLYSIS IN PREANALYTICAL PROCESS





UNIVERSITI
TEKNOLOGI
MARA

CLINICAL DIAGNOSTIC LABORATORIES DEPARTMENT
LEVEL 1, PUSAT PAKAR PERUBATAN UiTM (PPUiTM)
UNIVERSITI TEKNOLOGI MARA
CAWANGAN SELANGOR, SUNGAI BULOH CAMPUS
Jalan Hospital, 47000 Sungai Buloh, Selangor Darul Ehsan.
Tel: 03-6126 5215 Faks: 03-6126 5212



Name	:	[REDACTED]	MRN	:	[REDACTED]
Order No	:	[REDACTED]	DOB	:	[REDACTED]
Order Date	:	02-12-2021	Gender	:	[REDACTED]
Location	:	[REDACTED]	Order From	:	[REDACTED]
Requester	:	[REDACTED]	NIRC	:	[REDACTED]
Collection Date	:	02-12-2021 06:07	Received Date	:	02-12-2021 06:12

Analyte	Results	Unit	Flag	Reference	Methodology
---------	---------	------	------	-----------	-------------

SERUM

Total Protein	74.6	g/L		64.0 - 83.0	Biuret/endpoint (with blank)
Albumin	28.7	g/L	L	35.0 - 52.0	BCG-Citrate Buffer
Alanine Transaminase (ALT)	10.6	U/L		< 33.0	IFCC (w/out pyridox. phos)
<i>Sample is haemolyzed (haemolytic Index: 130). Haemolysis may interfere with serum ALT and Direct Bilirubin measurement.</i>					
<i>Suggest to repeat blood test with a new sample if clinically indicated.</i>					
Alkaline Phosphatase	90.0	U/L		35.0 - 105.0	AMP Buffer rate (IFCC)
GGT	18.0	U/L		< 40.0	Other g-Glut-3-carboxy-nitro
Total Bilirubin	4.8	umol/L		<= 21.0	Diazonium salt
Direct Bilirubin	<1.5	umol/L		<= 5.0	Diazo method
C-Reactive Protein	37.6	mg/L	H	< 5.0	Particle enhanced turbidimetri
HS Troponin T	REJECTED	ng/L		<= 14	ECLIA (sandwich)

REJECT. Hemolysed sample. Informed SN Zulaiha at 6.39am on 02/12/2021 by MLT Lela

Comment for Order: Sample is haemolyzed (haemolytic Index: 130). Haemolysis may interfere with serum ALT and Direct Bilirubin measurement. Suggest to repeat blood test with a new sample if clinically indicated.

Verified by : [REDACTED]
Validated by : [REDACTED]
Reported Date : 02-12-2021 06:42

Note: Test indicated with (*) are not Skim Akreditasi Makmal Malaysia (SAMM) accredited

WHY IS HEMOLYSIS AN ISSUE?

- ✓ **Impact the validity of test results**

- Certain lab tests can be affected and the reported results will be inaccurate.
- Falsely decreases values such as Na, ALP, GGT, glucose, albumin
- Falsely elevates values such as K, ALT, AST, creatinine, CK, LDH, PO4, Mg

- ✓ **Requires a repeat collection from the patient**

- ✓ **Delay in diagnosis/ treatment**

- ✓ **Patient discomfort & dissatisfaction**

- ✓ **Additional healthcare expenses**

HOW TO PREVENT HAEMOLYSIS?

When **collecting** specimens:

- ✓ Do not leave tourniquet on for longer than one minute
- ✓ Allow alcohol to dry completely before puncturing the skin
- ✓ Use a properly sized needle; 20-22 gauge needles work best for routine collections
- ✓ Do not remove the needle from the vein with the vacuum tube still engaged

When **processing** specimens:

- ✓ Make sure sample is not exposed to extreme heat or cold
- ✓ Allow blood to clot completely prior to centrifugation
- ✓ Avoid vigorous mixing or shaking of tubes
- ✓ Do not centrifuge specimens at higher speed or for longer than necessary

When **transporting/shipping** specimens:

- ✓ Make sure sample is not exposed to extreme heat or cold
 - ✓ Do not ship whole blood containers on dry ice (unless it's an SST or PST that has been centrifuged prior to shipment)
 - ✓ Do not subject the specimen to significant jostling or jarring.
-











ORDER OF DRAW

ORDER OF DRAW

- Specimens must be collected in the appropriate collection container, correctly labeled and transported promptly to the laboratory.
 - ‘**Order of draw**’ is the **tube sequence** that a phlebotomist needs to follow while collecting blood.
 - A correct Order of Draw ensures a good quality sample to be used for diagnostic purposes to provide accurate results.
-

Order of Draw: The Correct Tube Sequence

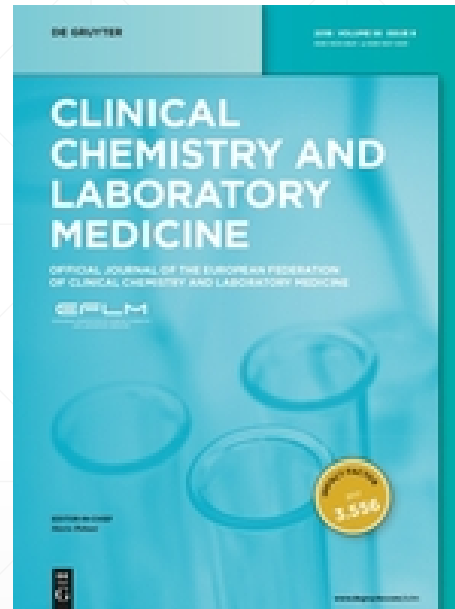
1st	2nd	3rd		
 <p>BLOOD CULTURES PEDIATRIC ACID FAST ANTIBIOTIC</p>	 <p>BLUE TOP SODIUM CITRATE Blue top must be filled to volume.</p>	 <p>RED No gel</p>		
4th	5th	6th	7th	8th
 <p>GOLD TOP With gel</p>	 <p>LIGHT GREEN TOP Lithium Hep</p>	 <p>LAVENDER TOP EDTA</p>	 <p>PINK TOP BLOOD BANK ONLY EDTA</p>	 <p>GRAY TOP NaFL K Oxalate</p>

WHY IS THE ORDER OF DRAW IMPORTANT?

- If the order of draw is not followed, then the additives in one tube can be transferred to another, causing **cross-contamination** and **inaccurate results**.
 - Inaccurate results may lead to **misdiagnosis** which may prevent patients from receiving the correct treatment.
-

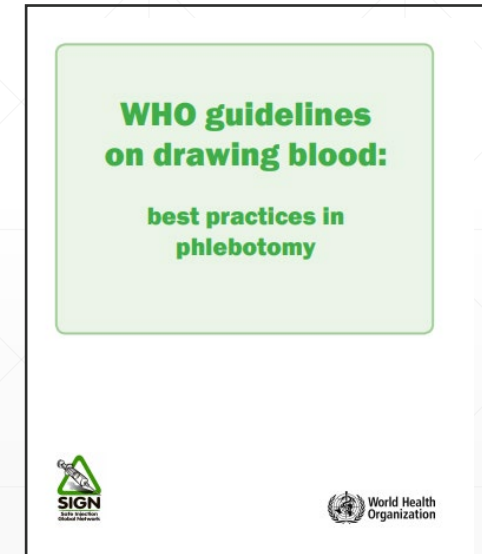
GUIDELINES WHICH RECOMMEND 'ORDER OF DRAW'

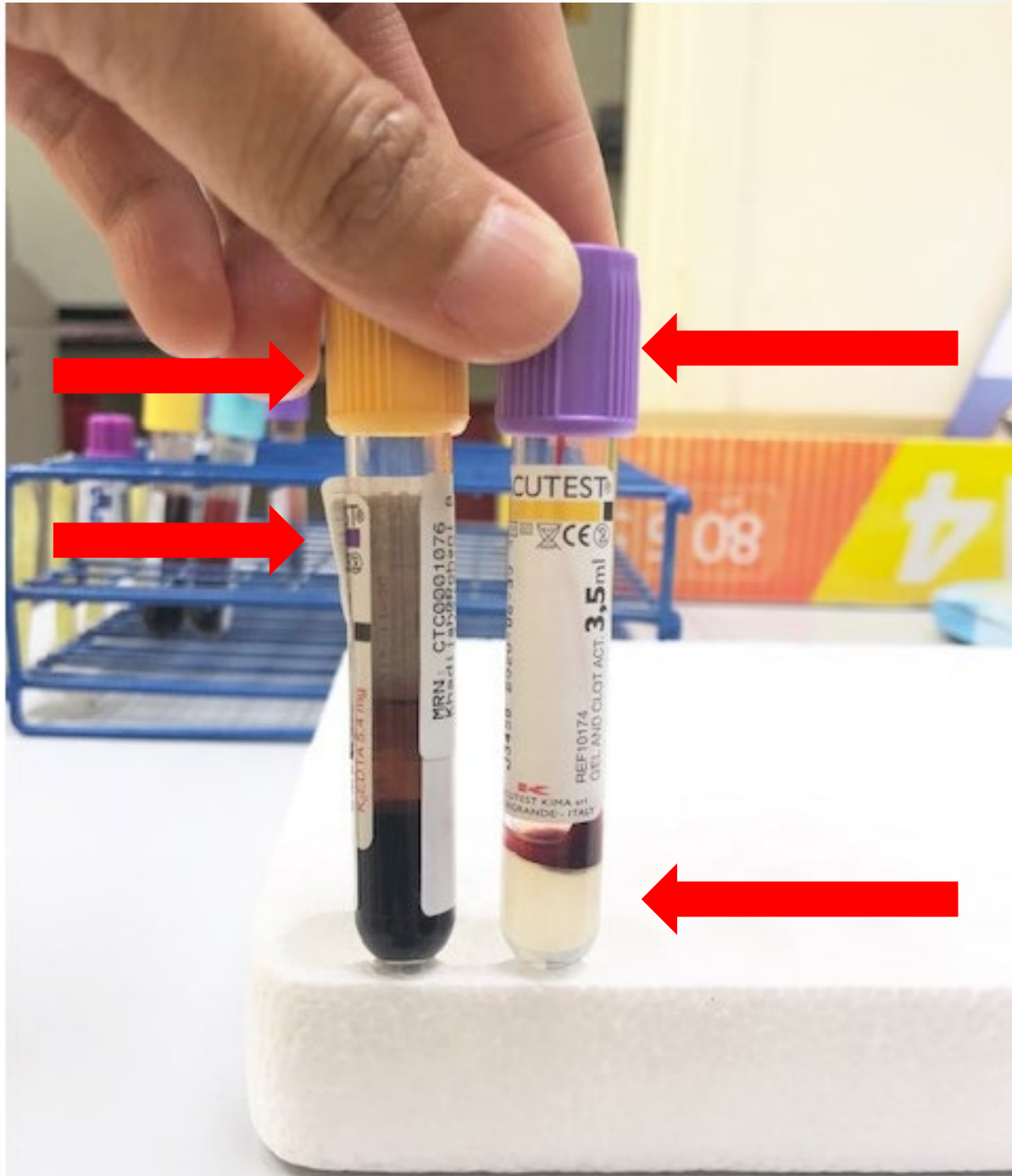
Clinical and Laboratory Standards Institute (CLSI) Guideline: GP41
Collection of Diagnostic Venous Blood Specimens, 7th Edition, April 2017



Cornes M et al. Order of blood draw: Opinion paper by the European Federation for Clinical Chemistry and Laboratory Medicine (EFLM) Working Group for the Preanalytical Phase (WG-PRE). Clin Chem Lab Med 2017;55:27–31

World Health Organization. (2010). WHO guidelines on drawing blood: Best practices in phlebotomy





Can you spot the error?

Tests ordered:

- FBC (EDTA tube)
- Renal & Bone profile, Magnesium (SST gel tube)

Patient's blood results:

K+ > 36.4 mmol/L (from analyser)

Others results: **↓ ALP, ↓ Ca²⁺, ↓ Mg²⁺**

**Sample NOT HAEMOLYSED
... but Gives Erroneous Results!**

The erroneous results are due to **contamination** with additives present in the **purple top tube** as **K-EDTA** additives bind with ALP, Ca²⁺ & Mg²⁺ giving low results → importance of 'Order of Draw'.



IMPORTANT REMINDERS

- **Separate request form is required for different Units (do not print on both sides of paper).**
- **Segregate samples into different biohazard bags according to the different Units.**
- **For dynamic function tests, inform CDL at least 1 day before performing the test and sending samples.**
- **Do 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.**

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.**
-

TOP 10 TIPS FOR REDUCING SAMPLE COLLECTION ERRORS

1. Before a sample is collected, ALWAYS check for the **CORRECT** patient's identity.

2. Ensure the **CORRECT** bottle is selected for the test(s) requested.

3. AVOID haemolysis during phlebotomy.

4. Use the **CORRECT** Order Of Draw to avoid sample contamination.

5. Ensure sample tubes are **CORRECTLY** filled (esp. for tubes containing anticoagulant and for clotting studies).

6. ALWAYS label the sample at the patient's side to prevent patient and specimen mix ups.

7. All samples MUST be labelled **CORRECTLY** with the appropriate Request Forms.

8. ALWAYS verify the accuracy of specimen labelling before you/ patient leaves the treatment area.

9. Use **CORRECT** urine containers with the **CORRECT** preservative for urine analysis.

10. If in doubt, **CONTACT the laboratory** or refer to the laboratory handbook.

CLINICAL DIAGNOSTIC LABORATORIES

[Introduction](#)

[Organisation Chart](#)

[ISO 15189](#)

[Services](#)

[Activities](#)

[Achievements](#)

[Operation Hour](#)

[Contact Us](#)

[Download](#)

Dr Aletza Binti Mohd Ismail (Head of Department)

Tel: 03-61267400

Email: aletza@uitm.edu.my

Medical Specialist UiTM Sg. Buloh:

1. Central Specimen Reception (CSR)

03-61265000 ext 5215

2. Anatomic Pathology Unit

03-61265000 ext 5053 / 5244

3. Haematology & Transfusion Medicine Unit

03-61265000 ext 5215 / 5209

4. Medical Microbiology & Parasitology Unit

03-61265000 ext 5247 / 5246

Medical Specialist Centre UiTM Selayang:

1. Selayang Campus Lab

03-61264813

<https://hospital.uitm.edu.my/images/departments/clinical/pathology/download/2021-CDL-Handbook-v11Oct.pdf>



**Unleashing Potentials
Shaping the Future**

[HOME](#) [SERVICES](#) [DOWNLOAD](#) [DIRECTORY](#) [CORPORATE](#) [CONTACT US](#)

CLINICAL DIAGNOSTIC LABORATORIES

- [Introduction](#)
- [Organisation Chart](#)
- [ISO 15189](#)
- [Services](#)
- [Activities](#)
- [Achievements](#)
- [Operation Hour](#)
- [Contact Us](#)
- [Download](#)

Clinical Laboratory Handbook ←

- Customer Education Series Handouts
- Guidelines
- Forms
- Reports

THE HOSPITAL

- [UITM Main Website](#)
- [Home](#)
- [Top Management](#)
- [Location](#)
- [FAQ](#)
- [Quotations](#)

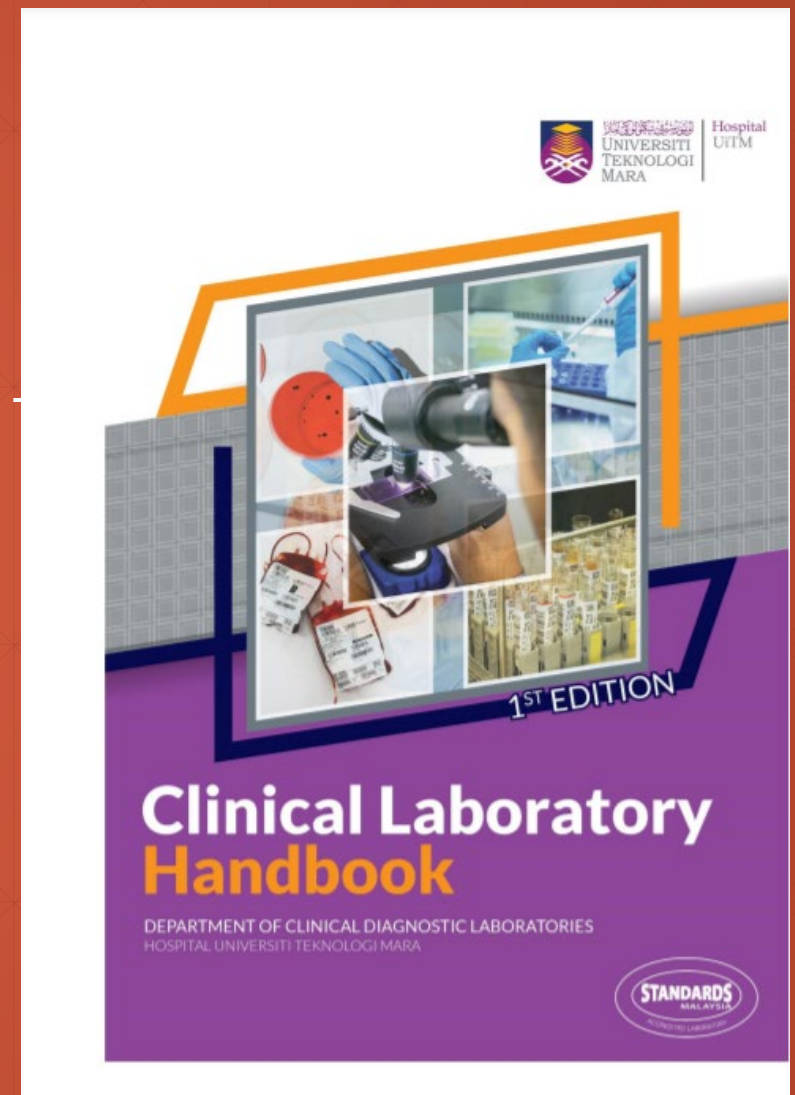
CONTACT US

Hospital UiTM
42300 Bandar Puncak Alam
Selangor+
☎ +6 (03) 3396 3000 / 3001 / 3002
✉ huitm.unitkorporat@uitm.edu.my

DIGITAL MOBILE APPS



For further information:



First Edition, September 2021

QUIZ 1

Causes of in-vitro haemolysis include:

i.	small needle gauge
ii.	forcing blood into tube using syringe
iii.	vigorous mixing of blood tubes
iv.	tubes transported horizontally

ANSWER

- | | |
|-----------|----------------------|
| A. | i and ii |
| B. | i and iii |
| C. | i, ii and iii |
| D. | All the above |

QUIZ 1

Causes of in-vitro haemolysis include:

i.	small needle gauge
ii.	forcing blood into tube using syringe
iii.	vigorous mixing of blood tubes
iv.	tubes transported horizontally

ANSWER

A. i and ii

B. i and iii

 C. i, ii and iii **CORRECT!**

D. All the above

QUIZ 2

Fill in the blanks:

1.	Blood sample for HbA1c test is rejected if previous request is less than __ weeks interval.
2.	TAT for urgent Troponin test is ____ hour.
3.	TAT for outpatient test request is ____ working days.
4.	Hemolysis is detected ____ (before/ after) the blood tubes have been spun.

QUIZ 2

Fill in the blanks:

1.	Blood sample for HbA1c test is rejected if previous request is less than _8_ weeks interval.
2.	TAT for urgent Troponin test is __1__ hour.
3.	TAT for outpatient test request is __5__ working days.
4.	Hemolysis is detected __after__ (before/ after) the blood tubes have been spun.

