

OPTIMIZING SAMPLE TRANSPORTATION, STORAGE & STABILITY FOR RELIABLE RESULTS

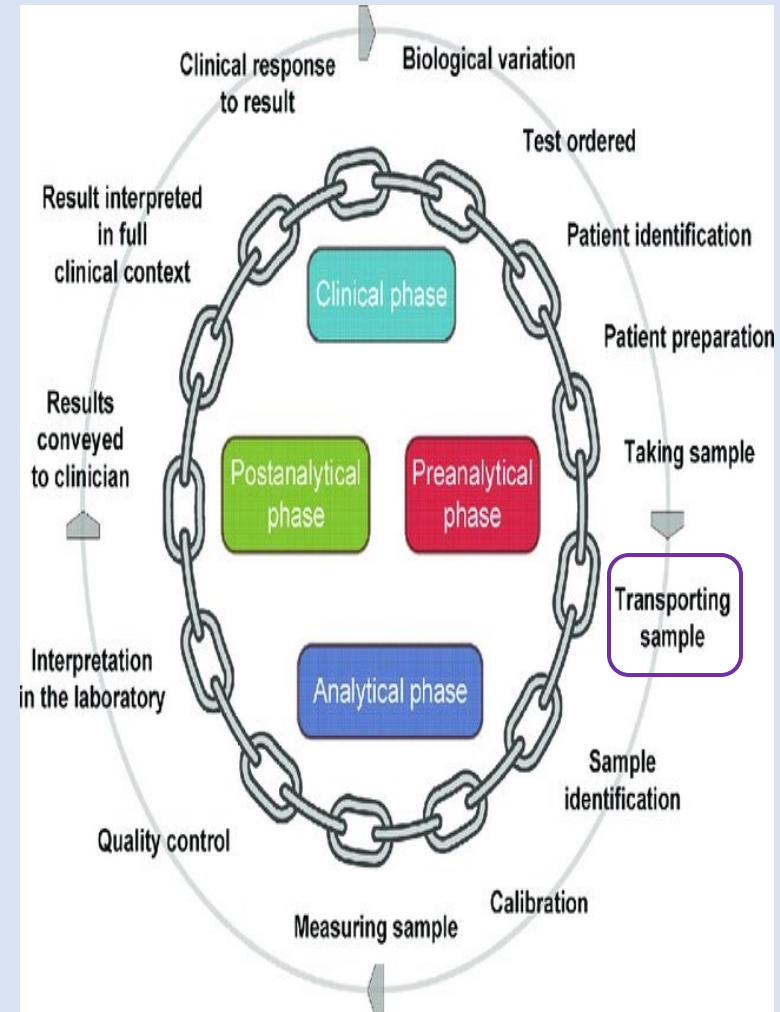
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INTRODUCTION

- ~70% of clinical decisions are made based on laboratory tests.
- The result of any laboratory test is only as good as the specimens received by the laboratory.



- Effects of poor quality specimen:
 - ✘ Compromise the validity of test results → misdiagnosis, wrong treatment, malpractice
 - ✘ Requires a repeat collection from the patient. → ?Precious sample, patient discomfort and dissatisfaction
 - ✘ Delay in diagnosis/ treatment/ patient care
 - ✘ Additional expenses



SAMPLE TRANSPORTATION

- All collected samples should be transported to the laboratory in appropriate containers and thereafter put into a biohazard plastic bag.
- The sample should be placed in the sealable compartment and the completed request form placed in the outer pouch to prevent contamination. Ensure the containers and bags are properly sealed to avoid spills / leakage.
- Separate biohazard bags and request forms should be used for samples that will be sent to different units.
- Some samples are not advisable to be transported using the pneumatic tube. This includes samples in dilute liquid form or containing liquid, with high probability of spillage / leakage, e.g.
 - ✘ Blood gases and lactate
 - ✘ Urine (random or 24-hour)
 - ✘ Body fluids



SAMPLE TRANSPORTATION & STORAGE

- Arterial blood gas and lactate measurements are **temperature-sensitive** and **affected by delay in analysis** due to metabolic processes by RBC and WBC that continue to occur.
- It is recommended that the samples should be **analysed within 15-30 minutes** of collection. Consequences of delayed analysis include:
 - ✘ pH decreases
 - ✘ pO₂ decreases
 - ✘ pCO₂ increases
 - ✘ HCO₃⁻ decreases
 - ✘ Lactate increases
- Store and transport the blood sample in **ice slurry / iced water**. Cooling the blood sample can help to minimize enzyme activity, slow down metabolic processes, preserve gas levels and prevent bacterial growth.

SAMPLE TRANSPORTATION & STORAGE

- A study showed that pO_2 in samples stored at room temperature fell an average of 1.21 kPa/min for the first 10 minutes. When the samples were stored in ice slurry, the decline in pO_2 decreased to 0.19 kPa/min.
- Transport of blood gas samples using the **pneumatic tube** can vigorously agitate the sample, creating **air bubbles**, which can cause inaccurate pO_2 and pCO_2 measurements.
- Sample should be sent in heparinised **syringe WITHOUT the needle**, as it pose a safety hazard.

Scenario 1

- Patient A was admitted to the ward at 11.30pm. His blood sample was taken for RP, bone profile, LDH and plasma glucose.
- Since it was a busy night and no staff was free to send the samples to the lab, the house officer decided to store them overnight in the fridge.
- The samples were sent to the lab at 5.00am the next morning.
- What do you think of this practice?

SAMPLE TRANSPORTATION & STORAGE

- The Clinical and Laboratory Standards Institute (CLSI) recommends that **serum / plasma samples are separated from cells within 2 hours** of collection.
- Specimens need to be transported to the laboratory within the recommended time interval to ensure validity of test results.
- Some analytes are significantly affected by delayed centrifugation and sample separation due to:
 - ✘ Prolonged contact of plasma/serum with cells and **leakage of intracellular constituents** e.g. **potassium, phosphate, magnesium, LDH**
 - ✘ Glycolysis in cells which **consumes glucose** and **produces lactate**
 - ✘ **Degradation of proteins / peptides** by blood enzymes

Scenario 2

- Patient B came to the clinic for blood taking. Samples (blood and urine samples) were collected at 8.00am.
- When closing for lunch hour at 1.00pm, the clinic staff noticed that Patient B's urine sample for UFEME was mistakenly left on the counter. Other blood samples have been sent to the lab.
- The staff waited after lunch hour at 2.00pm to send the urine sample to the lab. However, the sample was rejected.
- Why?

SAMPLE TRANSPORTATION & STORAGE

- Urine samples for UFEME should be transported to the lab and examined within the first **2 hours** after collection.
- Urine samples stored at room temperature for > 2 hours may have the following changes, which affect the validity of test results:

Urine Substance	Changes	Mechanism
pH	Increased (more alkaline)	Due to the breakdown of urea into ammonia by bacteria
Colour	Darker	Due to oxidation or reduction of metabolites
Turbidity	Increased	Due to bacterial growth and crystal precipitation
Odour	Increased / foul-smelling	Due to bacterial decomposition of urea and ammonia
Glucose	Decreased	Due to glycolysis by bacteria
Bilirubin	Decreased	Bilirubin is oxidized to biliverdin
Urobilinogen	Decreased	Urobilinogen is oxidized to urobilin.
Acetoacetate (Ketone)	Decreased	Due to conversion into acetone, which evaporates
Nitrite	Increased	Due to bacterial production
Cells (RBC, WBC, epithelial cells) and casts	Decreased or disappeared	Due to lysis of cells and dissolution of casts
Bacteria	Increased	Due to bacterial proliferation

Scenario 3

- Blood sample was collected from Patient C at 9.30am and sent to the lab for RP, LFT and glucose.
- During the afternoon ward round at 2.30pm, the specialist asked to test Patient C for thyroid function test.
- What would you do?
 - A) Take a new blood sample for TFT.
 - B) Send request form for add-on TFT to the lab.
 - C) Call the lab first to check whether you can request TFT as an add-on test.

SAMPLE STABILITY: ADD-ON TESTS

- Def: Additional tests requested by clinicians to be tested on existing samples that have been received by the lab.
- Add-on tests can be requested, provided:
 - ✓ **adequate sample volume** remains after the initial tests have been completed, AND
 - ✓ **stability** of the analyte(s) requested are still acceptable.
- **Please call the lab first to check** whether the above criteria are fulfilled.
- If accepted by the lab, order the add-on test(s) via UniMEDS.
- Send a new request form and barcode label to the lab.

Back to Patient B

- The initial blood sample at 9.30am was collected in plain tube (for RP & LFT), which is the same type of blood tube used for TFT.
- Stability at room temperature
 - ✓ Free T4: stable up to 8 hours
 - ✓ TSH: stable up to 18 hours
- Time interval from blood collection to new request = 5 hours (still within the stability period).
- Add-on TFT can be requested provided remaining sample volume is sufficient → please check with lab first.

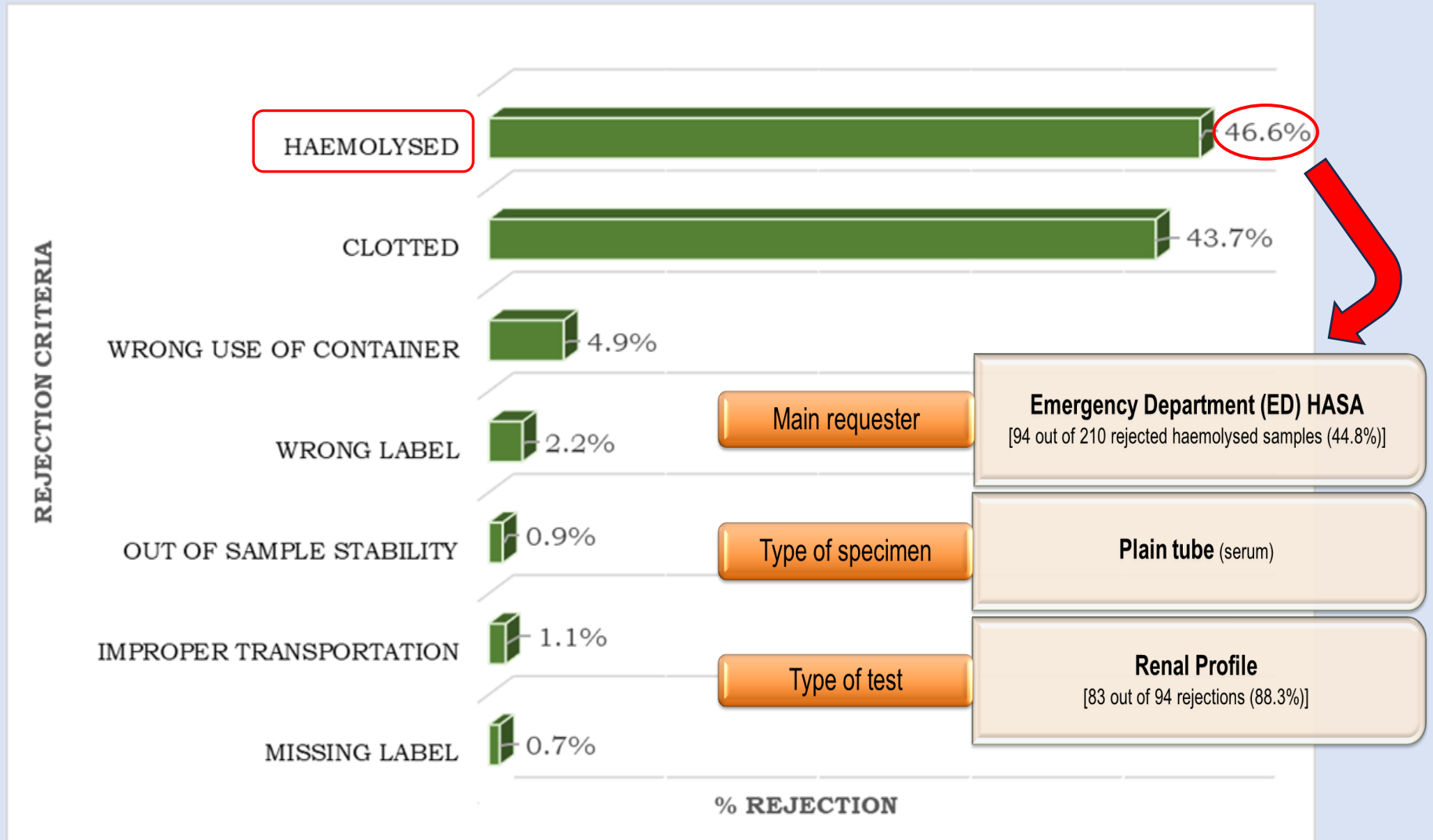
CHEMICAL PATHOLOGY UNIT SPECIMEN REJECTION STATISTICS (JULY – DECEMBER 2023)



SPECIMEN REJECTION IN CP UNIT, HASA (JULY-DEC 2023)

Total no. of received specimen	50,461
Total no. of rejected specimen	451
% of rejection	0.9%
Commonest cause for rejection	Haemolysed sample 210 out of 451 rejected samples (46.6%)
Requester with the highest no. of rejected specimen	Emergency Dept (ED) HASA 163 out of 451 rejected samples were from ED (36.1%)
The most rejected specimen	Plain tube (serum)

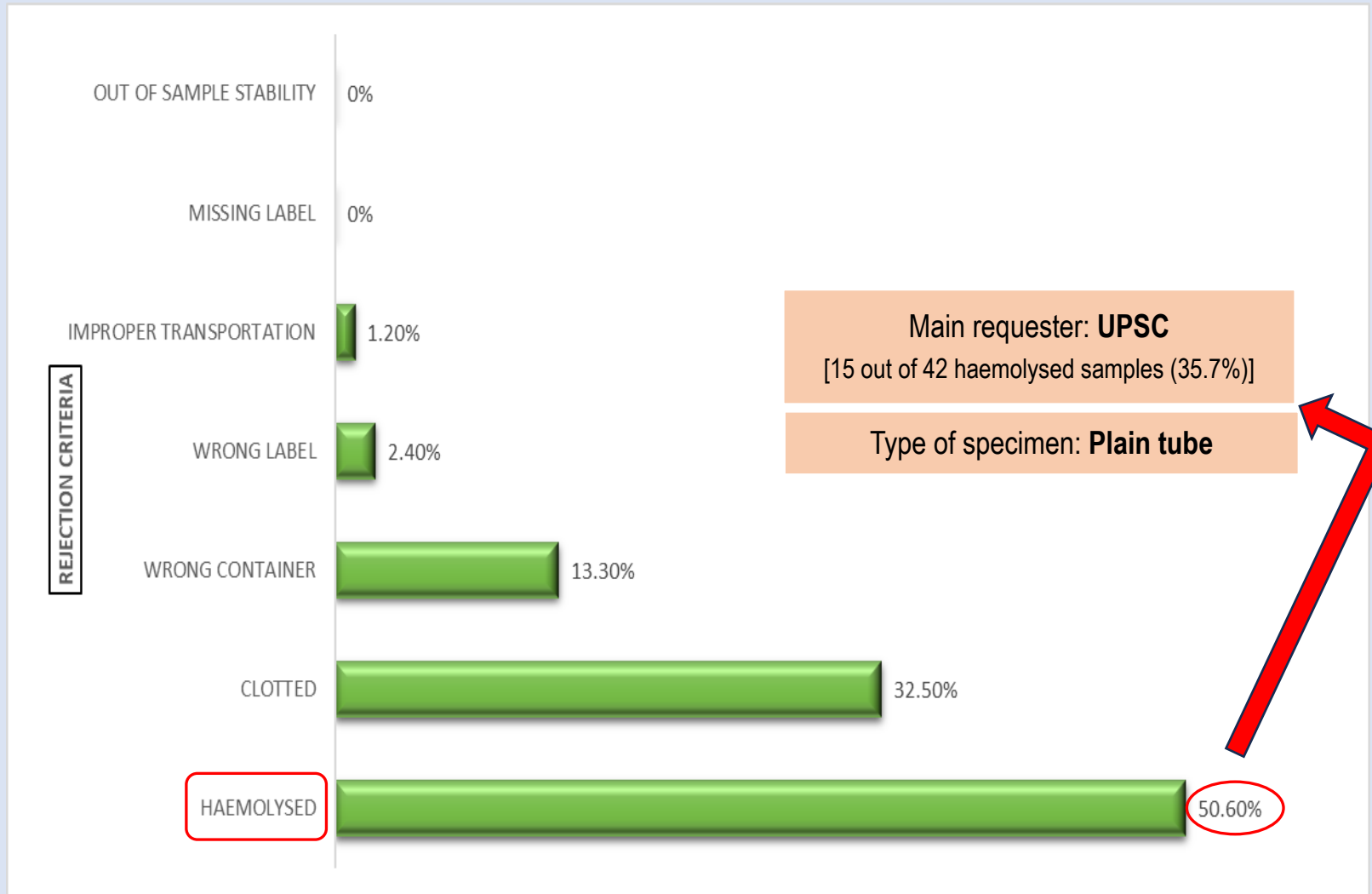
CAUSES OF SPECIMEN REJECTION IN CP UNIT, HASA (JULY-DEC 2023)



SPECIMEN REJECTION IN CP UNIT, SG BULOH (JULY-DEC 2023)

Total no. of received specimen	39,394
Total no. of rejected specimen	83
% of rejection	0.2%
Commonest cause for rejection	Haemolysed sample 42 out of 83 rejected samples (50.6%)
Requester with the highest no. of rejected specimen	Phlebotomy Unit, Sg Buloh 24 out of 83 rejected samples were from Phlebotomy Unit (28.9%)
The most rejected specimen	Plain tube (serum) 43 out of 83 rejected samples (51.8%)

CAUSES OF SPECIMEN REJECTION IN CP UNIT, SG BULOH (JULY-DEC 2023)



EFFECTS OF HAEMOLYSIS



- Overestimation of K, ALT, AST, creatinine, CK, iron, LDH, lipase, Mg, phosphate, and urea.
- Significantly decreased Na, albumin, ALP, Cl, GGT and glucose.
- A haemolysis index of 150 (Hb 1.9 g/L) may cause >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 haemolysis by visual inspection (Hb < 0.6 g/L).

STEPS TO MINIMISE HAEMOLYSIS

GOOD PHLEBOTOMY PRACTICE

- Use a suitable needle gauge. Too small a needle results in excess vacuum force and may cause shear stress on the cell walls.
- 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 haemoconcentration and increased risk of haemolysis.
- Allow venipuncture site to completely air dry after cleaning with alcohol. Alcohol may damage 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 syringe plunger 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 on the cells.
- Avoid drawing from catheters and lines, which involve shear forces and turbulence, causing haemolysis.
- Fill tubes to the 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 haemolysis in transit.



1ST EDITION

Clinical Laboratory Handbook

DEPARTMENT OF CLINICAL DIAGNOSTIC LABORATORIES
HOSPITAL UNIVERSITI TEKNOLOGI MARA



THANK YOU

QUIZ NO. 1

Sample for the following test(s) can be transported to the lab using the pneumatic tube:

- I. Arterial blood gas
- II. HbA1c
- III. Lipid profile
- IV. 24-hour urine protein

- A. I, II, III, and IV
- B. I, II and IV
- C. II and III
- D. III and IV

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A. I, II, III, and IV

B. I, II and IV

C. II and III

D. III and IV

QUIZ NO. 2

The correct sequence of steps for requesting add-on test(s) are:

- I. Order the add-on test(s) in UniMEDS
- II. Send a new request form and barcode label to the lab
- III. Call lab to check for sample volume sufficiency and stability of analyte of interest
- IV. Lab approves add-on test(s) request

- A. I, II, III, IV
- B. III, IV, I, II
- C. IV, III, II, I
- D. II, III, I, IV

QUIZ NO. 2

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- IV. Lab approves add-on test(s) request

A. I, II, III, IV

B. III, IV, I, II

C. IV, III, II, I

D. II, III, I, IV