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The impact of non-reported POCT errors on patient care and hospital resources

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Presenters:

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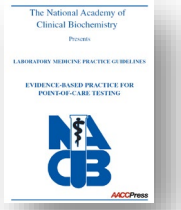
POCT Definition

- **NACB (Point of Care Testing):** Clinical laboratory testing conducted close to the site of patient care, typically by clinical personnel whose primary training is not in clinical laboratory sciences



- **ISO 22870 (Point of Care Testing (POCT):** Testing that is performed near or at the site of a patient with the result leading to possible change in the care of the patient.

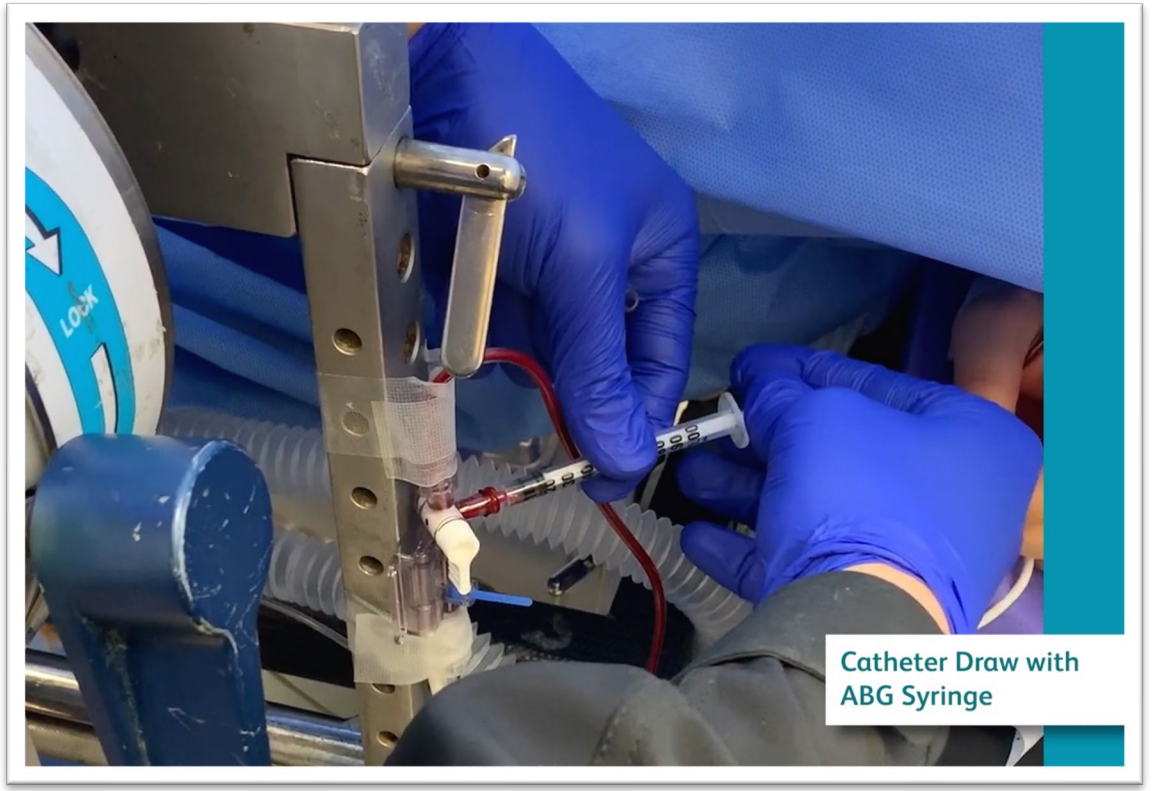
- **P. Collinson; 2006***: "The core principle underlying POCT measurements has been described as reducing turnaround time without compromising the quality of the information on which clinical decisions for patients are based*"

Clinical laboratory testing conducted close to the site of patient care by personnel untrained in laboratory skills, that can lead to a possible change in the care of the patient with the ability to reduce turnaround time but without compromising the quality

Real world practice


Tube sampling device on Arterial Line With ABG Syringe


Arterial Puncture with ABG Syringe


Catheter Draw with ABG Syringe

Advantages of POCT

- **Rapid test results** with the potential to expedite medical decision-making (decreased turn around time or TAT)
- **Small sample volume**
- **Portable** devices with wide menu of analytes
- **Reduced potential for sample deterioration**
- Unprocessed specimen
- Possibility for more lean processes
- Potential to improve patient outcome or workflow by having results immediately available,
- Ability to provide laboratory testing in a wider variety of sites or circumstances (underserved populations, rural areas, disaster areas, accidents or military sites)

Reference: Point of Care Testing Toolkit. College of American Pathologists

Difficulties of POCT

- **Reliability** of POCT results
- **Cost – per test costs** for POCT are often significantly higher than the cost of central laboratory testing. However, the overall cost of care may be lower when POCT is employed, especially if patients may be treated or moved through the system more quickly and care outcomes are improved
- **Number of testing personnel**
- **Management** of POCT is challenging
- Personnel performing POCT may **inappropriately use** a test kit or device outside of its intended use or the written procedure
- POC tests often employ different methods
- Not all methods are appropriate for diagnosis or monitoring treatment

Reference: Point of Care Testing Toolkit. College of American Pathologists

TAT – somewhere around -45 min

- *Walter S, et al:* **POC laboratory halves door-to-therapy-decision time in acute stroke**. *Ann Neurol 2011, **69**(3):581-6.*
- *Asha SE, et al:* **Impact from point-of-care devices on emergency department patient processing times compared with central laboratory testing of blood samples: a randomized controlled trial and cost-effectiveness analysis.** *Emerg Med J* 2014; 31(9):714-9
- *Goodacre S, et al:* **The RATPAC (Randomised Assessment of Treatment using Panel Assay of Cardiac markers) trial: a randomised controlled trial of POC cardiac markers in the ED**. *Health Technol Assess* 2011, 15(23):iii-xi, 1-102.
- *Singer AJ, et al:* **POCT reduces length of stay in emergency department chest pain patients**. *Ann Emerg Med 2005, 45(6):587-591.*

- *Parvin et al.* Clin Chem 1996 → 1722 vs 2918. Electrolytes. No difference LOS.
- *Murray et al.* JEM 1999 → 93 vs 87. Electrolytes, Hc, CO2, glucose, cardiacs. Overall LOS -54 min by POCT (3.28 vs 4.22 h). No difference in patients to be admitted, though.
- *Lee-Lewandrowski et al.* Arch Path Lab Med 2003 → 369 pts totally. BG, urine, preg, cardiacs. TAT -87%, LOS – 41 min.
- *Singer et al.* Acad Emerg Med 2008 → 4500 vs 4500. Electrolytes, cardiacs, bloods, urine and pregnancy panel. LOS – 64 min for admitted patients, -30 discharged. LOS decreased for non-tested patients (discharged – 13, admitted -30).

ED reality

- Lots of patients simultaneously
- Crowding, overcrowding and boarding
- Understaffing and high staff turnover

- Lack of hospital beds – increased length of stay – worse patient outcome
- Early decision making can help

Overcrowding consequences

Overcrowding - is killing patients

- *Sprivulis, PC, et al.,* The association between hospital overcrowding and mortality among patients admitted via Western Australian emergency departments. *The Medical journal of Australia, 2006. 184(5): p. 208-12.* → **+ 30% relative mortality within 7 days if admitted during overcrowding, 60.000 pats**
- *Richardson, DB,* Increase in patient mortality at 10 days associated with emergency department overcrowding. *The Medical journal of Australia, 2006. 184(5): p. 213-6.* → **+34% relative mortality at 10 days (34377 vs 32231 pats)**
- *Guttmann, A, et al.,* Association between waiting times and short term mortality and hospital admission after departure from ED: population based cohort study from Ontario, Canada. *BMJ, 2011. 342: p. d2983.* → **14 mio pats. Waiting time > 6 h 70% higher rel mortality, 95% (66% low acuity) higher admission probability**

…and impairing the quality of care

- *Pines, JM, et al.,* The impact of ED crowding measures on time to antibiotics for patients with community-acquired pneumonia. *Ann Emerg Med, 2007. 50(5): p. 510-6.* → **Each new pat increases risk of delayed antibiotics by 5%. Overcrowding more than doubles risk for delay**
- *Fee, C, et al.*, Effect of emergency department crowding on time to antibiotics in patients admitted with community-acquired pneumonia. *Ann. Emerg. Med., 2007. 50(5): p. 501-9, 509 e1.* → **Same as above. Each new patient increases risk of delayed antibiotics by 5%.**
- *Pines, JM and JE Hollander,* Emergency department crowding is associated with poor care for patients with severe pain. *Ann. Emerg. Med., 2008. 51(1): p. 1-5.* → **Similar as above. Each new patient increases risk for delays in pain medication and room placement.**
- *Hwang, U, et al.,* The effect of emergency department crowding on the management of pain in older adults with hip fracture. *J. Am. Geriatr. Soc., 2006. 54(2): p. 270-5.*
- *Diercks, DB, et al.,* Prolonged emergency department stays of non-ST-segment-elevation myocardial infarction patients are associated with worse adherence to the American College of Cardiology/American Heart Association guidelines for management and increased adverse events. *Ann. Emerg. Med., 2007. 50(5): p. 489-96.*
- *Liu, SW, et al.,* A pilot study examining undesirable events among emergency department-boarded patients awaiting inpatient beds. *Ann. Emerg. Med., 2009. 54(3): p. 381-5.*

Why do we need POCT in the ED?

- If used effectively, POCT has the potential to:
  - ✓ Decrease delays to treatment initiation
  - ✓ Increase ED efficiency
  - ✓ Influence patient care positively
  - ✓ Alleviate the negative effects of overcrowding

- For that purpose, we need:
  - ✓ Rapid turnaround time
  - ✓ Easy to operate methods
  - ✓ Highest quality test result to prevent potential adverse effect on patient (harm)
  - ✓ In a costly effective manner

Rooney K and Schilling M. Critical Care 2014 18:692.

So let’s make rapid decisions!

Case Study 1

History: LS

- 24-year-old female, 29+6 weeks' gestation, Para 1^{+0}
- Past medical history of vesico-ureteric reflux as a child
- Booking visit: BMI 35. Otherwise well at all antenatal appointments
- Presents to the ED SATA with a 72-hour history of grumbling back pain, radiating to the front (Triaged to SATA not Labour Ward because of shortness of breath)
- Worsening increase in intensity in the pain this morning
- Associated dizziness / light-headedness this morning and shortness of breath
- Associated malaise and lack of energy for 48 hours
- Denies cough, sputum production
- Also now reporting reduced foetal movement since the increased in intensity of pain this morning
- Reports increased urinary frequency since 20 weeks' gestation
- DHx: Iron & vitamin supplements. NKDA
- SHx: Vaping

Examination

- **Airway:** Maintaining own airway
- **Breathing:** RR 30, SpO_2 92% on air, Trachea central, Bilateral Chest Expansion and with reduced Air Entry at bases
- **Circulation:** HR 138, BP 82/63, CRT 3 seconds
- **Disability:** Alert, GCS: Eyes 4 (Spontaneously) Verbal 4 (Confused) Motor 6 (Obeys commands), PERL
- **Exposure:** Anxious +++, Unable to lie still, Diaphoretic, Temp 37.5, no calf swelling tenderness, gravid abdomen, tender abdomen & difficult to examine, "*bloody show*" apparent on sanitary towel

What is your differential diagnosis? (Vote)

1. Labour
2. Antepartum Haemorrhage
    - Placenta Praevia
    - Placental Abruption
3. Pulmonary Embolism
4. Sepsis

Scottish Maternity Early Warning Score (MEWS)

Booking BP: _____ Most recent weight/gestation: _____kg /_____weeks

IF THERE IS ANY CONCERN WITH CLINICAL CONDITION OR RAPID DETERIORATION, CALL URGENTLY FOR ASSISTANCE

		Date: / Time:	
Respiration write rate in corresponding box	≥25		≥25
	21–24		21–24
	10–20		10–20
	≤9		≤9
Saturations	95–100%		95–100%
	≤94%		≤94%
Oxygen	L/min		L/min
Temperature	≥38°C		≥38°C
	37.5–37.9°C		37.5–37.9°C
	36.5–37.4°C		36.5–37.4°C
	36.0–36.4°C		36.0–36.4°C
	≤35.9°C		≤35.9°C
Heart rate	180		180
	170		170
	160		160
	150		150
	140		140
	130		130
	120		120
	110		110
	100		100
	90		90
	80		80
	70		70
	60		60
	50		50
Systolic blood pressure ↑	210		210
	200		200
	190		190
	180		180
	170		170
	160		160
	150		150
	140		140
	130		130
	120		120
	110		110
	100		100
	90		90
	80		80
Diastolic blood pressure ↓	130		130
	120		120
	110		110
	100		100
	90		90
	80		80
	70		70
	60		60
	50		50
	40		40
Neurological response	Alert		Alert
	Sleep		Sleep
	Voice		Voice
	Pain		Pain
	Unresponsive		Unresponsive
Urine output	<30ml/hr		<30ml/hr
	>30ml/hr		>30ml/hr
Looks unwell	Yes		Yes
	No		No
Total yellow scores			
Total red scores			
Initials			

Healthcare Improvement Scotland | ihub

CONSIDER OBSTETRIC EMERGENCY CALL (2222) IF RAPID DETERIORATION

1 YELLOW

- Repeat full set of observations in 30 minutes
- If remains 1 yellow escalate in line with local policy
- Document action plan and MEWS frequency

2 YELLOW

- Inform charge midwife and obstetric FY2
- If no response from obstetric FY2 within 15 minutes escalate to middle-grade obstetrician (ST3 and above)
- Repeat full set of observations within 30 minutes
- Document action plan and MEWS frequency

1 RED OR CLINICAL CONCERN

- Inform charge midwife and obstetric FY2
- Repeat full set of observations in 15–30 minutes
- If no medical review within 15 minutes or deterioration at any time, call middle-grade obstetrician (ST3 and above)
- If no medical review after a further 15 minutes, call senior obstetrician or anaesthetist
- Document medical action plan and MEWS frequency

ANYTHING MORE THAN 1 RED OR RAPID DETERIORATION OF MATERNAL CONDITION

- Call charge midwife and middle-grade obstetrician (ST3 and above)
- Repeat full set of observations in 5–15 minutes
- If no medical review within 15 minutes, request senior obstetric or anaesthetic review
- Consider HDU level care
- Consider obstetric emergency call (2222)
- Document medical action plan and MEWS frequency

Maternal SEPSIS

DO NOT DELAY ADMINISTRATION OF IV ANTIBIOTICS IF UNABLE TO OBTAIN BLOOD CULTURES

MEWS trigger – THINK SEPSIS

CLINICAL SUSPICION OF INFECTION AND ANY 2 SIRS CRITERIA PRESENT

Temperature <36°C or >38°C

Heart rate >100 bpm

Respiratory rate >20 bpm

White cell count <4 or >16 × 10^9/L

Woman looks acutely unwell

SEPSIS 6: Complete within 1 hour

GIVE 3

1. Give **high flow oxygen** to maintain saturations ≥94%.
2. Give **IV antibiotics** (after blood cultures obtained) as per local guidance.
3. Give **IV fluids**. Start with 500ml as bolus then consider 20ml/kg (exercise caution with pre-eclampsia).

TAKE 2

1. Take **blood cultures** and infection screen.
2. Take **lactate** and other bloods.

MONITOR 1

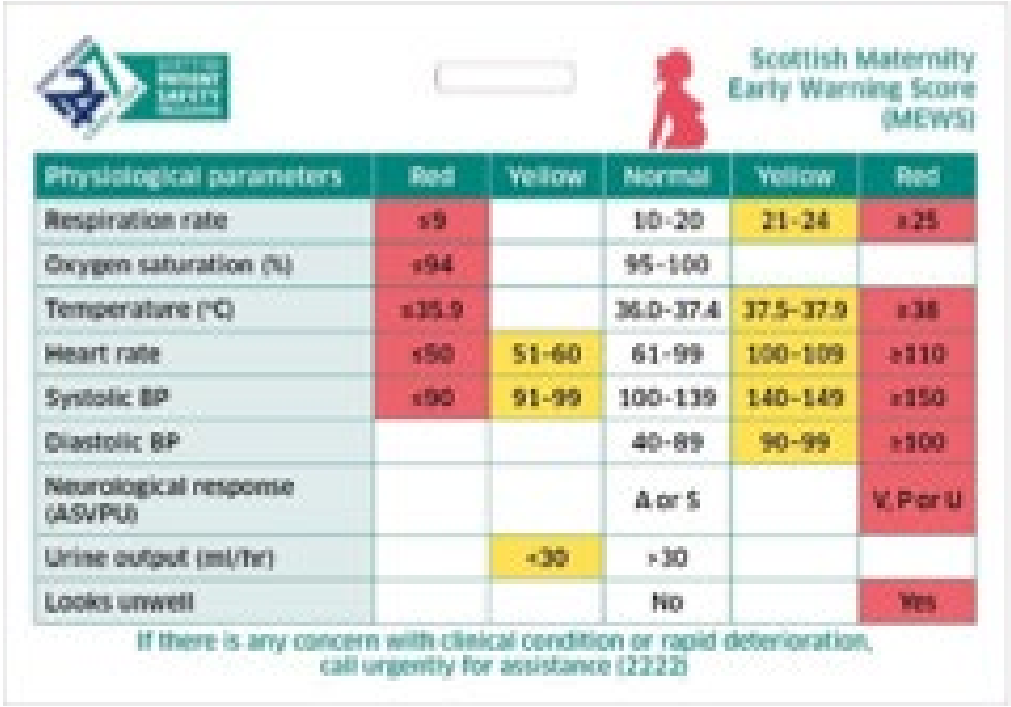
1. Monitor **urine output** (consider urinary catheter).

An intrapartum women may have an elevated white cell count and temperature in labour without having sepsis.

Premature rupture of membranes (PROM) provides a path for bacteria to enter the uterus, so an abnormal CTG after PROM should trigger suspicion of sepsis.

Management plan 1

- Maternal Early Warning Scoring System (MEWS)
  - 6 Red criteria and 1 yellow criteria
- Call charge midwife and middle grade obstetrician (ST3 and above)
  - Foetal Ultrasound
  - Cardiotocograph (CTG)
- Repeat full set of observations in 5–15 minutes
- If no medical review within 15 minutes, request senior obstetric or anaesthetic review
- Consider HDU level care
- Consider obstetric emergency call (2222) - Document medical action plan and MEWS frequency



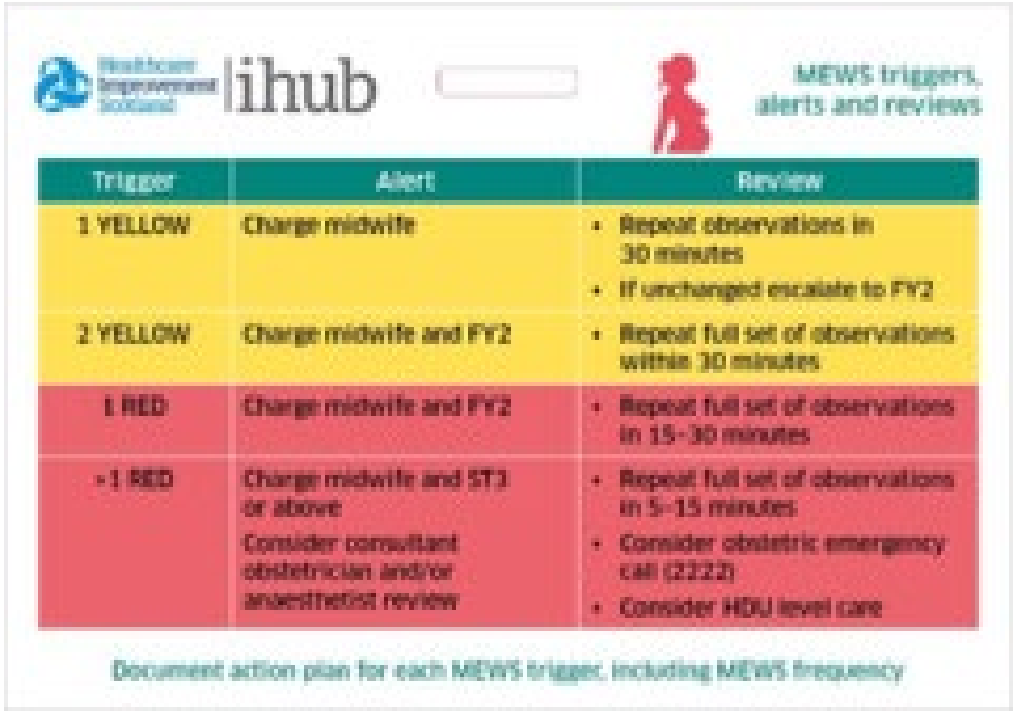
Scottish Maternity Early Warning Score (MEWS)

Physiological parameters	Red	Yellow	Normal	Yellow	Red
Respiration rate	≤9		10-20	21-24	≥25
Oxygen saturation (%)	≤94		95-100		
Temperature (°C)	≤35.0		36.0-37.4	37.5-37.9	≥38
Heart rate	≤50	51-60	61-99	100-109	≥110
Systolic BP	≤90	91-99	100-139	140-149	≥150
Diastolic BP			40-89	90-99	≥100
Neurological response (AVPU)			A or S		V, P or U
Urine output (ml/hr)		≤30	>30		
Looks unwell			No		Yes

If there is any concern with clinical condition or rapid deterioration, call urgently for assistance (2222)

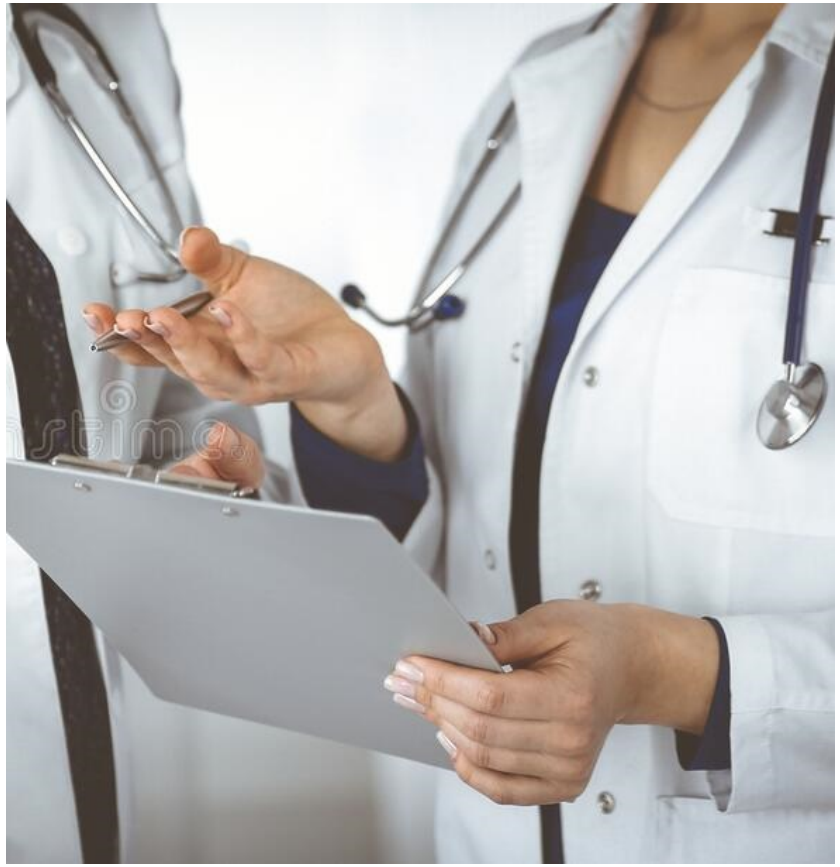
Management plan 2

- Give oxygen therapy. Target SpO2 95-100%
- Two 14G venous access. Start balanced crystalloid 500ml fluid challenge & reassess
- Bloods: FBC, Coag, U&Es, Glucose, LFT's, CRP, & POCT ABG & BM
- Urinalysis / Catheterise
- Anything else
- Consider blood cultures, MSSU cultures
- CXR
- CTPA



Immediate Results

- Urinalysis positive for glucose, protein, ketones and nitrites. Foul smelling
- BM 8.3
- ABG on air: H^+ 50 pO_2 9kPa pCO_2 3kPa HCO3 11 Lact 2.6 BE -9 Hb 80
- No frank PV bleeding
- Still waiting for CTG / foetal ultrasound



<u>Repeat vital sign observations after 500ml crystalloid</u>

- HR130, BP 105/63, CRT3, RR 26, SpO_2 100% on non-rebreathing mask at 15Lmin^{-1}, Temp 37.9^{o}C, Alert, but still confused
- MEWS: 3 Red criteria & 1 Yellow criteria

What is your differential diagnosis? (Vote)

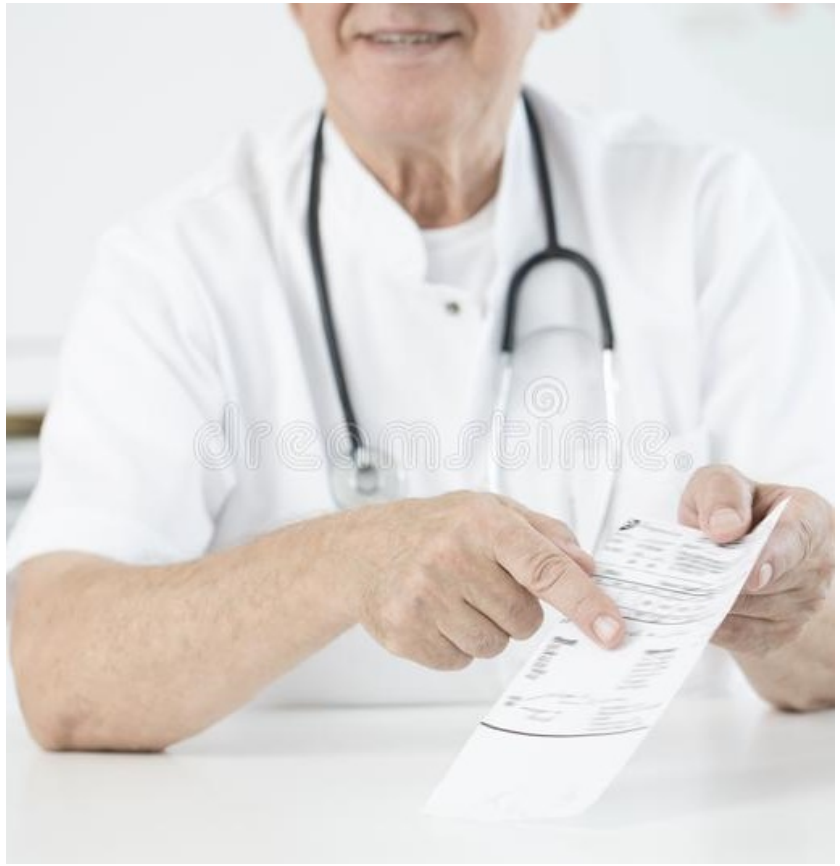
1. Labour
2. Antepartum Haemorrhage
    - Placenta Praevia
    - Placental Abruption
3. Pulmonary Embolism
4. Sepsis

Further management plan (Vote)

1. Immediate Emergency LUSCS
2. Further fluid resuscitation & reassess
3. Consideration of maternal sepsis & deliver the Sepsis 6
   - Give THREE
     - Give high flow oxygen to maintain saturations >94%.
     - Give IV antibiotics (after blood cultures obtained) as per local guidance.
     - Give IV fluids. Start with 500ml as bolus then consider 20ml/kg (exercise caution with pre-eclampsia).
   - Take TWO
     - Take blood cultures and infection screen.
     - Take lactate and other bloods
   - Monitor ONE
     - Monitor urine output and consider urinary catheterisation
4. CTPA after Focussed bedside Echo

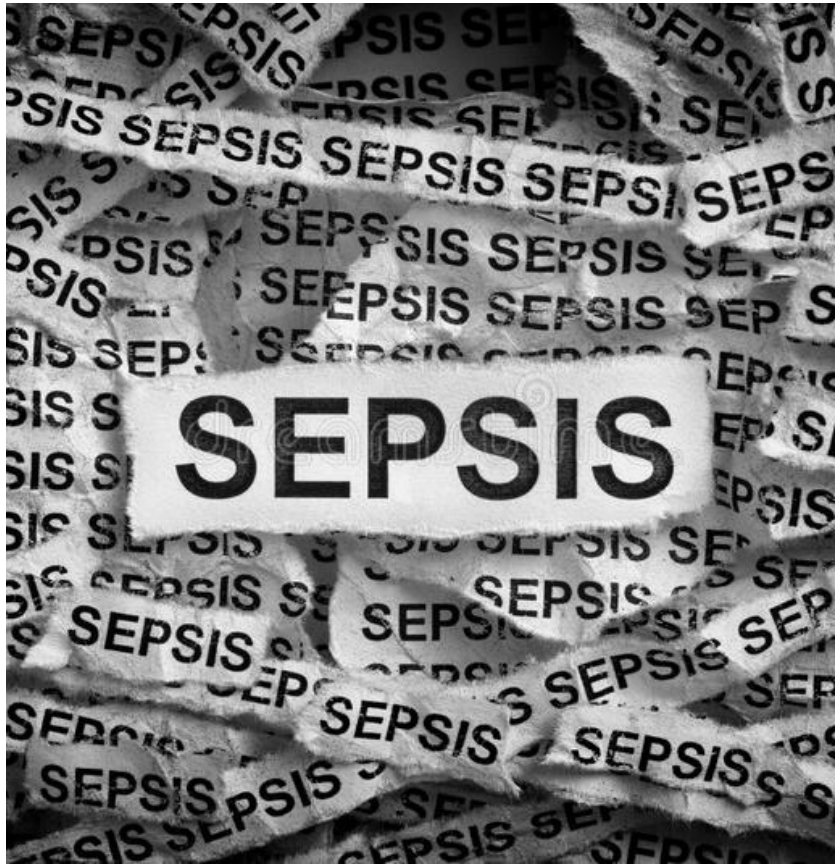
Blood Results

- WBC 2.8 (4-11), Hb 106 (90-170), Platelets 158, Haematocrit 0.302 (0.37-0.54)
- PT 13 (10-13), APTT 36 (26-36)
- Na 142 (133-146), K 4.2 (3.5-5), Cl 110 (95-108), Ur 4.3 (2.5-7.5), Cr 80 (40-130)
- Bil 6 (3-20), ALT 51 (<50), AST 40 (<40), Alk P 111, Alb 21
- CRP 100 (<10)
- Corrected Ca 2.23 (2.2-2.6), PO_4 1.21

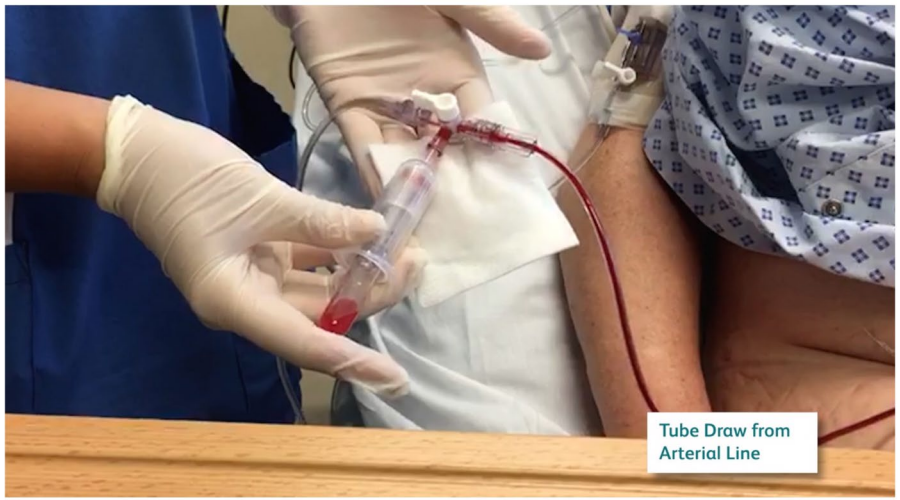


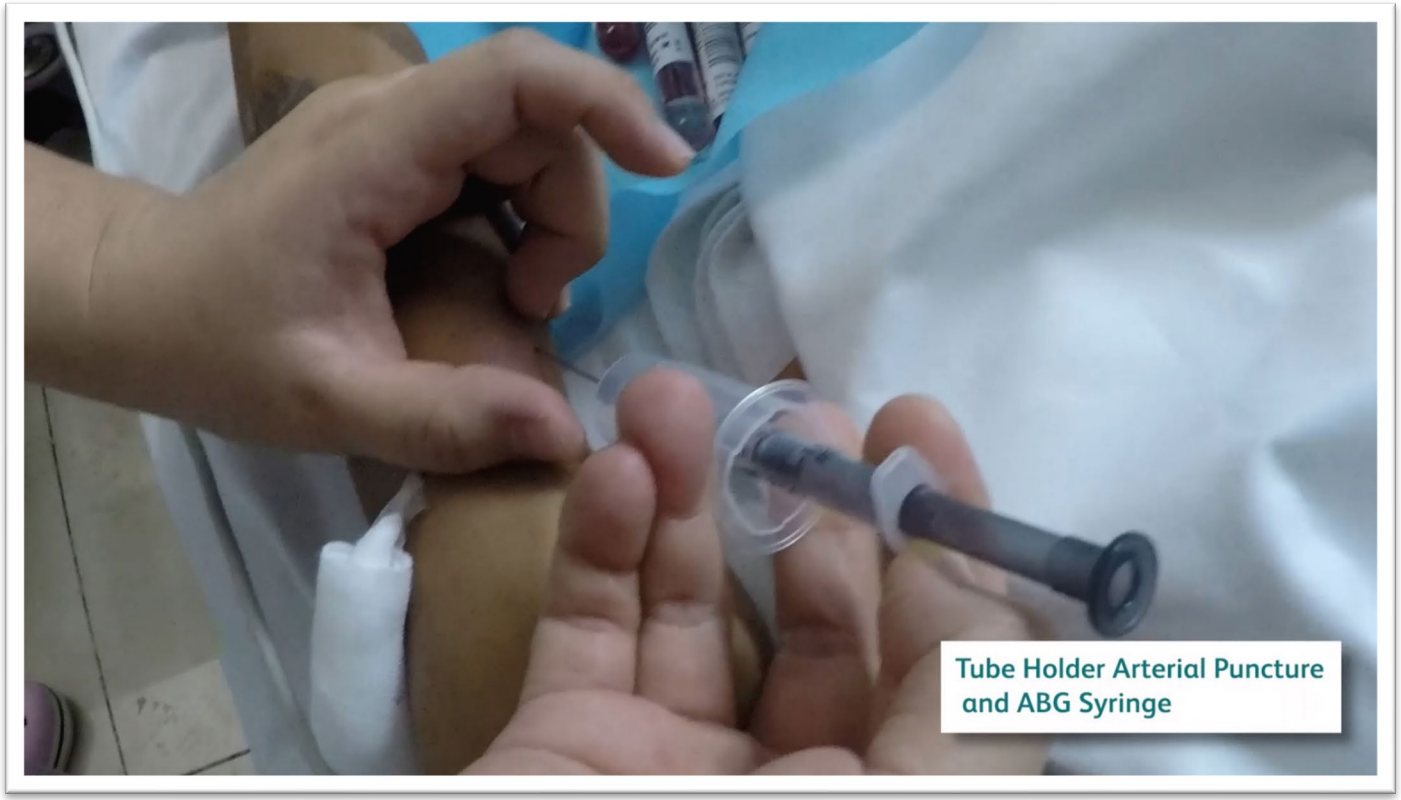
Diagnosis

- Urosepsis / Pyelonephritis
- Managed with further IV fluid resuscitation (2 Litres in total), gentamicin for 48 hours and then oral ciprofloxacin
- Ongoing pregnancy
- Would the POCT Hb result forced you down a different management plan?



Real world practice





How altered results for hemoglobin can occur?

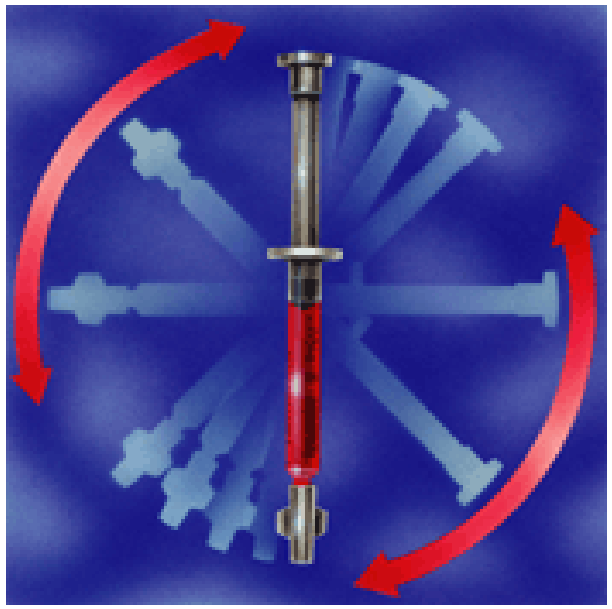
Potential causes

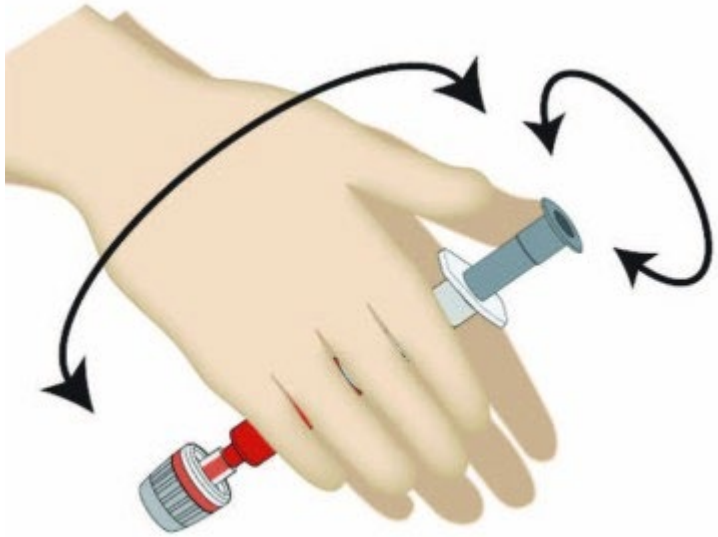
- Blood drawn using existing intravenous lines (instead of straight needle venipuncture)
- Incorrectly mixed syringe - insufficient rolling & inversions by user
- Sample not remixed right before measurement
- Clotted blood samples
- Hypertriglyceridemia
- Laboratory error (analytical)
- Insufficiently trained operators
- Increased workload and stressed environment

How altered results for hemoglobin can occur?

Potential causes

- Incorrectly mixed syringe - insufficient rolling & inversions

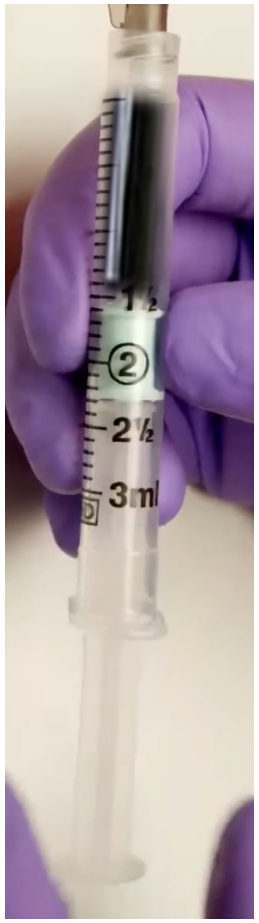




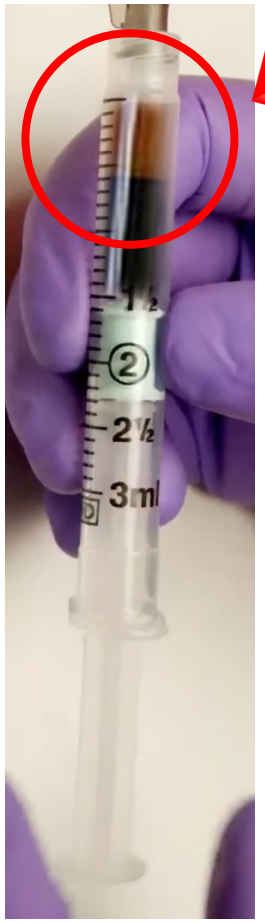
How altered results for hemoglobin can occur?

Incorrect mixing prior to sampling

Basal



10-15 min

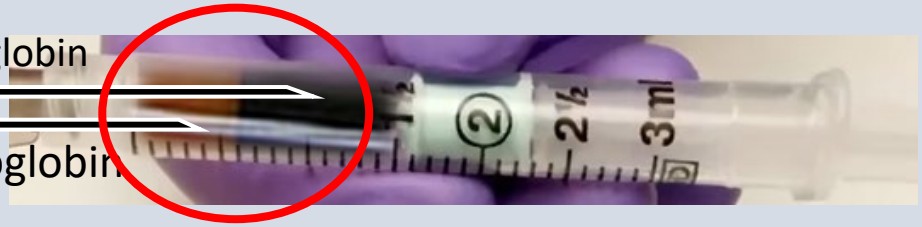


Syringe located in horizontal or inclined position

Aspiration needle introduced into the syringe

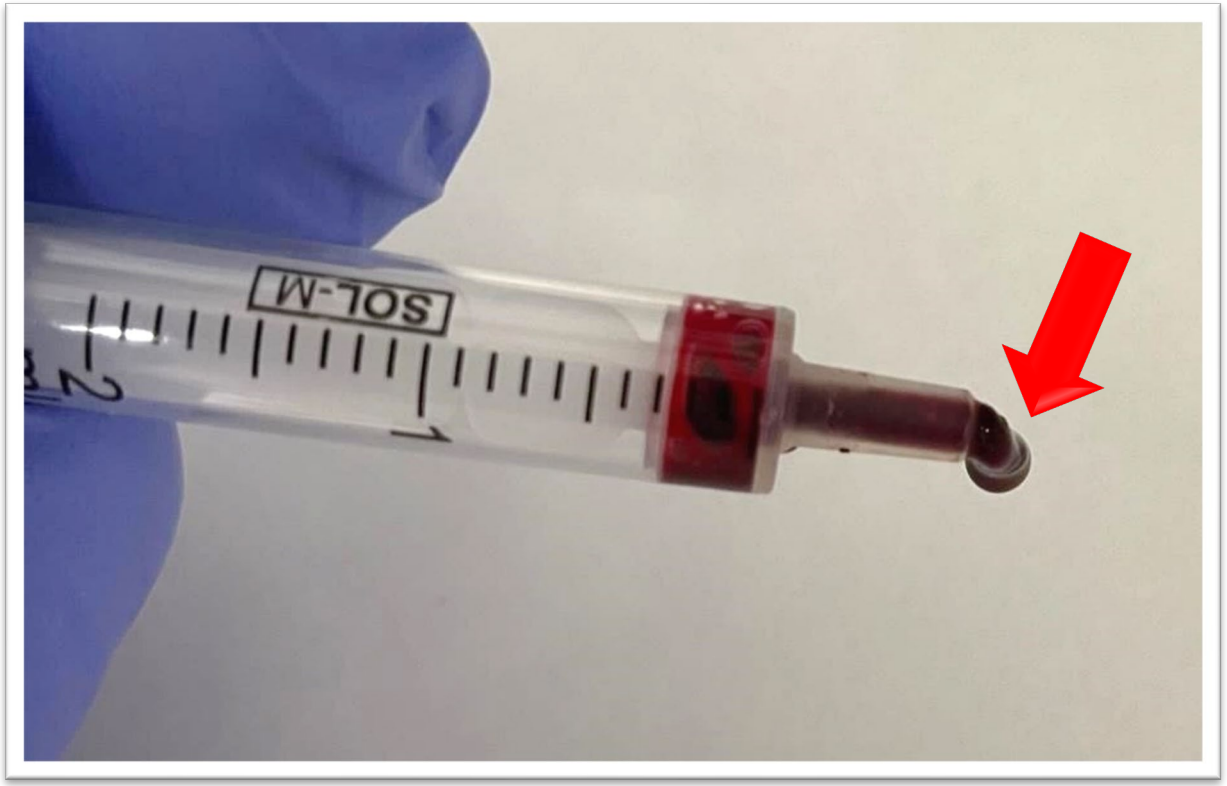
A → High hemoglobin

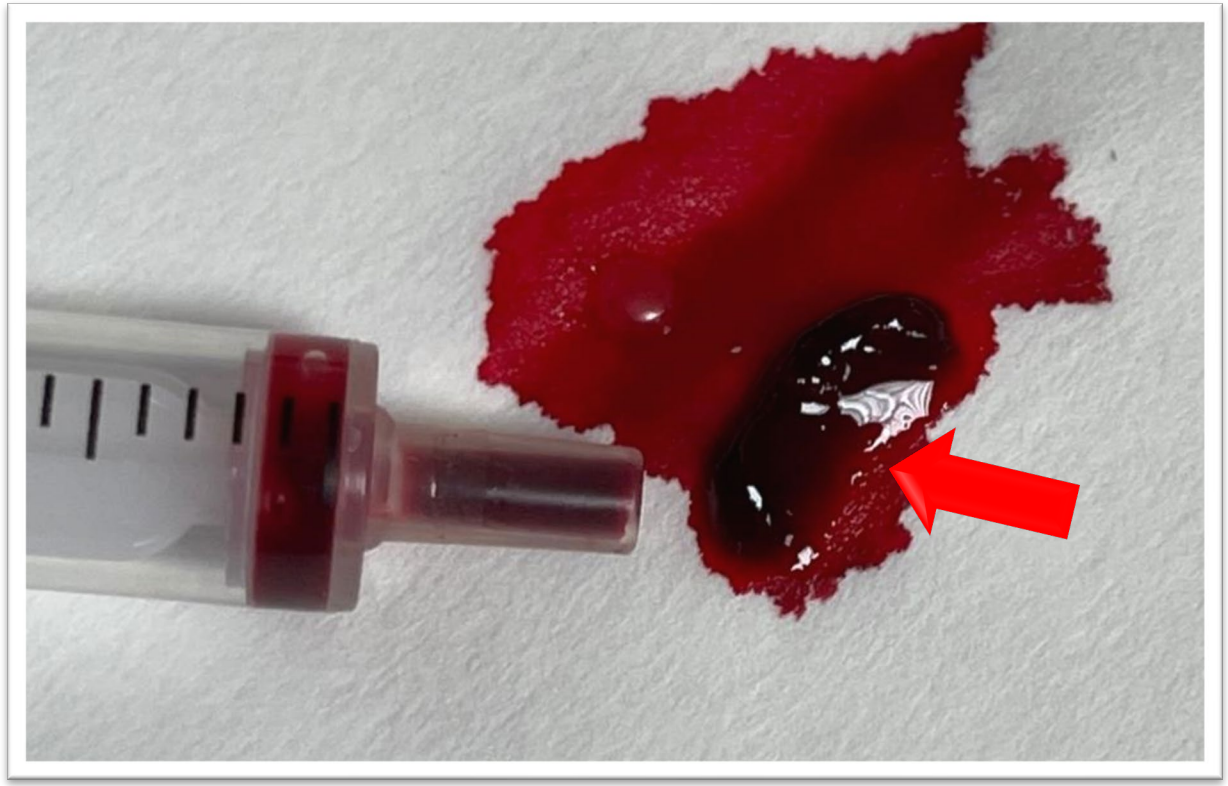
B → Low hemoglobin



How altered results for hemoglobin can occur?

Clots and micro-clots in arterial blood gases syringe





How altered results for hemoglobin can occur?

Practical Laboratory Medicine

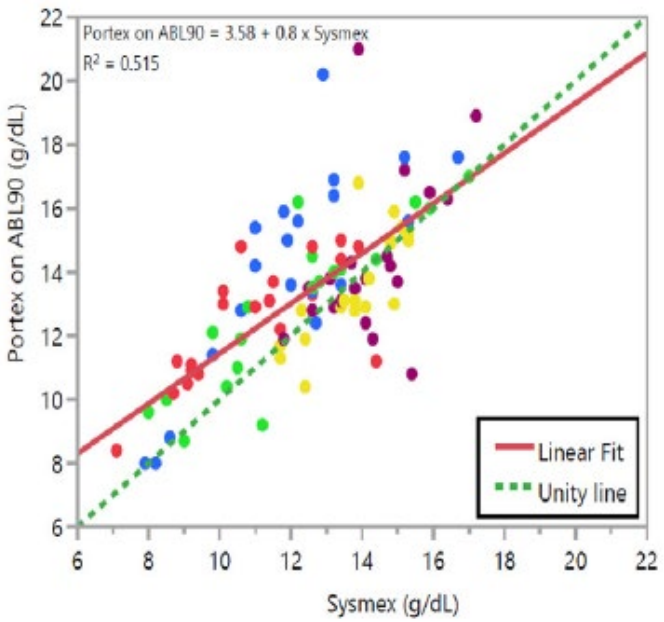
Evaluation of automatic mixing versus manual mixing for point of care hemoglobin measurement

Ghaith Altawallbeh [a], Pedro Castaneda [b], Gitte Wennecke [c], Amy B. Karger [a,*]

- Hemoglobin results comparing manual and automated mixing vs central laboratory (100 patients)

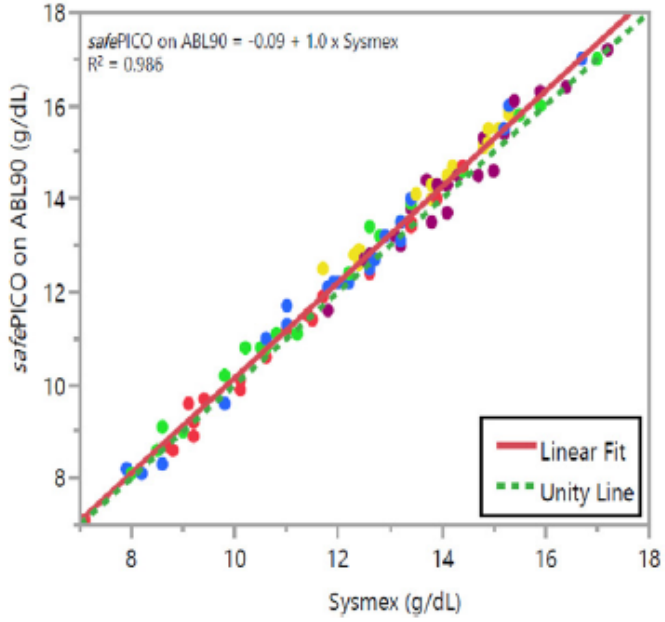
Manual mixing

R2 = 0.515
Mean diff.: -0.9 g/dL



Automated mixing

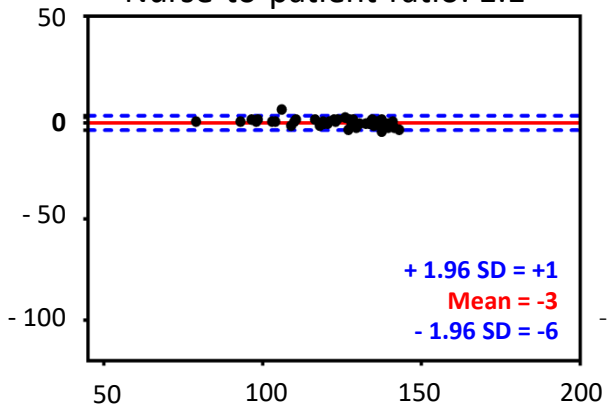
R2 = 0.986
Mean diff.: -0.2 g/dL



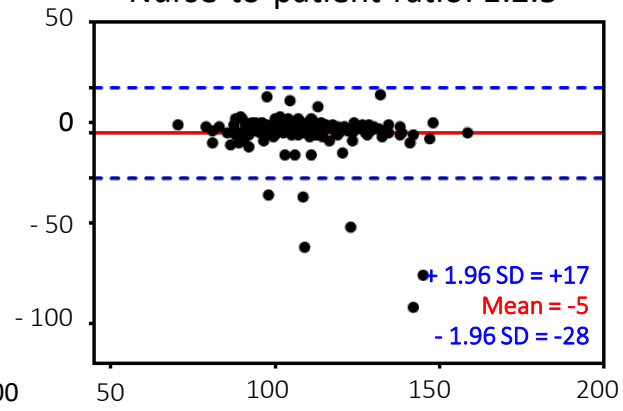
How altered results for hemoglobin can occur?

- 3 adult ICU, 491 paired blood samples Hgb, K and Na by blood gas analyzers (identical analyzer) and the central lab
- Step2: after a multidisciplinary (nurse managers, intensivists, and a clinical chemistry specialist) quality approach

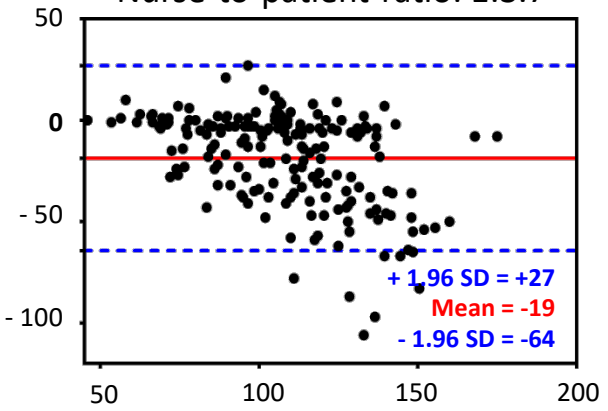
OR (n=53)
Nurse-to-patient-ratio: 1:1



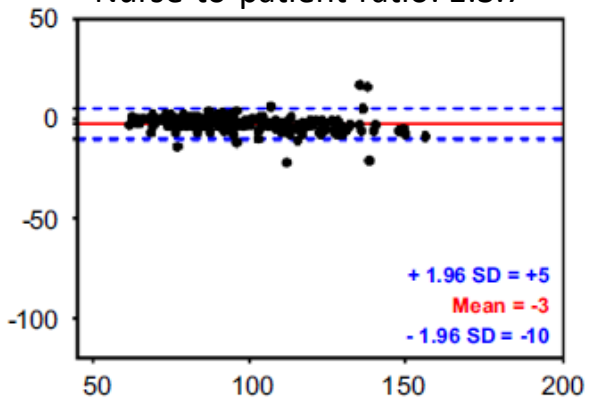
10-bed ICU (n=178)
Nurse-to-patient-ratio: 1:2.5



37-bed ICU (n=260)
Nurse-to-patient-ratio: 1:3.7



37-bed ICU – step2 (n=278)
Nurse-to-patient-ratio: 1:3.7



POCT	2 [2; 2]	5 [4; 7]*	24 [13; 38]*	15 [5; 29]*
Central lab.	82 [58; 130]	80 [63; 108]	112 [90; 135]	119 [80; 144]

- An identical analyzer can provide results of varying quality depending on the local constraint of the ICUs
- Quality management performed by the partners involved in the POCT achieved a clear improvement

Auvet et al. Ann. Intensive Care (2016) 6:57

Case Study 2

History

- 18 yr old female
- Sudden onset severe abdominal pain and general malaise 4 hours
- Vomiting and diarrea
- Feels like ”going to faint”

- No family history, as far as she knows no relative with similar symptoms
- No medication, no recreational drugs, no alcohol…. (?)
- No special diet, ”junk food”

Examination

- Abdominal pain and malaise for one week, diarrhea 2 days
- Nausea, vertigo
- Lethargic
- HR 65/min, BP 90/40 mmHg,
- RF 14/min, SpO2 96%,
- GCS 13, Temp 35.5 C (infrared)
- Hyporeflexia (???)
- Last period 5 weeks ago

- Abdomen soft, general slight ”achy” but no tenderness or defense
- Intestinal sounds active

Which samples would you take?

- 1) Electrolytes
- 2) Blood count including WBC
- 3) Urinary analysis / dipstick
- 4) HCG
- 5) ABG
- 6) All above
- 7) Stool sampling

Laboratory results

• Hb	9.8	mg/dl
• Glukosis	6.3	mmol/l
• Na	128	mmol/l
• K	3.2	mmol/l
• Cl	90	mmol/l
• Crea	65	mmol/l
• HCO3-	26	mmol/l
• BE	-1	mmol/l
• Urinary dipstick:	NAD	
• Urinary HCG	negative	
• Liver enzymes	normal	
• Lipase / amylase	normal	

How would you manage this patient?

1) Send home directly
2) Oral rehydration, discharge
3) IV rehydration, discharge
4) Admission, iv-rehydration, observation
5) Further diagnostic procedures (which?)
6) Further therapy?

Case Study 3

History

- 19 yr old female
- Sudden onset severe abdominal pain and general malaise 4 hours
- Vomiting and diarrea
- Feels like ”going to faint”

- No family history, no further patients with similar symptoms
- No medication, no recreational drugs, no alcohol…. (?)
- No special diet, ”junk food”

Examination

- Abdominal pain and malaise for one week, diarrhea 2 days
- Nausea, vertigo
- Lethargic
- HR 65/min, BP 90/40 mmHg,
- RF 14/min, SpO2 96%,
- GCS 13, Temp 35.5 C (infrared)
- Hyporeflexia (???)
- Last period 5 weeks ago

- Abdomen soft, general slight ”achy” but no tenderness or defense
- Intestinal sounds active

Laboratory results

• Hb	10.8	mg/dl
• Glukosis	6.3	mmol/l
• Na	135	mmol/l
• K	4.2	mmol/l
• Cl	98	mmol/l
• Crea	95	mmol/l
• HCO3-	26	mmol/l
• BE	-1	mmol/l
• Urinary dipstick:	NAD	
• Urinary HCG	negative	
• Liver enzymes	normal	
• Lipase / amylase	normal	

How would you manage this patient?

1) Send home directly
2) Oral rehydration, discharge
3) IV rehydration, discharge
4) Admission, iv-rehydration, observation
5) Further diagnostic procedures (which?)
6) Further therapy?

Case Study 4

Laboratory results

20 year old female

• Hb	12.8	mg/dl
• Glukosis	4.3	mmol/l
• Na	122	mmol/l
• K	5.2	mmol/l
• Cl	90	mmol/l
• Crea	110	mmol/l
• HCO3-	22	mmol/l
• BE	-4	mmol/l
• Urinary dipstick:	NAD	
• Urinary HCG	negative	

How would you manage this patient?

1) Send home directly
2) Oral rehydration, discharge
3) IV rehydration, discharge
4) Admission, iv-rehydration, observation
5) Further diagnostic procedures (which?)
6) Further therapy?

All of a sudden

- Simple gastroenteritis or severely ill?

K	3.2	4.6	5.2
Na	128	132	122
Crea	65	110	96
Cl	90	85	110

All of a sudden

- Simple gastroenteritis or severely ill?

K	3.2	4.6	5.2
Na	128	132	122
Crea	65	110	96
Cl	90	85	110

	Spurious ?	Hypochloremic hypokalemic alcalosis + pseudohyperkalemia	Addissonian crisis

All of a sudden - simple gastroenteritis became potentially life-threatening.

-

What happened???

Let’s ask the expert!

How altered results for potassium can occur?

Potential causes of hemolysis and pseudo”hyper-normo-hypo”kalemia

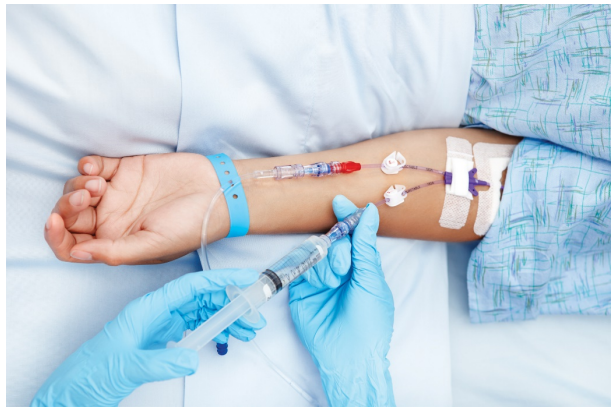
- Blood drawn using existing intravenous lines (instead of straight needle venipuncture)
- An excessive tourniquet or repeated fist clenching
- Inappropriate needle size (smaller needles shows higher hemolysis ratios)
- Excess blood flow rate (vacuum)
- Decanting blood from K+EDTA tube to the syringe
- Traumatic venipuncture (squeezing the puncture site)
- Overly vigorous sample mixing
- Prolonged storage of uncentrifuged blood
- Delayed analysis (leakage of potassium)
- Blood gas syringe transported in direct contract with ice
- Fragile RBC (inherited defects in RBC membrane: familial pseudohyperkalemia, stomatocytosis)
- Severe leucocytosis (>150 x 10^9/L) or thrombocytosis (>500 x 10^9/L)
- Laboratory error (analytical)
- Insufficiently trained operators
- Increased workload and stressed environment

How altered results for potassium can occur?

Two main reasons … that occurs at the preanalytical phase:

- Hemolyzed samples (account for 40–70% of all specimen rejections)

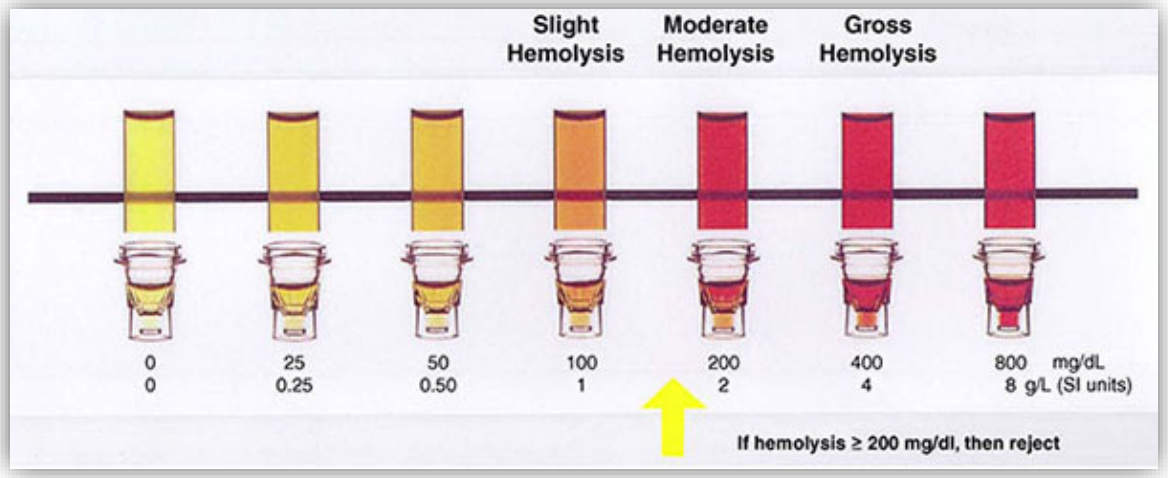
- Samples obtained from fluid infusion (potassium) lines



How altered results for potassium can occur?

At the Central Lab we have …

Visual inspection of the sample



Hemolysis index measurement

How altered results for potassium can occur?

And what about at the point of care…

Hemolysis index in blood gases analyzers?

Hemolysis can alter the result of different parameters, including potassium with abnormal high results or masking low levels (hypokalemia) when reporting normal concentrations.

¿What makes POCT so special?

Diagnostic cycle: central lab vs POCT

Central laboratory

POCT

- Testing is performed by clinical staff (nurses, physicians)
- Testing is usually done for patients (ICU, ED, …) with specific demands regarding sampling and analysis (TAT)

Errors in Laboratory Medicine

Clinical Chemistry 53:7
1338–1342 (2007)

Laboratory Management

Errors in a Stat Laboratory: Types and Frequencies 10 Years Later

Paolo Carraro and Mario Plebani*

Table 1. Laboratory errors in stat testing.

Defects: detection steps	Defects found No.	Frequency, %
Preanalytical		
Specimen collected from infusion route	3	1.9
Sample contaminated	1	0.6
Tube filling error	21	13.1
Empty tube	11	6.9
Inappropriate container	13	8.1
Nonrefrigerated sample	3	1.9
Missing tube	5	3.1
Digoxin test timing error	1	0.6
Patient identification error	14	8.8
Request procedure error	12	7.5
Data communication conflict	6	3.8
Physician's request order missed	3	1.9
Order misinterpreted	2	1.3
Check-in not performed (in the Laboratory Information Systems)	4	2.5
Subtotal	99	61.9
Analytical		
Instrument-caused random error	3	1.9
Analytical inaccuracy not recognized	21	13.1
Subtotal	24	15
Postanalytical		
Results communication breakdown	32	20
Lack of communication within laboratory	3	1.9
TAT excessive	2	1.3
Subtotal	37	23.1

Table 2. Error frequency and types: a comparison between data from 2006 and 1996.

	Absolute frequency, ppm		Relative frequency, %	
	1996	2006	1996	2006
Total errors	4667	3092		
Preanalytical	3186	1913	68.2	61.9
Analytical	617	464	13.3	15.0
Postanalytical	864	715	18.5	23.1

Significant decrease in the number of errors between 1996 and 2006, but the proportion of pre-analytical errors remained relatively unchanged.

POCT: most common preanalytical errors

1. **Patient preparation errors**
    - Incorrect sampling time
2. **Blood collection errors**
    - Patient and operator identification errors
    - Sampling errors
    - Tubes underfilled
    - Blood taken from fluids infusion line
3. **Sample handling and transport errors**
    - Inadequate sample mixing (clotted sample, microclots, incomplete clotting, …)
    - Air bubbles not sufficiently removed
    - Transport time and temperature
4. **Interferences**
    - Hemolyzed sample (non visible)
    - Patient with very high leukocytosis or thrombocytosis
5. **Circumstantial external factors**
    - Increased workload/stress

Concerns on cost of POCT

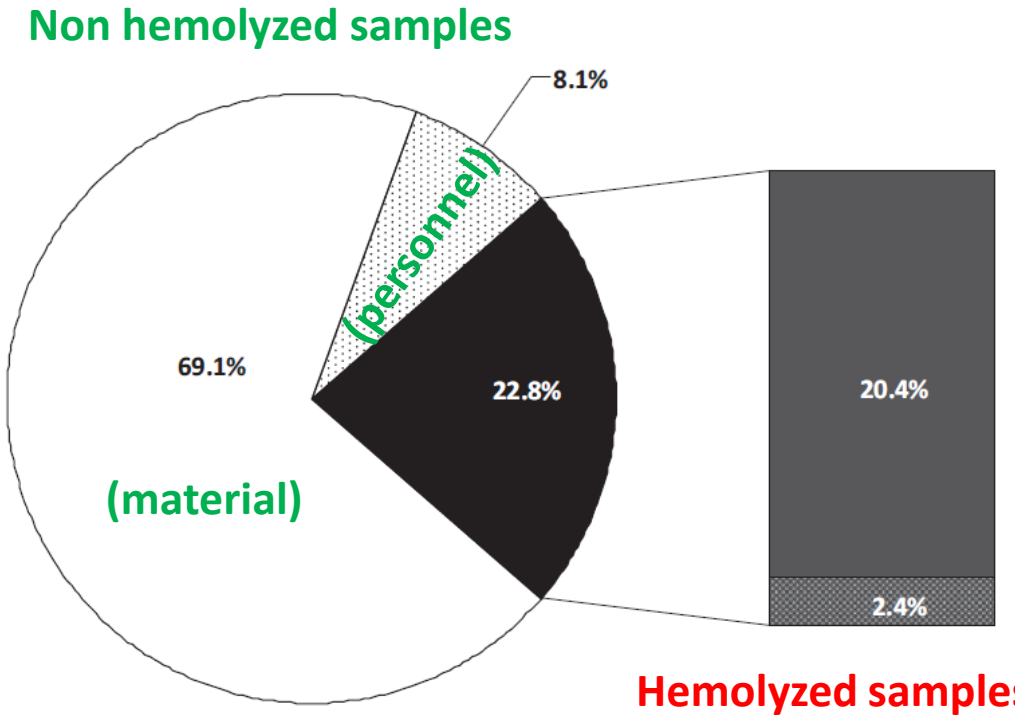
- POCT is usually more expensive on a unit-cost basis than testing performed in a central laboratory
- It is important to demonstrate that POCT can improve patient outcomes or clinical operational efficiency before testing is implemented
- Some POCT technologies have been shown to improve patient outcomes or to improve hospital or emergency department operations (eg, cardiac-marker testing and D-dimer testing in the emergency department), but …
- The literature on POCT and its relationship to improved outcomes is limited and divergent findings exists
- The rapid turnaround time provided by POCT is the main factor that is ultimately responsible for the improvement in outcomes, but …
- The economic benefits of POCT are more likely to be realized through improving the efficiency of the ED, and the wider impact across the care pathway

Cost of hemolyzed samples

International Journal of Laboratory Hematology

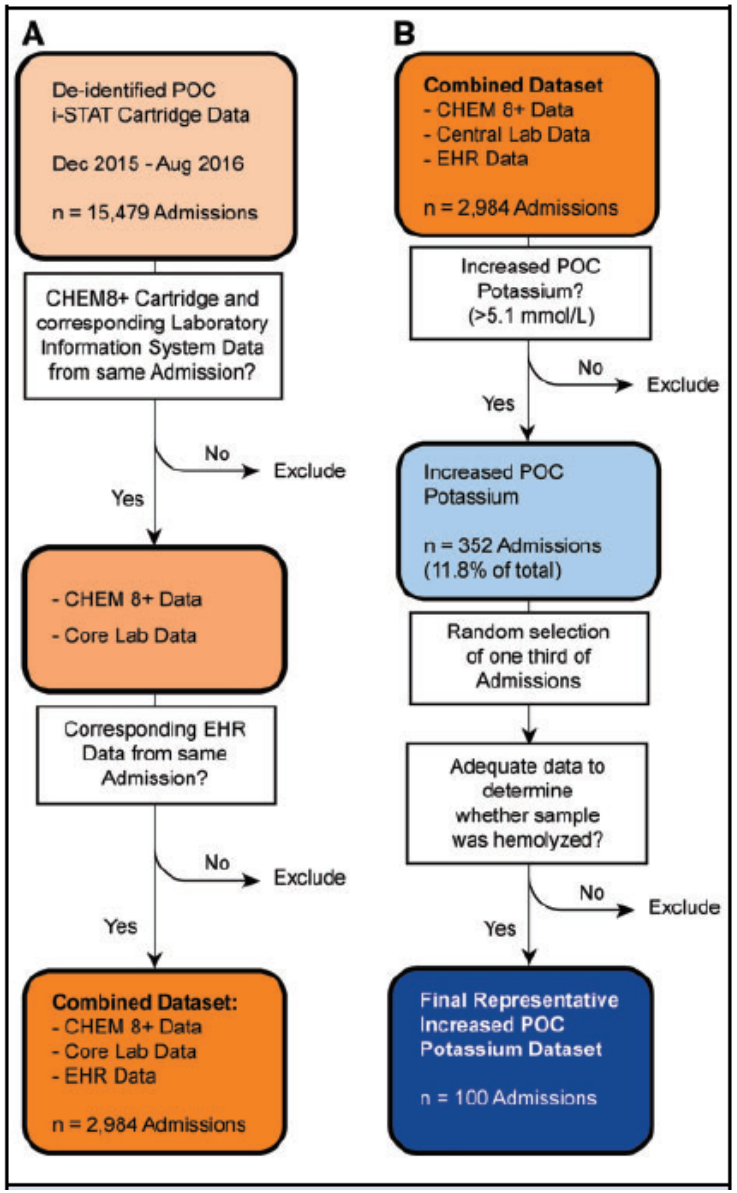
Prevalence and cost of hemolyzed samples in a large urban emergency department

- Hospital of Parma (Italy), with 1300 beds and 90.000 ED accesses per year
- A total of 166.414 diagnostic serum samples were drawn in the ED per year (78% collected through IV catheters)
- Rates of hemolyzed specimens (cell-free Hgb ≥0.5 g/L) 29% from catheters and 1% with straight needle venipuncture
- Overall cost of serum samples collection in the ED was 85.532 € (76.550 € for material and 8.981 € for personnel) → overall economical burden attributable to recollection of specimens in the ED was 19.535 €
- 99% of the overall cost of sample recollection in the ED was attributable to hemolysis (19.347 €)



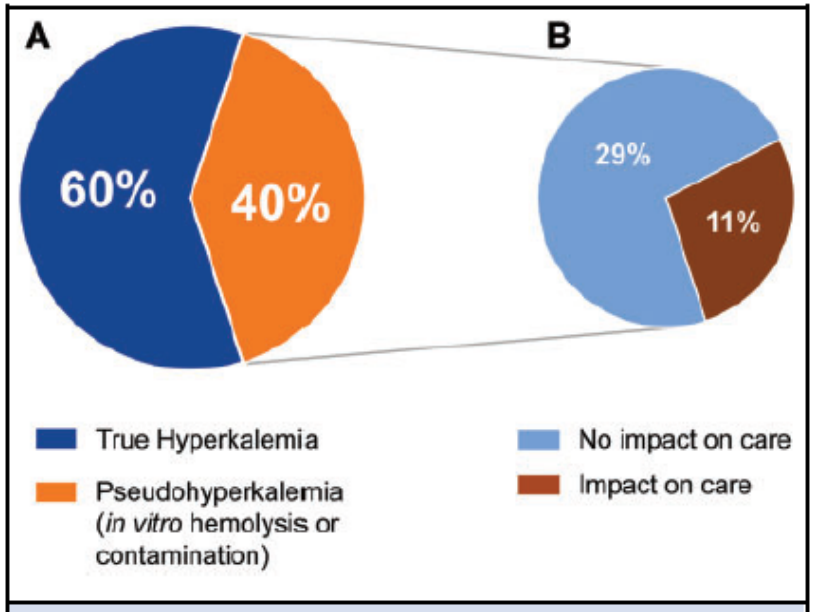
Lippi G, Bonelli P and Cervellin G. Int. Jnl. Lab. Hem. 2014, 36, e24–e26

Impact of undetected hemolysis



The Impact of Undetected In Vitro Hemolysis or Sample Contamination on Patient Care and Outcomes in Point-of-Care Testing: A Retrospective Study

Matthew O'Hara,[a,†] Elizabeth G. Wheatley,[a,†] and Steven C. Kazmierczak[b,*]



Altered outcome in patient management or care	Patients with pseudohyperkalemia *n* = 40
Unnecessary follow-up tests	6 (15.0%)
Delay in treatment	3 (7.5%)
Inappropriate intervention	2 (5.0%)
No change	29 (72.5%)

O'Hara M et al. J Appl Lab Med 2020; 332-341

Impact in LOS in the ED

Impact of Point-of-care Testing on Length of Stay of Patients in the Emergency Department: A Cluster-randomized Controlled Study

Pierre Hausfater, MD, PhD[1,2], David Hajage, MD, PhD[3], Julie Bulsei, MD[4,5], Pauline Canavaggio, MD, PhD[1], Alexandre Lafourcade, MD[6], Anne Laure Paquet, MD[1], Michel Arock, MD, PhD[7,8], Isabelle Durand-Zaleski, MD, PhD[4,5], Bruno Riou, MD, PhD[1,2], and Nathalie Oueidat, MD[8]

ACADEMIC EMERGENCY MEDICINE • October 2020, Vol. 27, No. 10 • www.aemj.org

- Conclusions: The implementation of an extended panel of POCT solutions in an ED did not significantly reduce the LOS but reduced the TTR.

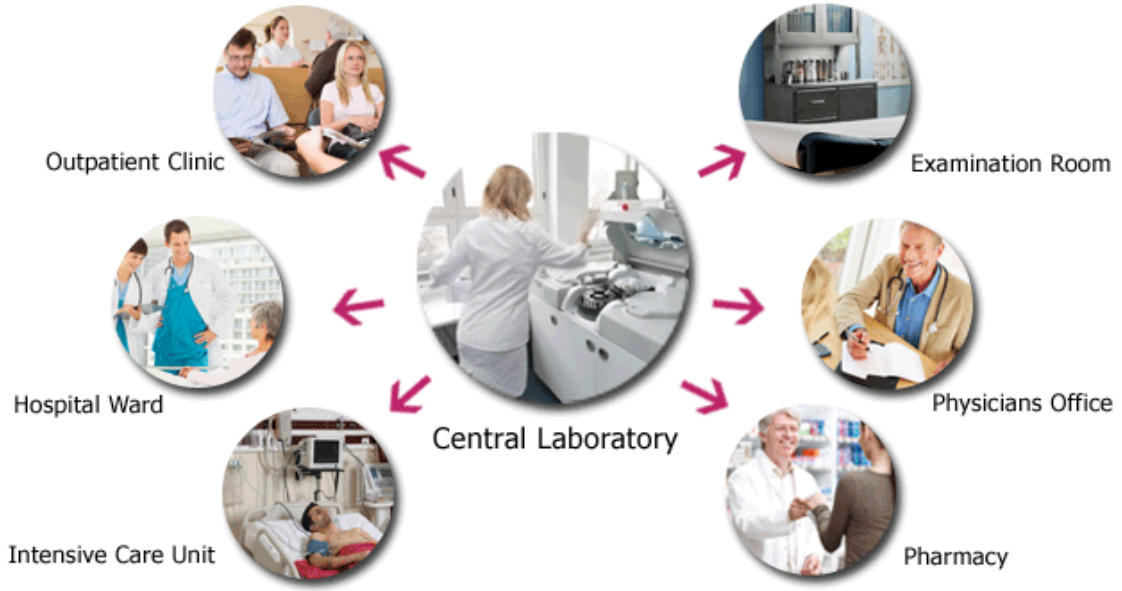
Table 2
Detailed Costs of the Two Strategies, POCT, and Central Laboratory

	Cost per ED Visit (€)	
	POC Strategy	Central Laboratory Strategy
Analyzers operating costs	9.7	0
Costs of the ED personnel	18.3	18.1
Laboratory charges induced by the ED	0.9	6.1
Gross direct costs	29.3	29.3
Induced charges of imaging, functional exploration, anesthesiology, and operating theater	23.1	23.1
Subcontracting costs	1.3	1.3
Total	82.5	77.9

¿What can we do?

Two ways of performing POCT

Led and controlled by Laboratory



NOT led or controlled by Laboratory

Management and use of POCT devices

MHRA
Regulating Medicines and Medical Devices

Top 10 Tips

Point Of Care Testing

1. **Involve your local hospital laboratory**
   Your local hospital pathology laboratory can play a supportive role in providing advice on a range of issues including the purchase of devices, training, interpretation of results, troubleshooting, quality control, and health and safety.

2. **Management**
   Many people will be involved in the creation, implementation and management of a POCT service. It is vital that an appropriate POCT co-ordinator is identified and a POCT committee established.

3. **Health and safety**
   Be aware of the potential hazards associated with the handling and disposal of body fluids, sharps and waste reagents outside of a laboratory setting.

4. **Training**
   Training **must** be provided for staff who use POCT devices. Only staff whose training and competence has been established and recorded should be permitted to carry out POCT.

5. **Always read the instructions**
   …and be particularly aware of situations when the device should **not** be used.

6. **Standard operating procedures (SOPs)**
   SOPs must include the manufacturer's instructions for use.

7. **Assuring quality**
   The analysis of quality control (QC) material can provide assurance that the system is working correctly.

8. **Results**
   Results should be reviewed by appropriately qualified staff with particular reference to the patient's history.

9. **Record keeping**
   …is essential and must include patient results, test strip lot number and operator identity.

10. **Maintenance**
    In order that devices continue to perform accurately they must be maintained according to the manufacturer's guidance.

Medicines and Healthcare Products Regulatory Agency. UK Government; 2013

When and how can the lab help

Management and Organization of POCT

1. Responsibility and accountability → POCT Committee
2. Selecting analyzer / method (validation process)
3. Staff training and competency
4. Instructions for use
5. Standard operating procedures (SOPs)
6. Health, safety and waste disposal
7. Infection control
8. Quality assurance (QA)
    - Internal quality assessment
    - External quality assessment
9. Pre-analytical considerations
10. Sample collection
11. Maintenance / troubleshooting
12. Accreditation
13. Record keeping / Traceability of measurement
14. Information technology (connectivity)
15. Adverse incident reporting

To avoid preanalytical errors in POCT …

… 20 tips are recommended

1. Sampling should preferably be done after an overnight (7 and 9 a.m.)
2. In case that sampling is done at some other time, the exact time needs to be recorded
3. Blood sampling should be done at least 1 hour after the i.v. administration of various intravenous fluids (electrolytes, glucose)
4. If a patient is receiving parenteral nutrition (fat emulsions), sampling should be done preferably before the administration of the infusion, or 8 hours after the infusion
5. To assure proper patient identification, recommended practice is to use barcoding systems that may link sample, operator, instrument and test result to the patient record
6. Patient identification should always contain full patient name, and unique identification number
7. Blood drawing is not recommended from i.v. catheters in patients who receive any kind of medication.
8. If a blood sample has to be obtained from a patient who is receiving i.v. fluid, the sample should be obtained from the opposite arm
9. If no other option is possible, sample may be drawn through an i.v. catheter after discarding the adequate amount of blood, shutting off the catheter (2-3 min), applying the tourniquet below the i.v. line and choosing the venipuncture site below the tourniquet (distally)
10. Sampling from the site above the i.v. catheter (proximally) should never be done
11. Excessive massage and squeezing around the puncture site during capillary sampling should be avoided
12. Whenever possible, syringes should not be used for blood sampling
13. Attention from a patient who is hyperventilating, crying or is anxious. Such patient should be calmed down and sampling postponed until the anxiety has been relieved
14. If tubes with additives are used, care must be taken during sampling to fill the tubes
15. If small-volume tubes are used for capillary sampling, the tubes must be filled to the mark, to required volume
16. If more than one tube is to be collected, the recommended order of draw must be followed
17. To prevent blood clotting, tubes must be mixed gently, as soon as collection is done
18. Samples should not be mixed too vigorously, to avoid hemolysis
19. Samples with visible clots should be rejected for analysis and sampling should be repeated
20. To prevent hemolysis during venous blood sampling, care must be taken to match the size of the needle and tube with the size of the vein

Ana-Maria Simundic. www.acutecaretesting.org; 2012

Take home messages

- POCT has the potential to improve patient outcome or workflow by having results immediately available
- The quality of the results must be equivalent to the central lab's
- Most of the errors occur in the preanalytical phase
- Erroneous POCT results not detected by the device can impact on patient diagnosis (patient safety) and management and on resources and budgets
- POCT is performed by personnel untrained in laboratory skills and busy environment (EDs) can also impact on the number of errors
- Multidisciplinary approaches involving the laboratory medicine professionals is the best strategy to mitigate this errors and to improve patient care


thank you
merci
danke
謝謝
gracias
obrigado
dziękuję
bedankt
hvala
mauruuru
terima kasih
sukriya
kop khun krap
go raibh maith agat
sagolun
takk
dakujem
arigatô
grazie
tack
teşekkür ederim
ngiyabonga
tapadh leat
mochchakkeram
спасибо
рахмат
Баярлалаа
faafetai lava
kiitos
dankie
dhanyavad
nandri
nanni
bayarlalaa
grâçie
enkosi
köszönöm
akun
dankon
ačiū
dank je
misaotra
matondo
paldies
grazzi
mahalo
barka
welalin
mersi
kia ora
spas
vinaka
спасибі
blagodaram
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asante
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taiku
sobodi
dëkuji
mèsi
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ありがとう
tanemirt
rahmet
diolch
dhanyavadagalu
shukriya
mercé
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trugarez
kam sah hamnida
rahmat
তোমাকে ধন্যবাদ
감사합니다
xièxie
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