

POCT – point of care testing

Test request



Result
interpretation

Result

Sampling



Specific problem:
point of care
testing (POCT)



POCT – what is that / when is it justified?

- There is no lab nearby
- Immediate decision is required
- Logistics – hard to be resolved
- More simple / cheaper when it done on field

POCT

Generally done

- Glucose
- Blood gas / electrolytes
- Urinary strip / chemistry / pregnancy
- Blood in stool
- Hemoglobin
- ESR
- Blood typing
- Strep test

POCT

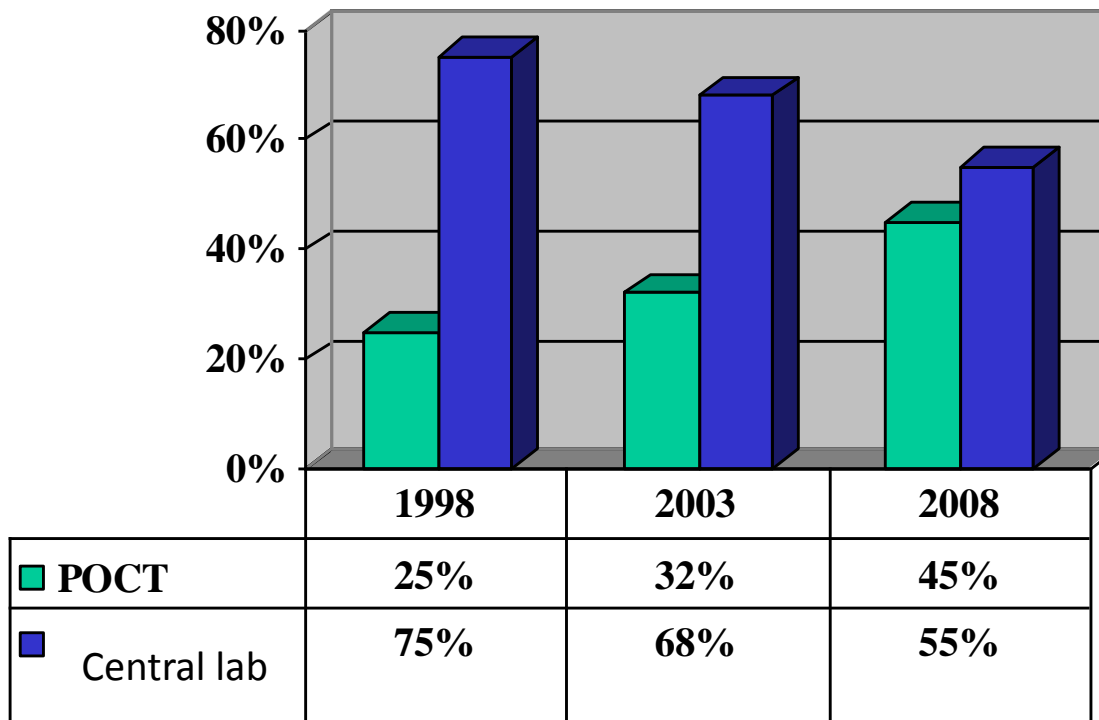
Other options

- Cardiology markers
- Drug / toxicity
- Hemostasis tests
- D-dimer
- Lactate
- Lipid
- HbA1c
- Microalbumin, creatinine
- H.pylori, rotavirus, influenza
- PTH, ACTH, growth hormone
- Sepsis
- Stroke
- DNA

POCT

- **BEDSIDE TESTING**
- **EMERGENCY TESTING**
- **POINT-OF-CARE TESTING**
- **CRITICAL CARE TESTING**
- **PATIENT FOCUSED TESTING**
- **NEAR PATIENT TESTING**
- **DECENTRALIZED LAB. TESTING**
- **SELF/HOME MONITORING TESTING**
- **PÁCIENS KÖZELI LABORVIZSGÁLAT**

Increase of POCT tests within total number of lab tests



POCT categories

Tests in an outpatient
setting

Self monitoring tests

POCT

Emergency tests

Specific tests

POCT - glucose



Source of errors

- Measured in an inappropriate timepoint
- Few blood. Forced pressure; contaminated with lymph.
(Area should be warmed with water; side of finger 3 or 4 should be spiked).
- Too much blood; test area may be contaminated.
- Dirty reading area of test device
- Expired strip (inappropriate storage)
- Data are not recorded
- Not clear who use the device (data are not retrievable)

Some words on urinary strip analysis

Composition of the urine

- 95% water, 5% soluble material
- Straw yellow; concentrated urine is darker
- Specific gravity is in wide range (1.005-1.030)
- pH 4,6 – 8
- Aromatic odor
- Absent normally:
glucose, ketone, blood, protein (<80 mg/l), bilirubin, nitrit, leukocytes

Urinary tests with strips are easy to perform. However, false results may be obtained with inappropriate methods

- Expired or inappropriately stored strip (storage: cool and dried place, tightly capped containers)
- Color code is not read correctly
- Bad technique
- Strip is turned upside down during testing
- Insufficient time is allowed for reaction
- Reagent pads are touched

Urinary strip testing is easy to perform, but

- You should inspect the sample before testing:
 - Fresh samples should be used
 - Samples should be kept on room temperatures
 - Appropriately mixed sample should be used

Before strip: inspect the sample

Feature	Cause	Note
No color	Diluted samples	polyuria; artefact (?)
Turbid	Salts, crystals, cells, semen, mucin, pus, contaminated with stool, contrast agent	
Milky	pus, lipiduria, chyluria, paraffine	Vaginal gels
Orange	Concentrated urine, urobilin or bilirubin	Dehydration, fever; yellow foam in case of high bilirubin
Greenish-yellow, Brownish-yellow	bilirubin-biliverdin	yellow foam
Red	hemoglobin, RBC, myoglobin	Strip indicates
	Porphyrin, fusicin, anilinf dye	Strip does not indicate
Brownish black	Methemoglobin	Acidic urine
	Melanin, homogentizin acid	Unfresh sample
Cyanic	Chlorophyll	Mouth deodorants
	Pseudomonas-infection	

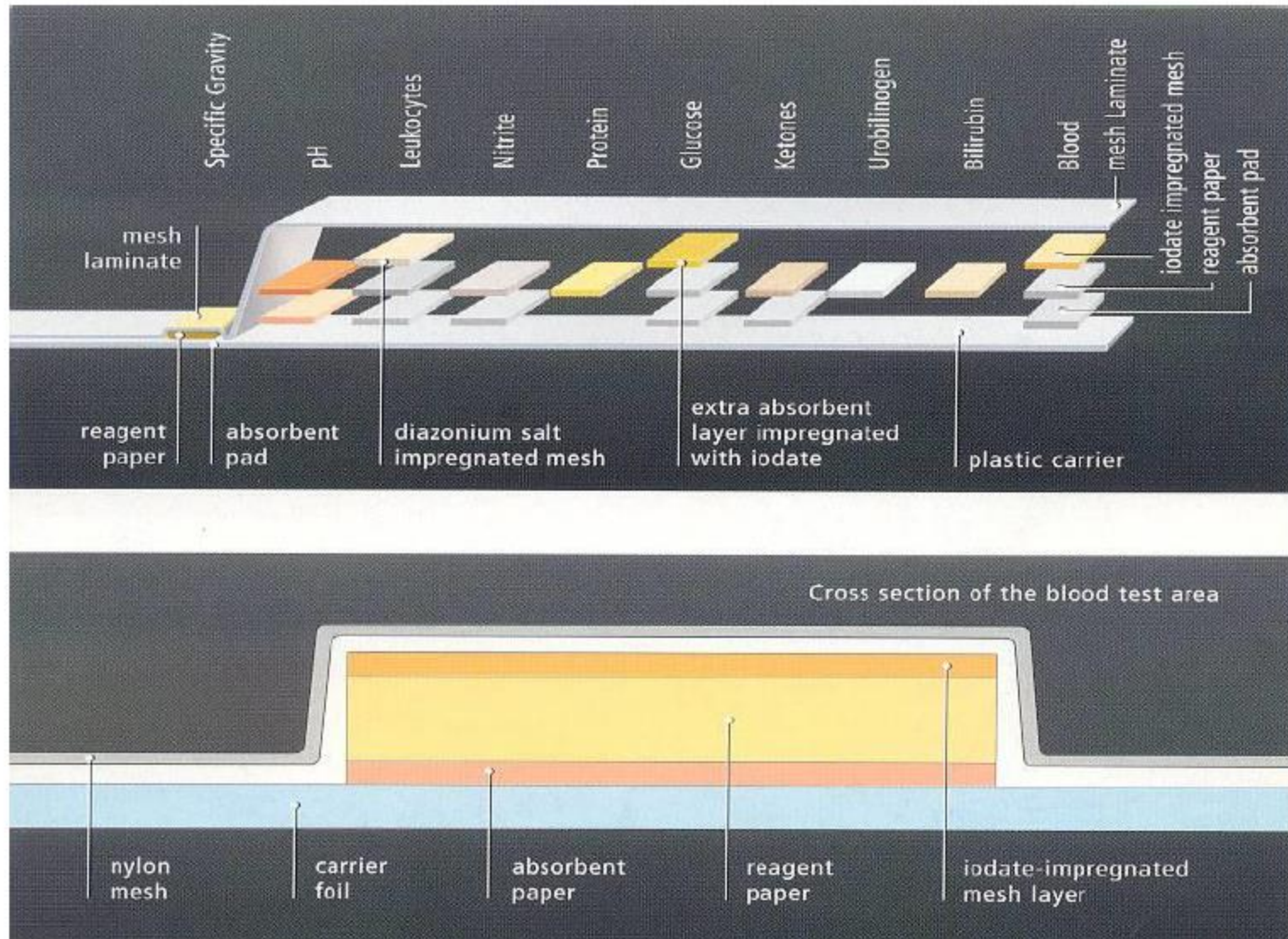
Drugs discoloring the urine

Drug	Color
Ethanol	Light (diuresis)
Senna (anthraquinone laxative)	alkaline: red; acidic : yellowish brown
Deferoxamine mesilate (iron chelator)	Red
Etoxazan (urinary analgetics)	orange, red
Fluorescein-sodium (IV)	Yellow
Nitrofurantoin (antibacterial agent)	Brownish yellow
Indigocarmine (cystoscope, renal function testing)	Blue
Iron sorbitol (supplement)	Brown after a while
Levodopa (anti-Parkinsonian)	Red, then brown

Drugs discoloring the urine

Drug	Color
Metildopa	darkening; reddish brown in the presence of oxidising agents
Metronidazol (antibacterial)	Dark; reddish brown
Phenazopiridin (urinary analgetics)	Reddish-yellow (acidic pH)
Fenindion (anticoagulant)	Orange (alkaline pH)
Fenfolftalein (laxative)	Red-purple (alkaline pH)
Rifampin	Light orange – yellow
Ribaflavin (multivitamin)	Light yellow
Sulfasalazin (ulcerous colitis)	Orange – yellow (Alkaline pH)

Structure of urinary strip



Analytes present on strip

Specific gravity 1,003 – 1,035

Components responsible for SG:

- Urea: 20%
- NaCl: 25%
- Sulphate & phosphate salts

Principle:

- Polyelectrolyte, indicator and buffer.
- Acidification proportionally to ionic strengths
- pH dependent indicator

Limitations / notes:

- Not altered by glucose, protein, contrast agents

Analytes present on strip

- **pH**

Acidic: consumption of meat, some fruits (blueberry); sleeping (compensating of ventilatory acidosis); NH_4Cl , methionin, metenamin-mandelate [used for phosphate and calcium-carbonate stones]

Alkaline: citrus fruit, after a meal, NaHCO_3 , citrate, acetazolamide [used for uric acid, cistin, calcium-oxalate stones, potentiation of neomycin, canamycin, streptomycin effect, therapy of salicylate intoxication], renal tubular acidosis

Principle:

Indicator: methyl red and bromotimol-blue (orange, green & blue)

Interference: higher with storage (CO_2 levels decrease, NH_4 produced by bacteria)

Analytes present on strip

- **protein**

Normal: Max. 150 mg/day, 200 different species; 1/3 albumin, 1/3 uromucoid [Tamm-Horsfall glycoprotein produced by distal tubular cells], remnant: globulins, IgA, cellular fragments, WBC.

Principle:

Tetrabromophenol blue, acidic pH: pH increased in the presence of proteins; blue color in the presence of protein, indicates level above 100 mg/l

Interference: false negative in very thin urine. false positive: concentrated & alkaline urine, quaternary ammonium or chlorhexidine; NO interference with drug, contrast agent or turbidity

note: particularly sensitive for albumin

Analytes present on strip

- **Microalbuminuria**

Principle immune reaction [Micral II]

- Oxytetracycline increases the level; no interference with pH

Color reaction [Clinitek]

- Interference with Tamm-Horsfall protein

Analytes present on strip

- **glucose**

Principle:

glucose + O₂ ---- glucose oxidase → gluconic acid + H₂O₂

H₂O₂ + chromogenic ---- peroxidase → oxidized chromogenic + H₂O

Interference:

false positive: oxidising agents (detergents in container), low gravity

false negative: high gravity, ascorbic acid, ketones, salicylates, L-DOPA, sodium-fluorid, bacteria

NO interference with other sugars

Analytes present on strip

- **Ketone** (acetacetate, 20%, acetone 2%, 3-hydroxy-butirate, 78%)

Principle:

Color reaction of acetacetate and acetone with nitroprusside

Interference:

false positive: ftaleins (sulphobromoftalein, phenolsulphonftalein dye), phenylketonuria, L-dopa, antihypertensive agents: methyldopa and captopril

Analytes present on strip

- **Blood (hem)**

Principle: based on hem peroxidase activity

RBCs are lysed

$\text{H}_2\text{O}_2 + \text{chromogenic} \rightarrow \text{oxidized chromogenic} + \text{H}_2\text{O}$

(tetramethylbenzidine: green)

10 RBC/HPF [3 mg/l]

Detects the presence of both hemoglobin and myoglobin

Interference: RBCs may sediment. Sensitivity decreased: high gravity, high protein content

false negative: ascorbic acid, formalin

Nitrit: reaction is delayed

false positive: hypochlorite, iodine, bacteria (peroxidase)

Jaundice

result	normal	Biliary obstruction	Hemolysis, hemolyticus anemia	Liver damage, hepatitis, cholestasis
urinary bilirubin	No	Increased in dark urine	No	In the beginning increased
urinary urobilinogen	Detectable	Tumor —low or absent; Stone – varying	increased	In the beginning decreased; then increased
Color of the stool	Dark	Light; in the presence of biliary stones intermittent; persisting in presence of tumor	Dark	In the beginning light, then dark (hepatitis); light (cholestasis)

Analytes present on strip

- **Bilirubin**

Principle: chromogenic reaction (diazonium salt)

Interference: levels decrease in unfresh urine / light exposure, high ascorbic acid levels, high nitrit levels, red urinary sample

Levels increase: rifampin and chorpromazine

No interference: urobilinogen

Analytes present on strip

- **Urobilinogen**

Principle: chromogenic reaction (Ehrlich-aldehyde reaction, or diazonium-salt)

Interference: interference with red drug metabolites; decrease in unfresh urine

Analytes present on strip

- **Nitrite**

Nitrit producing bacteria: E. coli, Klebsiella, Enterobacter, Proteus, Staphylococcus, Pseudomonas species

At least 4 hours are required to produce a sufficient amount of nitrites by bacteria → first specimen in the morning

NO NITRIT POSITIVE: *Enterococcus*

In general, 70% sensitivity

In hospital infection it is more frequent that this test is negative

Principle: chromogenic reaction

Interference:

false positive: unfresh urine, urinary coloring agents (phenazopyridine)

false negative: ascorbic acid, urobilinogen, low pH (<6), random sample (sample from catheters), insufficient amount of nitrate in diet

Analytes present on strip

- **WBC (leukocyte esterase)** also detects cell fragments

Principle: Neutrophyl esterases hydrolyse esters; the generated alcohol is detected by chromogenic reaction

Interference:

Decreased by: high urinary gravity, protein, glucose, ascorbic acid

Increased by: vaginal discharge (presence of squamous cells and bacteria), oxidising agents and formalin

Analytes present on strip

- **ascorbic acid**

Interferes with glucose, blood, bilirubin, nitrit, and leukocytes tests

Principle: chromogenic reaction

phosphomolibdate → molibden-blue, 50 mg/l.

Interference: gentisin acid and L-DOPA

or:

Methylene green → dyscoloration. Interference: alkaline pH, bilirubin

Take home message

In general, test results obtained with urinary strips are interfered by:

- Color of urine
- pH
- Presence of reducing or oxidising agents (ascorbic acid & detergents)

Other analytes – specific tests

- hCG test - detects one week of pregnancy
- Drug detection – severe limitations (not sensitive to derivatives)

Serological quick test: GLORIA

- **Gold Labelled Optical Read Immuno Assay**
- **Ab** attached to vehicle +
- **Ag** present in sample
- = **Ab-Ag** Immune complex1
- +
- Gold labelled secondary antibody
- **Ab-Au*** (FREE)
- = **Ab-Ag~Ab-Au*** (BOUND)
- Basic principle of quick tests



Detection of blood in stool

- FOBT: fecal occult blood test – colorimetric reaction of guaiachol with hemoglobin
dietary restriction
- FIT: antibody against hemoglobin.
not sensitive to upper gastrointestinal bleeding
detects human Hb alone

More specific POCT tests

- Breath tests
- Cystic fibrosis test
- Continuous glucose monitoring system (CGMS)
- Blood glucose monitor

Criteria for utilization of POCT tests for clinical decision making

Criterion
Professional use of POCT device
Appropriate functionin of POCT device
Measurements are documented

POCT in a hospital

Use of an integrated hospital system

- Information link between departments and the lab
- Devices can be / are connected to the system.
- Lab is able to monitor / validate the results remotely
- Documentation.

POCT in hospital: integrated informatic system

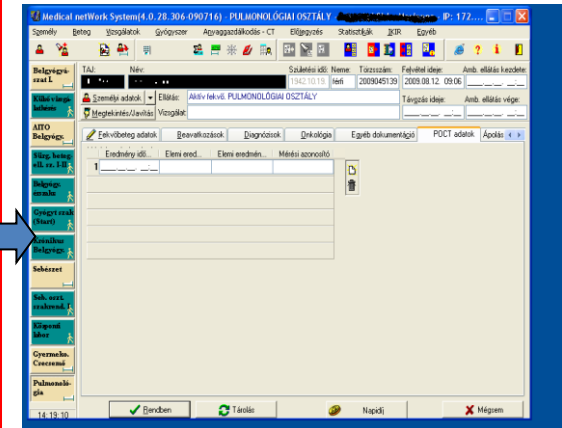
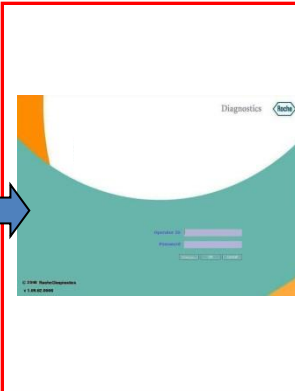
1. Operator ID

2. Patient ID

3. Testing

4. Transmission of result into POCT interface

5. Transfer of test result into medical informatic system



POCT

Benefits

- Support immediate clinical decision making
- Quick
- Comfortable for the patient / the doctor

Risks:

- Expensive
- Not sufficient training
- QC / maintenance is often not solved
- Absence of documentation
(unidentified sample, unrecorded data)