Tiny Veins, Big Problems: Vascular Access in Children

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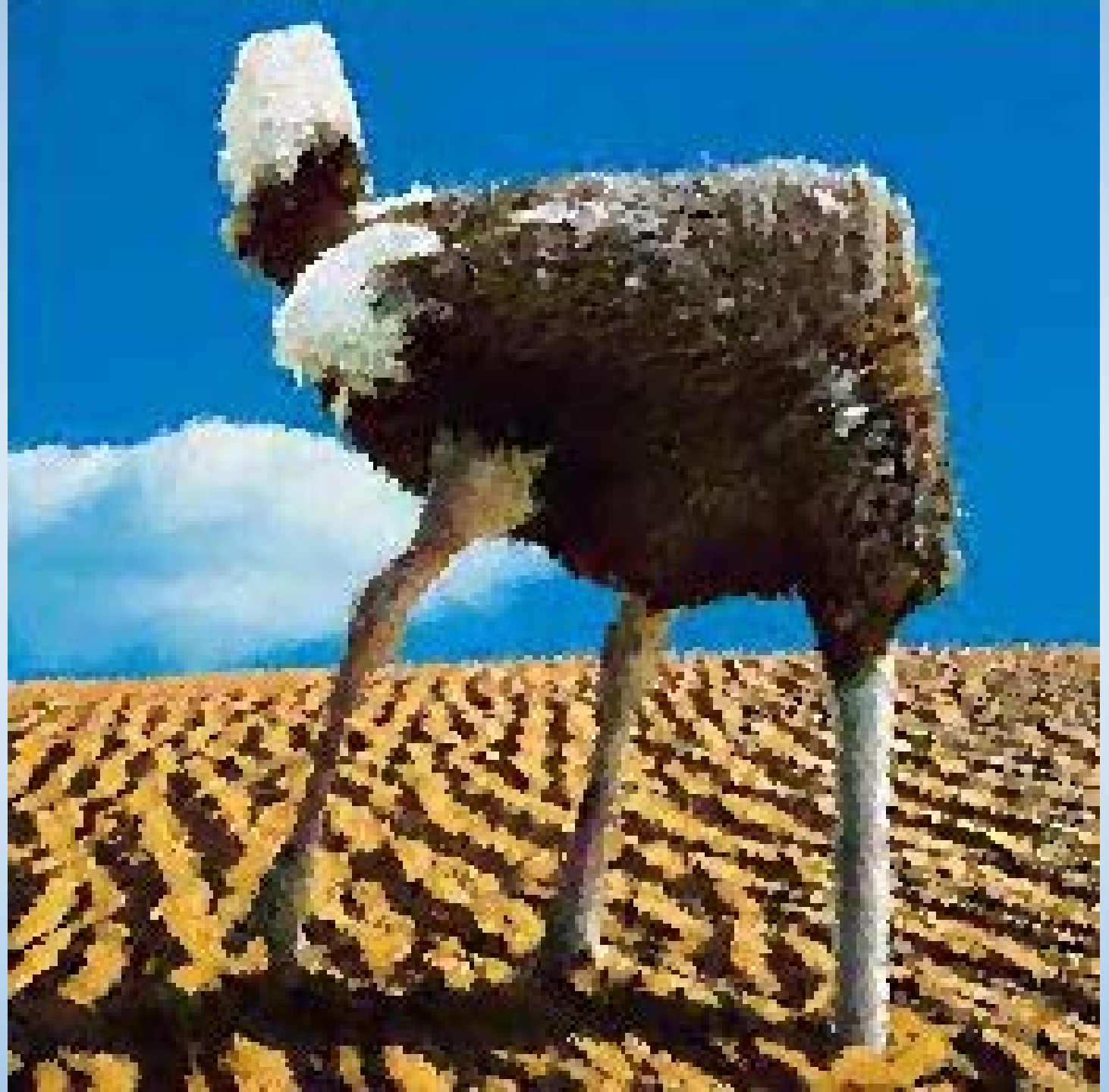
HARBOR-UCLA DEPARTMENT OF EMERGENCY MEDICINE



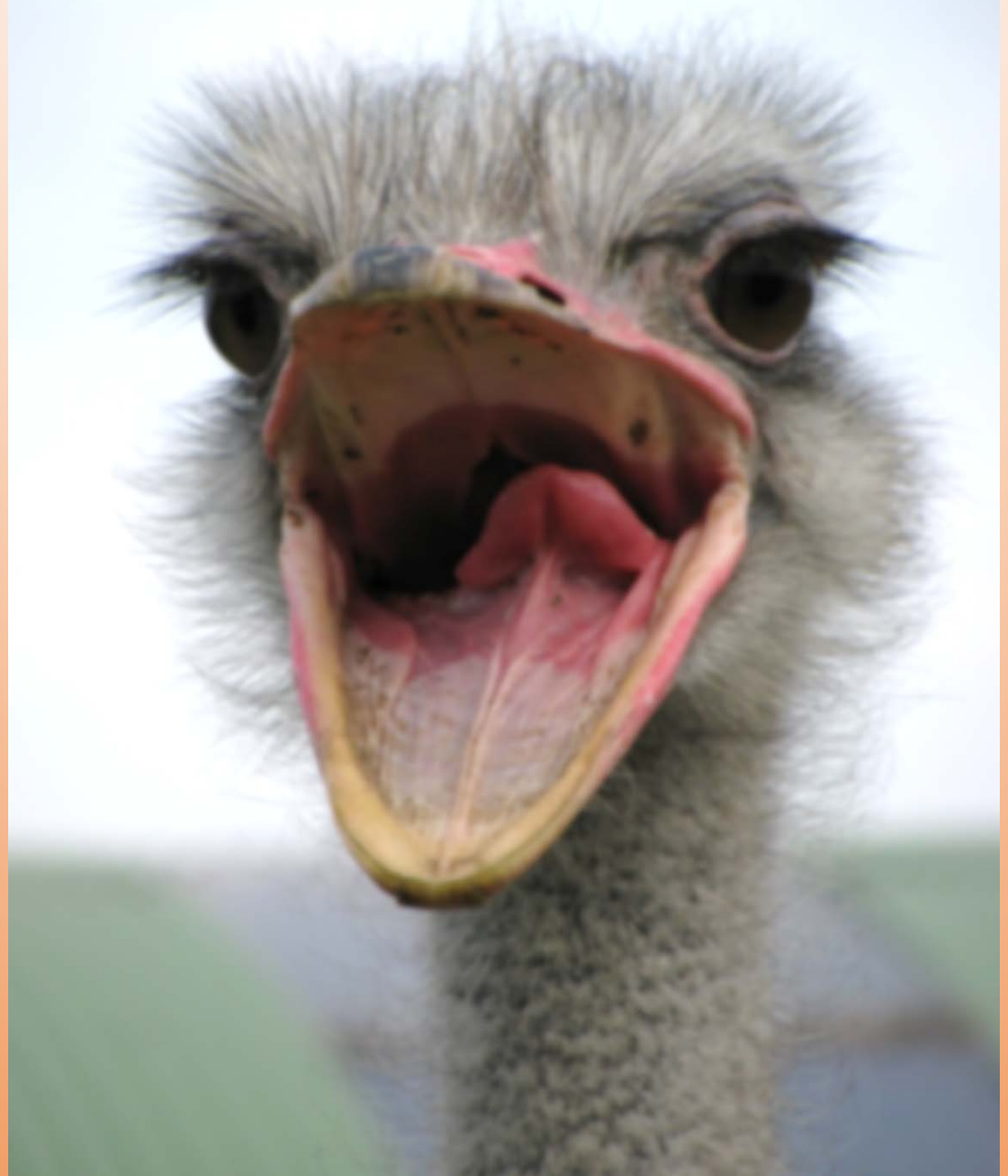
RALLY

RALLY

REPLETE

REPLETE

RESUSCITATE



RESUSCITATE

RALLY

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REPLETE

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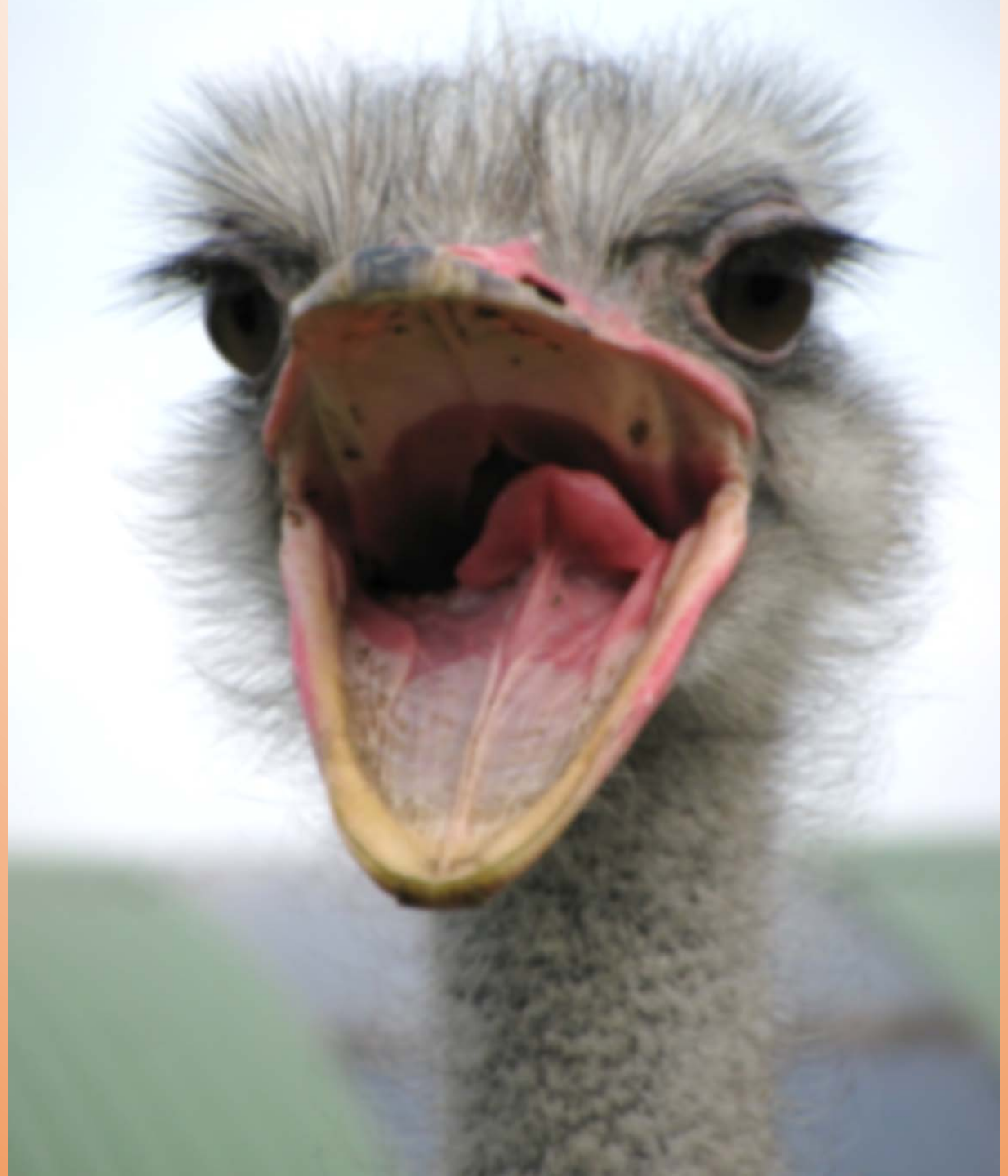
RESUSCITATE

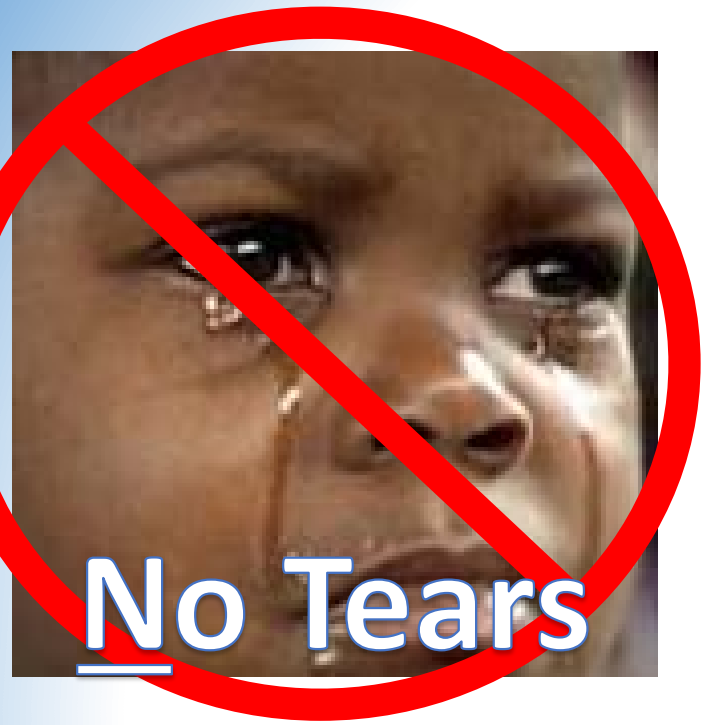


RESUSCITATE

Signs	**Mild** < 3% Body Weight Lost	**Moderate** 3-9% Body Weight Lost	**Severe** > 9% Body Weight Lost
Mental Status	Normal	Fatigued, Irritable	Lethargic, Unconscious
Breathing	Normal	Increased	Tachypnea
Mucous membranes	Moist	Dry	Parched
Tears	Normal	Decreased	Absent
Capillary refill	< 2 seconds	Prolonged	Minimal

Clinical Sign	LR + [95% CI]
<u>Two or more of following 4 signs:</u> • Capillary refill time • Dry mucous membranes • Absence of tears • Abnormal overall appearance	**6.1** [3.8 to 9.8]

Gorelick MH et al. Validity and reliability of clinical signs in the diagnosis of dehydration in children. *Pediatrics.* 1997; 99(5):E6



NARL 2

too gnarly

RALLY

RALLY

Mild Volume Depletion

- **Control** nausea
- **Break** ketosis
- **Replace** volume by mouth over time

Mild Volume Depletion: management

- **Control Nausea**
  - Ondansetron (Zofran) 0.15 mg/kg
  - Alternative PO dosing (Freedman, 2006)
    - 8-15 kg: 2 mg/dose once
    - 15-30 kg: 4 mg/dose once
    - 30+ kg: 8 mg/dose once
- **Break ketosis**
- **Oral rehydrating solution**

Rally the Parents!

- **Acknowledge** frustration
- **Build confidence** by starting PO hydration in ED
- Guide them how **to continue at home**

Fonseca BK, Holdgate A, Craig JC. Enteral vs intravenous rehydration therapy for children with gastroenteritis: a meta-analysis of randomized controlled trials. Arch Pediatr Adolesc Med. 2004 May;158(5):483-90.

Rally the Parents!

Goal: **50 mL/kg over 4 hours**

- **1 mL/kg** of oral rehydration solution **every 5 minutes** for 4 hours
- **3 mL/kg** of oral rehydration solution **every 15 minutes** for 4 hours

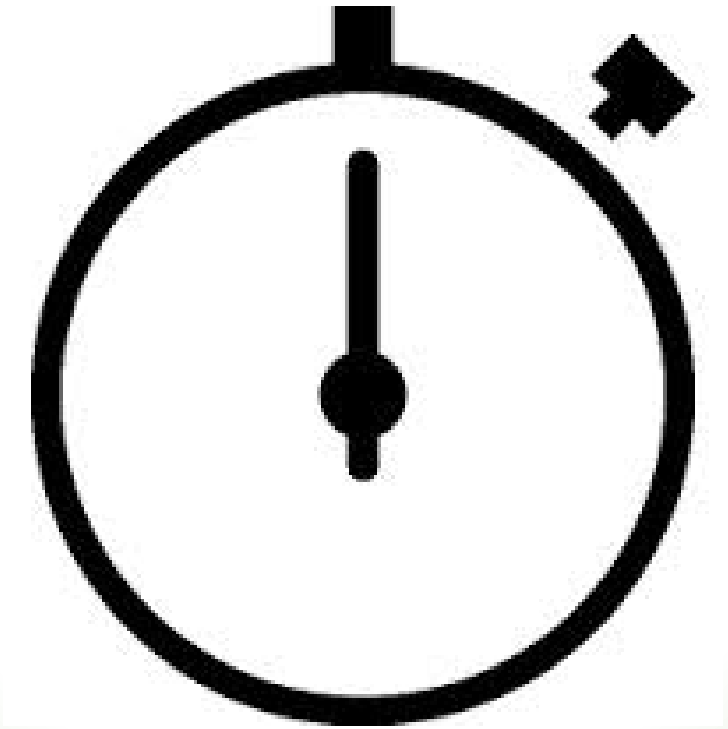
Rally the Parents

- One teaspoon = **5 mL**
- Write clearly type of solution in teaspoons

E.g.:

- **10 kg infant**, 50 mL/kg over 4 hours = 500 mL over 4 hours
- 500 mL/5 mL = 100 teaspoons
- 100 teaspoons/4 hours = **6 tsp every 15 min**

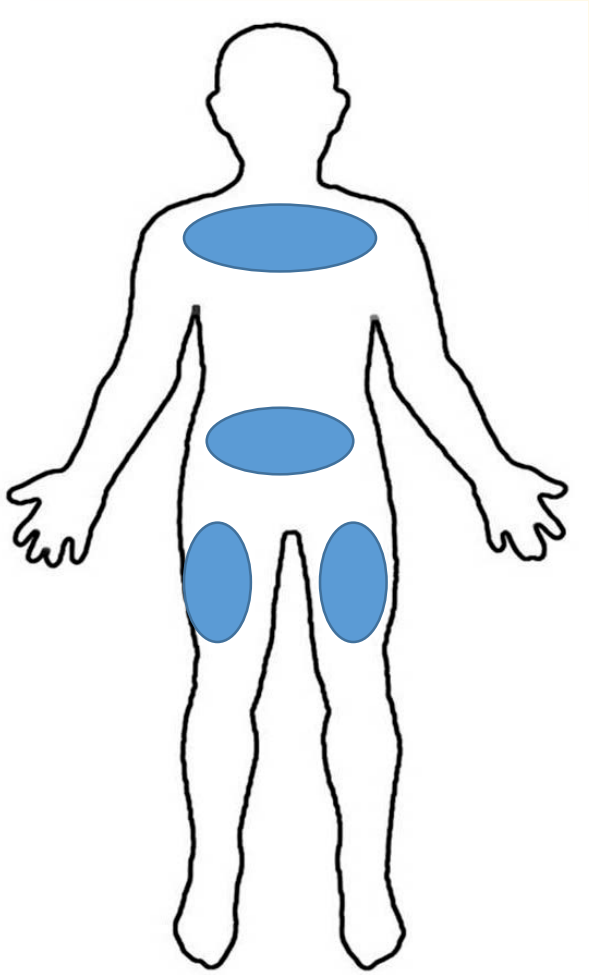
15 minute trial: 3 mL/kg



REPLETE

REPLETE

Moderate Volume Depletion



- **Continue PO** if possible
- *Stable child?*
- *Try*: **hypodermoclysis**
- Parenteral fluids given into subcutaneous space

Hypodermoclysis

- Place EMLA
- Inject **hyaluronidase** 150 U into subcutaneous space
- Insert angiocatheter into **subcutaneous space**
- Infusion by gravity or pump

Allen CH et al. Recombinant Human Hyaluronidase-Enabled Subcutaneous Pediatric Rehydration. Pediatrics. 2009;124:e858–e867.

Hypodermoclysis

Hypodermoclysis

Hypodermoclysis

We're gonna need an IV…

- General Principles
- Adjuncts
- Topical anesthetics (EMLA, vapocoolant)
- Needleless anesthetic injector (J-tip)
- Near-infrared light (AccuVein, VeinFinder)

We're gonna need an IV…

- Optimize your attempts

Pain

Environment

Visualization and Mechanics


ECOLAB

We're gonna need an IV…

Neonate	– 1 g
Infant	– 2 g
Child	– up to 10 g
Adolescent/Adult	– 10 – 16 g


emla 5%
5 g cream
EXP
LOT
2010-11


emla 5%
5 g cream
EXP
LOT
2010-11

x2


emla 5%
5 g cream
EXP
LOT
2010-11


emla 5%
5 g cream
EXP
LOT
2010-11

x3

We're gonna need an IV…

- J-Tip
- Needle-free injection of local anesthetic


ECOLAB

We're gonna need an IV…

- Ultrasound-guided peripheral venous access

Ultrasound-assisted peripheral vascular access in a paediatric ED

Ed Oakley[1,2] and Ai-Ming Wong[3]
[1]Department of Emergency Medicine, Monash Medical Centre, [2]Murdoch Children's Research Institute and [3]Department of Medicine, University of Melbourne, Melbourne, Victoria, Australia

- Prospective, observational; landmark v. US-guided techniques
- 84 patients enrolled
- 61 line placement episodes in the landmark group (with 253 attempts)
- 38 in the US group (with 90 attempts)

Ultrasound-assisted peripheral vascular access in a paediatric ED

Ed Oakley[1,2] and Ai-Ming Wong[3]
[1]Department of Emergency Medicine, Monash Medical Centre, [2]Murdoch Children's Research Institute and [3]Department of Medicine, University of Melbourne, Melbourne, Victoria, Australia

- Prospective; US group (USG-PIVA) v. B group (blind)
- 1° outcome: **time to cannulation**
- 2° outcomes: success rate at 1st puncture, number of punctures, and diameter of the catheters

Ultrasound-assisted peripheral vascular access in a paediatric ED

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- US recorded **slightly higher success** per attempt overall
  (42% vs 38%, *P* = 0.08)

- **US performed better** in the **patients with difficult access**
  (success 35% vs 18%, *P* = 0.003)

- **US attempts took longer** than landmark attempts
  (2 min 15 s vs 4 min, P < 0.001)

Ultrasound guidance allows faster peripheral IV cannulation in children under 3 years of age with difficult venous access: a prospective randomized study

Mehdi Benkhadra[1], Mathieu Collignon[1], Isabelle Fournel[2], Christian Oeuvrard[1], Patricia Rollin[1], Murielle Perrin[1], François Volot[1] & Claude Girard[1]

- 20 children, no group difference in for sex, age, and BMI.
- **USG-PIVA** was **considerably faster** (63.5 s vs 420.5)
- **Less** punctures (1 vs 2.5)
- **Better success rate** at 1st cannulation (85% vs 35%)
- Overall success rate did not differ (90% vs 85%) faster; recommend in children with difficult venous access

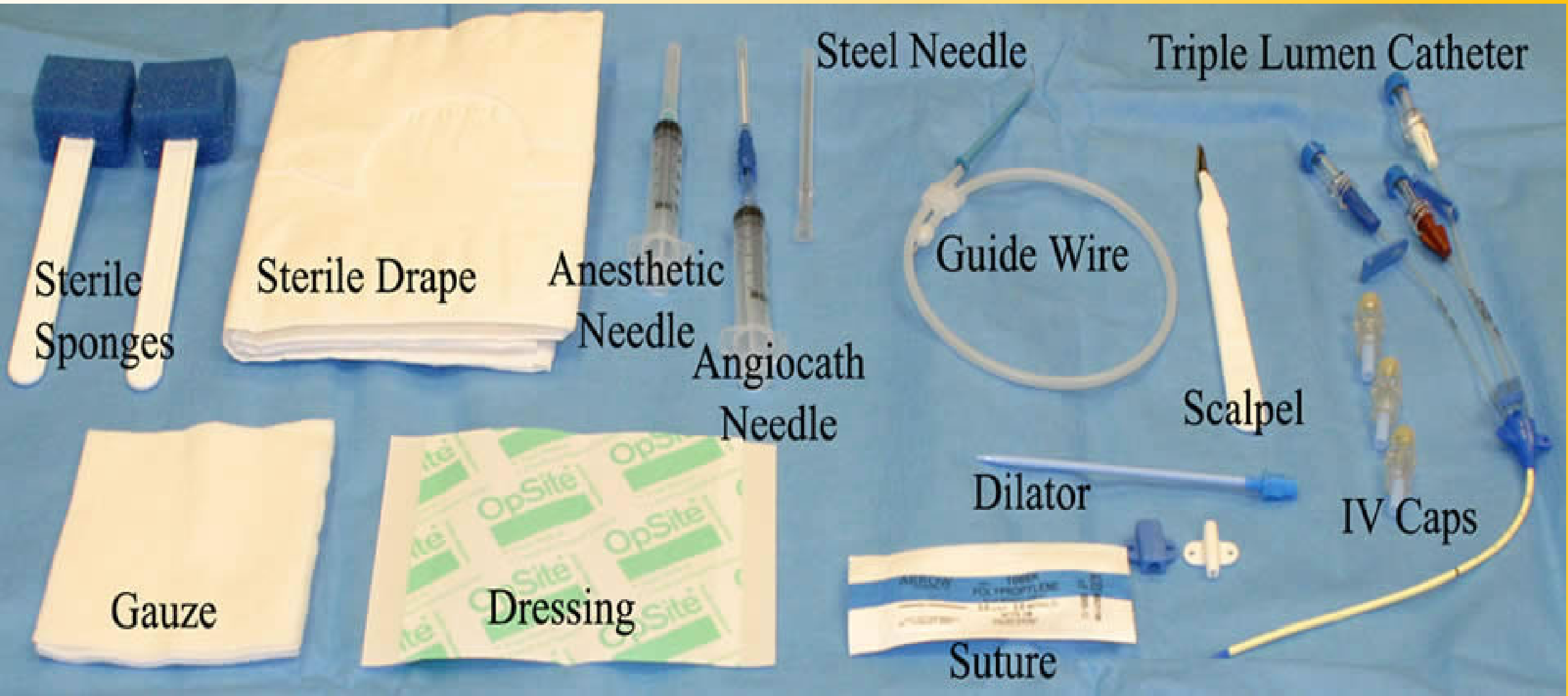

3M
Tegaderm


KONIX
Sterile gel
STERILE R
CONTACT MEDIUM FOR ULTRASONIC AND ELECTRICAL TRANSMISSION GEL
20ML
WATER SOLUBLE
GUARANTEED STERILE UNLESS OPENED OR DAMAGED
CE 1014
Ref.: SG001
turkuaz
WIPAK MEDICAL
STERIKING R41

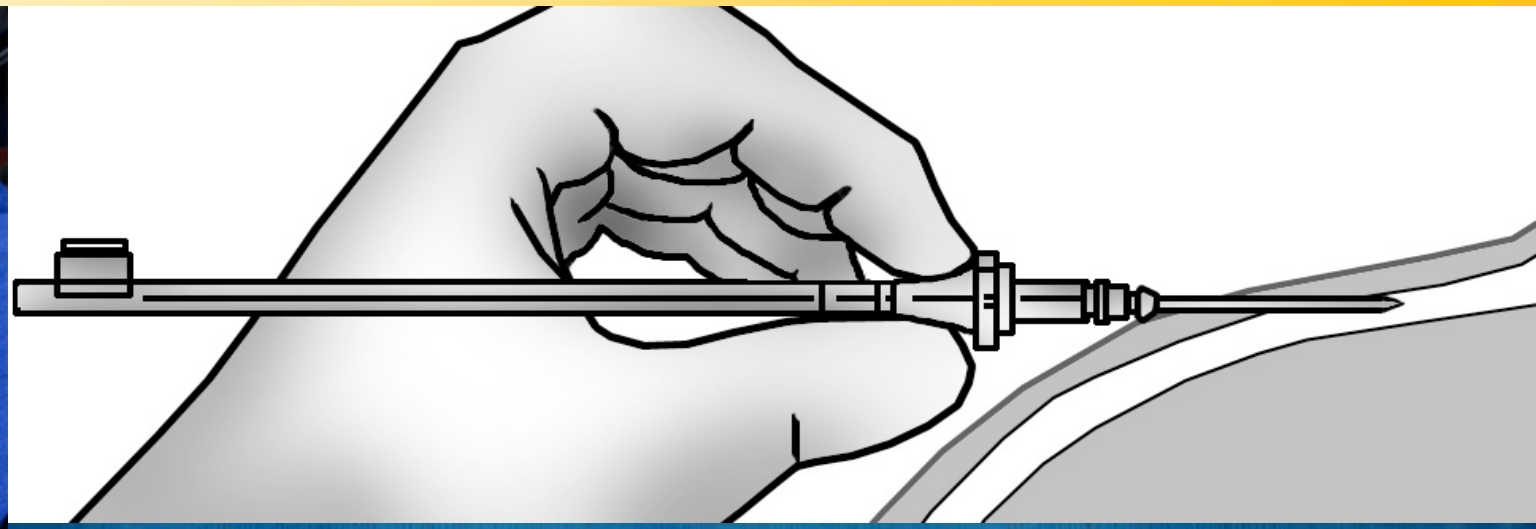

surgilube
645C MAR13
SAVAGE LABORATORIES
surgical lubricant
sterile bacteriostatic
DO NOT USE IN EYES AND EARS.
This product available in tubes at pharmacy.
NET WT 3 g
foilpac

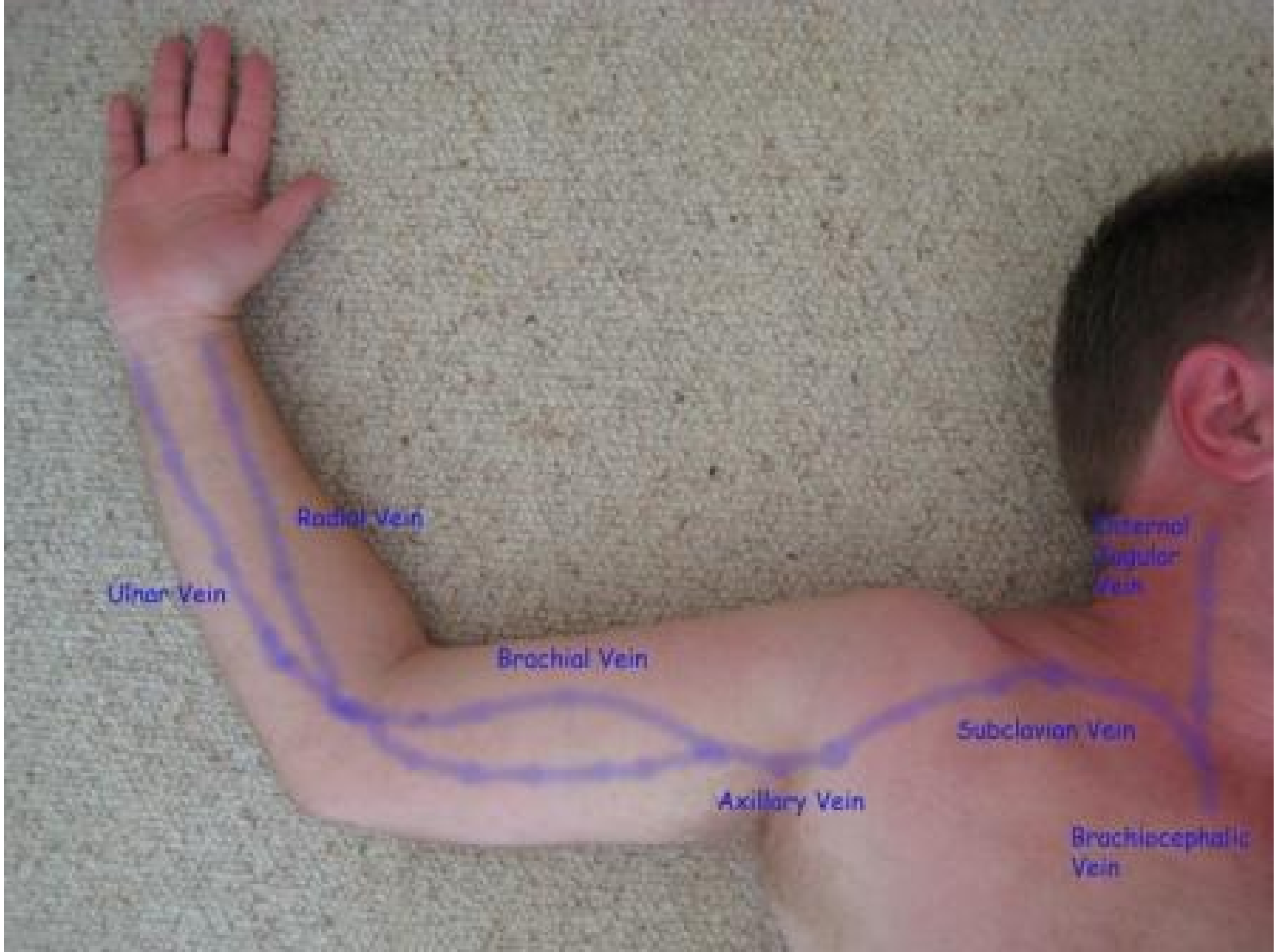
Tip: Use a **longer** angiocatheter

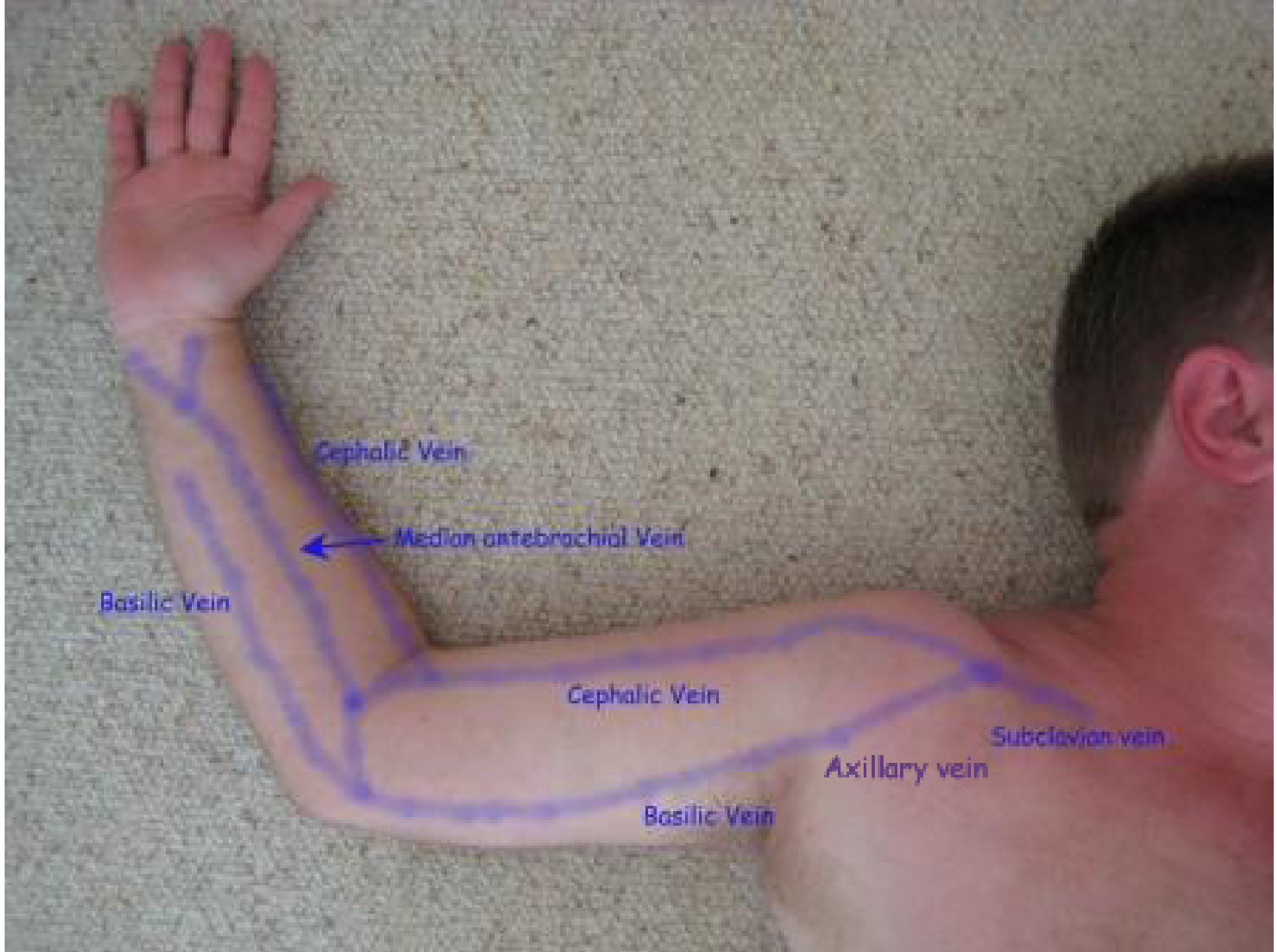
Tip: Use **angiocath** from **central line kit**



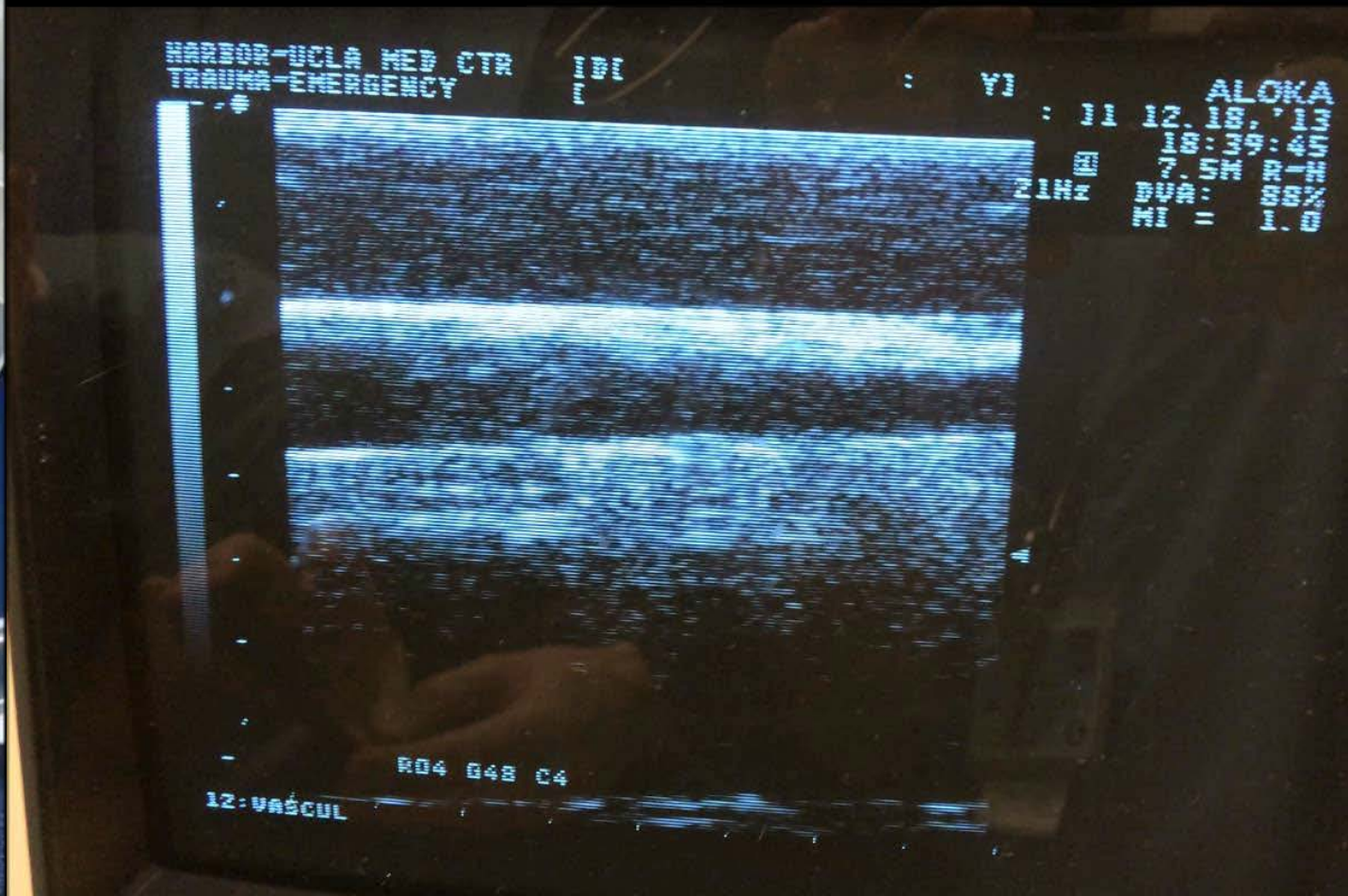
Tip: Use **arterial catheter** and **Seldinger technique**

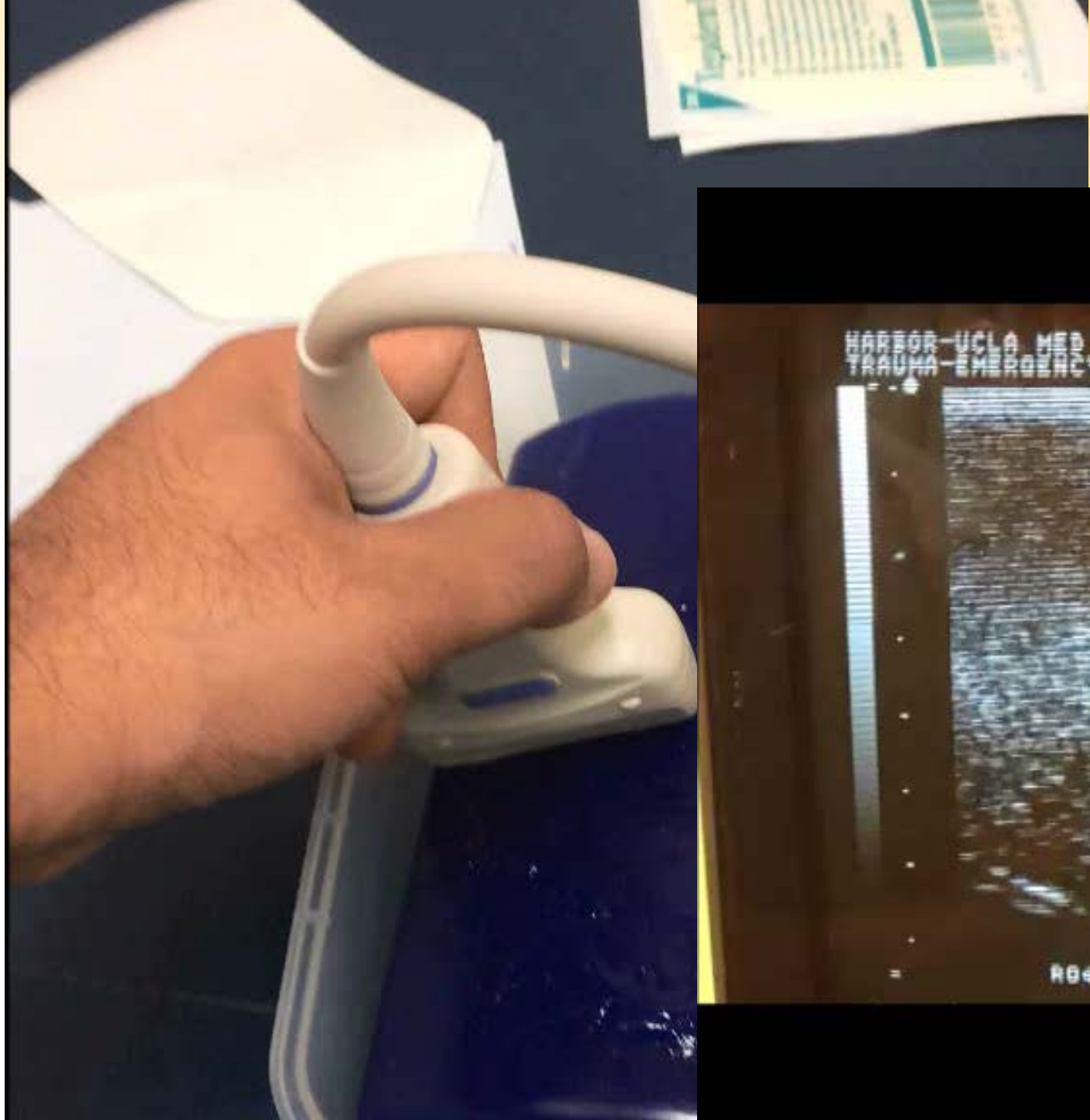



Radial Vein
Ulnar Vein
Brachial Vein
Subclavian Vein
Axillary Vein
Brachiocephalic Vein


Cephalic Vein
Median antebrachial Vein
Basilic Vein
Cephalic Vein
Subclavian vein
Axillary vein
Basilic Vein


RBOR-UCLA MED CTR
AUMA-EMERGENCY
21Hz


HARBOR-UCLA MED CTR
TRAUMA-EMERGENCY
ALOKA
12.18.'13
18:39:45
7.5M R-H
DVA: 88%
MI = 1.0
R04 G48 C4
12:VASCUL




HARBOR-UCLA MED CTR
TRAUMA-EMERGENCY
ALOKA
21Hz
MI = 1.0
R84 G48 C4

We're gonna need an IV…

0.9% Normal Saline

- 20 mL/kg, may repeat

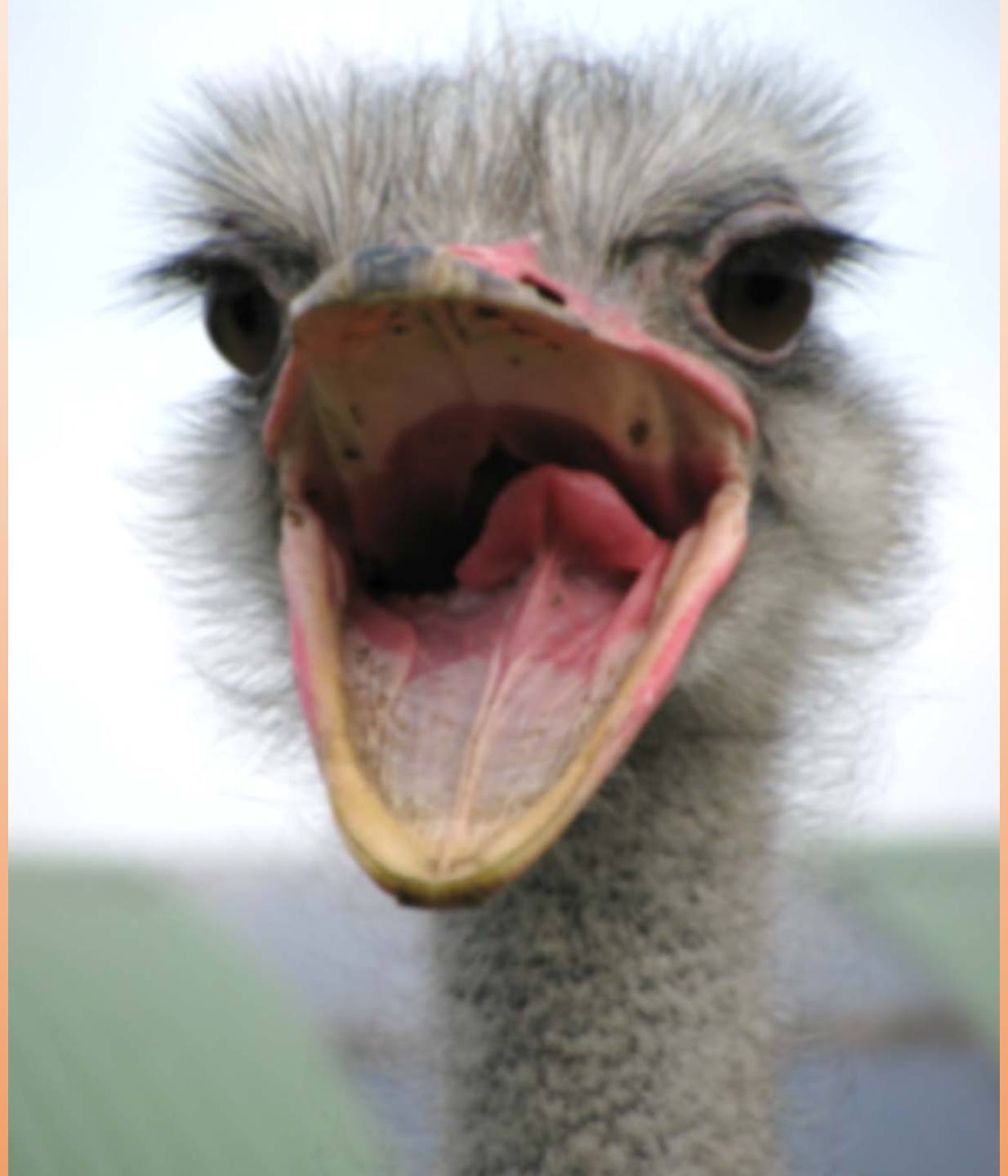
D5NS

- 20 mL/kg, may repeat

Plan for/overlap with PO challenge

Levy JA, Bachur RG, Monuteaux MC, Waltzman M. Intravenous dextrose for children with gastroenteritis and dehydration: a double-blind randomized controlled trial. Ann Emerg Med. 2013 Mar;61(3):281-8.

RESUSCITATE



RESUSCITATE

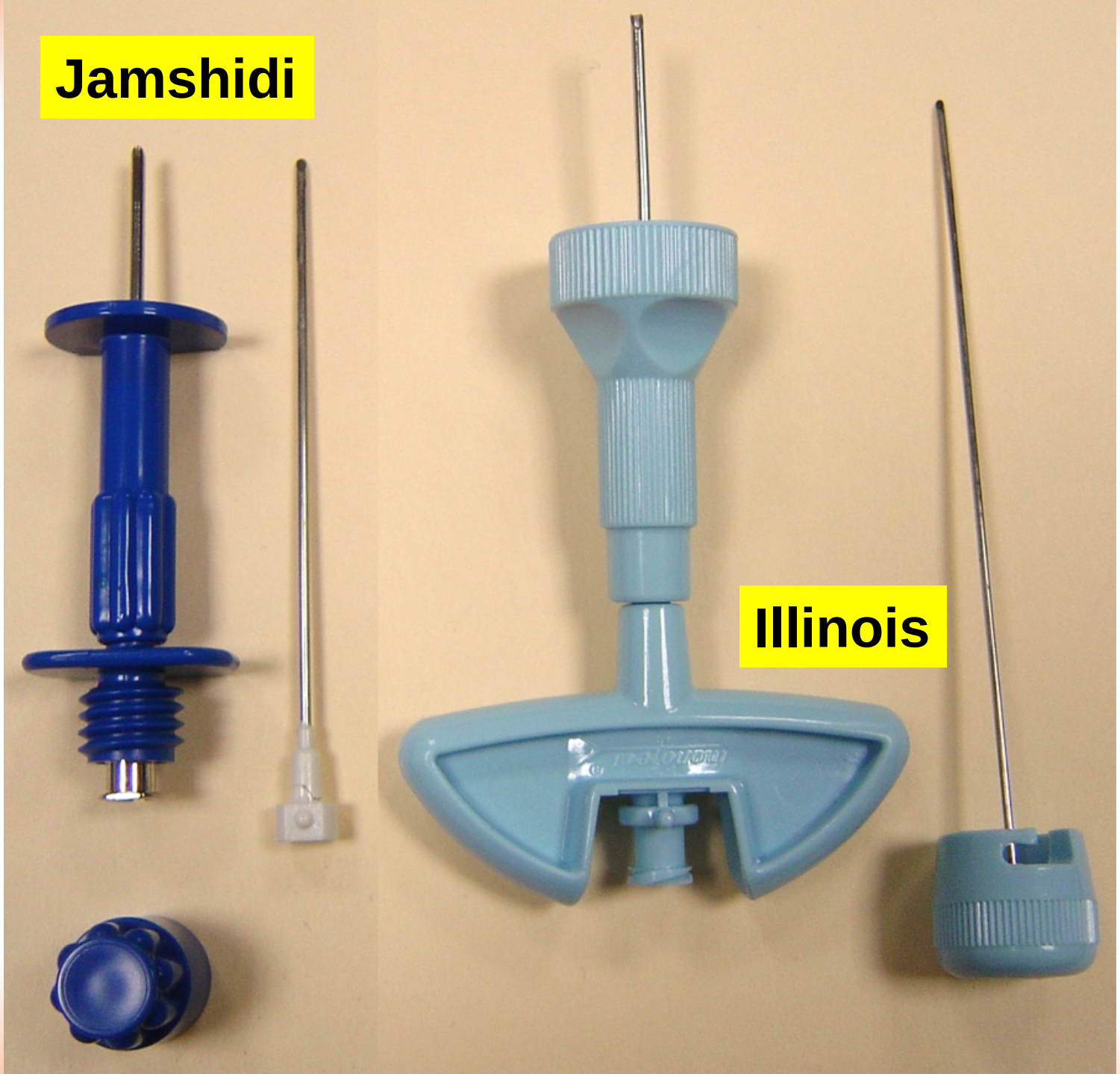
Feel the need, the need for speed

- **PALS**: “Limit the time spent attempting to establish peripheral venous access in a critically ill or injured child.”

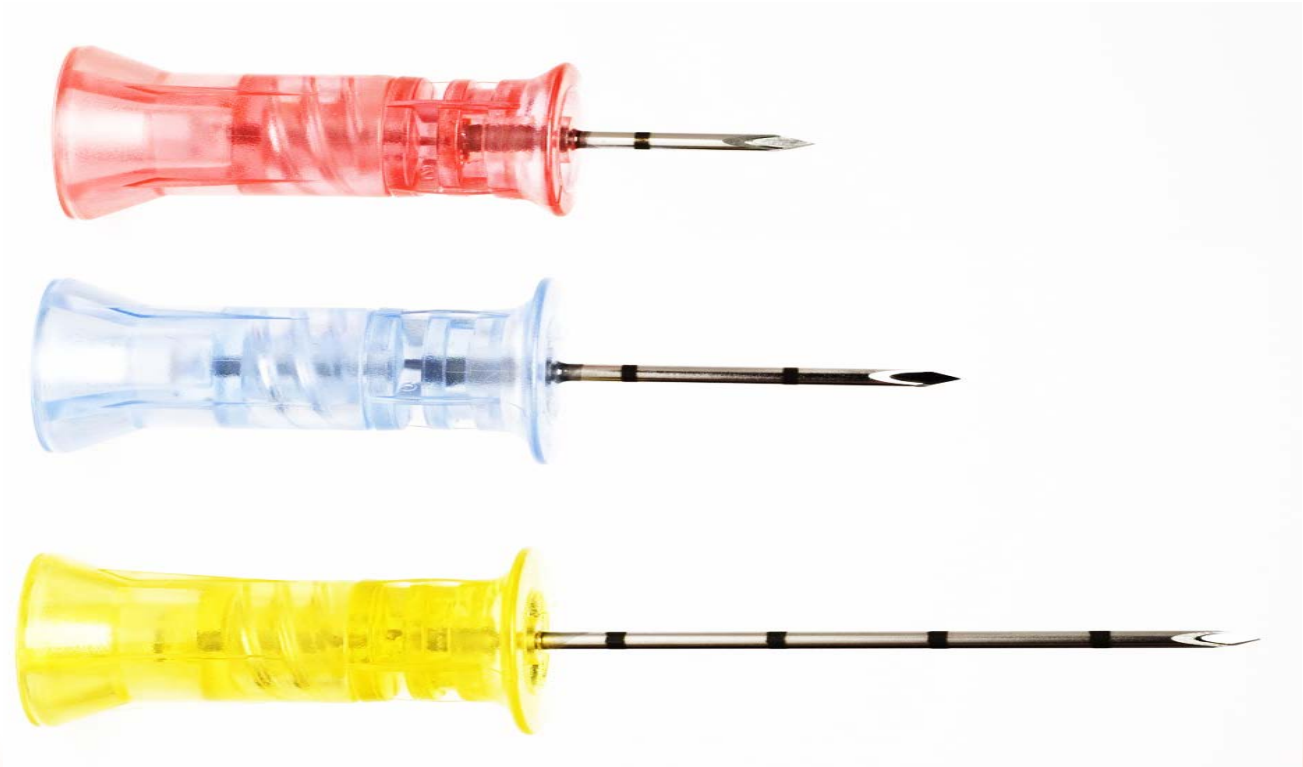
- PIV attempts x 2 → IO

- **Directly to IO** if cardiac arrest

2015 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science. Part 12: Pediatric Advanced Life Support. Circulation. 2015; 132: S526-S542


Jamshidi
Illinois

Cook




ADULTS:
From Tibial Tuberosity-
Go 2cm toward inner leg
& 1cm up, toward knee
Penetration site
ox.Tibia
PEDIATRICS:
From Tibial Tuberosity-
Go 1cm toward inner leg
& 1cm down, toward foot
Penetration site
6-12

Intraosseous Needles: Contraindications

- **Infection** or **burn** at entry site
- Ipsilateral **fracture** of the extremity
- Osteogenesis imperfecta, osteopenia, etc
- **Previous ortho** procedures near site
  - Prostheses, hardware, etc

- *Relative contraindications*
  - **Previous attempt** on same bone
  - Unable to locate landmarks

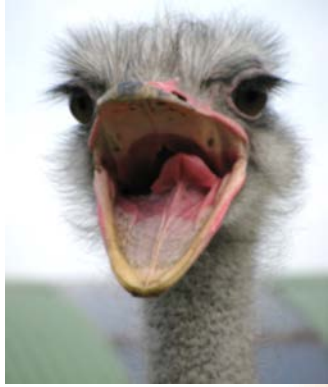
IO Failure to Place

- Incorrect **landmarks**
- **Bent** needle
- Needle **obstruction**: marrow, clot, or bone spicules
  - Flushing or continuous infusion
- Penetration of **both cortices**
  - Excess force
- Subcutaneous/periosteal **infiltration**
  - Incomplete placement/dislodgement

Post-placement complications

- Cellulitis, osteomyelitis
  - < 0.6% in lit review of 4000 cases over 35 years;
    < 3% in another large review
- Compartment syndrome - fluid extravasation
- Pain
- Hematoma
- Growth plate injuries
- Fat embolus (adults: sternal and ileum IO)

A Bone to Pick…

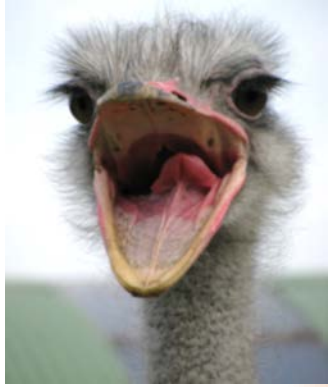


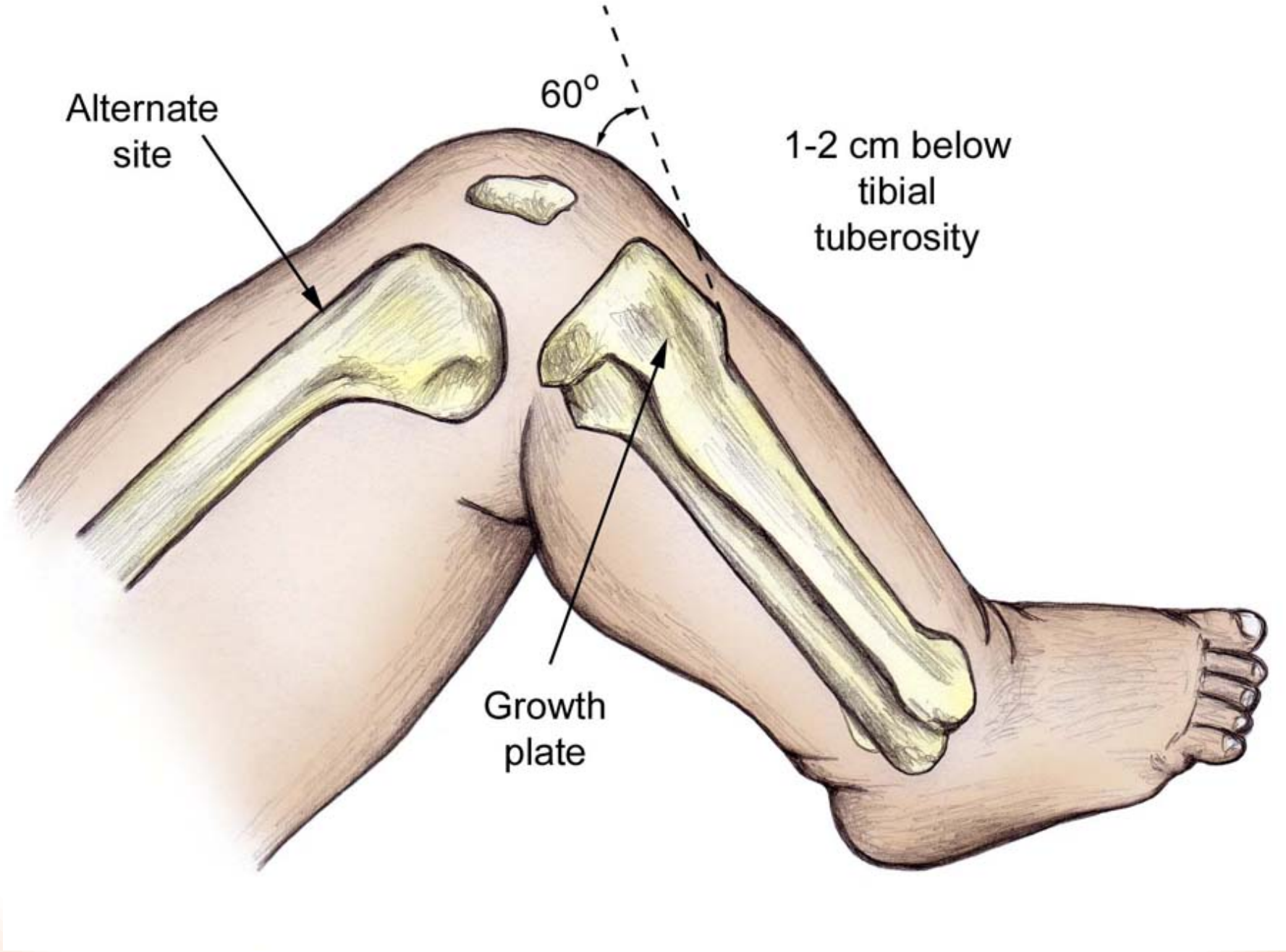
- Proximal Tibia
- Distal Tibia
- Distal Femur
- Proximal Humerus

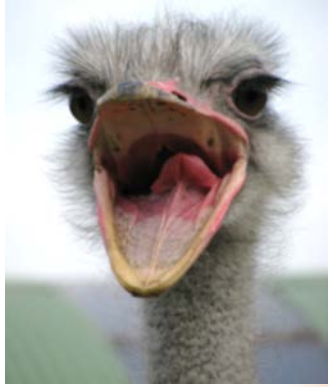
Adults and Children

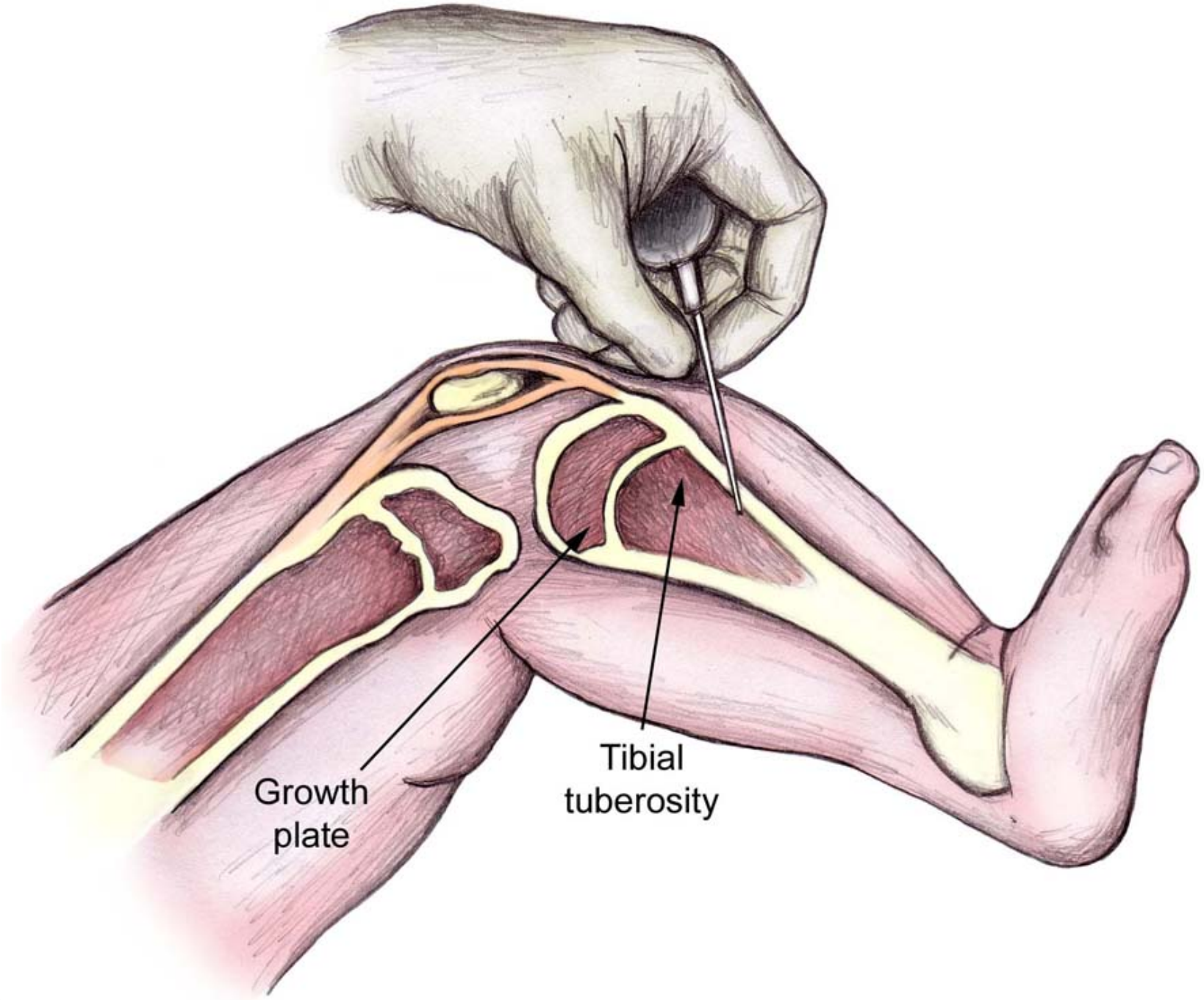
- Sternum
- Iliac Crest

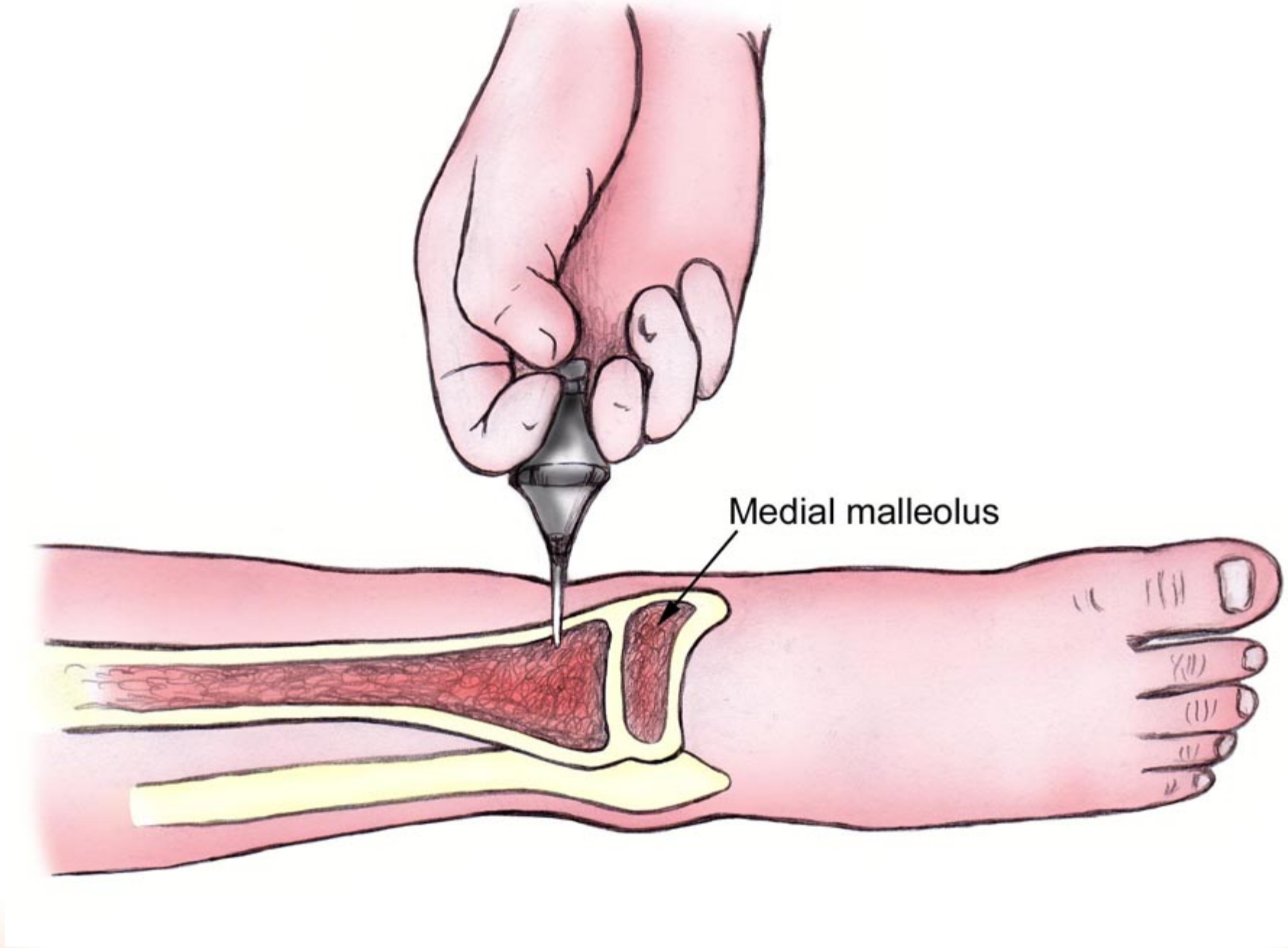
Adults

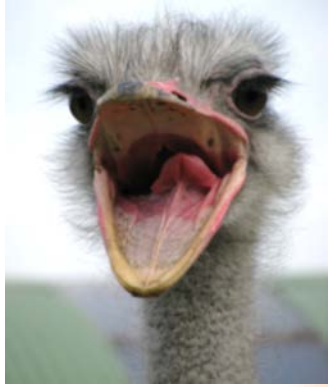


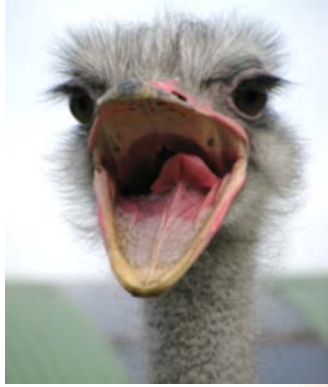

Alternate site
60°
1-2 cm below tibial tuberosity
Growth plate

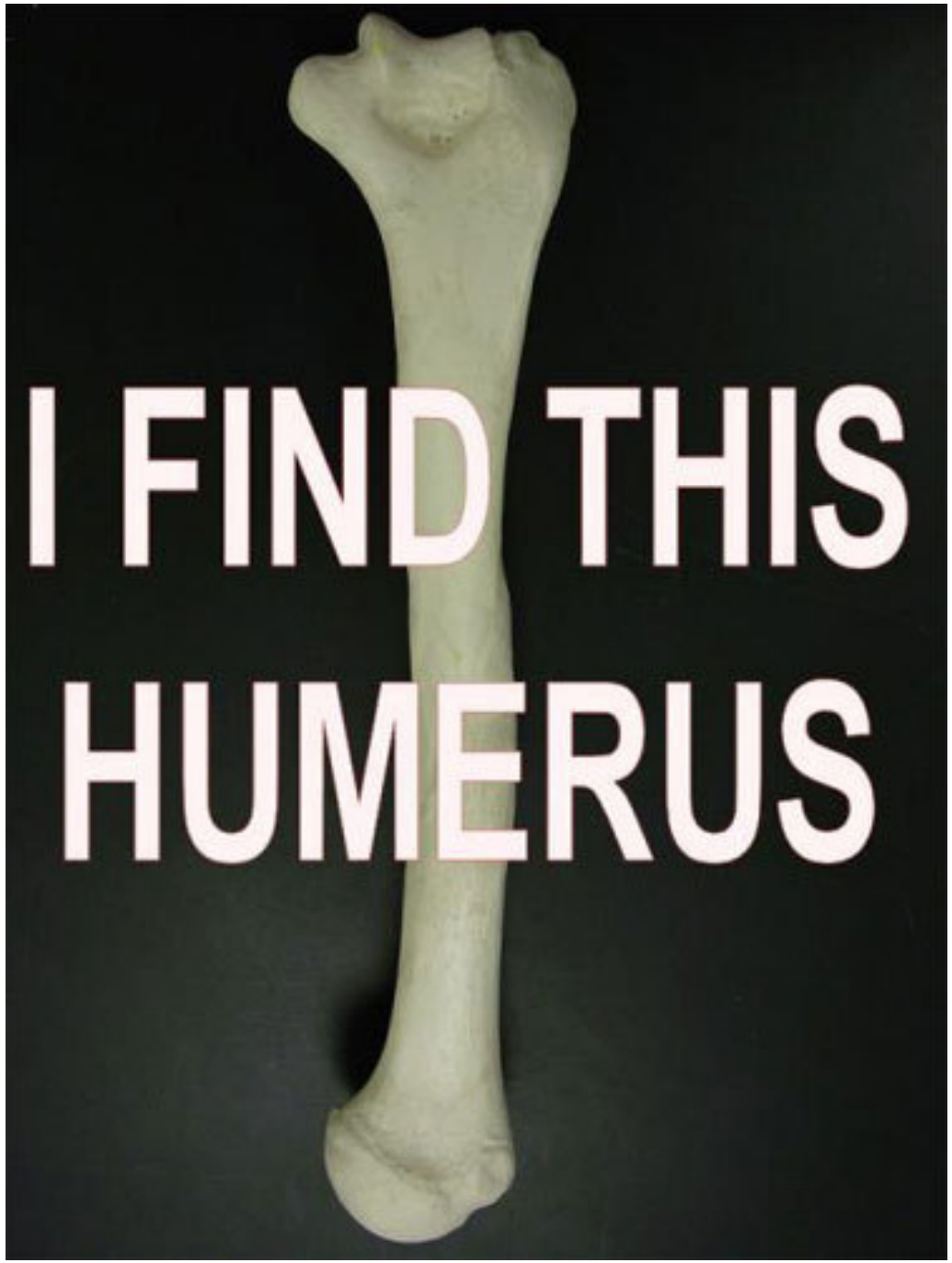


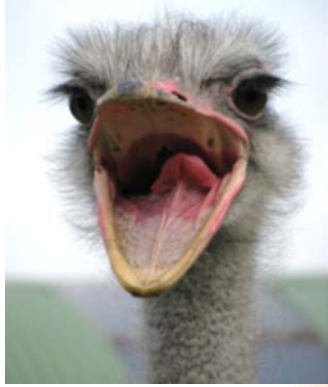

Growth
plate
Tibial
tuberosity

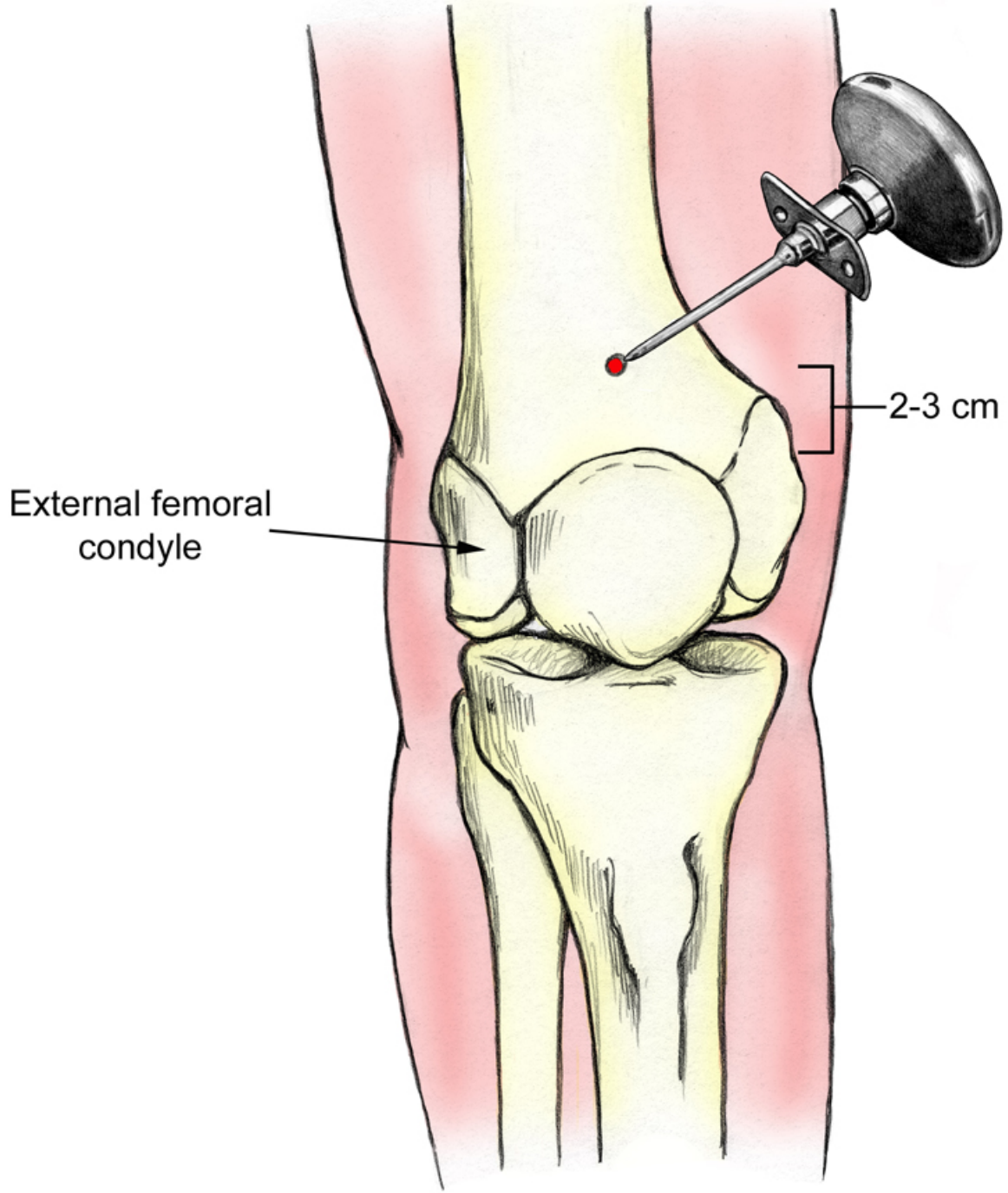

Medial malleolus

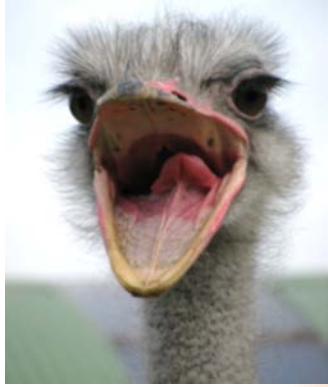


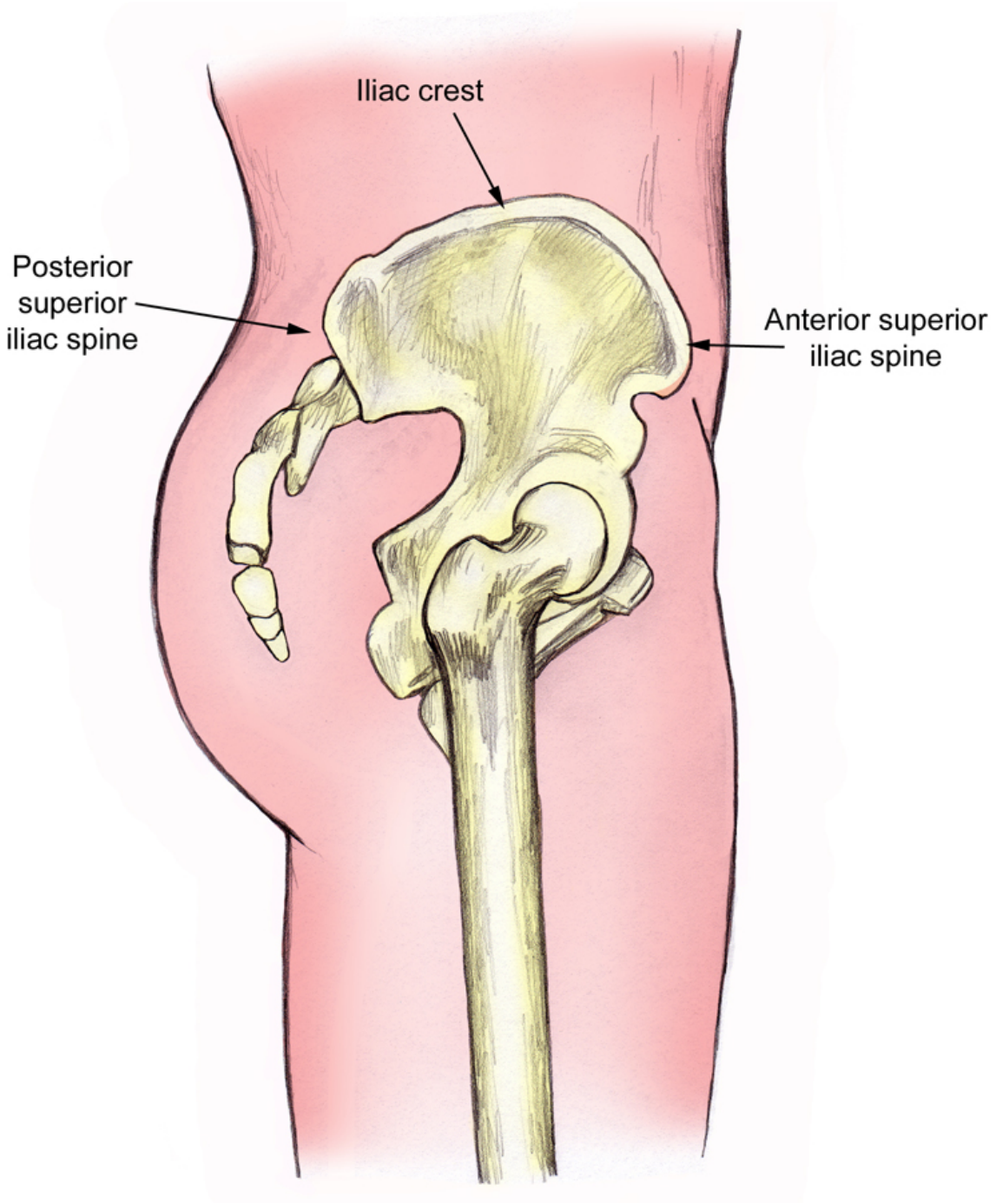


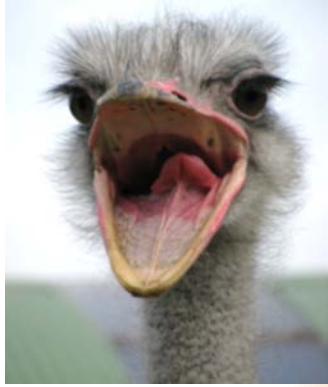

I FIND THIS
HUMERUS

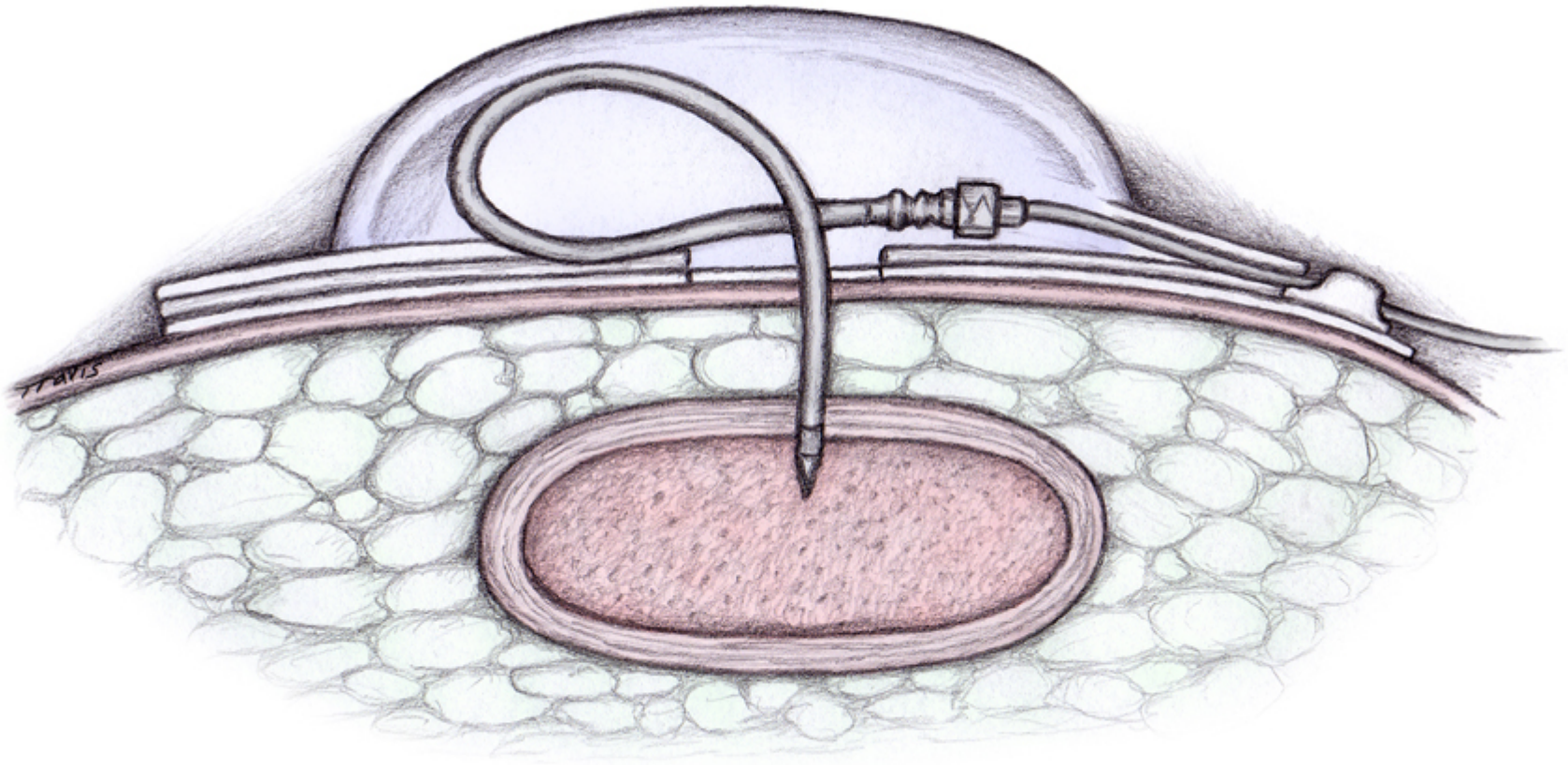


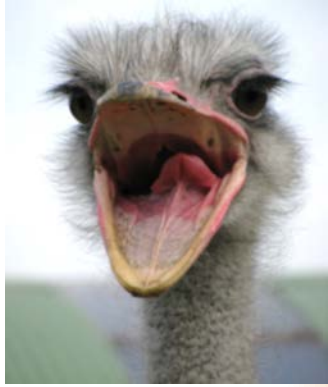

2-3 cm
External femoral
condyle

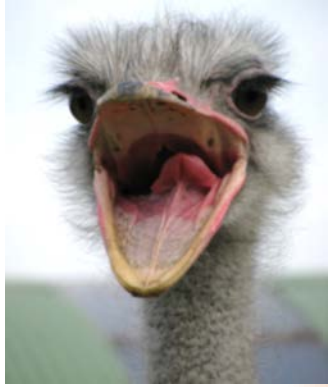


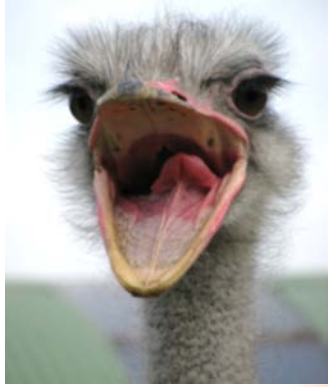

Iliac crest
Posterior superior iliac spine
Anterior superior iliac spine

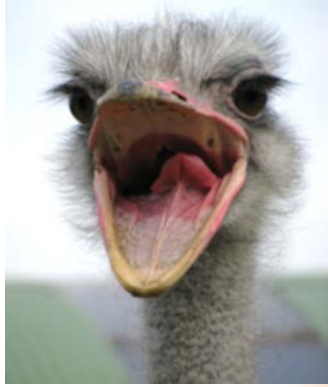




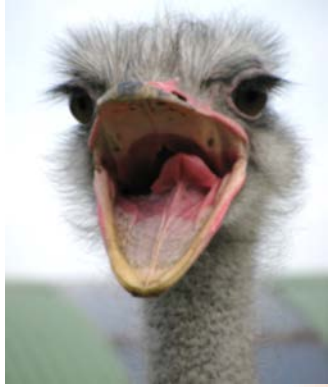








Bone Marrow Aspirate as an Accessible and Reliable Source for Critical Laboratory Studies



Study objective: *To determine whether laboratory studies performed on bone marrow aspirate can be used to predict values in the peripheral blood of human beings.*

Design: *Prospective correlative study.*

Setting: *Tertiary care pediatric hospital.*

Type of participants: *Fifteen patients from the hematology-oncology division of Children's Hospital, Oakland, California, were studied during routine diagnostic bone marrow aspirations.*

Interventions: *Aliquots of serum and bone marrow obtained as part of routine diagnostic studies were analyzed.*

Measurements and main results: *Venous and bone marrow samples were analyzed for blood gas values, hemoglobin, and serum chemistries. Bone marrow specimens were found to reliably predict venous values of pH, bicarbonate, base excess, P_{CO_2}, hematocrit, sodium, chloride, and glucose. Bone marrow was not predictive of blood oxygenation, potassium, or ionized calcium.*

Conclusion: *This study demonstrates in human beings what has previously been shown in animals — that the bone marrow is an alternative source of blood for a variety of laboratory studies. [Grisham J, Hastings C: Bone marrow aspirate as an accessible and reliable source for critical laboratory studies. Ann Emerg Med October 1991;20:1121-1124.]*

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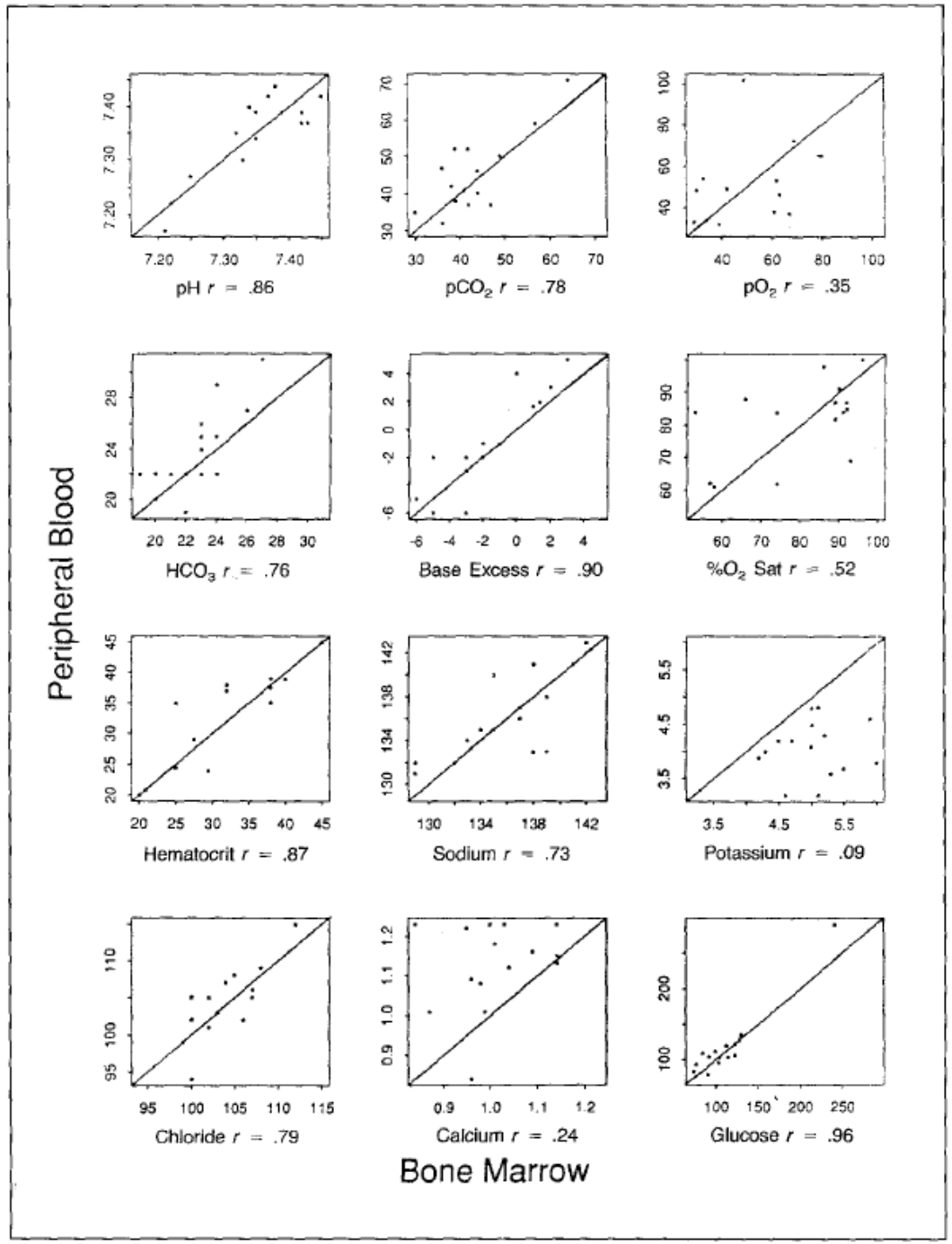
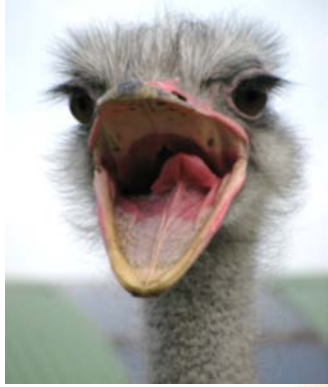

Peripheral Blood
pH r = .86
pCO2 r = .78
pO2 r = .35
HCO3 r = .76
Base Excess r = .90
%O2 Sat r = .52
Hematocrit r = .87
Sodium r = .73
Potassium r = .09
Chloride r = .79
Calcium r = .24
Glucose r = .96
Bone Marrow



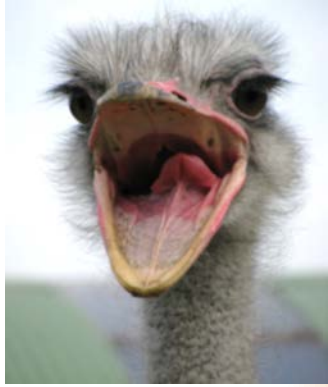


TABLE. *Correlation coefficients and P values*

Parameter	*r*	*P*
pH	.86	< .001
Pco_2	.78	< .001
Po_2	.35	NS
HCO_3	.76	< .05
Base excess	.90	< .001
$\%O_2$ saturation	.52	NS
Hematocrit	.87	< .005
Sodium	.73	< .005
Potassium	.09	NS
Chloride	.79	< .001
Calcium	.24	NS
Glucose	.96	< .001

Miller LJ et al. A new study of intraosseous blood for laboratory analysis. *Arch Pathol Lab Med*. 2010 Sep;134(9):1253-60.

IO and IV good correlation:

- Albumin
- BUN
- Chloride
- Creatinine
- Glucose
- Hematocrit
- Hemoglobin
- Total protein

IO may be lower than IV:

- CO2 level
- Platelet count

IO may be higher than IV:

- WBC count

Contents lists available at ScienceDirect

Resuscitation

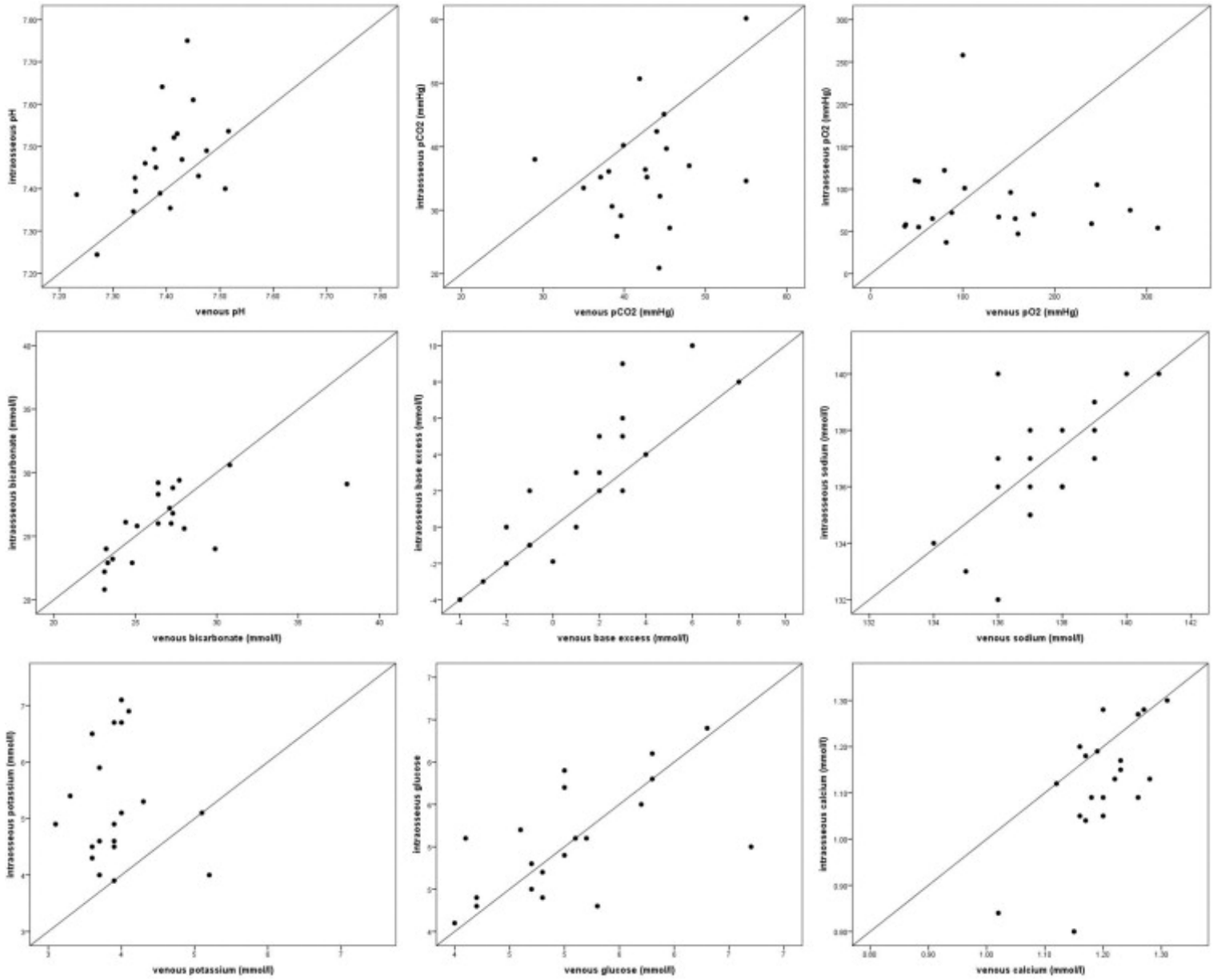
journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

Analysis of bloodgas, electrolytes and glucose from intraosseous samples using an i-STAT® point-of-care analyser☆

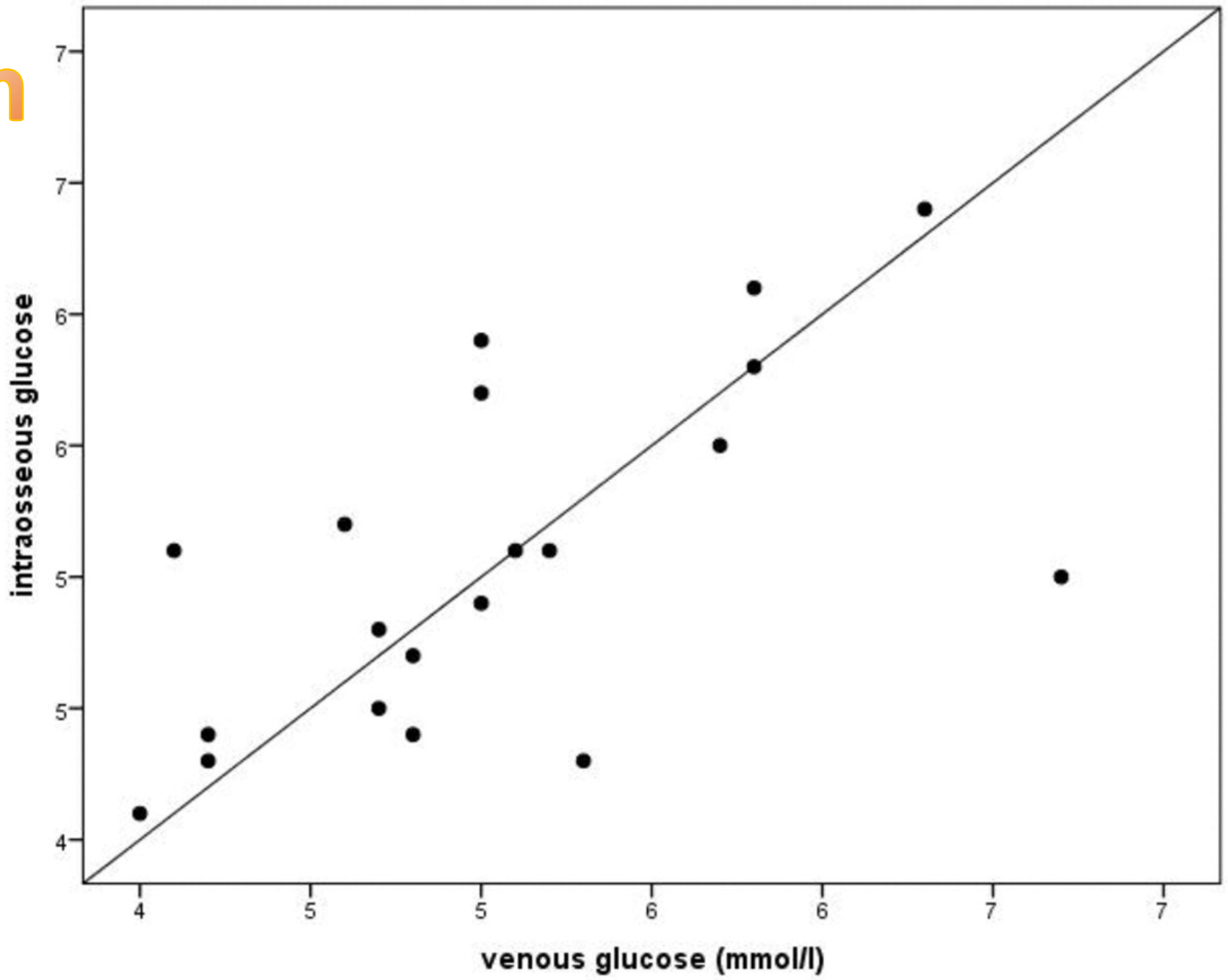
Esther S. Veldhoen (MD, MRCPCH)[a,*], Karen M.K. de Vooght (PharmD, PhD)[b], Martijn G. Slieker (MD, PhD)[c], Anne B. Versluys (MD)[d], Nigel McB. Turner (MB ChB, MMEd, PhD, FRCA)[e]

- IV + IO samples from 20 children (HD normal; routine BMB) run through i-STAT
- Differences were “clinically acceptable for pH, base excess, sodium, ionised calcium and glucose”
- Coefficient of variance of intraosseous samples was smaller than for venous samples
- Conclusion: Analysis of intraosseous samples with a bedside, single-use cartridge-based analyser is feasible; may be a useful guide to treatment

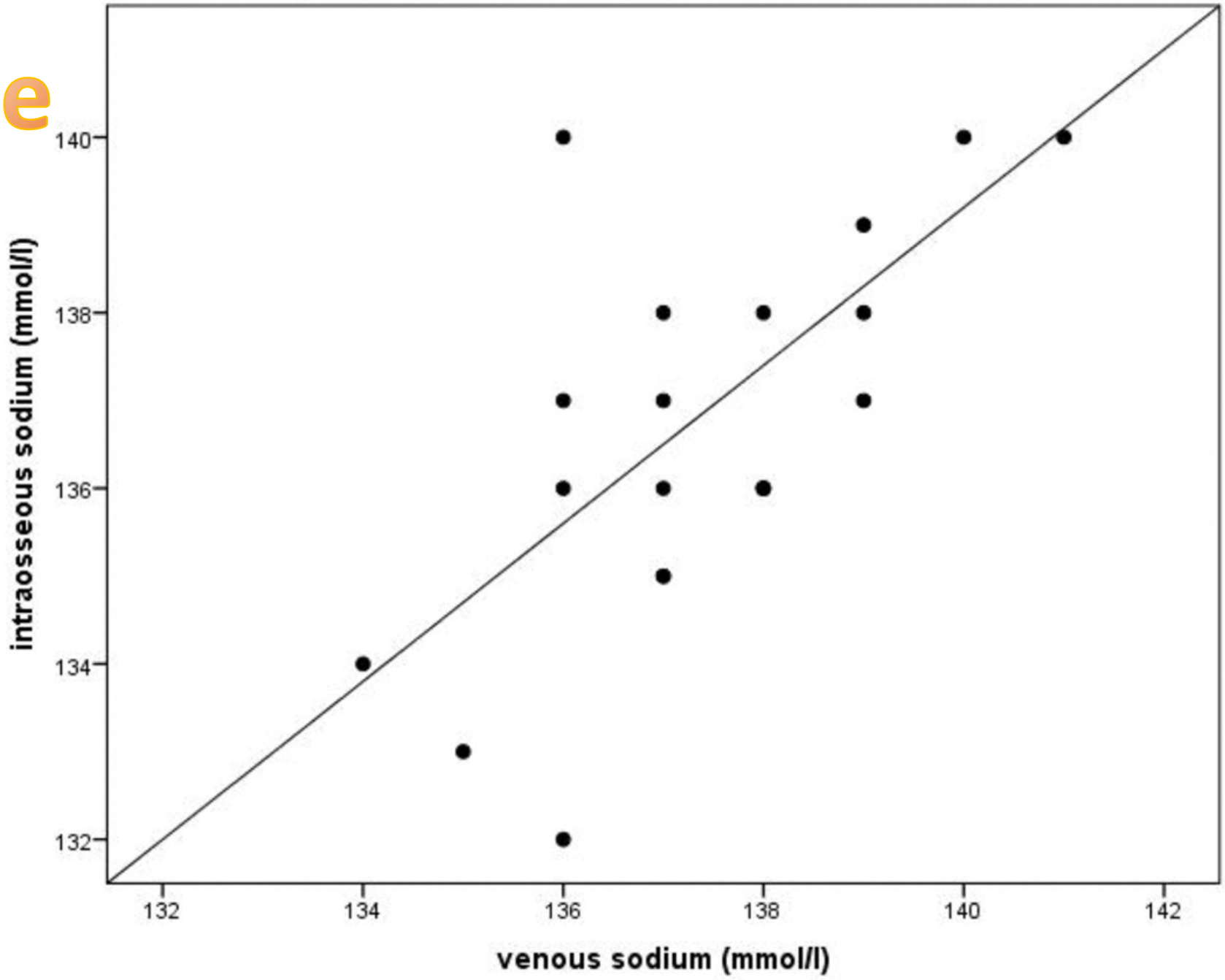


Veldhoen ES, de Vooght KMK, Slieker MG, Versluys AB, Turner NM. Analysis of bloodgas, electrolytes and glucose from intraosseous samples using an i-STAT® point-of-care analyser. *Resuscitation.* 2014; 85359-363.

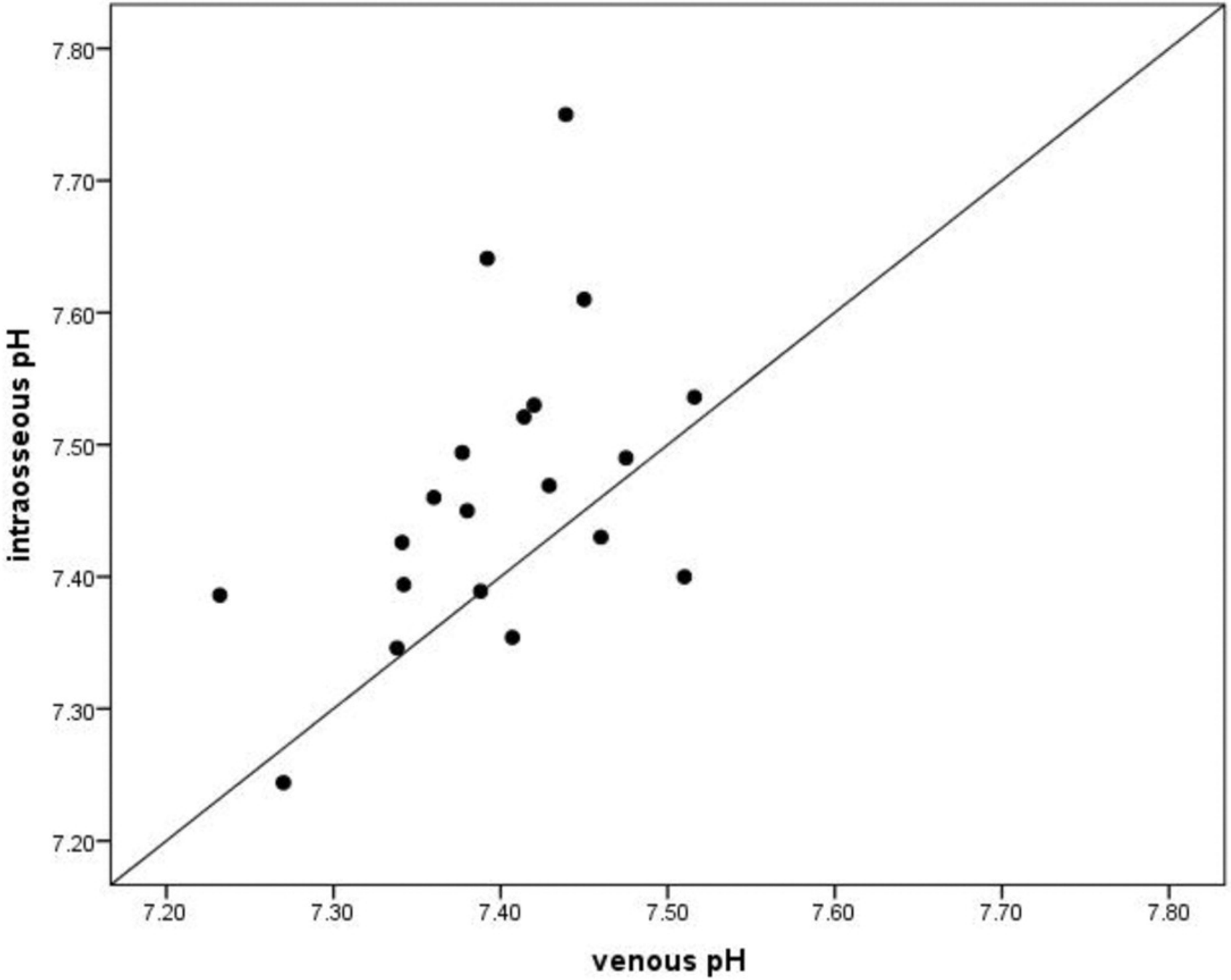
Sodium


intraosseous glucose
venous glucose (mmol/l)
4
5
5
6
6
7
7
4
5
5
6
6
7
7

Glucose


intraosseous sodium (mmol/l)
140
138
136
134
132
132
134
136
138
140
142
venous sodium (mmol/l)

pH


7.80
7.70
7.60
7.50
7.40
7.30
7.20
intraosseous pH
7.20
7.30
7.40
7.50
7.60
7.70
7.80
venous pH

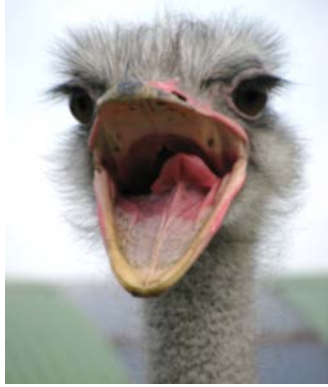
Intraosseous medications

IV = IO

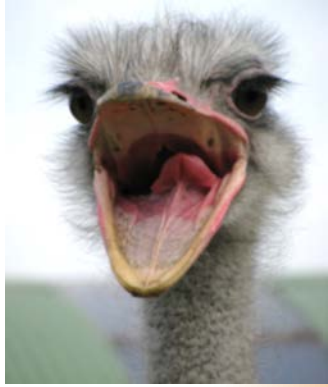
Caveat: Adenosine

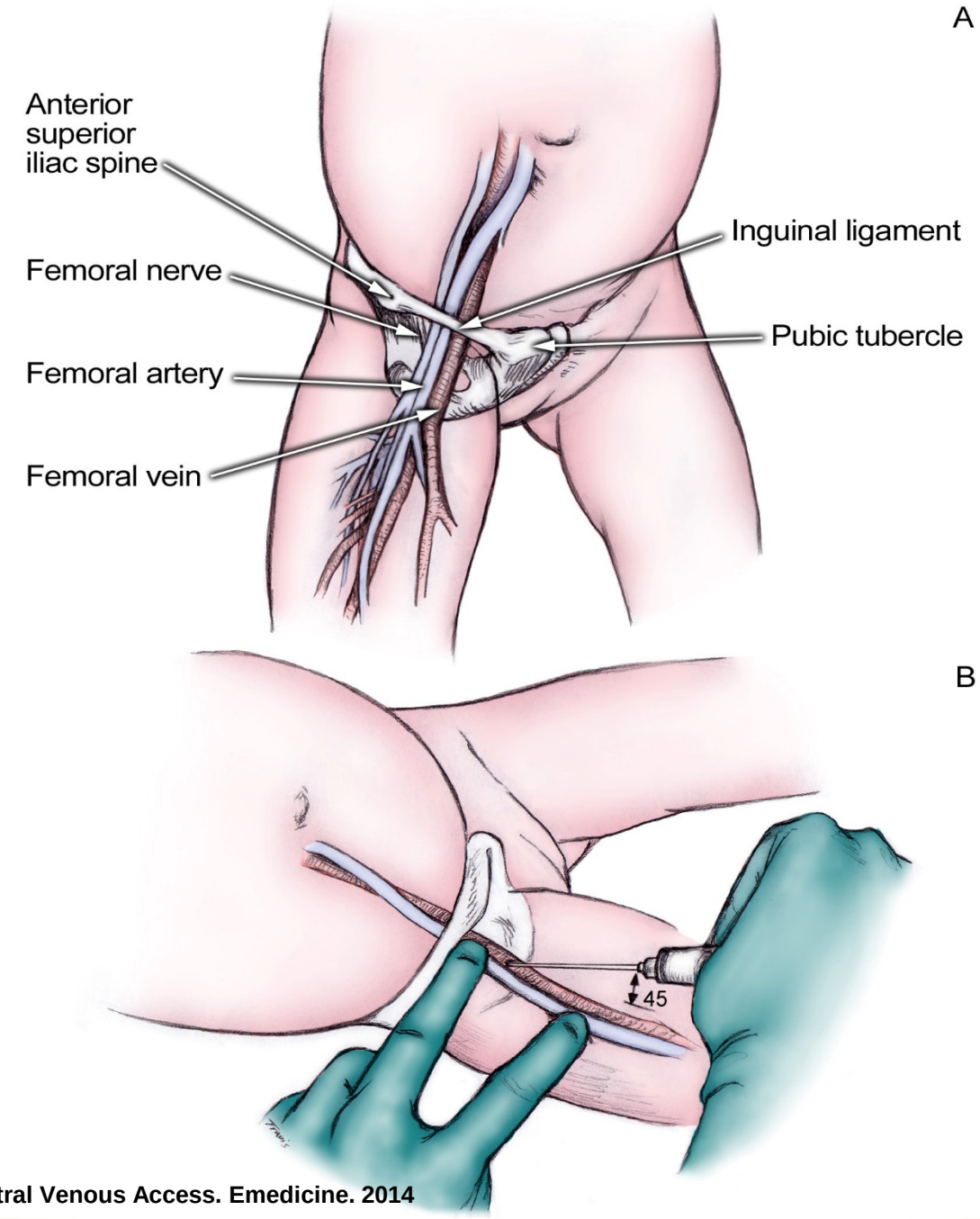
Buck ML, Wiggins BS, Sesler JM. Intraosseous drug administration in children and adults during cardiopulmonary resuscitation. Ann Pharmacother. 2007;41(10):1679.


0.9%
SODIUM CHLORIDE
INJECTION, USP

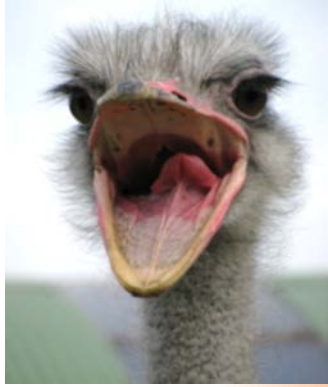


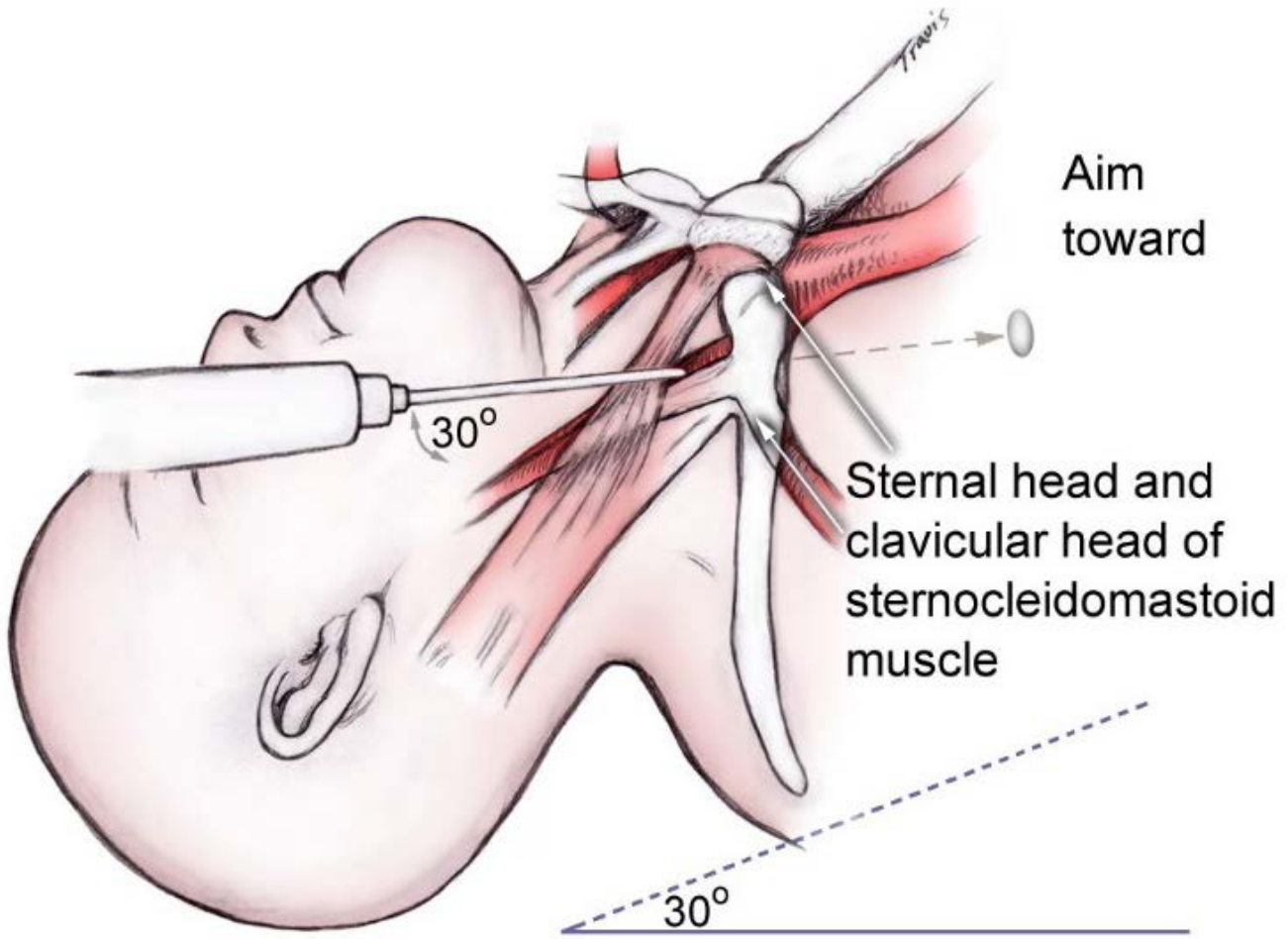

ml
30
20
10



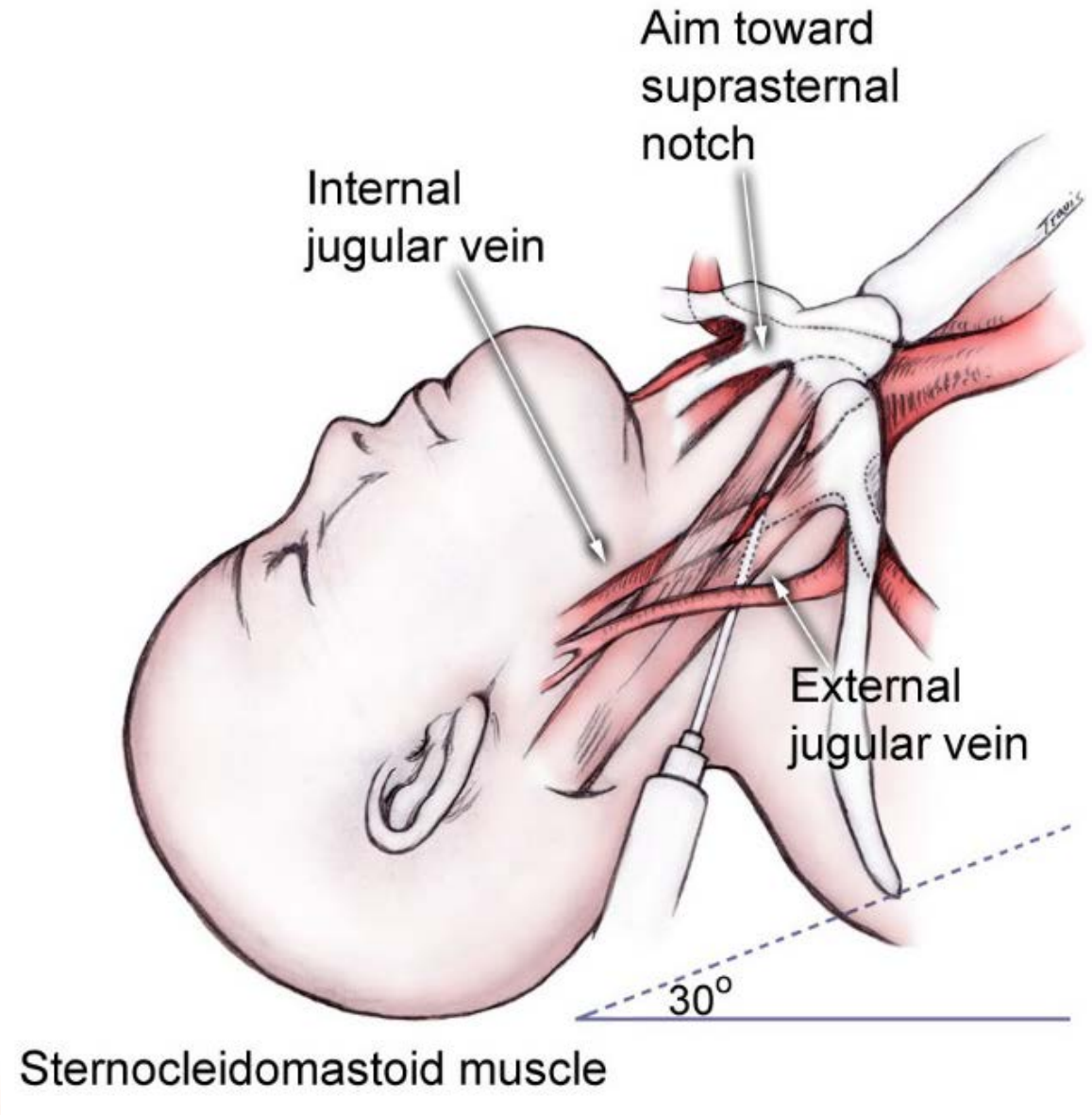


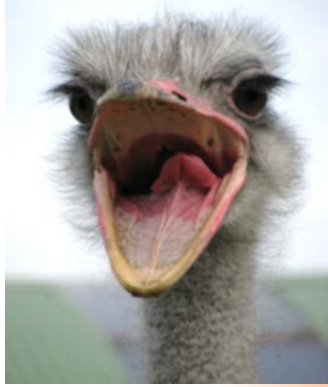
Putigna F, Solenberger R. Pediatric Surgery for Central Venous Access. Emedicine. 2014





Putigna F, Solenberger R. Pediatric Surgery for Central Venous Access. Emedicine. 2014





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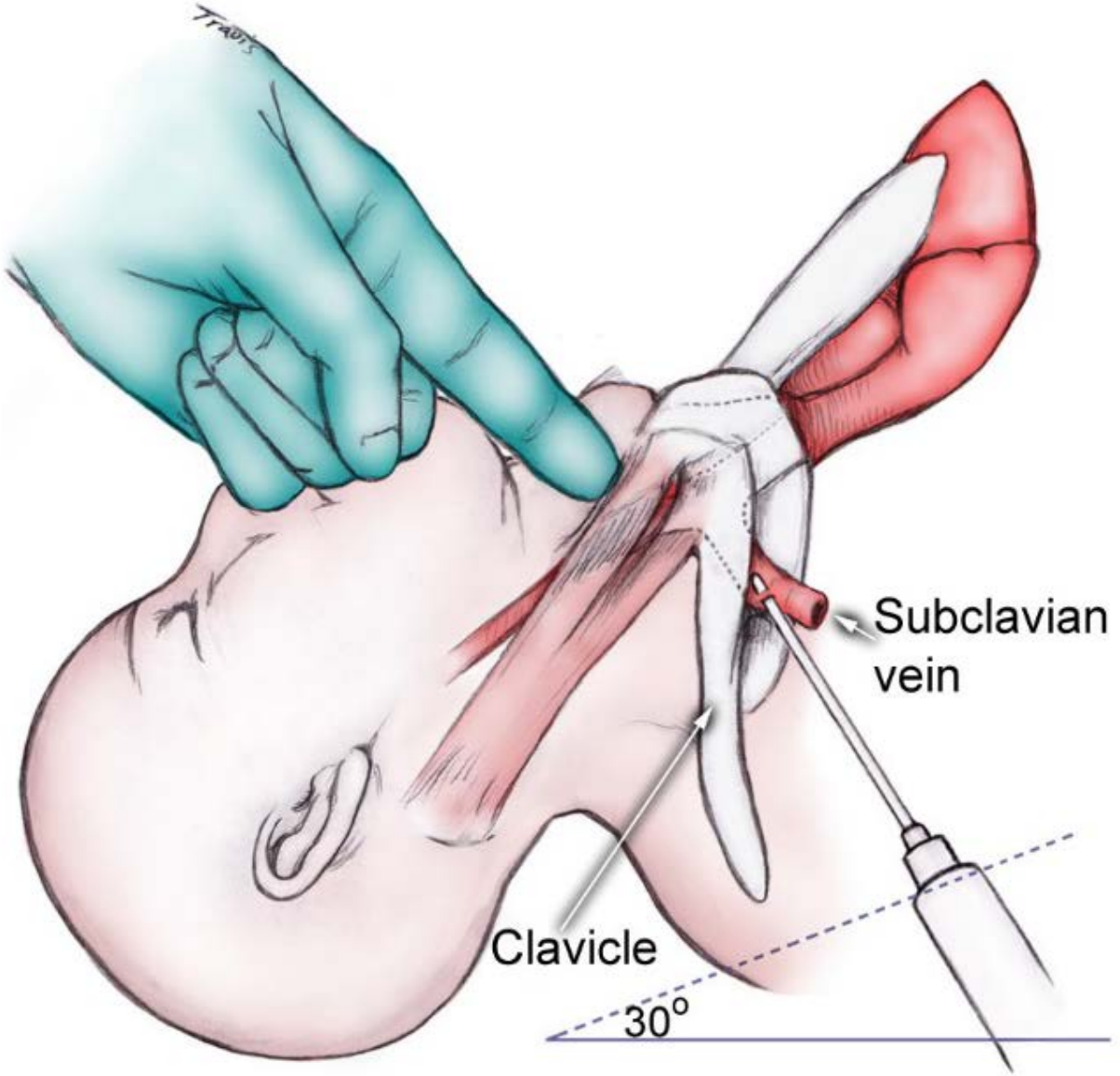
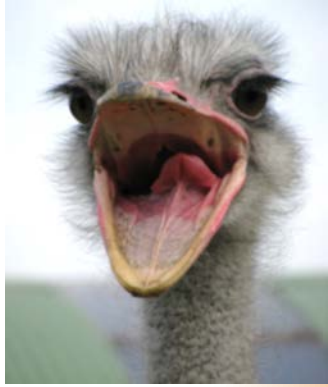
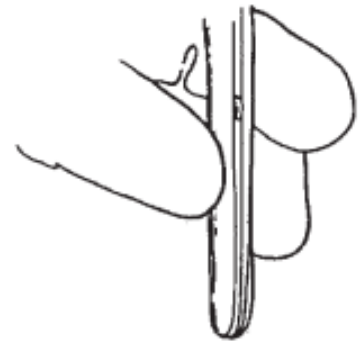
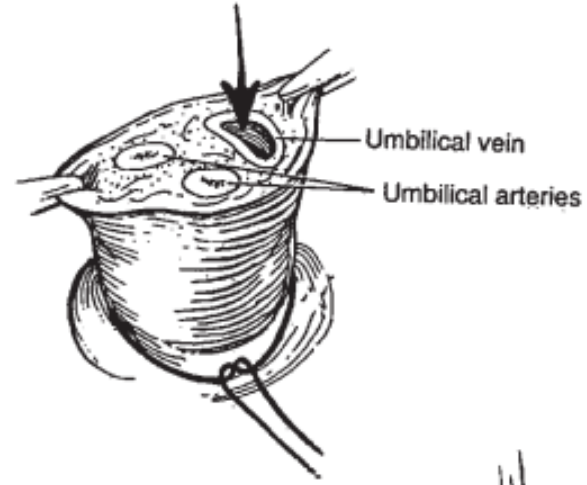


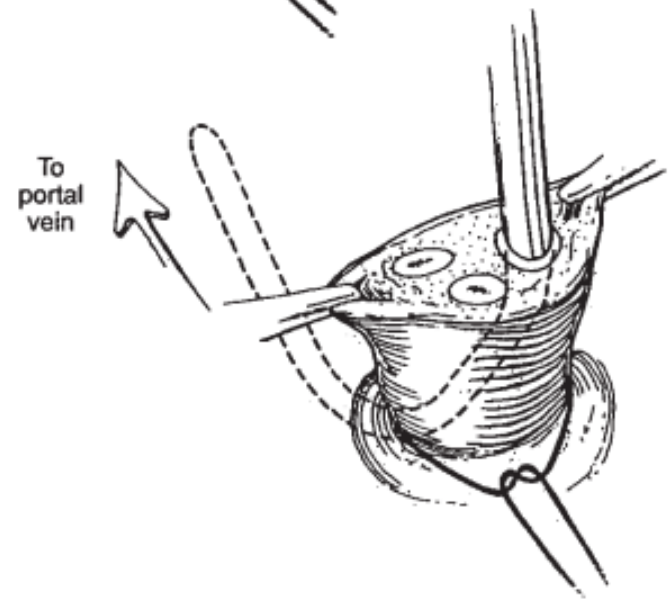


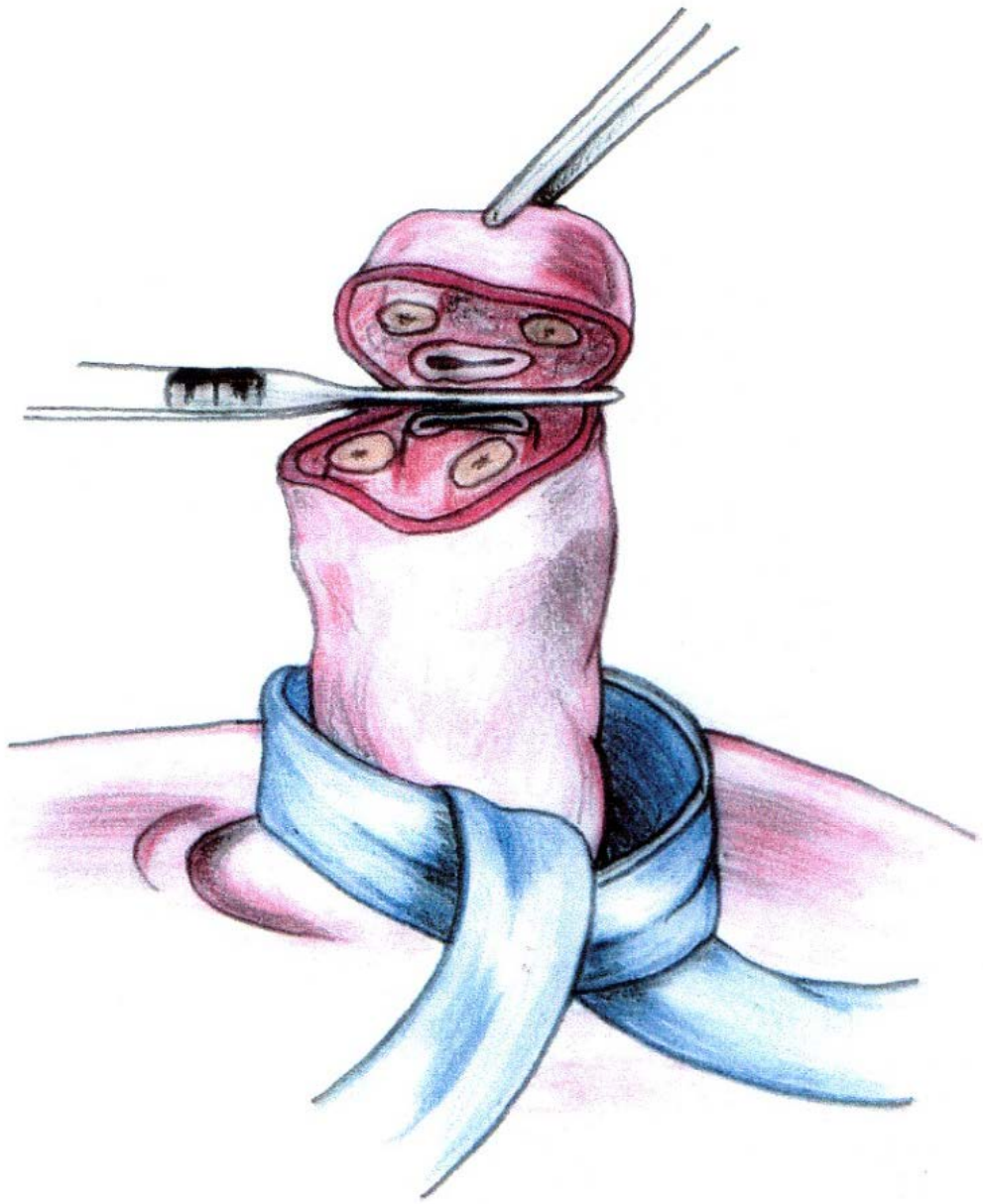
Putigna F, Solenberger R. Pediatric Surgery for Central Venous Access. Emedicine. 2014

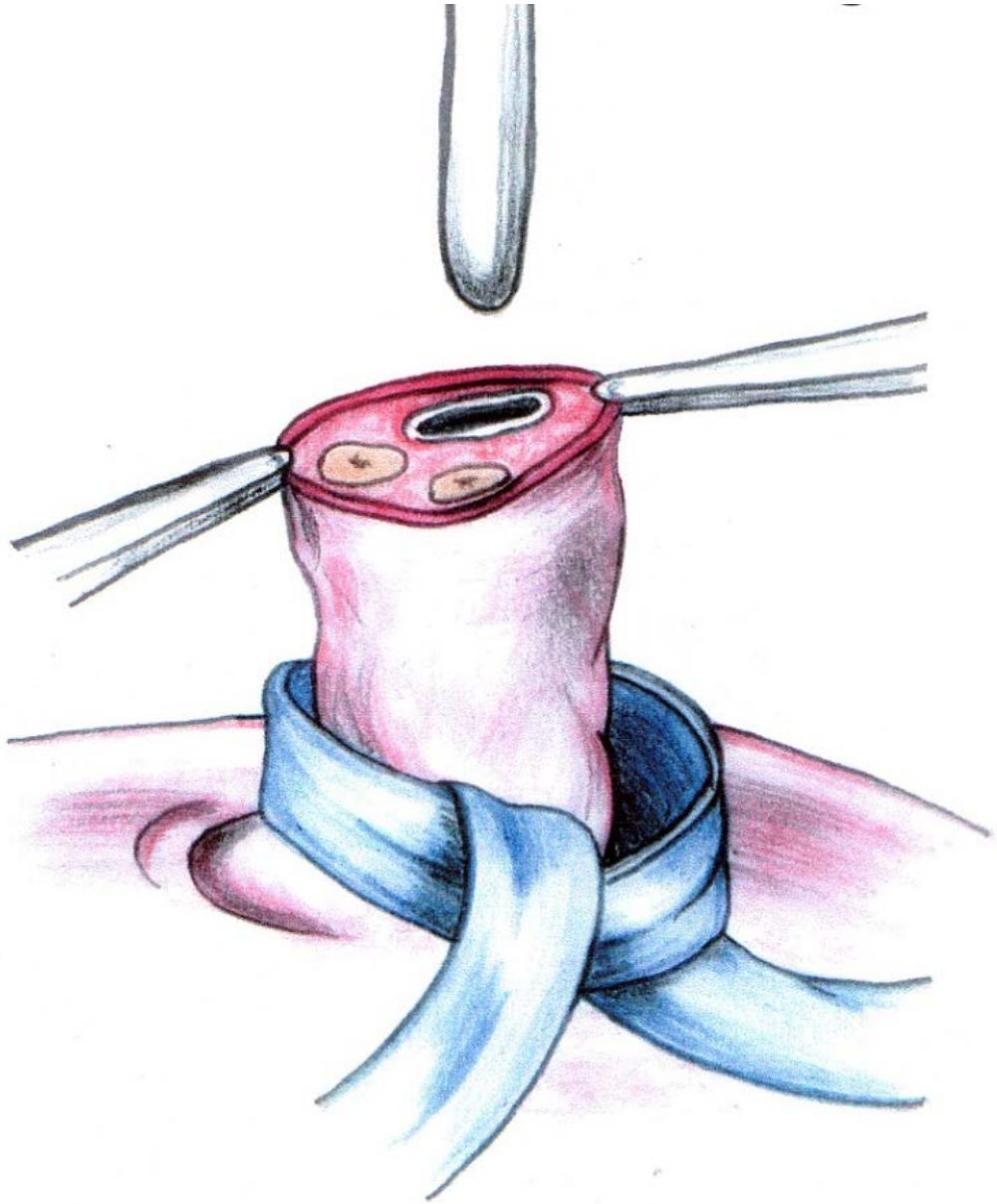

5ml
1
2
3
4

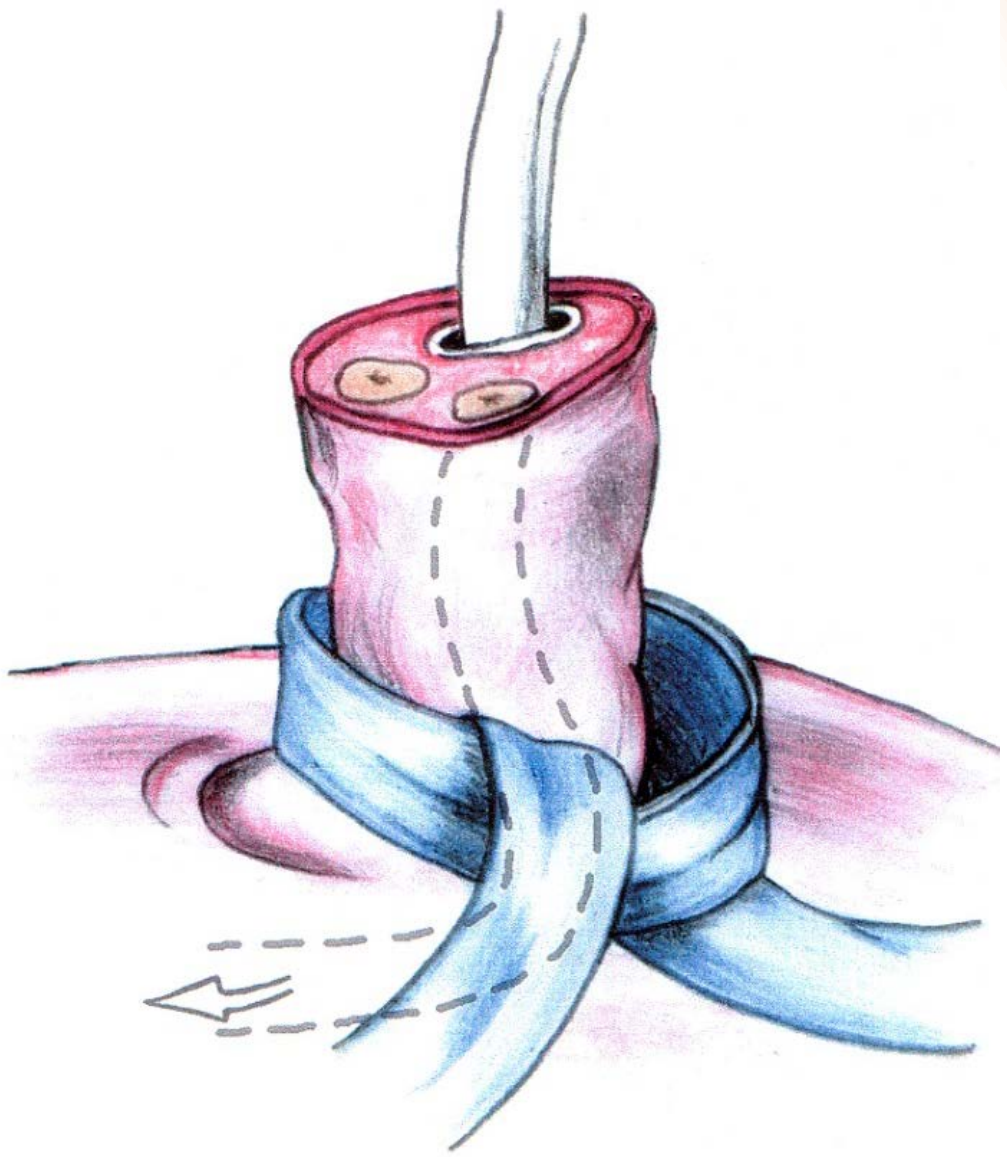


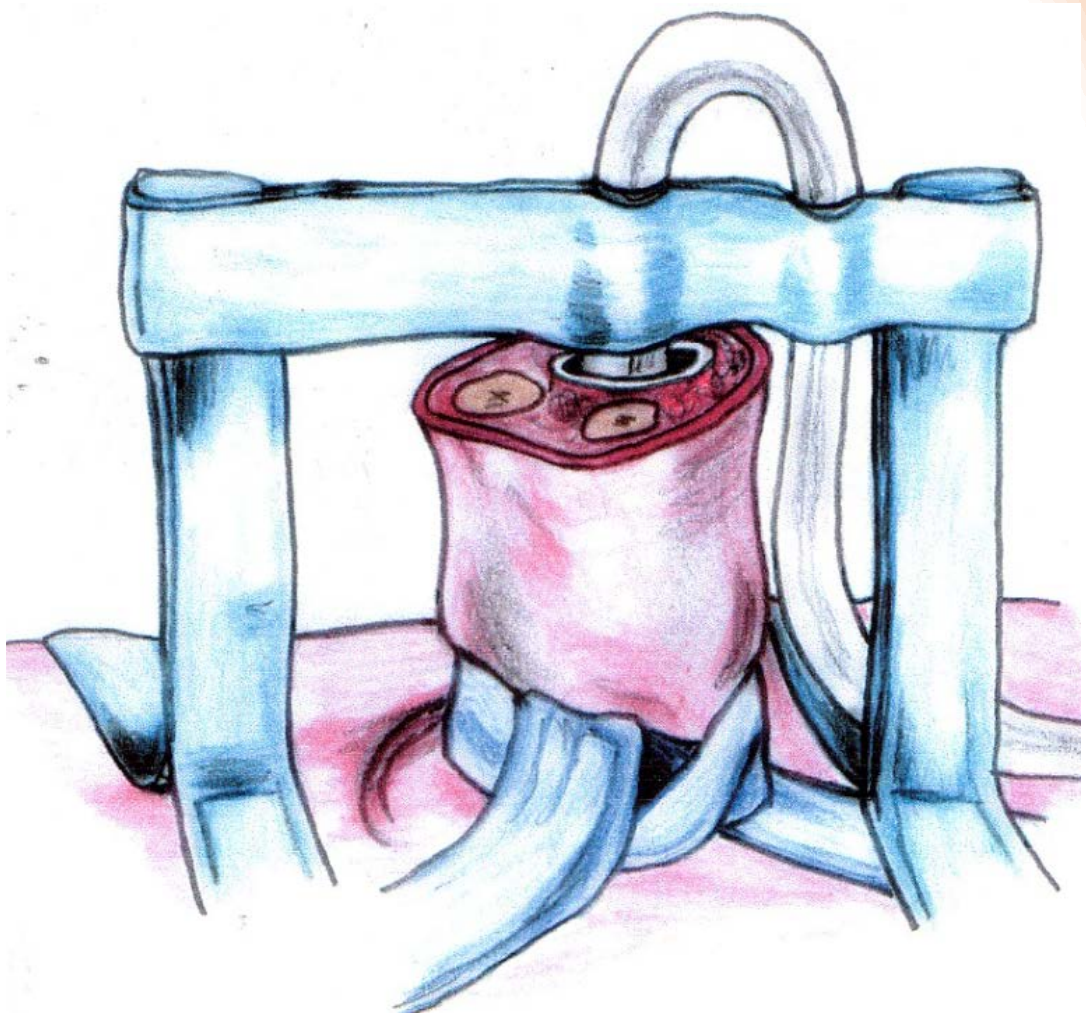

Umbilical vein
Umbilical arteries


To
portal
vein

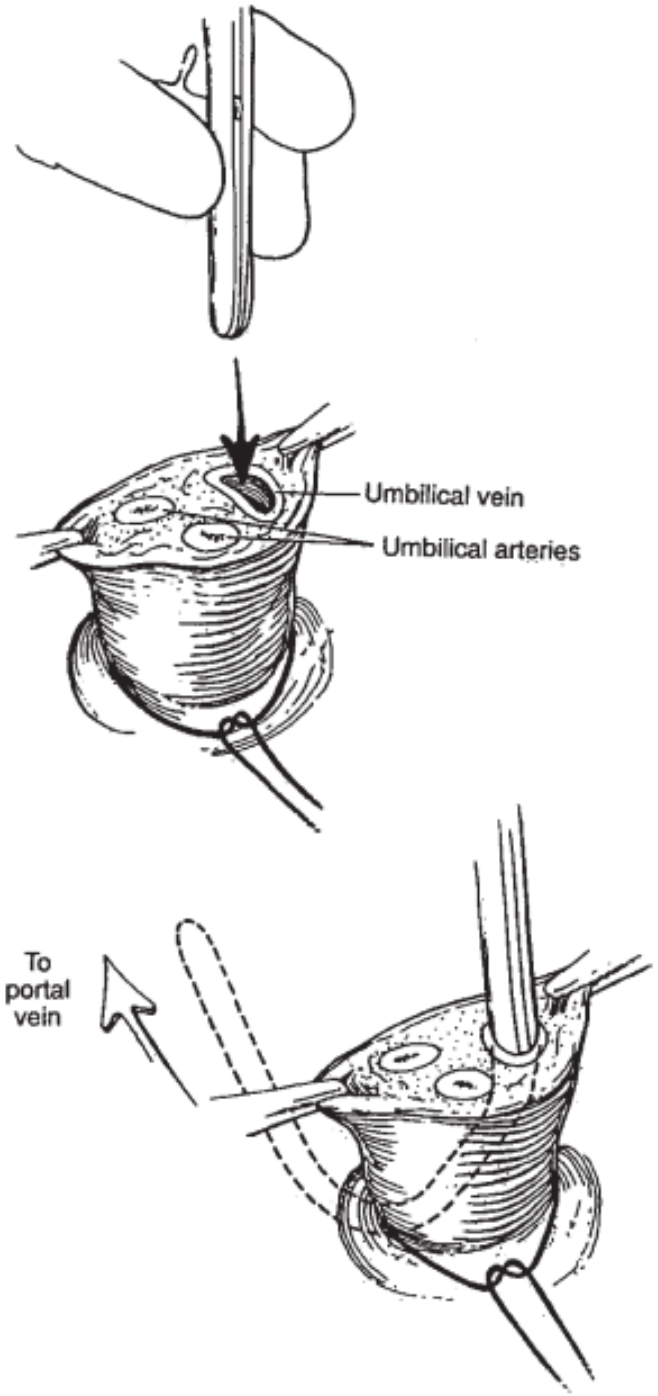


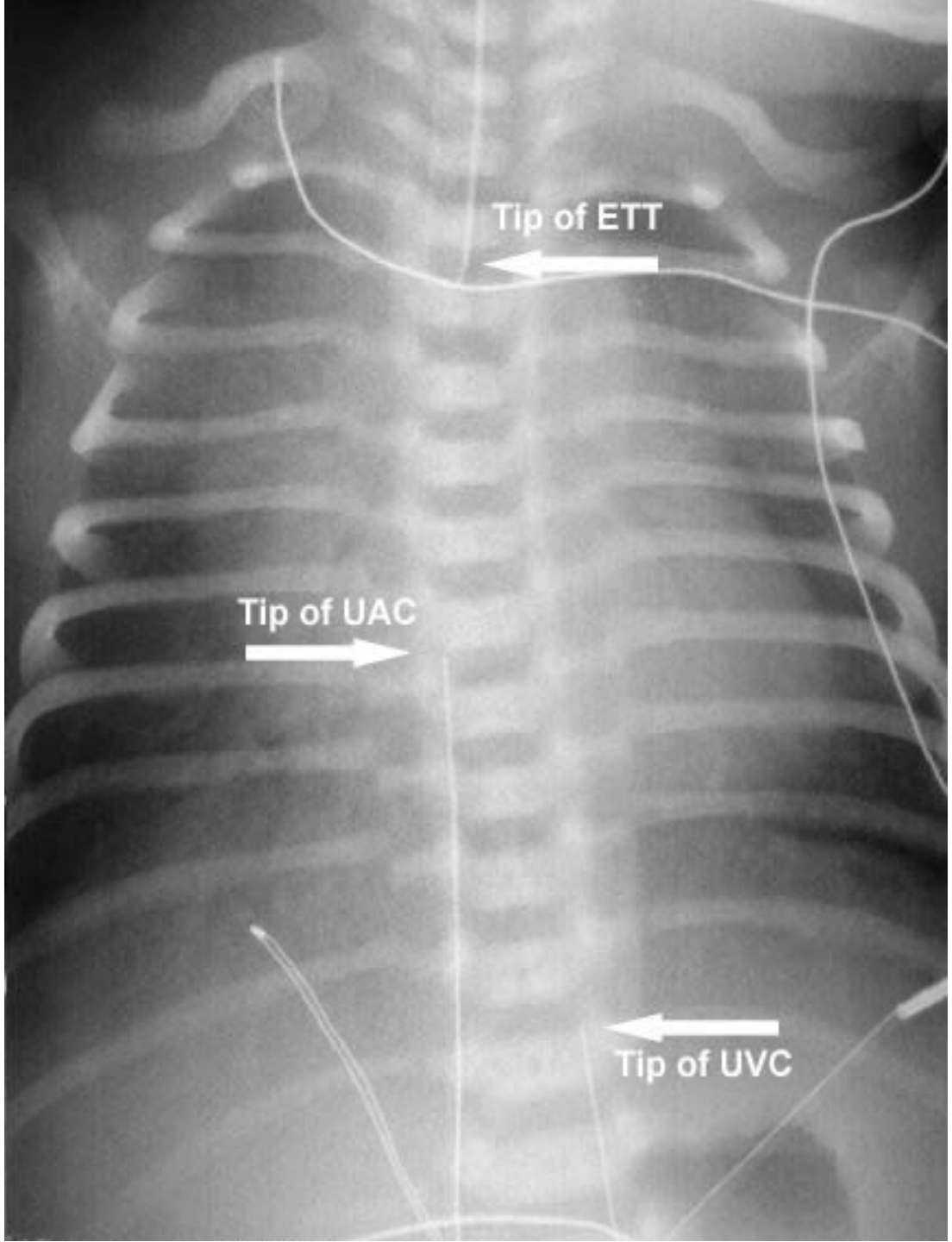


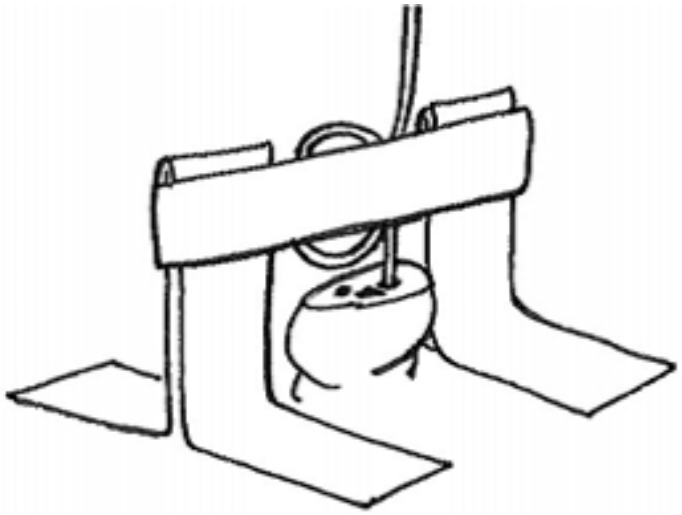


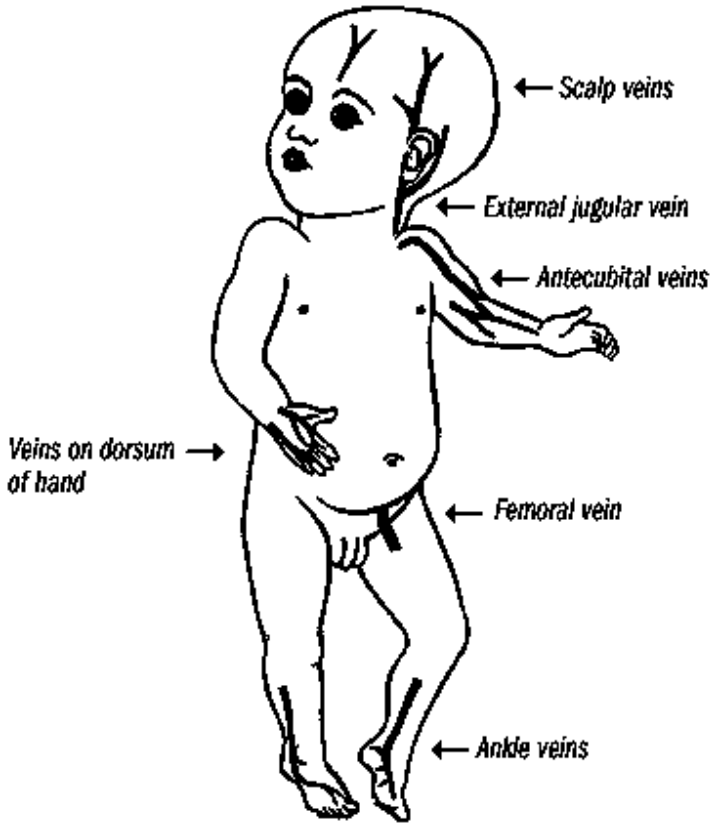


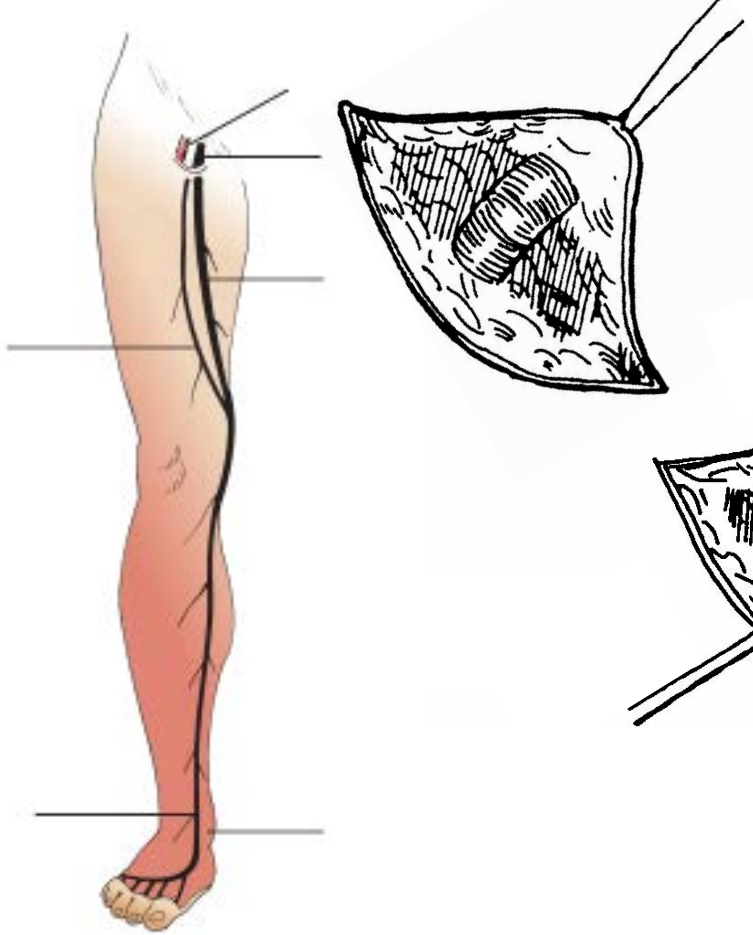

Vein with catheter inserted
Note umbilical tape for hemostasis

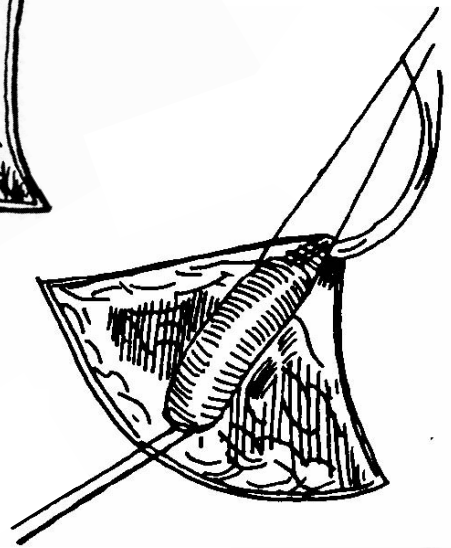


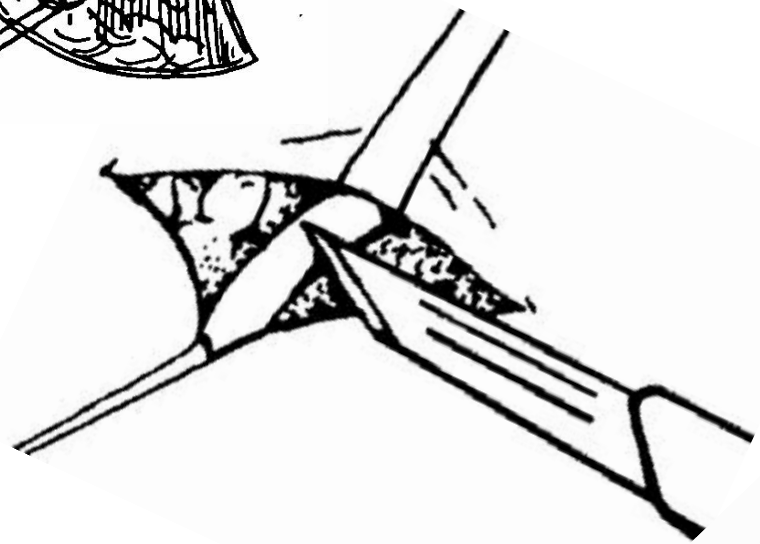




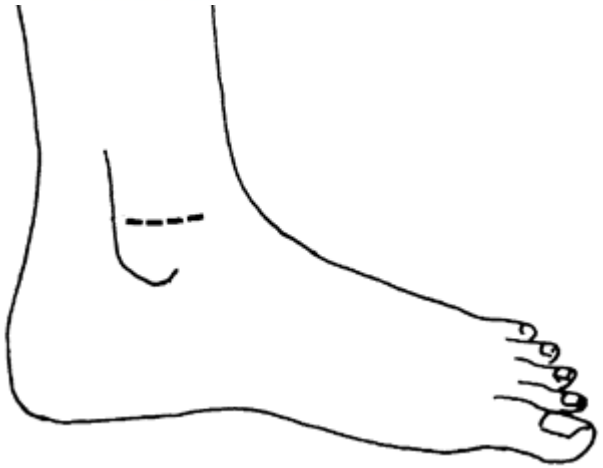

Scalp veins
External jugular vein
Antecubital veins
Veins on dorsum of hand
Femoral vein
Ankle veins

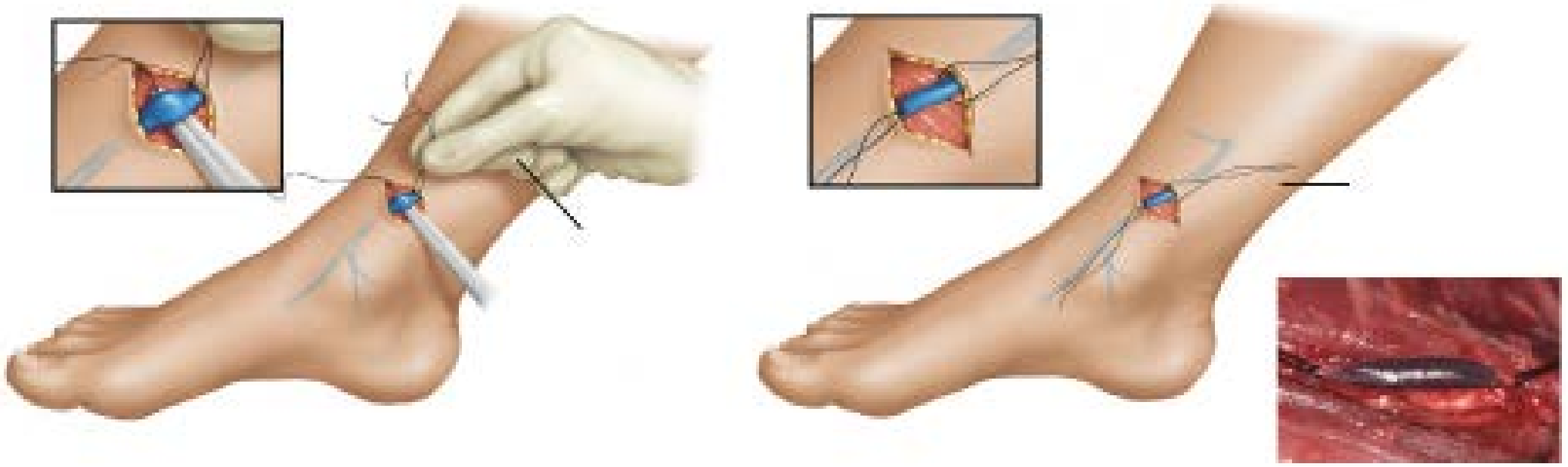


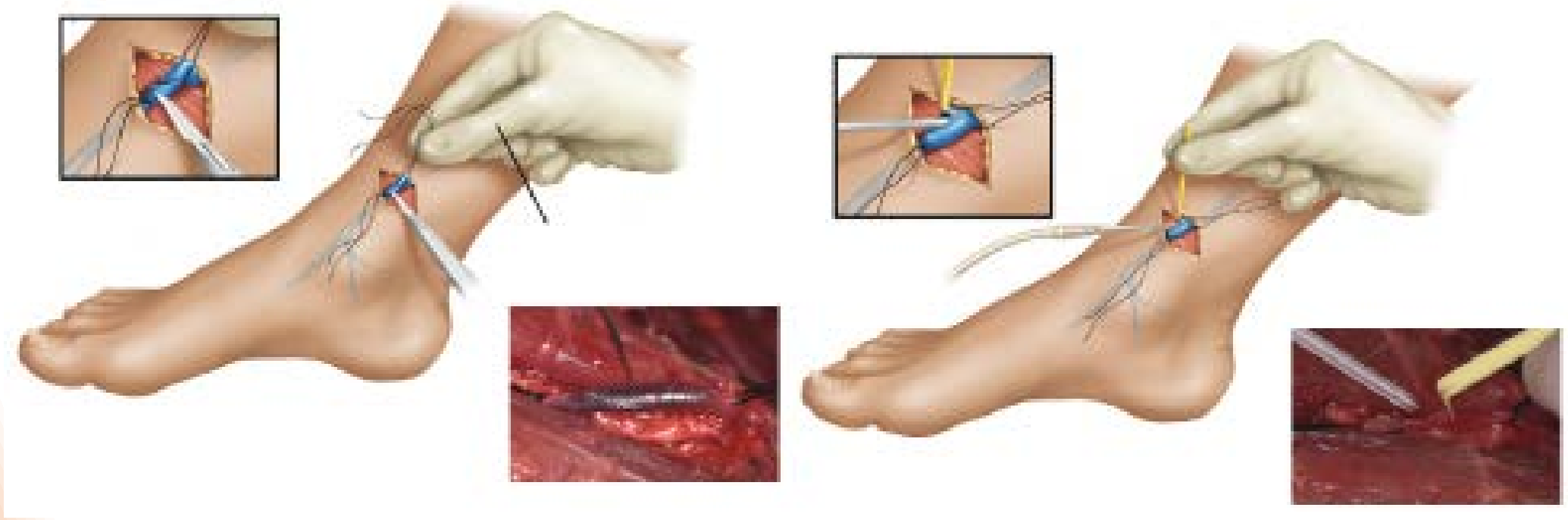


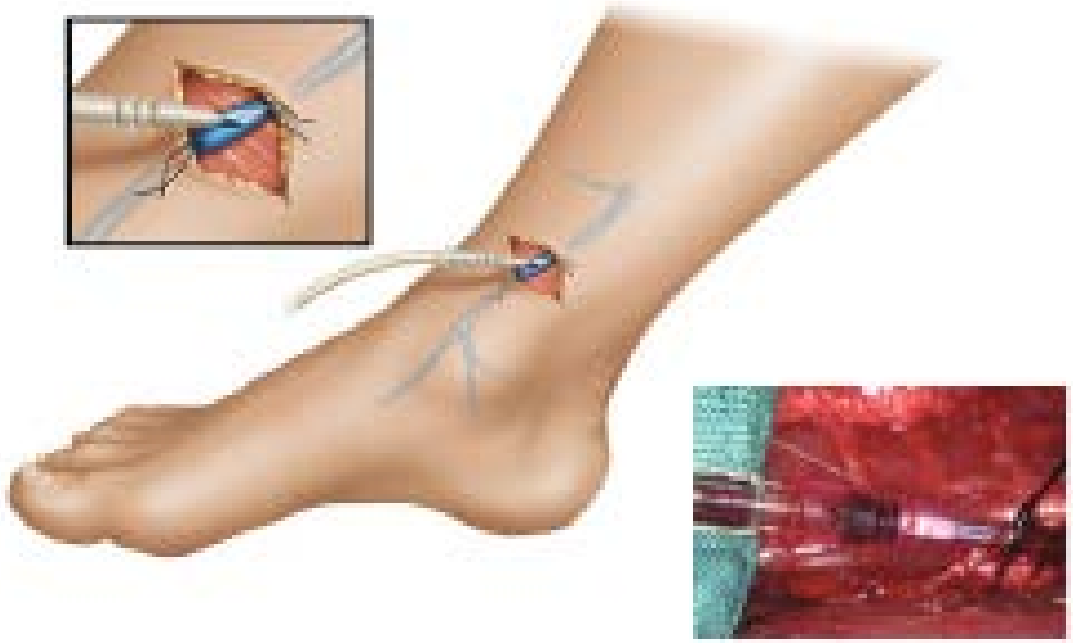


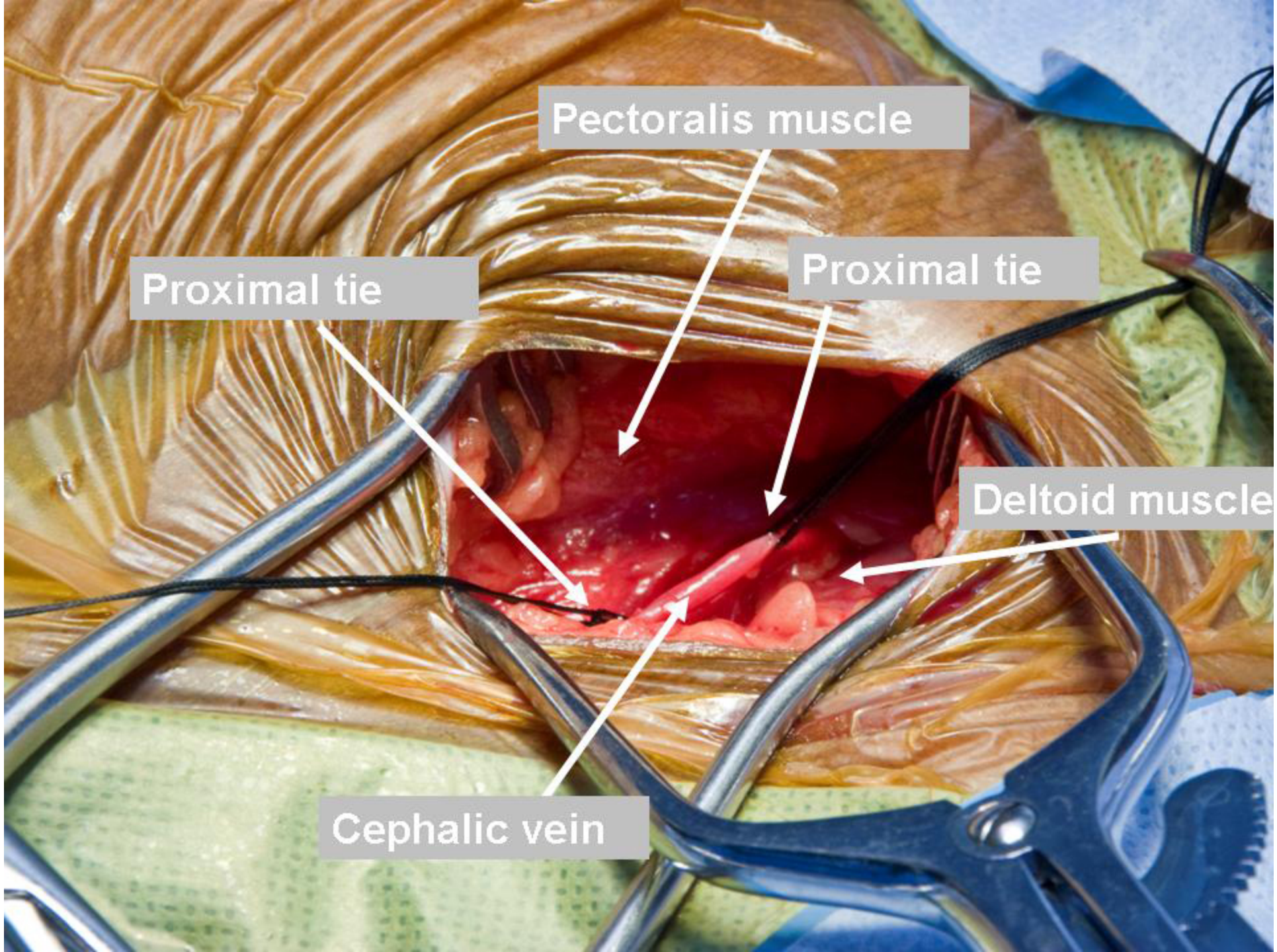

Anterior head deltoid muscle
deltoid and pectoralis muscle
Cephalic vein
Pectoralis major muscle

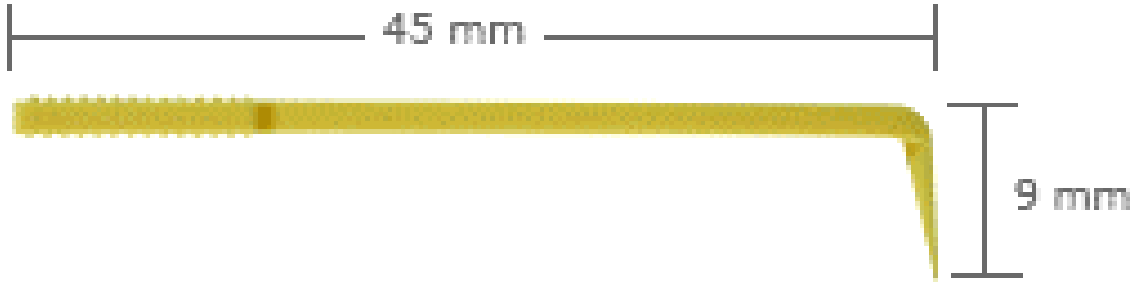


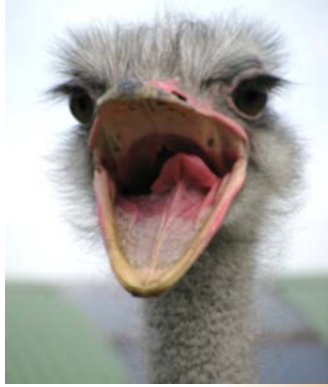


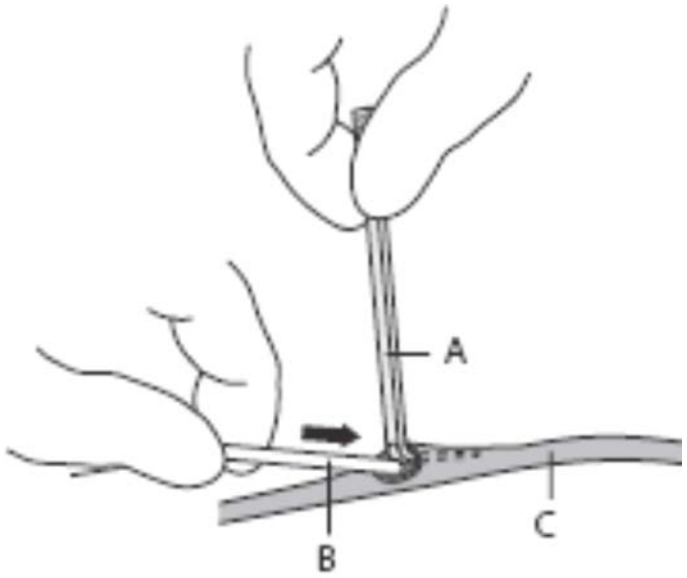




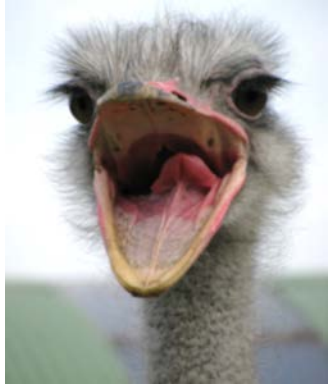

Pectoralis muscle
Proximal tie
Proximal tie
Deltoid muscle
Cephalic vein


45 mm
9 mm




A
B
C


ml
30
20
10




SOON...

Summary

Rally: Mild Volume Depletion
PO

Replete: Moderate Volume Depletion
PO, SC, and/or IV

Resuscitate: Severe Volume Depletion
IV, IO

Summary

- Try **PO** for **mild and moderate** volume depletion
- Make liberal use of **adjuncts**
- To resuscitate: use the **push-pull technique**: 30 mL syringe, 3-way stop-cock


Thank You!
@EMtogether

A curated, up-to-date syllabus is maintained for you at:

PEMplaybook.org/lectures/

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