



Congresso GAVeCeLT

FIRENZE
FLORENCE
2017

Accessi ecoguidati, accessi NIR-guidati e accessi intraossei: quale accesso nelle emergenze pediatriche?

Daniele G. Biasucci, M.D.

Fondazione Policlinico Universitario "A. Gemelli"

Università Cattolica del Sacro Cuore di Roma



Gemelli



Fondazione Policlinico Universitario A. Gemelli
Università Cattolica del Sacro Cuore

European Resuscitation Council Guidelines for Resuscitation 2015

Section 6. Paediatric life support

Ian K. Maconochie^{a,*}, Robert Bingham^b, Christoph Eich^c, Jesús López-Herce^d,
Antonio Rodríguez-Núñez^e, Thomas Rajka^f, Patrick Van de Voorde^g, David A. Zideman^h,
Dominique Biarentⁱ, on behalf of the Paediatric life support section Collaborators¹



- Vascular access is essential to enable drugs and fluids to be given, and blood samples obtained
- ***Venous access can be difficult to establish during resuscitation of an infant or child***
- ... whenever venous access is not readily attainable, intra- osseous access should be considered early, especially if the child is in cardiac arrest or decompensated circulatory failure...
- In any case ... ***if attempts at establishing IV are unsuccessful after one minute, insert IO...***



- *In children younger than 6 years*, the placement of an *IO needle should be attempted before* CVC
- The important determinant for selecting a procedure or route for establishing vascular access is the clinician's experience and skill
- Intraosseous access with specially designed equipment is possible in all age groups, and is being used with increasing frequency
- As in the pediatric population, this access may be used in-hospital until intravenous access is obtained



ORIGINAL RESEARCH CONTRIBUTION

Validation and Refinement of the Difficult Intravenous Access Score: A Clinical Prediction Rule for Identifying Children With Difficult Intravenous Access

Michael W. Riker, MD, Chris Kennedy, MD, Brad S. Winfrey, RN, Kenneth Yen, MD, MS, and M. Denise Dowd, MD, MPH

Predictor Variable	Scores		
Visibility	Visible = 0		Not visible = 2
Palpability	Palpable = 0		Not palpable = 2
Age	≥ 36 months = 0	12–35 months = 1	< 12 months = 3
Prematurity	Not premature = 0		Premature = 3
Skin shade	Light = 0	Dark = 1	



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Model	% Correctly Identified as IV Failure (n)/118	% Incorrectly Identified as IV Failure (n)/248
DIVA 4 (Yen)	61.0 (72)	27.8 (69)
DIVA 5 (Yen)	66.1 (78)	36.7 (91)
DIVA 4 (Riker)	62.7 (74)	28.2 (70)
DIVA 3 (Riker)	56.8 (67)	22.2 (55)

*Using scoring system in Table 1, with score ≥ 4 as cutoff value for predicting failure.



Intraosseous

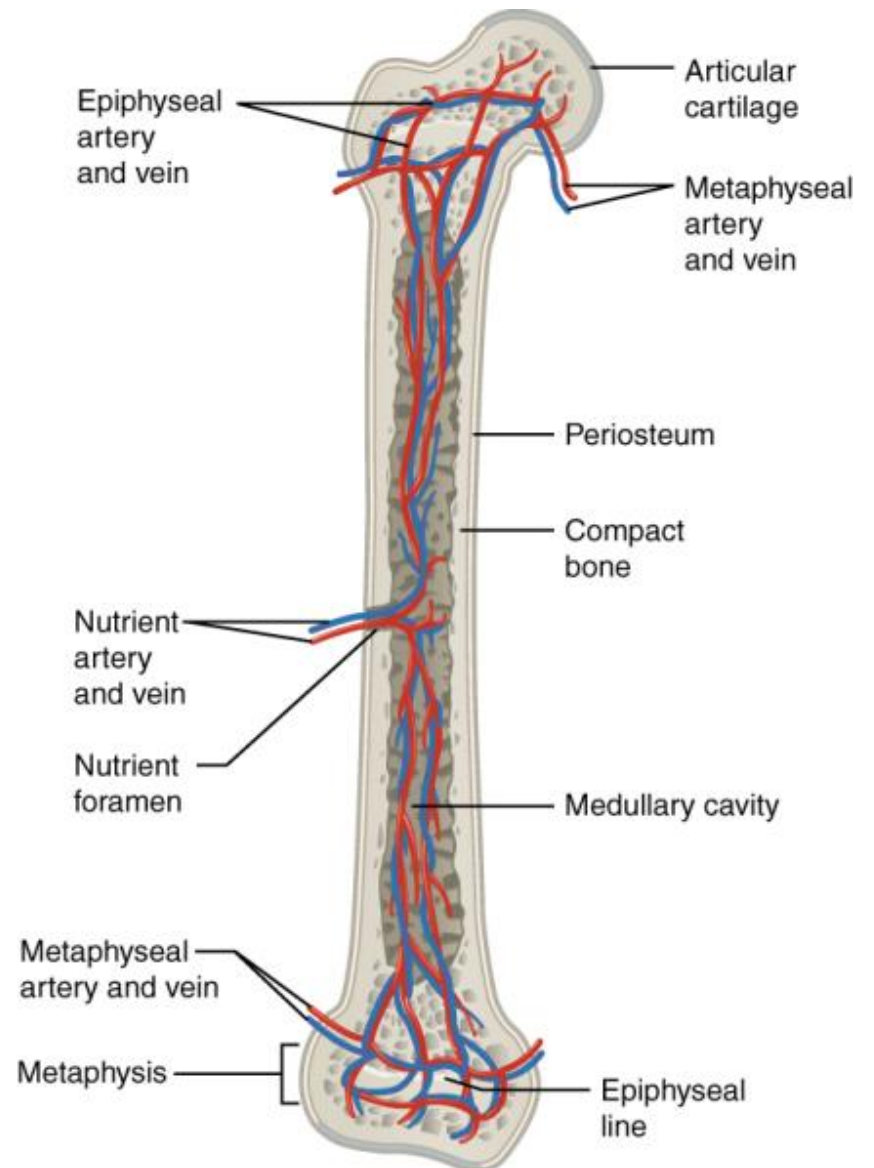


Accesso IO

- Inventato più di 80 anni fa
- Utilizzato nella Seconda Guerra Mondiale (4000 paz)
- Dimenticato per circa 40 anni
- Riscoperto negli anni 80
- Rapidamente inserito in raccomandazioni (non-EB) di diverse istituzioni (ERC, PALS, AHA, etc.)

Accesso IO: basi anatomiche

- Il midollo osseo è molto vascolarizzato ed è collegato al sistema venoso centrale attraverso il plesso venoso midollare
- La consistenza dell'osso in cui è contenuto il midollo rendono questa cavità un sistema non-collassabile anche in presenza di shock o grave ipovolemia



IO: Controindicazioni

- Skin infection at insertion site
- Fractured bone
- Severe bone diseases
- Imperfect osteogenesis
- Osteoporosis
- Osteomyelitis
- Compartment syndrome in target extremity
- Prior surgery
- Burns
- Localized cellulitis at device insertion site
- Recent failed intra-osseous attempt in same bone

Accesso IO

I principali punti di inserzione sono:

- **Omerale:** parte più prominente del trochite omerale al di sopra di circa 1 cm del collo chirurgico
- Tibiale prossimale: piatto tibiale, circa 2 cm sotto la rotula e 2 cm medialmente alla tuberosità tibiale
- Tibiale distale: circa 3 cm al di sopra del malleolo mediale, sulla superficie mediale della tibia distale
- Sternale: perpendicolarmente al manubrio sternale, al di sotto dell'incisura giugulare

Selezione del sito

- Nessun IO nelle 48 ore precedenti
- Assenza di controindicazioni
- Accessibilità
- Capacità di fissare e monitorare

Accesso IO

Portata

- La portata dei fluidi infusi (ml/h) è diversa da sito a sito ed è correlabile a quella di cannule di diversa misura
- A parità di pressione d'infusione, un ***accesso omerale o sternale*** sono paragonabili in termini di portata ad un 16 Gauge, mentre un accesso tibiale è paragonabile a un 21 Gauge

Guy 1993

pediatric trauma

32 pts con IO

- OH & IH resuscitation of **critically injured children**
- *rapid, safe, and simple*
- short term vascular access
- primary consideration as an alternative route for *fluid resuscitation in pediatric trauma* patients regardless of age
- It should be placed without delay *when venous access is not rapidly obtainable*

Neal 1994

- child in *shock or cardiac arrest*
- when **two attempts** to access peripheral vasculature have failed or when **more than 2 minutes** have elapsed in the attempt to gain access.
- Epinephrine, bicarbonate, calcium, lidocaine, and volume expanders can be infused via the intraosseous route.

Tobias 1996

Pediatric airway emergencies: practical recommendations

it should be kept in mind that intraosseous access is an acceptable alternative for the administration of several different *agents*, including those used *for endotracheal intubation*

Ciononostante...

- Chiang 2000 - 121 ped emerg in ED : **11%** IO
- Babl 2001 - 555 ped emerg : IO only in 3 pts (**0.5%**)
- Chu 2003 - 100 ped with femoral fracture : **no** IO
- Smith 2005 - ped trauma in UK
 - IO = used only in 129 pts out of 23,489 (**0.5%**)
- Helm 2007 - HEMS
 - IO = **4.2%** of children
- Behn 2010 - HEMS
 - 643 ped emerg (58% were trauma): IO in **2.5%** VA in 81.5%

Lo 2009

- Despite resuscitation councils' clear recommendation to use IO access in the arrested infant, only 51 participants (52%) chose IO as their first vascular access choice in this situation
- *Previous real life IO insertion experience significantly increased trainees' willingness to use IO as their first emergency vascular access choice ($P<0.0001$)*

Baker 2009

183 pediatric emergencies

- *PALS-trained squads* were more successful in intraosseous line placement than non-PALS-trained squads (100% vs 55%; $P < 0.01$)

Sunde 2010

78 IO con **diversi dispositivi**

- *Newer intraosseous techniques may enable faster and more reliable vascular access*, and this can lower the threshold for intraosseous access on both adult and paediatric patients in critical situations

Manuali

Cateteri venosi



Ago per intraossea



Assistiti/automatici

BIG

Bone Injection Gun



FAST1



Meccanici

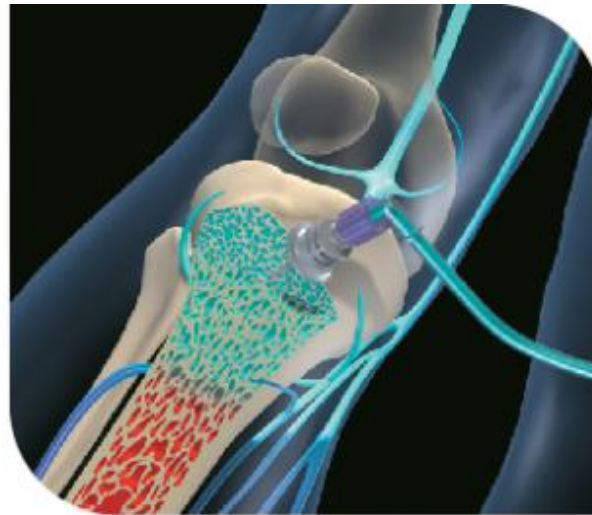
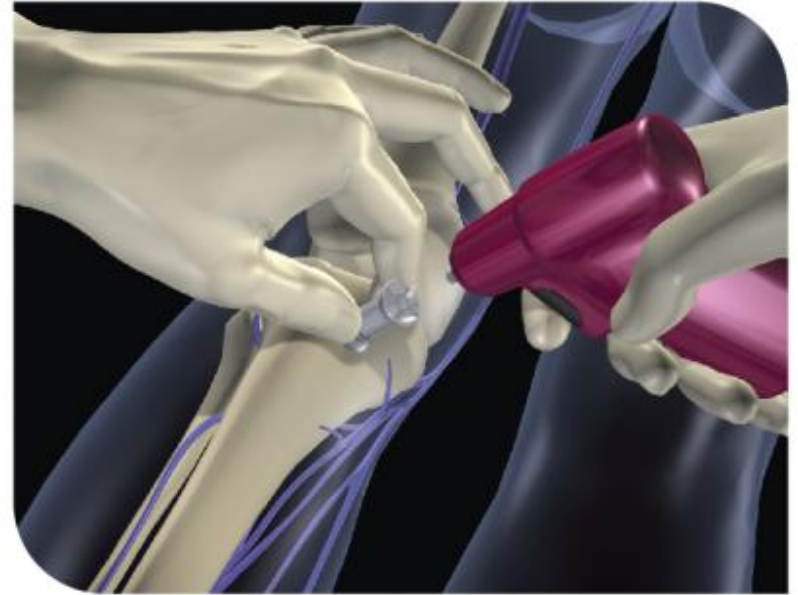
EZ-IO



Gabin 2011

30 IO con dispositivo meccanico (EZ-IO)

- *EZ-IO device proved safe and highly effective in both adult and paediatric patients in an out-of-hospital emergency setting*
- It is a suitable device for consideration as a *first-line option for difficult vascular access in Out-of-H*



ORIGINAL RESEARCH

Open Access



Intraosseous blood samples for point-of-care analysis: agreement between intraosseous and arterial analyses

Table 1 The point-of-care results for the analyses of IO1 (initial intraosseous sample), IO2 (second intraosseous sample after 2 ml of waste blood), arterial blood, and venous blood

	IO1	IO2	Artery	Vein
Na (mmol/l)	132 (123–137) <i>n</i> = 29	131.5 (125–138) <i>n</i> = 30	138 (131–140)	138 (132–142)
K (mmol/l)	5.8 (4.0–7.7) <i>n</i> = 27	6.9 (4.5–8.8) <i>n</i> = 26	3.7 (3.5–4.2)	3.7 (3.3–4.2)
iCa (mmol/l)	1.12 (0.95–1.2) <i>n</i> = 29	1.07 (0.91–1.24) <i>n</i> = 30	1.21 (1.13–1.26)	1.23 (1.18–1.3)
pH	7.420 (7.363–7.614) <i>n</i> = 29	7.433 (7.379–7.679) <i>n</i> = 30	7.408 (7.356–7.789)	7.377 (7.298–7.463)
BE (mmol/l)	1.0 (–3.0–5.0) <i>n</i> = 29	1.0 (–3.0–6.0) <i>n</i> = 30	–1.0 (–6.0–9.0)	–1.0 (–5.0–4.0)
HCO ₃ (mmol/l)	25.1 (20.9–29.3) <i>n</i> = 29	25.0 (20.7–30.6) <i>n</i> = 30	22.6 (18.0–27.8)	24.4 (20.8–28.7)
pO ₂ (kPa)	7.35 (4.7–13.4) <i>n</i> = 28	7.55 (4.1–13.7) <i>n</i> = 30	12.35 (9.5–15.5) <i>n</i> = 30	4.3 (2.6–10.5)
pCO ₂ (kPa)	5.12 (2.97–6.16) <i>n</i> = 29	4.96 (2.44–6.16) <i>n</i> = 30	4.82 (2.25–5.36)	5.55 (4.07–7.29)
Hb (g/l)	153 (68–204) <i>n</i> = 28	139.5 (92–190) <i>n</i> = 30	153 (116–228)	150 (119–241) <i>n</i> = 30
Hct (%)	45 (20–60) <i>n</i> = 28	41 (27–56) <i>n</i> = 30	45 (34–67)	44 (35–71)
Gluc (mmol/l)	5.5 (4.4–7.0) <i>n</i> = 27	5.5 (4.6–6.8) <i>n</i> = 29	5.5 (4.4–7.0)	5.4 (3.8–6.6)
Lact (mmol/l)	1.03 (0.58–2.42) <i>n</i> = 26	1.04 (0.68–2.11) <i>n</i> = 26	1.15 (0.56–2.0) <i>n</i> = 30	1.44 (0.74–2.58)

Data are presented as median (range). The number of results is indicated only if it differed from 31. Potassium values over 9.0 mmol/l were excluded from the analysis as outliers (the upper limit of measurement for the used method, IO1 *n* = 2, IO2 *n* = 4)

Ulteriori esperienze...

- Hansen 2011 - 291 children with IO
 - cardiac arrest (**34%**), trauma (**19%**), and resp.failure (6%)
- Selig 2011 - 2207 emergencies (Austrian HEMS)
 - only 19 IOS (**0.9%**)
- Carlson 2015 - Salt Lake City: 2618 IO (**0.5%**)
- Reuter-Rice 2015 - 143 IO (cardiac & resp. **53%**)

Voigt 2012

- Randomized controlled trials are lacking
- Newer IO access technologies appear to do a better job of gaining successful access more quickly
- *Intraosseous access is underutilized in the ED because of lack* of awareness, lack of guidelines/indications, *proper training*, and a lack of proper equipment.

Accesso IO: complicanze

www.medscape.com

Complication With Intraosseous Access



Inquiry of Scandinavian Users' Experiences

Peter Hallas, MD, Mikkel Brabrand, MD, Lars Folkestad, MD |
Western J Emerg Med. 2013;14(5):440-443.

IO-equipment used	All	%	EZ-IO	B.I.G	Cook	Others	p-value*
Cases reported	1,802	100.0	861	255	418	268	

Prima dell'uso...

Start complications							
Equipment difficult to assemble	36	2.0	4	21	5	6	< 0.0001
Difficult to identify correct anatomical site	57	3.2	28	17	5	7	0.0013
Bended or broken needle	72	4.0	11	17	20	24	< 0.0001
Patient discomfort/pain	128	7.1	73	13	20	22	0.0663
Difficult to penetrate the periosteum	186	10.3	18	56	51	61	< 0.0001
Difficult to aspirate bone marrow	221	12.3	92	51	38	40	< 0.0001

Nell'utilizzo...

Complications in use							
Difficult to inject fluid and drugs	133	7.4	59	33	27	14	0.0026
Slow infusion despite use of pressure bag	159	8.8	77	32	34	16	0.0610
Displacement after insertion	153	8.5	47	50	38	18	< 0.0001
Extravasation	66	3.7	25	12	17	12	0.4089

Complicanze Tardive

Late complications							
Compartment syndrome	10	0.6	6	1	1	2	0.796
Osteomyelitis	7	0.4	4	1	1	1	1.000
Skin infection	6	0.3	4	1	1	0	0.829

Conclusion

In users' recollection of real-life IO use, the overall rate of complications was higher than usually reported from model and cadaver studies. The relatively high rate of difficulties after insertion should be addressed when the procedure is taught. Research on IO devices should focus on all stages of IO use. Focus only on "penetration through cortex" as a measure of IO success rate could miss clinically relevant complications.

Accesso Intraosseo

Da considerarsi in caso di emergenza, ed in particolare:

- Nel soccorso *preospedaliero*
- Nelle *emergenze di massa*
- Nelle *emergenze pediatriche intraospedaliere, laddove l'accesso venoso sia difficile o lungo da ottenere*
- *Scenari di guerra o aree remote*

Il futuro dell'IO...

- Necessità di divulgazione della metodica
- Necessità di ***formazione e training*** del personale coinvolto nelle emergenze
- ***Necessità di RCTs: NIR o US vs IO***
- Riduzione dei costi del dispositivo

Tecniche di visualizzazione

- Le linee guida ILCOR e ACS ***non tengono conto dell'ecoguia né delle altre tecniche di visualizzazione*** dei vasi venosi
- La maggior parte degli studi in letteratura non tengono conto dell'ecografia né di altre tecniche di visualizzazione dei vasi

Tecniche di visualizzazione

- Tecniche di visualizzazione dei vasi venosi
 - Ecografia
 - NIR
 - Transilluminazione

22. VASCULAR VISUALIZATION

Standard

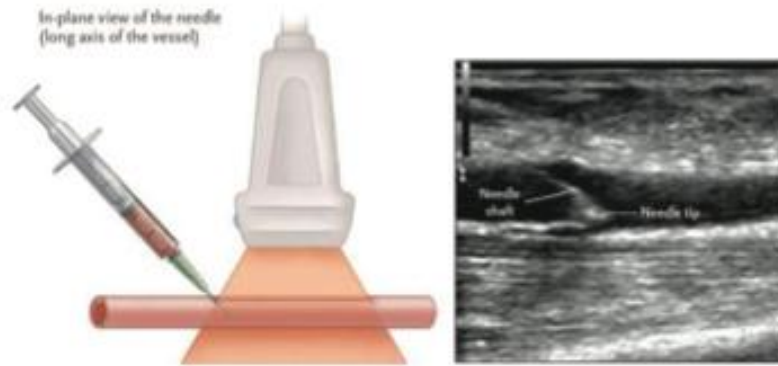
22.1 To ensure patient safety, the clinician is competent in the use of vascular visualization technology for vascular access device (VAD) insertion. This knowledge includes, but is not limited to, appropriate vessels, size, depth, location, and potential complications.

22.2 Vascular visualization technology is used in patients with difficult venous access and/or after failed venipuncture attempts.

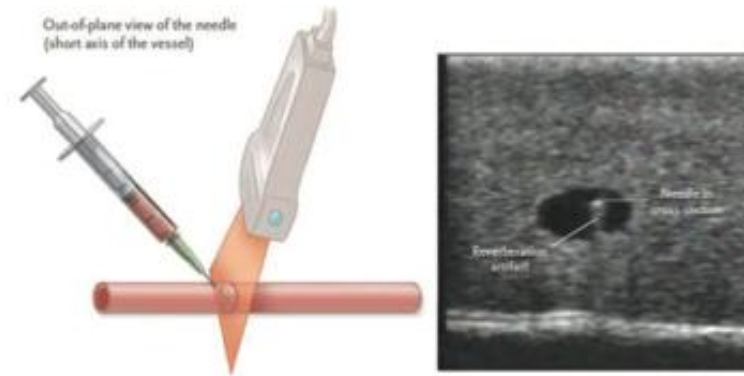
22.3 Vascular visualization technology is employed to increase the success with peripheral cannulation and decrease the need for central vascular access device (CVAD) insertion, when other factors do not require a CVAD.

Tecniche di Imaging

- Vene profonde (> 7 mm)
 - Visualizzazione ecografica
- **Vene superficiali (< 7 mm)**
 - Visione in trasparenza e/o Palpazione
 - **Visualizzazione con tecnologie specifiche**
 - Transilluminazione
 - Riflessione di raggi infrarossi (**NIR**)



Ecoguida



ORIGINAL ARTICLE

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

Mehdi Benkhadra, Mathieu Collignon, Isabelle Fournel,
Christian Oeuvrard, Patricia Rollin, Murielle Perrin, François Volot,
Claude Girard

- ...anche in età pediatrica...
 - Maggior % di successo al primo tentativo
 - Minor tempo impiegato
 - Minor numero di punture ripetute

Ecoguida

- Agocannule
 - Attenzione alla profondità
 - Attenzione al sito/vena
- Cannule lunghe o mini-midline
 - Attenzione alla vena

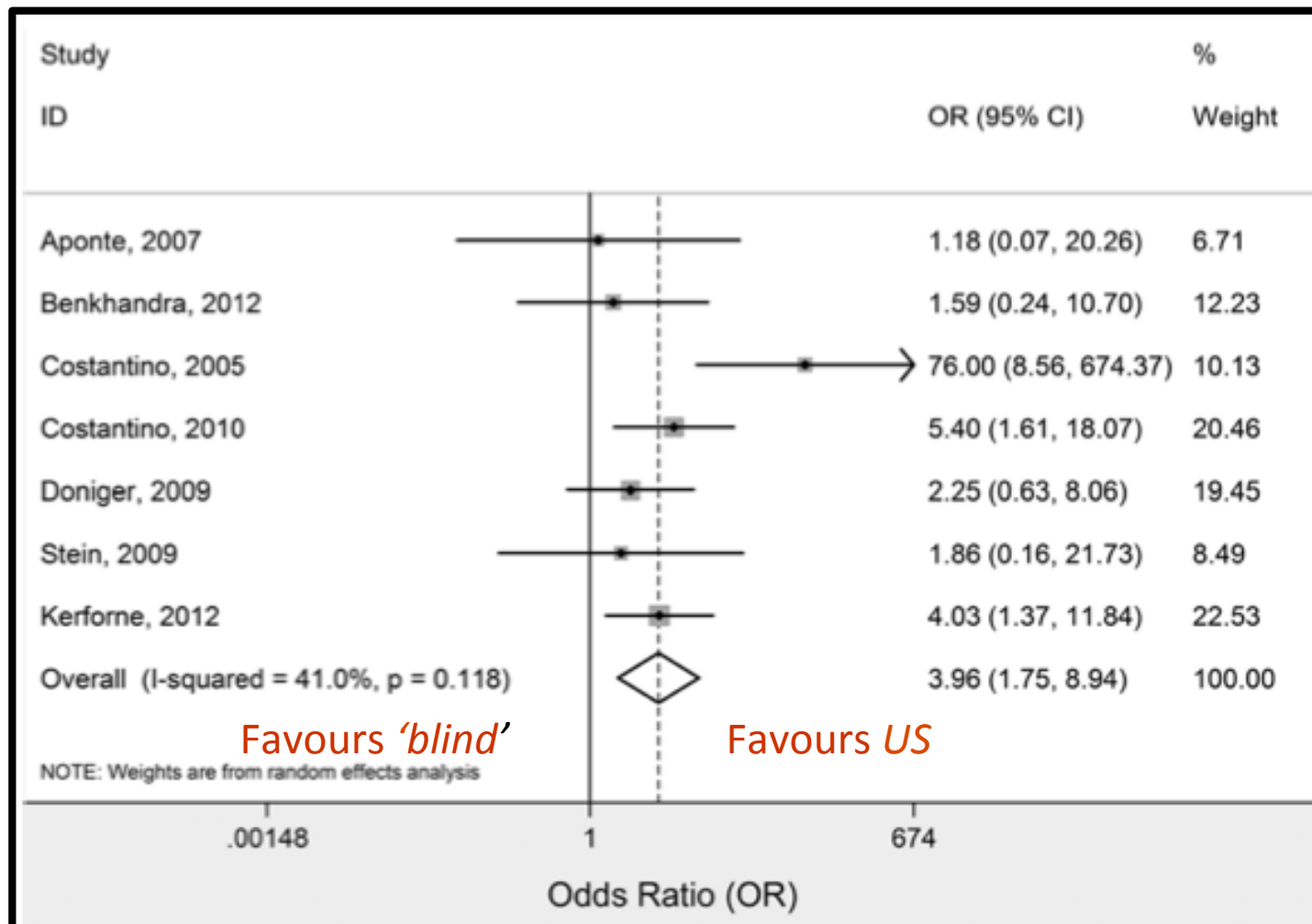
Ultrasound-guided peripheral venous access: a meta-analysis and systematic review

Lori A. Stolz¹, Uwe Stolz¹, Carol Howe², Isaac J. Farrell¹, Srikar Adhikari¹

¹ Department of Emergency Medicine, University of Arizona Medical Center, Tucson, AZ - USA

² Information Services, Arizona Health Sciences Library, University of Arizona, Tucson, AZ - USA

***Conferma la maggiore
% di successi al primo
tentativo***



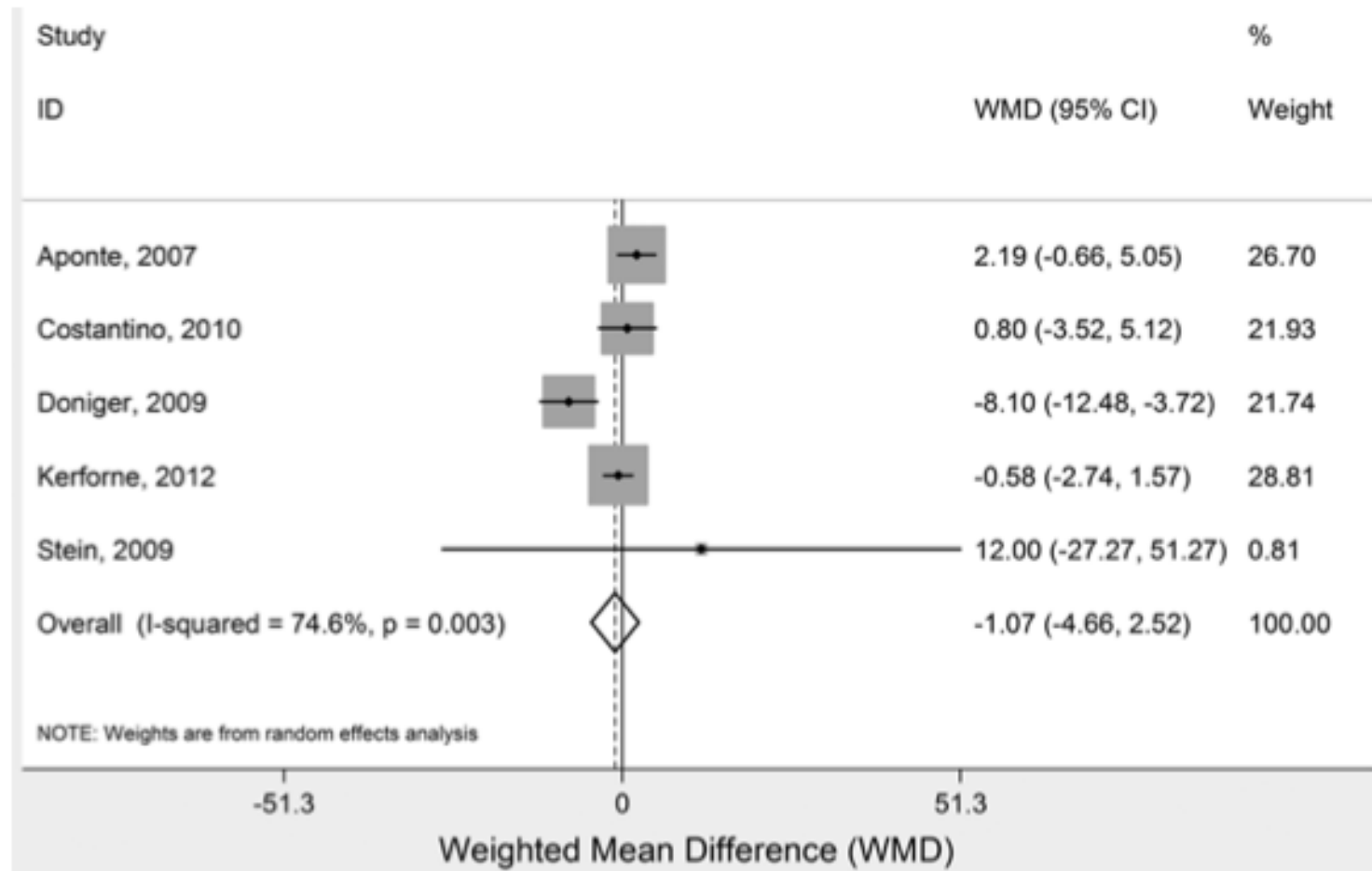
Ultrasound-guided peripheral venous access: a meta-analysis and systematic review

Lori A. Stolz¹, Uwe Stolz¹, Carol Howe², Isaac J. Farrell¹, Srikar Adhikari¹

¹ Department of Emergency Medicine, University of Arizona Medical Center, Tucson, AZ - USA

² Information Services, Arizona Health Sciences Library, University of Arizona, Tucson, AZ - USA

- ***Non significativa la riduzione del tempo impiegato***



Use ultrasonography (US) for short peripheral catheter placement in adult and pediatric patients with difficult venous access.² (II)



Ann Emerg Med. 2013 Apr;61(4):444-454.e1. doi: 10.1016/j.annemergmed.2012.11.014. Epub 2013 Feb 15.

Ultrasonographically guided peripheral intravenous cannulation of children and adults: a meta-analysis.

Heinrichs J¹, Fritze Z, Vandermeer B, Klassen T, Curtis S.

⊕ Author information

Abstract

STUDY OBJECTIVE: Peripheral intravenous cannulation is a common procedure in emergency departments (ED) and operating rooms. We performed a systematic review to evaluate the effectiveness of ultrasonographic guidance as an aid to peripheral intravenous cannulation.

METHODS: We searched MEDLINE, Cochrane Central Register of Controlled Trials, EMBASE, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Web of Science, and Scopus. We included randomized trials evaluating ultrasonographically guided peripheral intravenous cannulation. Outcomes included cannulation failure, number of attempts, procedure time, or time from randomization to cannulation. We separately analyzed pediatric and adult data and emergency department (ED), ICU, and operating room settings. We used the Cochrane Risk of Bias Tool.

RESULTS: We assessed 403 full texts for eligibility, and included 9 trials. Five had low risk, 1 high risk, and 3 unclear risk of bias. Meta-analysis of all trials suggested that ultrasonography decreased mean difference (MD) in the number of attempts (MD -2.00; 95% CI -3.27 to -0.73) and procedure time (MD -8.10 minutes; 95% CI -12.48 to -3.72 minutes). In an operating room pediatric trial, ultrasonography decreased risk of first-attempt failure (risk ratio 0.23; 95% CI 0.08 to 0.69), number of attempts (MD -1.50; 95% CI -2.52 to -0.48), and procedure time (MD -5.95; 95% CI -10.21 to -1.69). Meta-analysis of adult ED trials suggests that ultrasonography decreases the number of attempts (MD -0.43; 95% CI -0.81 to -0.05). Ultrasonography decreased risk of failure (risk ratio 0.47; 95% CI 0.26 to 0.87) in an adult ICU trial.

CONCLUSION: Ultrasonography may decrease peripheral intravenous cannulation attempts and procedure time in children in ED and operating room settings. Few outcomes reached statistical significance. Larger well-controlled trials are needed.

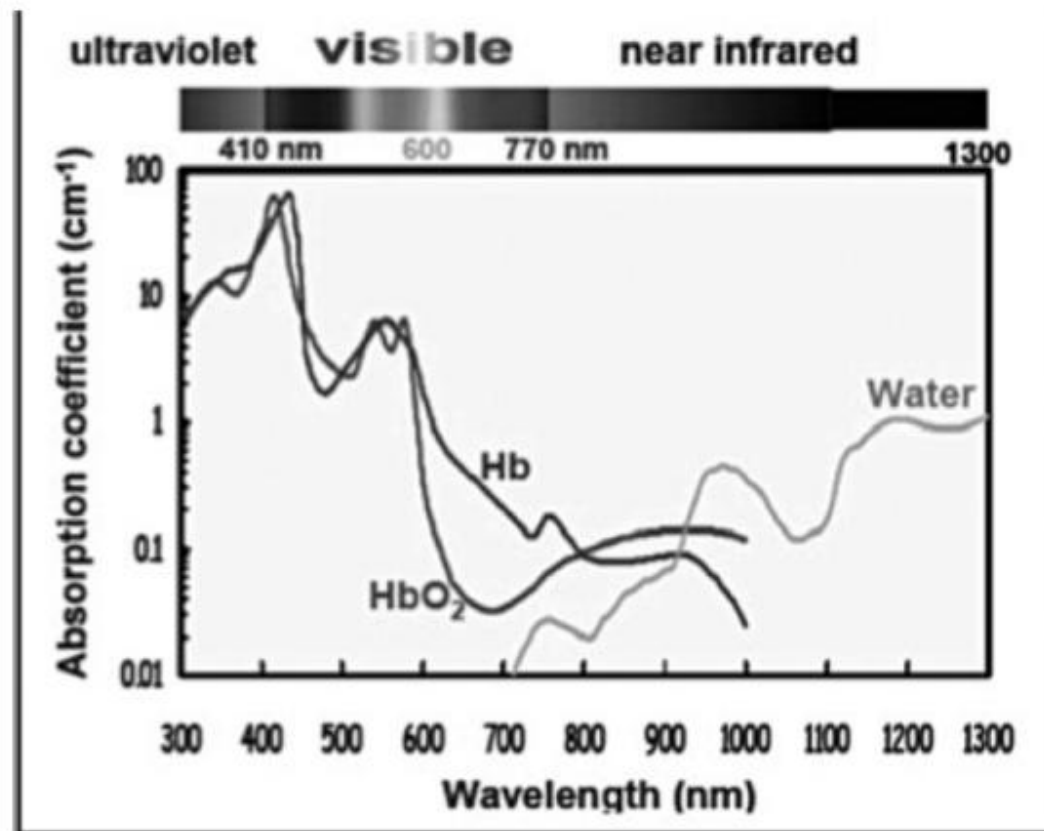
CONCLUSION: Ultrasonography may decrease peripheral intravenous cannulation attempts and procedure time in children in ED and operating room settings. Few outcomes reached statistical significance. Larger well-controlled trials are needed.

Eterogeneità degli studi

- Studi molto eterogenei riguardo a:
 - Tecniche
 - Vasi target e loro criteri di scelta
 - Vene profonde di braccio
 - Vene superficiali di avambraccio
 - Devices utilizzati
 - Ago cannule standard
 - Cannule lunghe
 - *Training*

NIR

- Vasi supeficiali
 - < 7 mm di profondità



Diversi metodi permettono la venipuntura avvalendosi della tecnologia NIR

- Diretto (Veinsite): visualizzazione diretta della vena da parte dell'operatore
- Indiretto (Accuvein, Veinviewer): la luce infrarossa permette la visualizzazione indiretta della vena sulla pelle del paziente

NIR Devices

- VeinViewer – Vision



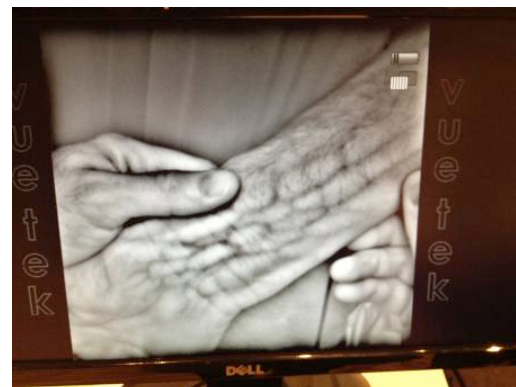
- AccuVein



- Vasculuminator



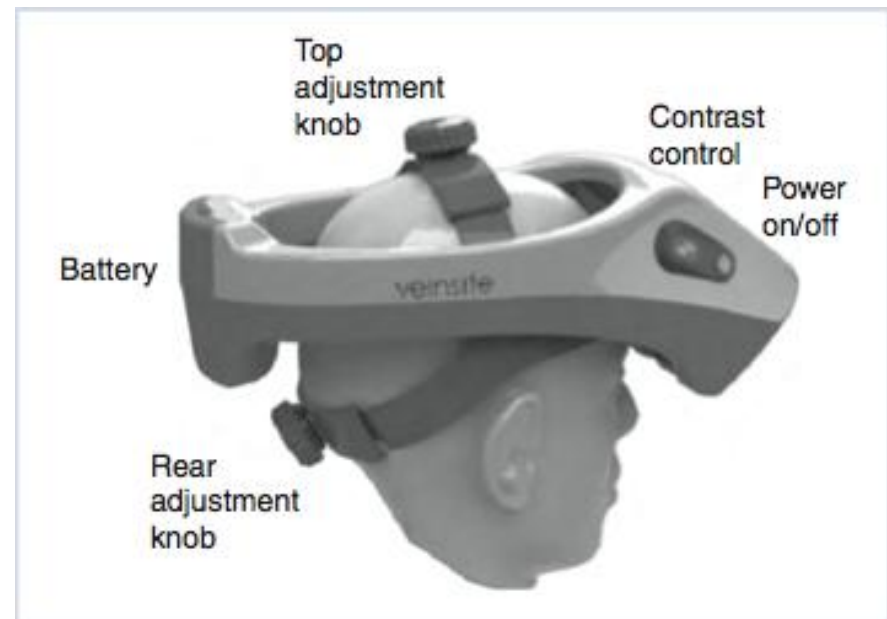
- Veinsite



NIR TECHNOLOGY



Veinsite



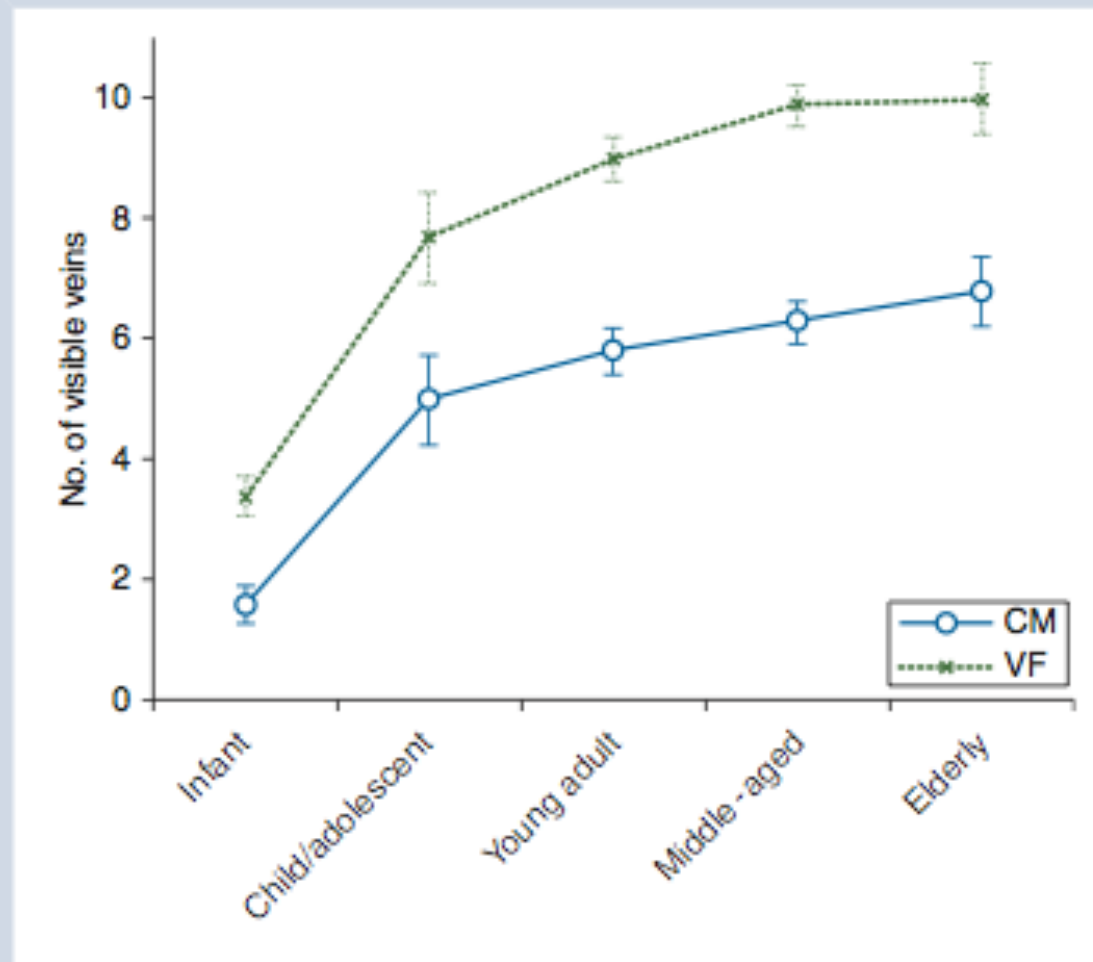


Fig 4 Comparison of VF and CM visible sites [mean (SE)] across age groups.

British Journal of Anaesthesia 110 (6): 966–71 (2013)
Advance Access publication 5 February 2013 · doi:10.1093/bja/aet003

BJA

CLINICAL PRACTICE

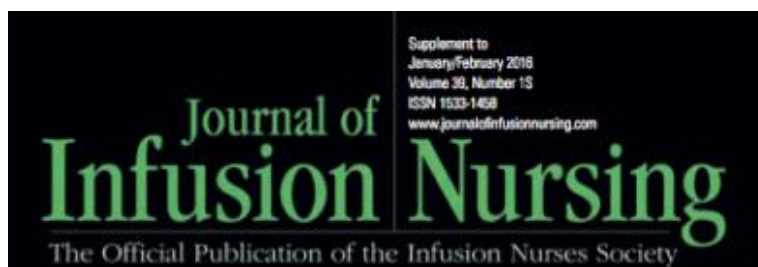
Vein visualization: patient characteristic factors and efficacy of a new infrared vein finder technology†

F. B. Chiao*, F. Resta-Flarer, J. Lesser, J. Ng, A. Ganz, D. Pino-Luey, H. Bennett, C. Perkins Jr and B. Witek

Visualizzazione mediante fasci di infrarossi

Near-infrared technology (NIR)

Consider the use of near-infrared (nIR) light technology to aid in locating viable superficial peripheral venous sites and decreasing procedure time for short peripheral catheter insertion.



1. Available technology includes hands-free devices that capture an image of the veins and reflect it back to the skin's surface or to a screen and transillumination projected to a screen. The clinician may choose to use a static process by imaging and marking the vein location on the skin or a dynamic process of using the image to guide catheter insertion. No studies have compared these various methods of device use, leaving this decision to the discretion of the clinician.^{1,6,12}

Consider nIR light technology to identify peripheral venous sites and facilitate more informed decisions about vein selection (ie, bifurcating veins, tortuosity of veins, palpable but nonvisible veins). Two nonrandomized studies have shown improvement in first-attempt success for peripheral catheter insertion using nIR; however, other studies have not shown this same outcome. Additional research is needed to address the reason(s), which could include differences in nIR devices, patient-related factors, and skill level of the inserters before using the nIR devices.¹¹⁻¹⁹ (I)

NIR

- Agocannule periferiche
 - Bambino e neonato
- ECC
 - Neonato

A systematic review and meta-analysis of new interventions for peripheral intravenous cannulation of children.

Heinrichs J¹, Fritze Z, Klassen T, Curtis S.

- To synthesize and evaluate the best evidence for novel **interventions** designed to improve pediatric PIVC
- A **meta-analysis** of 3 RCTs found that use of a transilluminator was associated with a decreased risk of first-attempt PIVC failure
 - Transilluminators modestly improve pediatric PIVC, but the clinical significance of this benefit is questionable
- **Meta-analysis** of 3 other RCTs found that near-infrared light devices do not impact the risk of first-attempt PIVC failure
 - *Near-infrared light devices might be efficacious in selected subpopulations, but the available evidence does not support an overall benefit in the pediatric population*

British Journal of Anaesthesia **110** (6): 888–91 (2013)
doi:10.1093/bja/aet078

EDITORIAL II

Difficult peripheral veins: turn on the lights

M. Lamperti^{1*} and M. Pittiruti²

¹ Department of Neuroanaesthesia, National Neurological Institute Besta, Via Celoria, 11, 20136 Milan, Italy

² Department of Surgery, Catholic University, Rome, Italy

* Corresponding author. E-mail: doclampmd@gmail.com

Second: cost-effectiveness. In other words, is this technology affordable in this period of international financial crisis? New technologies may be difficult to be accepted by our hospital managers, if not supported by a proper economical and clinical rationale. A budget impact analysis¹³ of this technology should include not only the raw cost of the device (from \$4500 up to \$25 000) and the cost of training vs the time-saving benefit, but also the advantage of a convincing improvement in the quality of venous cannulation in terms of perception of pain by

patients and handiness of the device by operators. Should the results of this analysis show a significant cost-effectiveness, the technique should be progressively introduced in the clinical practice, with the clinical goals of (i) preserving the peripheral vein patrimony of the patients and (ii) avoiding the risks associated with a potentially unnecessary central vein cannulation.¹⁴

Finally, there is a technical concern about vein visualization. Difficult venous cannulation may be related to the small diameter of the vein (as in infants) or to their deep location (as in obese patients) or to poor visibility or palpability due to other factors (oedema, pigmentation, etc.). It is still not clear whether NIR devices can be effective not only in venous visualization but also in venous cannulation; more specifically, since NIR technology does not provide a depth of field, accidental puncture of the posterior wall of the vein, and extravasation may easily occur. Ultrasound guidance has been proposed in recent years¹⁵ to improve the visualization of difficult superficial veins in paediatric patients, but the results of these studies are controversial in terms of improved success rate, first-time success, and overall time to cannulation.

There are three main unresolved issues regarding the use of NIR technology that makes its application still far from real life and clinical practice in our hospitals.

First: what about training? It is not clear how operators should be trained in the use of this new technology. Most of the studies do not report how many procedures the operators had to perform before being considered proficient with this new method. To define an operator proficient in a new technology or procedure, two main outcomes should be satisfied: goal achieved and time to success. Considering these devices, first-time successful cannulation should be considered the main goal and a learning curve should be calculated on this parameter;¹² this would suggest the average number of procedures required before obtaining a minimal training for getting proficiency.

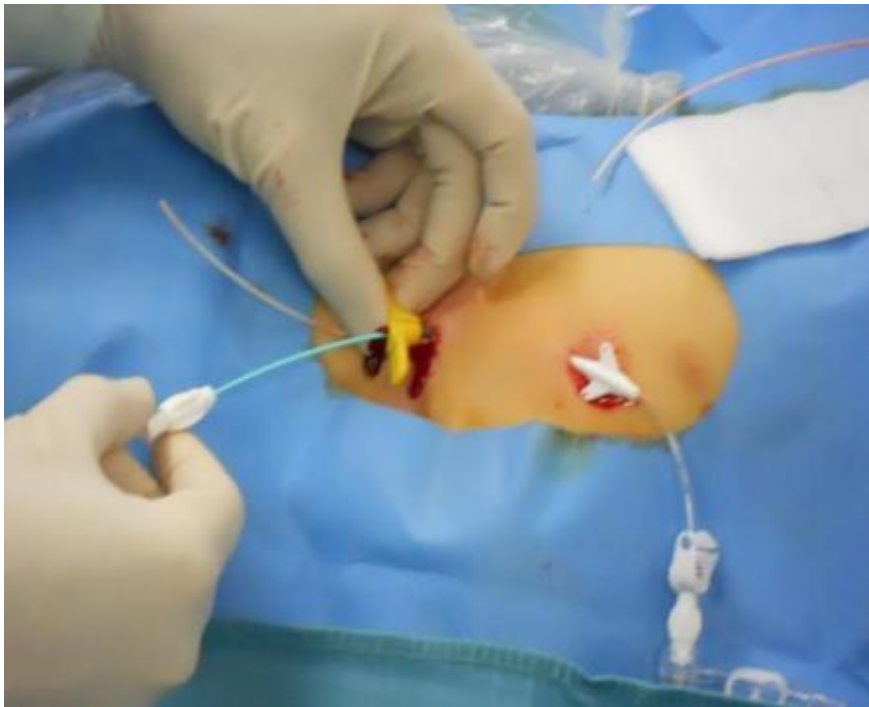
Cannulation time is not less important, if we consider that these portable devices should also be used in the emergency room to obtain a prompt venous access. It is mandatory to define a training curriculum on the use of NIR devices, if we want to use them properly every time, those superficial veins are not easily visible, palpable, or both.

Necessità di RCTs

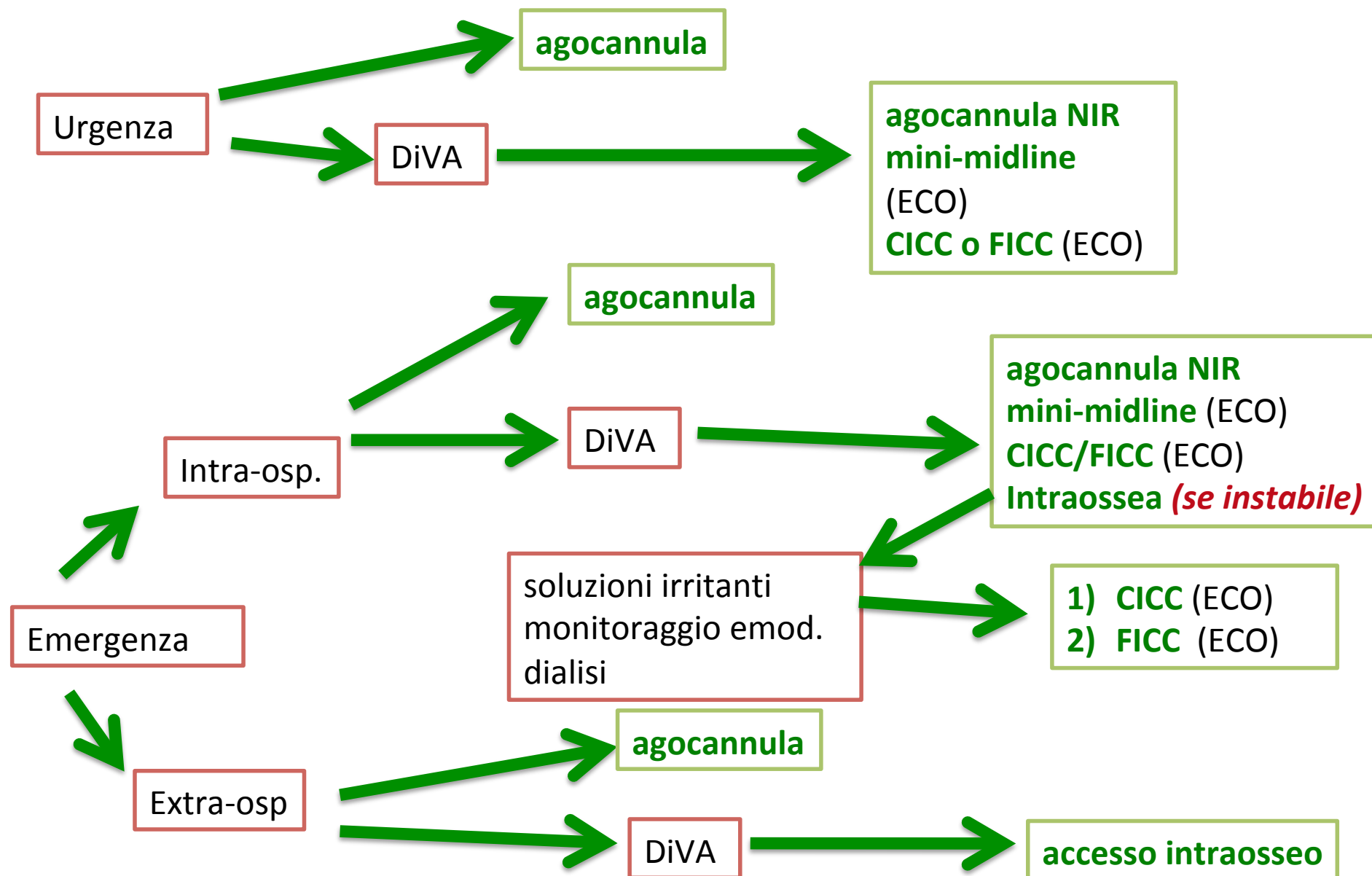
- Non ci sono studi che confrontino l'efficacia e la sicurezza di ***NIR & Ecoguida vs accesso IO*** in condizioni di emergenza (arresto cardiaco, politrauma maggiore con instabilità emodinamica)

dopo l'emergenza... in ICU

- Nel post-ROSC, al contrario, i pazienti necessitano di un accesso venoso centrale, ovvero di un CICC
 - Infusione di vasopressori o inotropi
 - Monitoraggio emodinamico
 - Prelievi di sangue venoso centrale per monitoraggio ossimetrico ed emodinamico
 - ...



Accesso Venoso in Emergenza/Urgenza



Grazie