



Milano 2022

30 - 31 maggio

IV Convegno Nazionale GAVePed

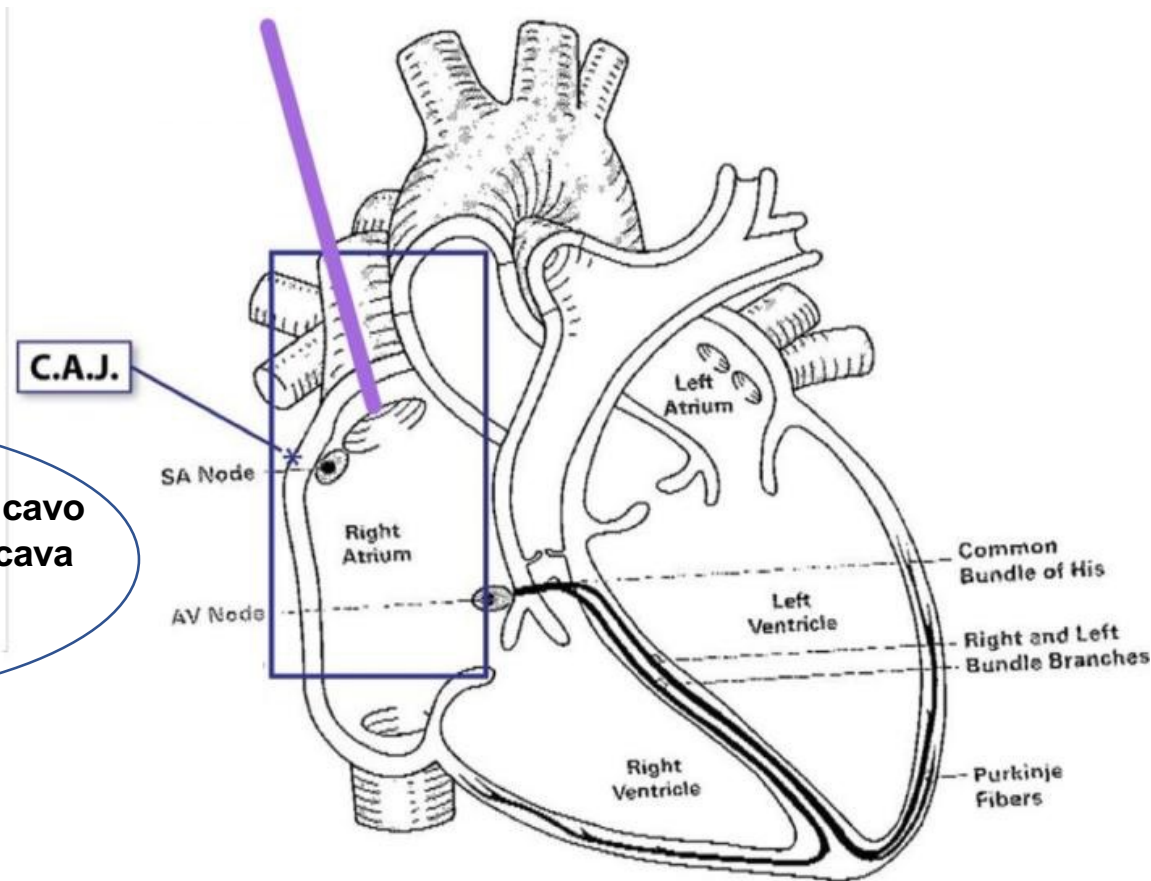
***ECG intracavitario nel
neonato e nel bambino***

Rossella Mastroianni

Best position “Safe area”

23.3 The CVAD tip location with the greatest safety profile in adults and children is the cavoatrial junction (CAJ).

CICC- PICC-ECC = giunzione cavo atriale ovvero terzo inferiore cava sup terzo superiore atrio dx



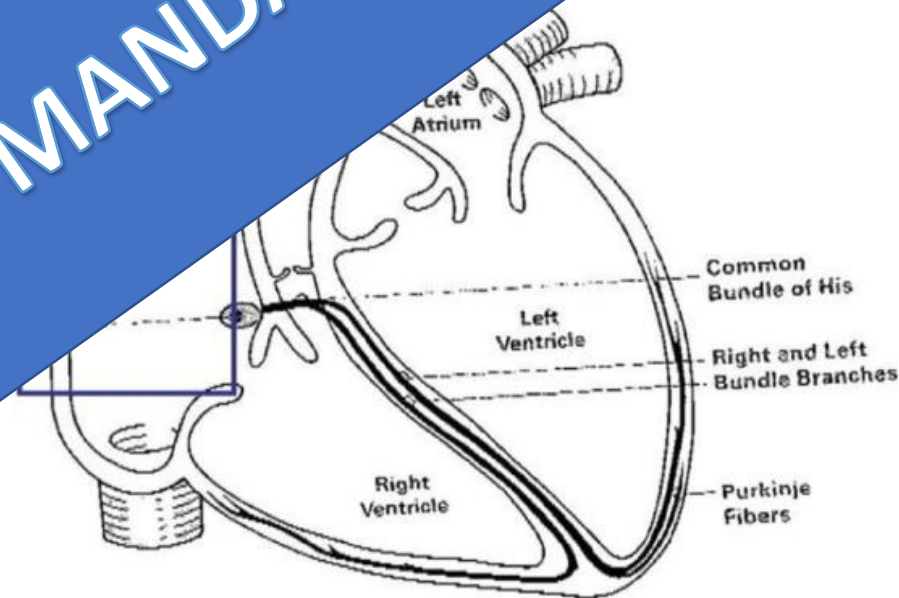
- Infusion Therapy Standard of Practice, 2020
- Association of Vascular Access Networks
- AVA (Association For Vascular Access) (Pedivan)
- GaVeCelt

Best position “Safe area”

23.3 The CVAD tip location with the greatest
in adults and children is the cavoatrial jun

MANDATORY

CICC- PICC-ECC = c
atriale ovvero to
sup terzo superio



- Infusion Therapy Standard of Practice, 2020
- Association of Vascular Access Networks
- AVA (Association For Vascular Access) (Pedivan)
- GaVeCelt

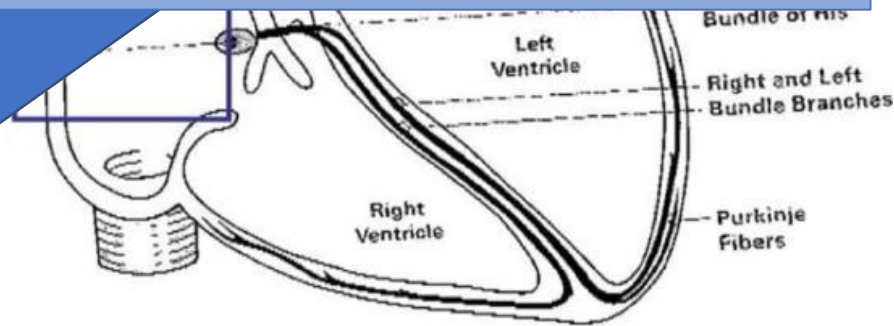
Best position “Safe area”

23.3 The CVAD tip location with the greatest
in adults and children is the cavoatrial junction

Prior to initiating infusion therapy, a
clinician with documented competency
must verify the CVAD tip position

INS 2021

CICC- PICC-ECC =
atriale ovvero to
sup terzo superio



- Infusion Therapy Standard of Practice, 2020
- Association of Vascular Access Networks
- AVA (Association For Vascular Access) (Pedivan)
- GaVeCelt

OUR ROUTINE



Lisa A. Gorski, MS, RN, HHCHS-BC, CRNI®, FAAN
Lynn Hadaway, MEd, RN, NPD-BC, CRNI®
Mary E. Hagle, PhD, RN-BC, FAAN
Daphne Broadhurst, MN, RN, CVAA(C)
Simon Clare, MRes, BA, RGN
Tricia Kleidon, MNSc (Nurs. Prac), BNSc, RN
Britt M. Meyer, PhD, RN, CRNI®, VA-BC, NE-BC
Barb Nickel, APRN-CNS, CCRN, CRNI®
Stephen Rowley, MSc, BSc (Hons), RGN, RSCN
Elizabeth Sharpe, DNP, APRN-CNP, NNP-BC, VA-BC, FNAP, FAANP, FAAN
Mary Alexander, MA, RN, CRNI®, CAE, FAAN

8TH EDITION
REVISED 2021



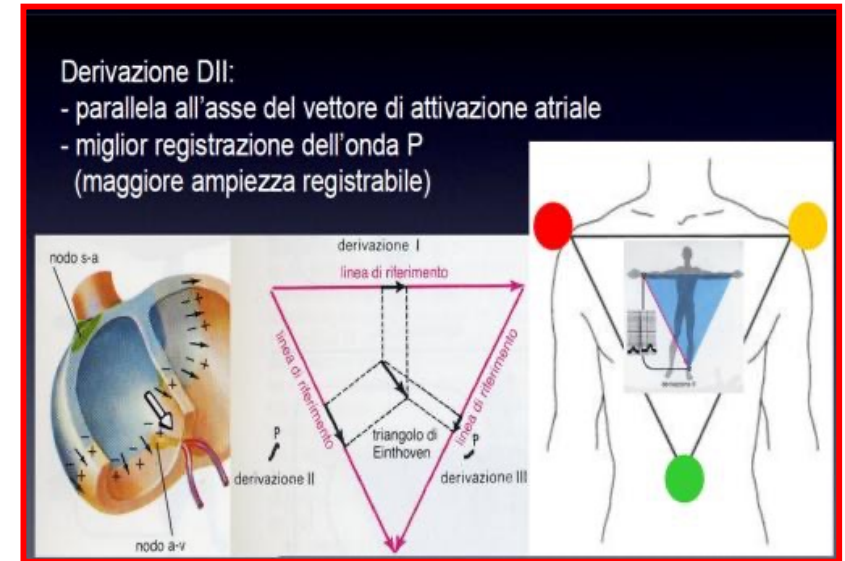
“Ideally, the position of the tip should be checked **during** the procedure”

“Use methods for identifying CVAD tip location **during** the insertion procedure (ie, real time) due to greater accuracy, more rapid initiation of infusion therapy, and reduced costs”

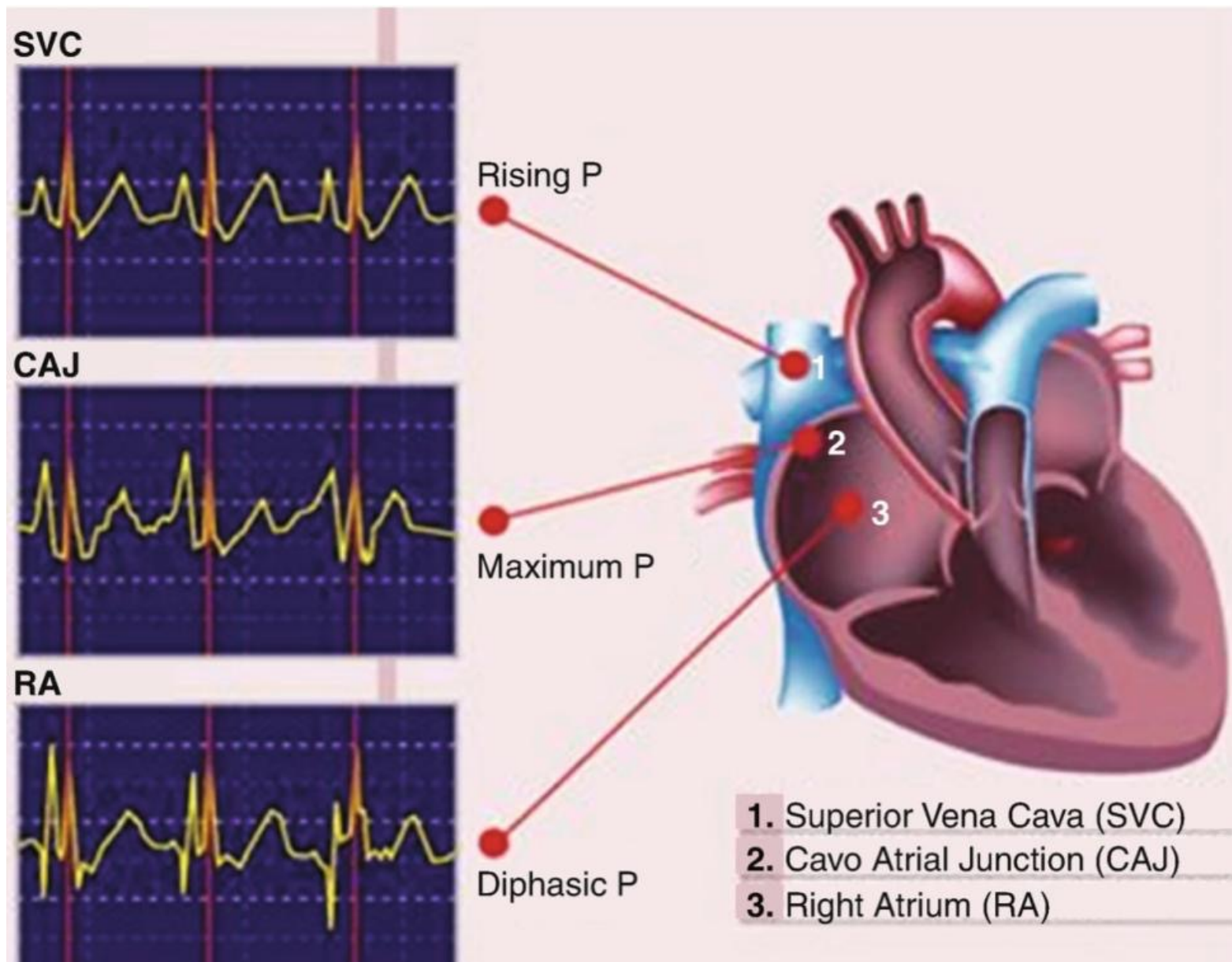
INTRACAVITARY ECG

The catheter filled with saline solution is the “travelling intracavitary electrode.”

- When the electrode is moving inside the superior vena cava (SVC)—the ECG trace shows a progressive increment of the height of the P wave
- Maximal positivity P wave= cavoatrial junction (CAJ)

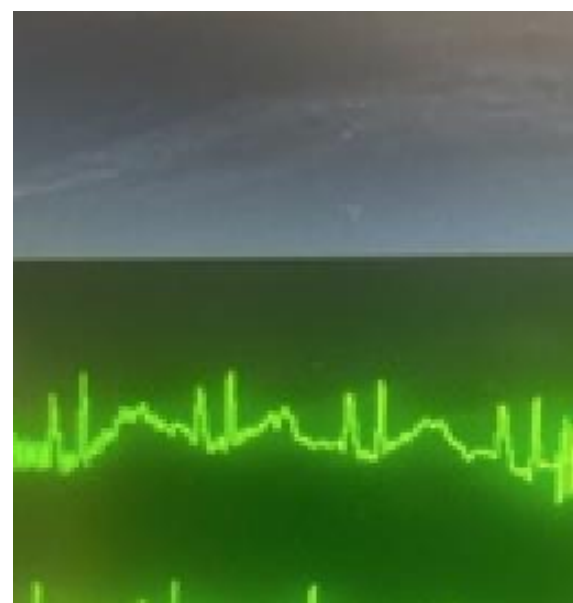
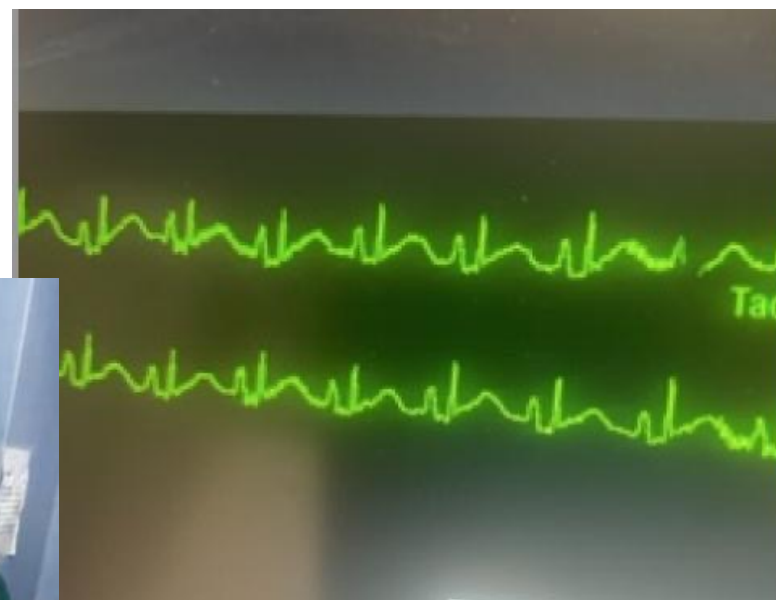
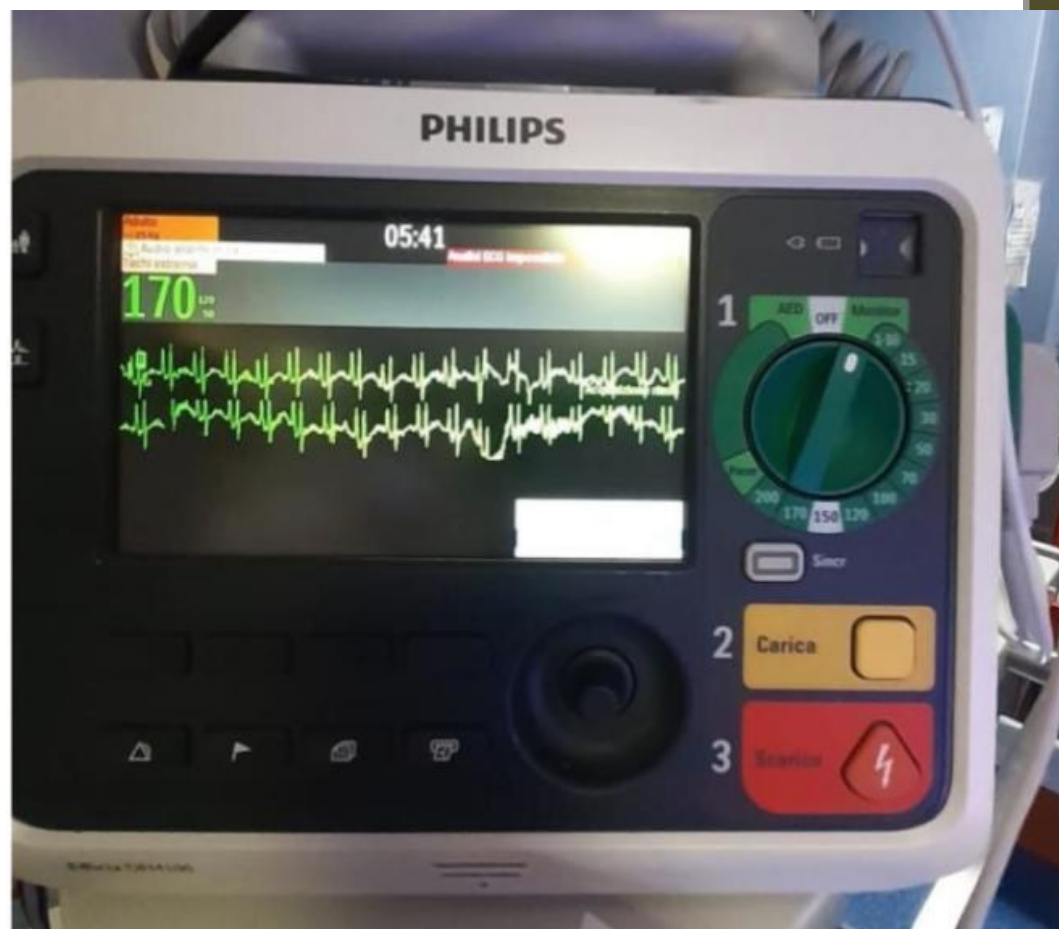


INTRACAVITARY ECG









70 years of clinical studies on IC-ECG

Review

JVA | The Journal of
Vascular Access

Intracavitary electrocardiography for tip location during central venous catheterization: A narrative review of 70 years of clinical studies

Mauro Pittiruti¹ , Filippo Pelagatti² and Fulvio Pinelli³ 

The Journal of Vascular Access
1–8

© The Author(s) 2020

Article reuse guidelines:

sagepub.com/journals-permissions

DOI: 10.1177/1129729820929835

journals.sagepub.com/home/jva

 **SAGE**

TIP LOCATION X-RAY FREE

5. Non è necessario ricorrere ad una radiografia del torace post-procedurale se si è adottata una tecnica alternativa per la conferma della posizione appropriata della punta.^{3,12-18} (II)

^sF. La conferma della localizzazione della punta per mezzo di una radiografia del torace post-procedurale rimane una pratica accettabile ed è necessaria soltanto quando non si sia adottata una tecnica intra-procedurale per la verifica della posizione della punta. La radiografia è un metodo meno accurato poiché non consente una visualizzazione diretta della giunzione cavo-atriale bensì prevede una stima basata su reperi radiologici quali la carena, l'angolo tracheobronchiale o i corpi delle vertebre toraciche. Inoltre, il movimento del paziente dalla posizione supina a quella ortostatica come normalmente richiesto dalla radiografia si associa ad una dislocazione della punta del catetere per un tratto che può arrivare anche a 2 centimetri.^{3,11,12,19,20} (II)

H. Medici o infermieri con documentata competenza in materia possono verificare autonomamente la posizione della punta di un catetere venoso centrale interpretando il tracciato dell'ECG intracavitario o la radiografia del torace post-procedurale e quindi autorizzare l'inizio della terapia endovenosa sulla base di questa valutazione. Quando si utilizza una radiografia toracica post-procedurale sarà comunque il radiologo a firmare il referto completo, in ottemperanza alle procedure locali.^{2,21} (V)

I. Comprovare la posizione della punta del catetere venoso centrale allegando alla cartella clinica una copia del tracciato ECG, il referto della radiografia del torace o altra documentazione appropriata (vedi lo Standard 10, *Documentazione nella Cartella Clinica*)

IC ECG in pediatrics

Serafini in 1985 reported the first example of ECG positioning technique in children in 52 children needing antineoplastic chemotherapy. The authors stress that this technique may avoid chest X-ray control.

Hoffman and colleagues experimented this technique on 50 patients infant and children obtaining a success rate of 96% and 100% accuracy

Hoffmann MA. Central venous catheters no X-rays needed: a prospective study in 50 consecutive infants and children. J Paediatr Anaesth. 1999

Weber in 2013 used a commercialized endovascular ECG-system (Alphacard®) in 50 pediatric patients: in 44 cases, the CVC was properly placed at first attempt

Determination of the optimal length of insertion of central venous catheters in pediatric patients by endovascular ECG
F Weber

IC ECG in pediatrics

309 patients (1 month-18 years)

- **Applicability: 99,4%**
- **Feasibility: 99.4%**
- **Accuracy: 95,8%- 98,8%**
- **Safety:100%**

Studio GAVeCeLT ECG pediatrico

JVA
ISSN 1129-7298

J Vasc Access 2014; 00 (00): 000-000
DOI: 10.5301/JVA.5000281
ORIGINAL ARTICLE

Studio Prospettico

The intracavitary ECG method for positioning the tip of central venous access devices in pediatric patients: results of an Italian multicenter study

Francesca Rossetti¹, Mauro Pittiruti², Massimo Lamperti³, Ugo Graziano⁴, Davide Celentano⁵, Giuseppe Capozzoli⁶

¹Department of Anesthesia, Children's Hospital "Meyer", Florence - Italy
²Department of Surgery, Catholic University Hospital, Roma - Italy
³Department of Neuroanesthesia, Neurological Institute "Scola", Milano - Italy
⁴Department of Surgery, Children's Hospital "Santobono", Napoli - Italy
⁵Pediatric Intensive Care Unit, Catholic University Hospital, Roma - Italy
⁶Department of Anesthesia and Intensive Care, Ospedale Civile di Bolzano, Bolzano - Italy

Studio Multicentrico

- (1) Ospedale Pediatrico Meyer- Firenze (F.Rossetti) Centro coordinatore
- (2) Policlinico Universitario "A.Gemelli"- Roma (M.Pittiruti, D. Celentano)
- (3) Istituto Besta - Milano (M.Lamperti)
- (4) Ospedale pediatrico Santobono – Napoli (U.Graziano)
- (5) Azienda Ospedaliera di Bolzano (G.Capozzoli)

Conclusions: We conclude that the IC-ECG method is safe and accurate in the pediatric patients.

Central venous access devices in pediatric malignancies: a position paper of Italian Association of Pediatric Hematology and Oncology

**Alessandro Crocoli¹, Assunta Tornesello², Mauro Pittiruti³, Angelica Barone⁴, Paola Muggeo⁵, Alessandro Inserra¹,
Angelo Claudio Molinari⁶, Valeria Grillenzoni⁷, Viviana Durante⁸, Maria Pia Cicalese⁹, Giulio Andrea Zanazzo¹⁰, Simone Cesaro⁷**

- The tip location should be ideally verified in real time during the procedure (by fluoroscopy, by intracavitary electrocardiogram (ECG) or by echocardiography)
- Intracavitary ECG and/ or echocardiography is safer and more accurate than fluoroscopy

A GAVeCeLT bundle for central venous catheterization in neonates and children: A prospective clinical study on 729 cases

**Mauro Pittiruti¹ , Davide Celentano², Giovanni Barone³ ,
Vito D'Andrea⁴ , Maria Giuseppina Annetta⁵ and Giorgio Conti²**

The Journal of Vascular Access
1–12

© The Author(s) 2022

Article reuse guidelines:

sagepub.com/journals-permissions

DOI: 10.1177/11297298221074472

journals.sagepub.com/home/jva



Methods: The Italian Group for Long Term Venous Access Devices (GAVeCeLT) has developed an insertion bundle for central venous catheterization in neonates, infants, and children, which includes seven evidence-based strategies:

Results: All neonates, infants and children requiring a non-emergency central line (except for umbilical venous catheters and epicutaneo-cava catheters) were included in the study. Out of 729 central line insertions, there were no immediate

SIC-Ped (Safe Insertion of Central access in Pediatric patients) BUNDLE

1. Preprocedural evaluation (adequate collection of clinical history and proper ultrasound examination of the venous patrimony):(RaCeVA),(RaPeVA),(RaFeVA)
2. Appropriate aseptic technique (hand hygiene, maximum barrier protections, skin antisepsis with 2% chlorhexidine)
3. Ultrasound-guidance: Real-time ultrasound guided venipuncture of the chosen vein
- 4. Intra-procedural verification of the central position of the tip by non-invasive methods: Intracavitary ECG technique. Ultrasound was often used as an additional method**
5. Tunneling
6. Sutureless securement of the catheter
7. Protection of the exit site with glue and semipermeable transparent membranes

- **Intra-procedural verification of the central position of the tip by non-invasive methods: Intracavitary ECG technique. Ultrasound was often used as an additional method**

∫: Intracavitary ECG technique was used to control the correct position of the catheter tip,^{20,21} in most cases. Ultrasound was often used as an additional method to confirm tip location,^{18,19} in association with intracavitary ECG. In some cases of FICC insertion, if the tip had been planned to be in the inferior vena cava, the correct position of the tip was verified by ultrasound-based tip location only. Post-procedural X-ray was taken into consideration as an option only in case of failure (not feasibility or not applicability) of intracavitary ECG and ultrasound.

IC ECG in neonates (CICC>3 FR)

The intracavitary ECG method for tip location of ultrasound-guided centrally inserted central catheter in neonates

Vito D'Andrea¹ , Lucilla Pezza¹, Giorgia Prontera¹,
Gina Ancora², Mauro Pittiruti³ , Giovanni Vento¹
and Giovanni Barone² 

JVA | The Journal of
Vascular Access

2022

105 neonates

100% applicability, feasibility, accuracy

Conclusions: When applied to ultrasound guided CICC, tip location by IC-ECG is applicable and feasible in neonates, and it is safe and accurate.

BUT...

- In very small catheters ECC(caliber <3Fr), the IC-ECG may be not easy and not always feasible, as the conductivity of the thin column of saline inside the catheter may impair the signal of intracavitary ECG.

And in ECC...does it work?

J Perinat Neonatal Nurs. 2017 Oct/Dec;31(4):326-331. doi: 10.1097/JPN.0000000000000264.

Effectiveness of Intracavitary Electrocardiogram Guidance in Peripherally Inserted Central Catheter Tip Placement in Neonates.

Zhou L¹, Xu H, Liang J, Xu M, Yu J.

Optimal tip location at first attempt
93.9% were correctly positioned, IC ECG group
62.5 were correctly positioned on the first attempt, standard group

Outcome of Intracavitary Electrocardiogram Guidance in PICC Tip Placement in Preterm Infants: A Single-center Experience of 327 Cases

Lilan He, Weiju Chen^{*}, Meng Zhang, Na Lin, Wenyan Yang

Neonatal Department, The First Affiliated Hospital of Jinan University, Guangzhou, China

American Journal of Nursing Science

Volume 8, Issue 4, August 2019, Pages: 142-144

327 preterm neonates
1.9 fr catheters

313 (95.7%) were correctly positioned
228 (72.3%) were correctly positioned on the first attempt

IC ECG in neonates

Accuracy and Safety Study of Intracavitary Electrocardiographic Guidance for Peripherally Inserted Central Catheter Placement in Neonates

Oiving Ling:Hong Chen:Min Tang:Yi Ou:Binzhi Tang:

The Journal of Perinatal & Neonatal Nursing. 33(1):89–95, JAN 2019

160 neonatal patients
anthropometric measurement combined with IC-ECG guidance (n = 80)
conventional anatomical landmark guidance (n = 80)
Catheter tip position was confirmed by
postinsertion radiograph

- First attempt target rate
 - 95% markers and ECG
 - 78,8 markers

European Journal of Pediatrics (2020) 179:439–446

<https://doi.org/10.1007/s00431-019-03524-3>

ORIGINAL ARTICLE



Effectiveness of intracavitary electrocardiogram-guided peripherally inserted central catheter tip placement in premature infants: a multicentre pre-post intervention study

Optimal tip location at first attempt
IC ECG group 93.5%
Standard group 73.4%

Ai-qing Xiao¹ • Jing Sun^{2,3} • Li-hui Zhu³  • Zhen-yu Liao¹ • Ping Shen¹ • Lin-lin Zhao⁴ • Jos M. Latour^{3,5}



Effectiveness of intracavitary electrocardiogram-guided peripherally inserted central catheter tip placement in premature infants: a multicentre pre-post intervention study

Ai-qing Xiao¹ • Jing Sun^{2,3} • Li-hui Zhu³  • Zhen-yu Liao¹ • Ping Shen¹ • Lin-lin Zhao⁴ • Jos M. Latour^{3,5}

the ECG signal transmission may be weakened to some degree because of long distance conductive path, multiple mediums including blood, saline, needle, and connecting lines, and the connecting status as well. Hence, the key to successful inducement of stable and legible ECG is to maintain unobstructed conduction. It is very necessary to calm down neonates and abate any interference in the insertion process.¹⁰ A recent Italian

IC ECG in neonates

The intracavitary electrocardiography method for positioning the tip of epicutaneous cava catheter in neonates: Pilot study

A.Capasso,R.Mastroianni,G.Ausanio

The Journal of Vascular Access
1-6
© The Author(s) 2018
Reprints and permissions:
sagepub.co.uk/journalsPermissions.n
DOI: 10.1177/1129729818761292
journals.sagepub.com/home/jva
SAGE

39 catheters 1Fr

- **Applicability : 100%**
- **Feasibility: 76%**
(monitor non
dedicato)
- **Accuracy: 97 %**
- **Safeness :100%**

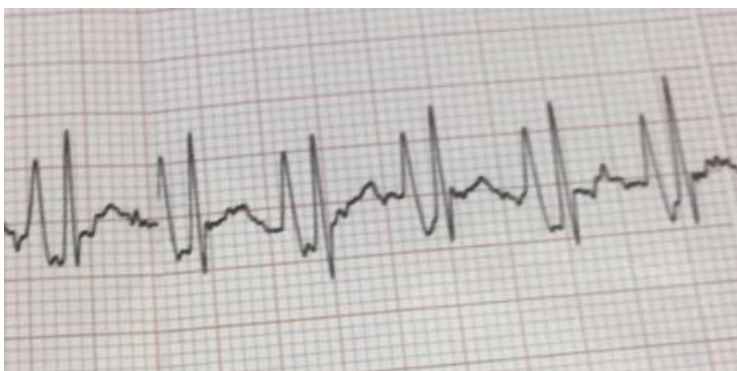
The concordance between the tip verification by the IC-ECG method and by the radiological methods was mildly high: the overall match, that is, tip correctly located both according to IC-ECG and according to x-ray, was observed in 29 of 38 cases (76%) but it rises to 97% (29/30 cases) if peak P wave is detected.

The percentage of concordance between IC-ECG and echocardiography was the same as IC-ECG and x-ray.

The intracavitary electrocardiography method for positioning the tip of epicutaneous cava catheter in neonates: Pilot study

The Journal of Vascular Access
1-6
© The Author(s) 2018
Reprints and permissions:
sagepub.co.uk/journalsPermissions.nav
DOI: 10.1177/1129729818761292
journals.sagepub.com/home/jva
SAGE

A.Capasso,R.Mastroianni,G.Ausanio



**Difficulties in signal stability
due to patient moviments,
electrical devices
interferences**

The combined use of IC-ECG and echocardiography for tip location is ideal because of the following reasons:

1. It allows you to establish exactly the tip of the catheter in the target zone (CAJ), thus reducing the incidence of malpositions and complications caused by them.
2. It leaves little or no space to x-ray, which can be limited to selected cases, and so reduces newborn's exposure to x-ray.
3. It reduces the costs because the IC-ECG use-related products are easily available and very cheap. Our study is a

Neo-ECHOTIP: A structured protocol for ultrasound-based tip navigation and tip location during placement of central venous access devices in neonates

Giovanni Barone¹ , Mauro Pittiruti² , Daniele G Biasucci³,
Daniele Elisei⁴, Emanuele Iacobone⁴ , Antonio La Greca²,
Geremia Zito Marinosci⁵ and Vito D'Andrea⁶ 

The Journal of Vascular Access

1–10

© The Author(s) 2021

Article reuse guidelines:

sagepub.com/journals-permissions

DOI: 10.1177/11297298211007703

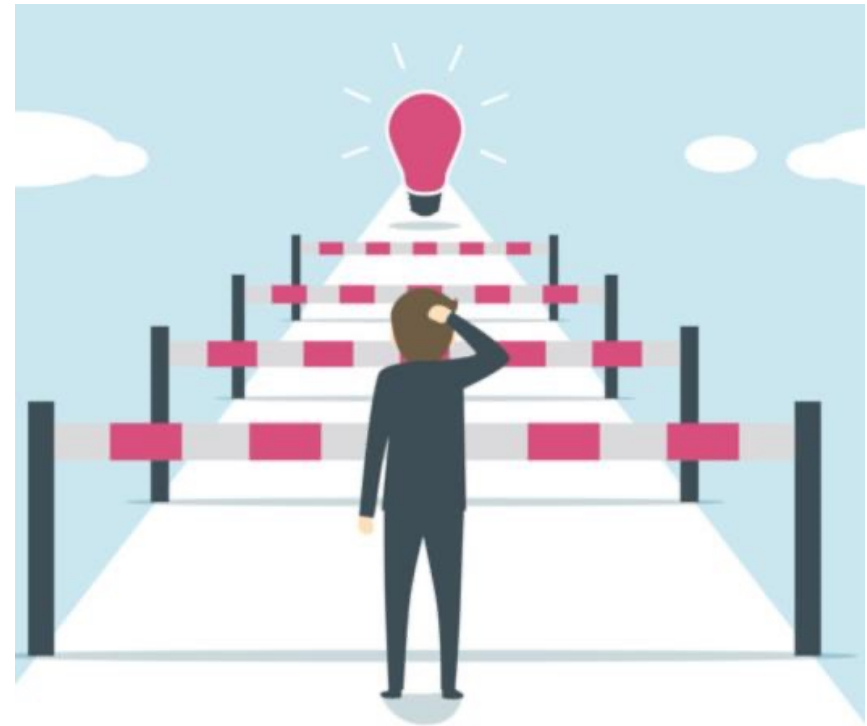
journals.sagepub.com/home/jva



- Even though US-based tip location of ECC has been proved to be effective and safe, few data are available about the training needed for performing ultrasound-based tip location of ECCs. Clinical studies on RT-US for tip location of ECCs show a direct correlation between the level of expertise of the clinician and the percentage of successful tip visualization. Basic knowledge in the field of vascular ultrasound and echocardiography

CHALLENGE...IC ECG in ECC

- Position of electrodes (the green electrode should be placed in an appropriately low position)
- Choose the most appropriate voltage values (the amplitude must be set in order to comfortably visualize the P variations, 50 mm/sec)
- Choose a dedicate monitor, in order to reduce:
 - Interference caused by electro-medical devices operating in proximity of the patient
 - Passive warmers influence, that may interfere with the reading of the IC-ECG trace.



Ongoing study

2019-

173 neonati

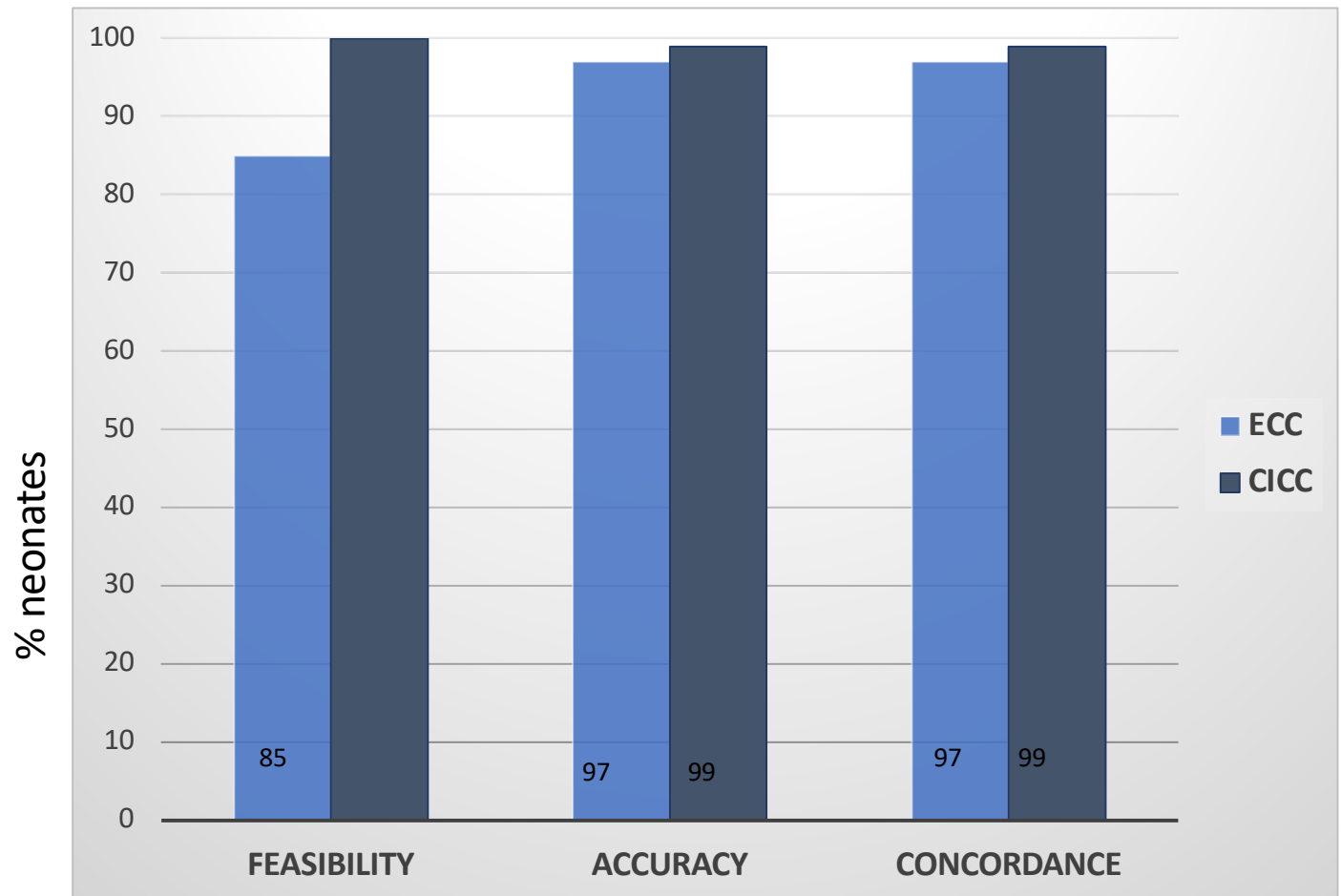
106 ECC

63 CICC

Feasibility: identifiable
atrial P max

Accuracy: P max at CAJ

Concordance with echo

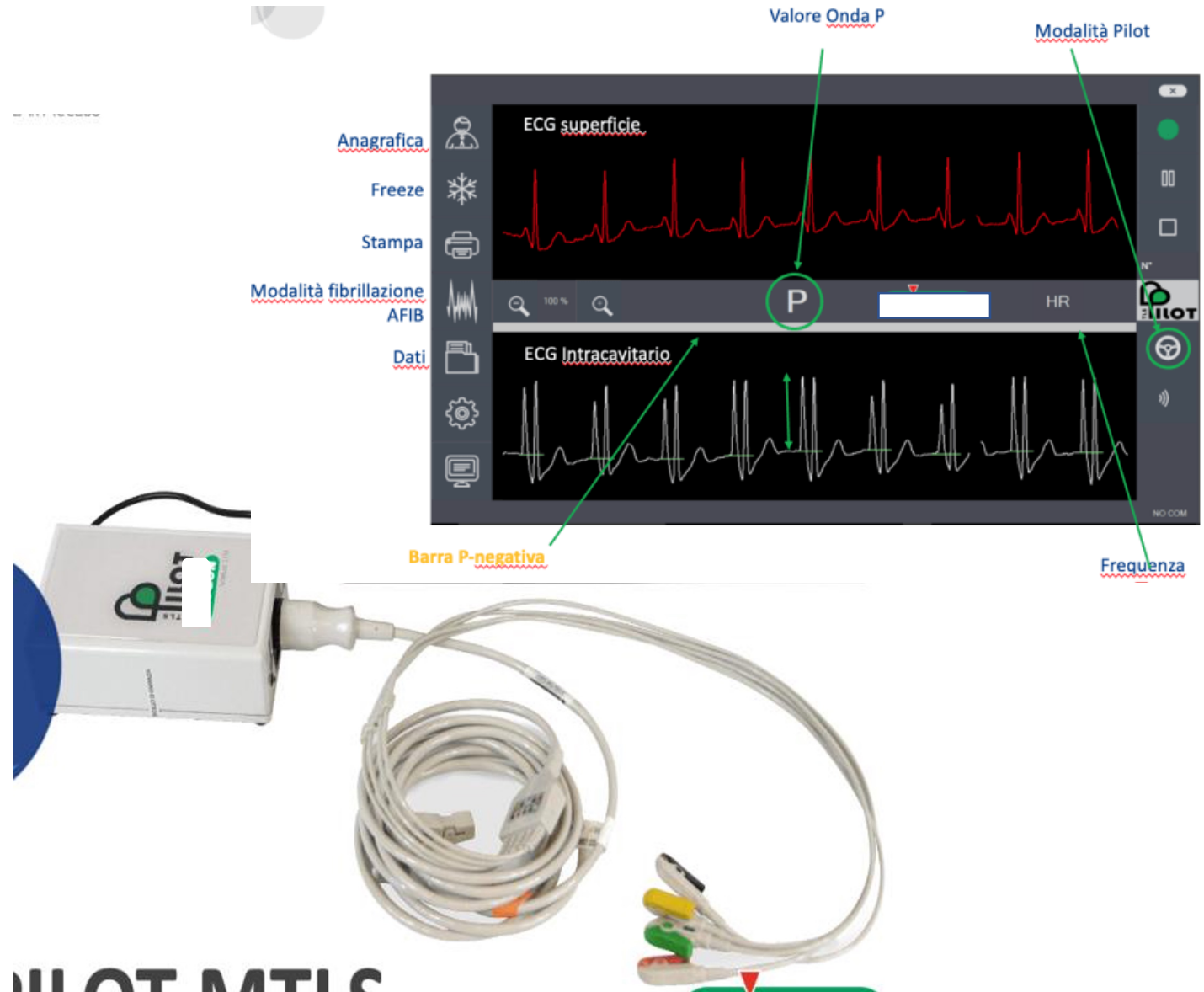


Ongoing study

3 centers involved
0-14 years

DEDICATE MONITOR

- Simultaneous visualization of endocavitary DII lead and surface ECG
- Improving feasibility
- Electrical safety
- Portable
- Signal quality
- Quantitative P wave measures



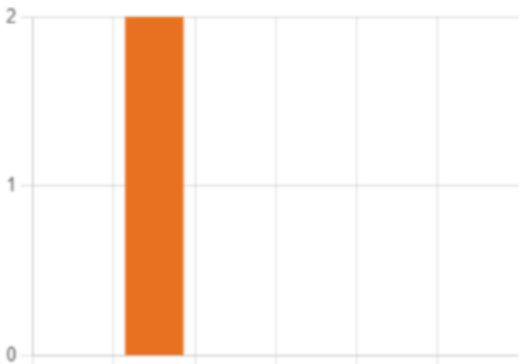
Ongoing study

20 patients

4. Tipo di Catetere ECC



7. PICC



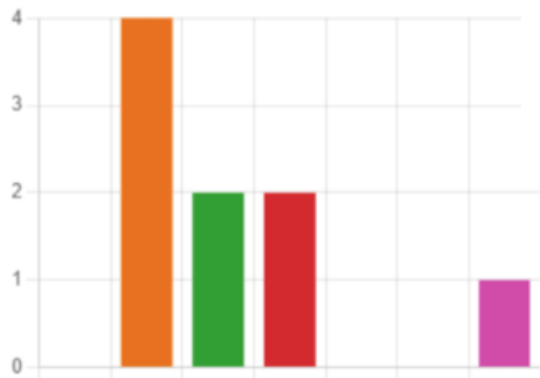
5. Mandrino



8. Ombelicale



6. CICC



Ongoing
study

11. Qualità traccia intracavitaria

20
Risposte

4.80
Numero medio

12. Visualizzazione Onda P massima

● SI	19
● No	1



Take home messages

IC-ECG can be applied to all CVAD in pediatric and neonatal patients

For CICCes >3Fr in neonates and for all CVADs in children, IC-ECG is the ideal tip location method, being simpler than TTE, but safer, more accurate, and less expensive than CXR.

The future of tip location in infancy is x-ray FREE

Further studies are needed to make the method routinely feasible with ECC

Most of the important things
in the world have been
accomplished by people who
have kept on trying when there
seemed to be no hope at all.

Dale Carnegie



Grazie

Rossella Mastroianni
UOC TIN- Azienda Ospedaliera Caserta
University of Washington- Department
of Pediatrics-NEST (Neonatal
Education & Simulation-based
training program)