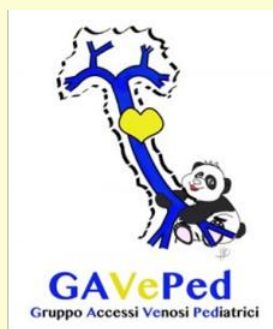


ECG intracavitario nel neonato e nel bambino



UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II

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III Convegno
Nazionale
GAVePed

Intracavitary ECG

The catheter acts as an intracavitary electrode which transmits an electric signal thanks to a column of saline solution (or metallic guide inserted inside)

The catheter is filled with saline and attached to the connector of the transducer

The catheter is threaded further on into the venous system



In agree with (TEE) transesophageal echocardiography

Pmax= CAJ in agree with TEE (crista terminalis)

(Cost comparison of elettrocardiography versus fluoroscopy for central venous line in children. SN Tierney, J.katke, J.Langer. Journal of the American College of Surgeon, 2000, 191: 209-211)

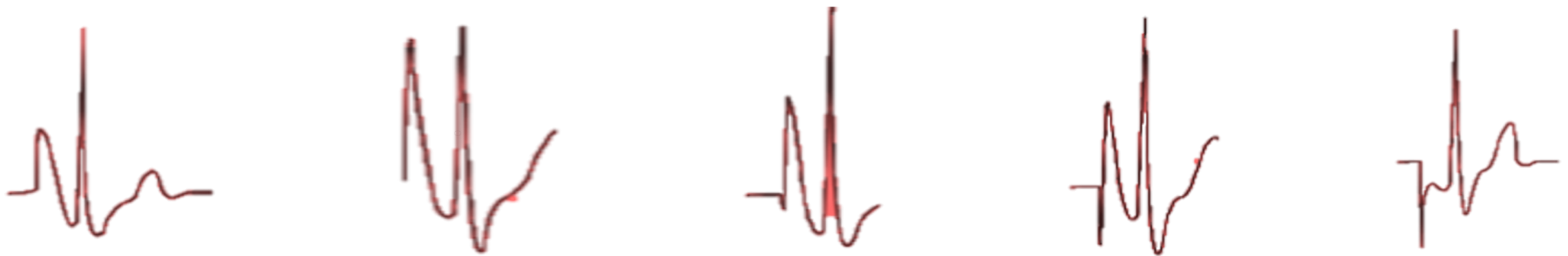
**Intracavitary electrocardiography for
tip location during central venous
catheterization: A narrative review
of 70 years of clinical studies**

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1-8
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Mauro Pittiruti¹, Filippo Pelagatti² and Fulvio Pinelli³

The maximal height of the P wave is not related to the location of the sinus node, but to the site of transition between electrically inactive tissue (SVC) and electrically active tissue (RA);

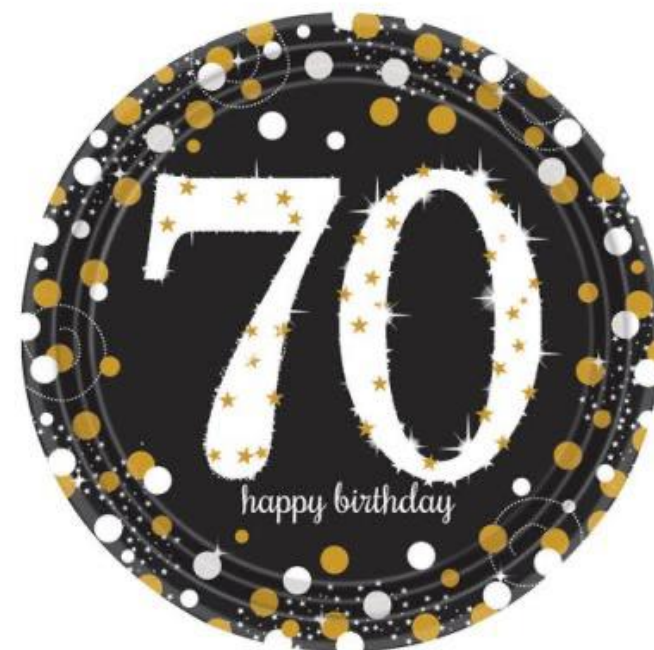
Using TEE imaging, IC-ECG patterns of the different explorable areas were finally described with precision: (a) a normal P wave identifies a position in the upper portion of the SVC, (b) a growing P wave identifies a position in the lower portion of the SVC, (c) the maximum peak of the P wave identifies exactly the CAJ, and (d) a biphasic P wave identifies the entry into RA



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 

Hellerstein et al.⁴ in 1949, its early use as a method for tip location is dated back in the 60s in the field of neuro-anesthesia,⁵ with a subsequent exponential development only in the last 20 years. The year 2019 marked the 70th anniversary of the first study about IC-ECG.



The golden age of IC-ECG

With the beginning of the new millennium, we entered the so-called “golden-age” of IC-ECG. In 2004, Pawlik et al.²³ compared the guidewire and column of saline techniques, suggesting that the guidewire technique was better in terms of quality of ECG recording, being comparable in terms of accuracy, while the risk of arrhythmias related to the introduction of the wire into the right atrium seemed minimal. A few years later, in 2011, Kremser et al.²⁴ designed a similar

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

Serafini G .Positioning of a central venous catheter in children by intracavitary ECG. A new technic Minerva Anesthesiol.

Three years later, 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

GAVECELT 2013 PICU (Pediatric Intensive Care Unit) BUNDLE

A multicenter study 2012 conducted by GAVeCeLT in 8 hospital centers on 1,400 patients has demonstrated the safety and feasibility of IC-ECG in the positioning of short, medium, and long-term central venous accesses in adult patients and has confirmed its accuracy compared with the postoperative chest x-ray.

Pittiruti M, et al. The intracavitary ECG method for positioning the tip of central venous catheters: results of an Italian multicenter study. J Vasc Access. 2012;13(3):357-365.

1. Scelta ragionata mediante esame ecografico sistematico

2. Tecnica asettica appropriata mediante lavaggio delle mani, massime precauzioni di barriere, disinfezione con clorexidina

3. Utilizzo dell'ecografo per la venipuntura e per il successivo controllo delle complicanze

4. Verifica intraprocedurale della posizione centrale della punta mediante la tecnica ECG intracavitario e/o mediante ecografia

6. Protezione del sito di emergenza mediante colla istoacrilica

7. Stabilizzazione del catetere mediante sutureless device e membrana trasparente semipermeabile

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

Studio GAVeCeLT ECG pediatrico

JVA
ISSN 1129-7298

JVet Access 2024; 02 (02): 000-000
DOI: 10.3302/jva.5000202

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", Firenze - Italy

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⁵Pediatric Intensive Care Unit, Catholic University Hospital, Roma - Italy

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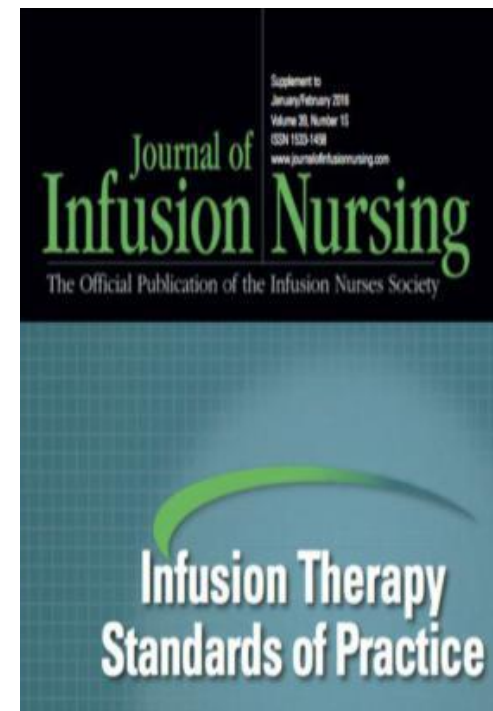
Studio Multicentrico

- (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)

In 2009, the ESPEN (European Society of Parenteral Nutrition) guidelines were the first international guidelines to recommend the use of IC-ECG for tip location, stressing the great advantage of an intra-procedural assessment as opposed to the post-procedural CXR

Pittiruti M, Hamilton H, Biffi R, et al. ESPEN guidelines on parenteral nutrition: central venous catheters (access, care, diagnosis and therapy of complications). Clin Nutr 2009; 28(4): 365–377.

Confirmation of tip location by postprocedure chest radiograph remains acceptable practice and is required in the absence of technology used during the procedure. This method is less accurate because the CAJ cannot be seen on the radiograph, requiring identification of tip location by measurement from the carina, trachea-bronchial angle, or thoracic vertebral bodies. Additionally, a change in the patient position from supine to standing, usually required for the radiograph, results in movement of the catheter tip by as much as 2 cm.^{3,11,12,19,20} (II)



INS 2016

Infusion Therapy Standards of Practice

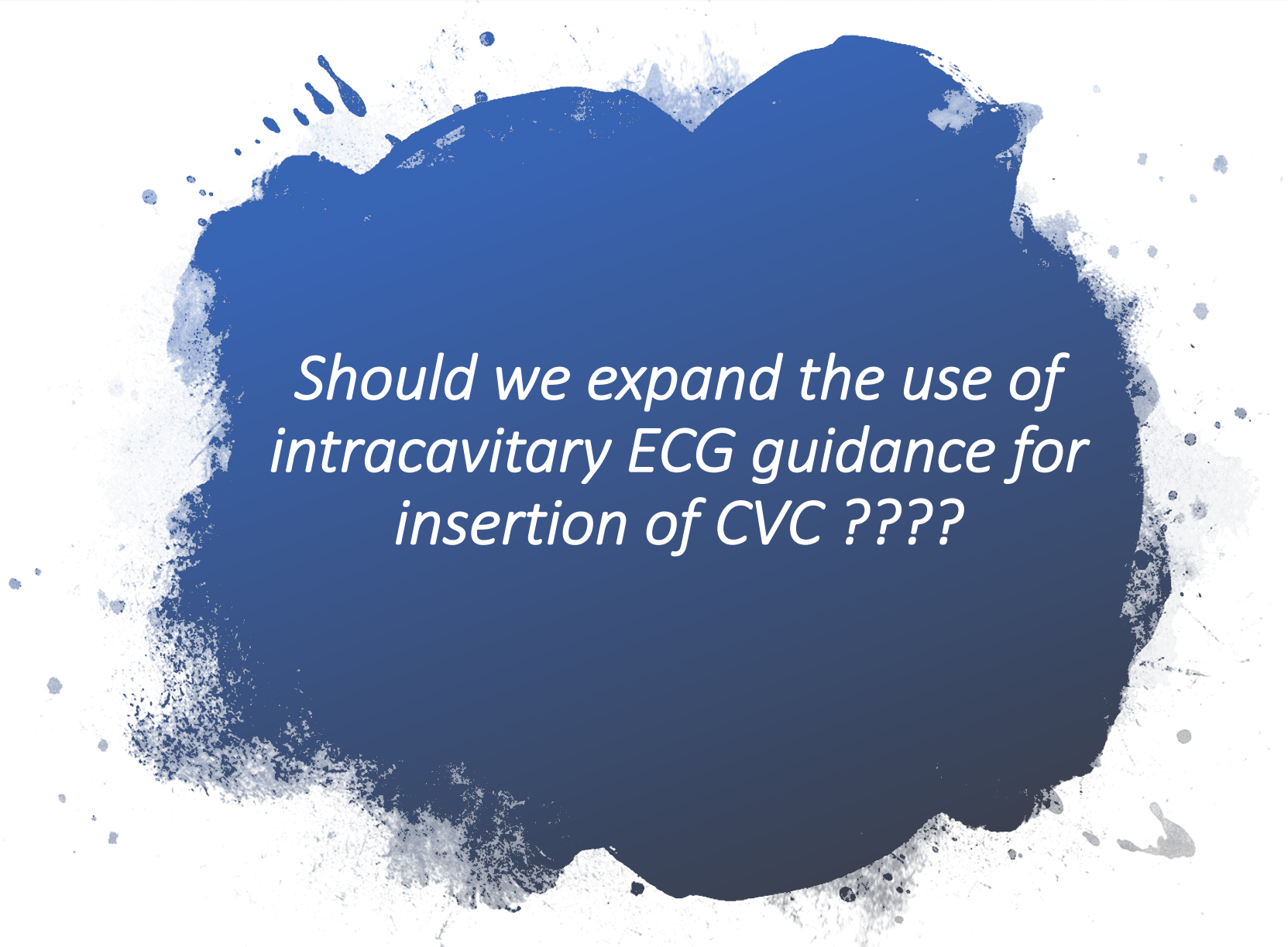
2021

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.³⁸⁻⁴⁷ (III)

1. Use electrocardiogram (ECG) methods with either a metal guidewire or a column of normal saline inside the catheter lumen and observe the ECG tracing to place the CVAD tip at the CAJ. Follow manufacturers’ directions for use with other ECG-based technology using a changing light pattern to detect tip location.^{1,2,4,11,23,24,26,27,43,44,48-61} (II)

TABLE 4. Catheter Tip Location and Verification Procedure

Survey Question	Response	N	%
Following initial PICC insertion, is it routine to obtain an x-ray film? (N = 187)	On initial insertion	153	81.8
	On initial insertion and 24 h postinsertion	34	18.2
What type of x-ray film is routinely taken following PICC placement in the upper extremities? (N = 187)	AP view	176	94.1
	Lateral view	0	0
	Both	11	5.9
	Lateral oblique	0	0
What type of x-ray film is routinely taken following PICC placement in the lower extremities? (N = 186)	Anterior posterior view	130	69.9
	Lateral view	1	0.5
	Both	55	29.6
Is an x-ray film taken on a regular basis to evaluate catheter tip location? (N = 186)	Yes, indicate interval:	84	45.2
	Every 7 d	40	21.5
	No specified interval	35	18.8
	Other	9	4.8
	No	102	54.8
Is it routine to obtain an x-ray film after any repositioning of the catheter? (N = 187)	Yes	148	79.1
	No	39	20.9
Is the final sterile dressing placed prior to the confirming x-ray? (N = 185)	Yes	79	42.7
	No	106	57.3
Is difficulty visualizing the tip of the catheter a prevalent problem? (N = 185)	Yes	16	8.7
	No	169	91.3



*Should we expand the use of
intracavitary ECG guidance for
insertion of CVC ????*

Problem and problem solving

- **Setting and interferences: electromedical devices**
- **False positives: intraarterial and extravasal positions**
- **Small caliber: ECC**
- **Lower limbs: CVO , FICC**

Setting and interferences

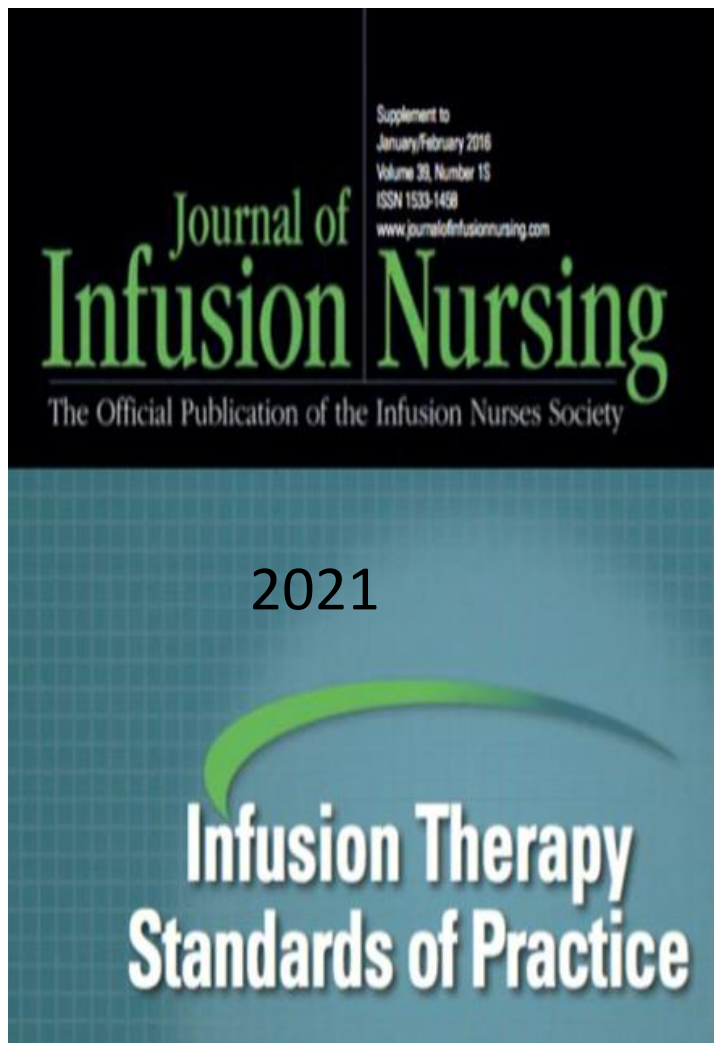
- **Position of electrodes (the green electrode should be placed in an appropriately low position)**
- **Choice of the most appropriate voltage values (the amplitude must be set in order to comfortably visualize the P variations)**
- **Choice of the monitoring mode (the “diagnostic” mode is preferred)**
- **Interference caused by other electro-medical devices operating in proximity of the patient**
- **In the pediatric setting, passive warmers may significantly interfere with the reading of the IC-ECG trace.**

Central venous catheters--the inability of 'intra-atrial ECG' to prove adequate positioning. Schummer Br j anaesth 2004

In 6 pigs the LJV and RCA were cannulated

All catheters-arterial and venous, in animals and humans-revealed an increase in size of the P wave as well as the QRS complex.

All venous catheters were positioned in the superior vena cava, beyond the pericardial reflection but outside the right atrium. All arterial catheters were positioned in the ascending aorta thus also beyond the pericardial reflection.



6. Postprocedure radiograph imaging is not necessary if alternative tip location technology confirms proper tip placement.^{46,50,71} (II)
5. Confirmation of tip location by postprocedure chest radiograph remains acceptable practice and is required in the absence of technology used during the procedure. This method is less accurate because the CAJ cannot be seen on the radiograph, requiring identification of tip location by measurement from the carina, trachea-bronchial angle, or thoracic vertebral bodies. Patient repositioning or movement results in distal or proximal migration of the catheter tip by as much as 2 cm dependent on the movement.^{4,12,69,72-75} (II)
5. Recognize that radiographic or ECG tip location technology does not differentiate between venous and arterial placement. If arterial placement is suspected, use other methods to confirm or refute arterial placement.



**Extravasal position of central venous catheters despite
unsuspicious ECG-guidance. Schummer Anasthesiol Intensive
Med Nofhtallmed Schmerzther 2005**

Intraoperatively, another J-wire within a triple-lumen catheter was placed by the heart surgeon on 3 extravasal sites and the ECG was recorded: Extra-1: extravasal at the left innominate vein above the pericardial reflection; Extra-2: extravasal on the superior vena cava below the pericardial reflection; Extra-A: extravasal on ascending aorta below the pericardial reflection.

The electrocardiographic method can not differentiate between intra- and extravasal position of a central venous catheter, and thus, presumably fails to identify malpositioning as a result of vascular perforation.

Problem solving

The current methods of ultrasound guided venipuncture, ultrasound-based tip navigation, and correct interpretation of the changes of the P wave pattern have minimized the clinical relevance of these pitfalls

IC-ECG and lower limbs

Positioning of umbilical vein catheter with
ECG-guided technique: randomized study 2000 P. Biban et al

Studio su catetere ombelicale in 44 neonati

ACTA BIOMEDICA

*Official Journal of the Society of Medicine
and Natural Sciences of Parma*

ORIGINAL ARTICLE

Application of a modified electrocardiogram-guided technique for umbilical venous catheterisation in neonates: A retrospective trial

Liyuan Wu,^{1,2} Min Peng,^{1,2} Tian Cao,^{1,2} Yonghui Yang,¹ Qin Wang,^{1,2} Kaiju Luo¹ and Pingyang Chen¹

¹Division of Neonatology, Department of Pediatrics, and ²Clinical Nursing Teaching and Research Section, The Second Xiangya Hospital, Central South University, Changsha, China

*L'onda P diventa difasica e poi alta
all'interno dell'atrio destro. Il catetere viene
ritirato fino a quando l'onda P ritorna
normale.*

Pediatric Anesthesia

Umbilical vein catheterization under electrocardiogram guida

TSUI BC et al 2005

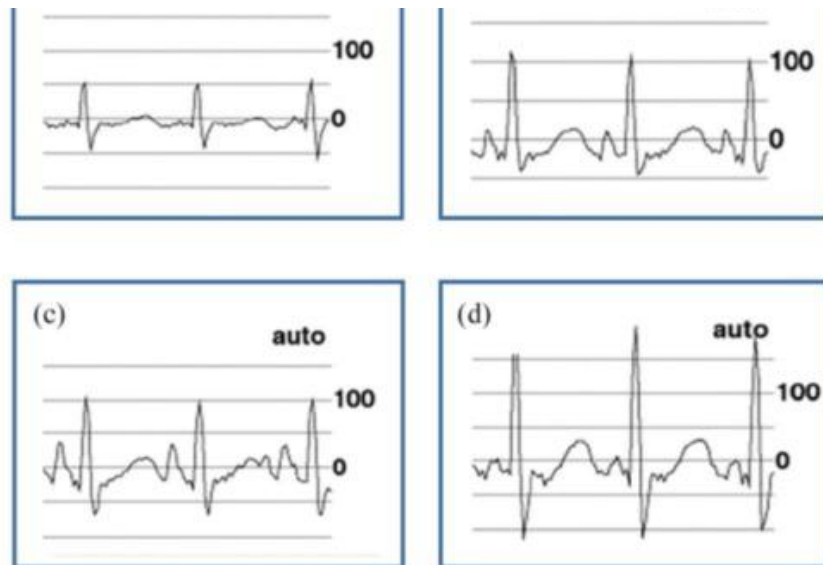


Studio condotto su 8 neonati

Use of intracavitary-ECG for tip location of femorally inserted central catheters

The Journal of Vascular Access
1-5
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DOI: 10.1177/1129729820982864
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Mark D Weber , Adam S Himebauch and Thomas Conlon



A case series of three patients demonstrate methods of FICC positioning in children. of assessing FICC tip

IC-ECG can be a primary method when ultrasound is not available or cannot directly visualize the catheter.

IC-ECG P-wave characteristics identify optimal tip position at the inferior cavoatrial junction and are different from characteristics at the superior cavoatrial junction

Figure 1. (a) IC-ECG tracing with catheter tip inferior to the renal veins, the P-wave and QRS complex demonstrate low amplitude waveforms, (b) catheter tip approaching the diaphragm with QRS amplitude increasing, (c) catheter tip in the right atrium with P-wave amplitude dramatically increasing, and (d) catheter tip withdrawn with the P-wave amplitude reduced to amplitude previously seen at the level of the diaphragm.

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

**327 preterm infants in China
mean gestation of 31.3 weeks (25.3 to 36.8)**

J Perinat Neonatal Nurs. **2019 Accuracy and Safety Study of Intracavitary Electrocardiographic Guidance for Peripherally Inserted Central Catheter Placement in Neonates.**

Ling Q1, Chen H, Tang M, Qu Y, Tang B

Lian-juan Zhou, Hong-zhen Xua*, Mei-fang Xu, Yan Hu, Xiao-Fang Lou

**An accuracy study of the Intracavitary
Electrocardiogram (IC-ECG) guided peripherally
inserted central catheter tip placement among
neonates**

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

Epicutaneous cava catheters 1 Fr in neonates 29.41 ± 3.04 (range: 25-40) weeks

Tip location with ECG IG vs echocardiography and RX

Applicabilità : 100%

Fattibilità: 86% (monitor non dedicato)

Accuratezza: 97 %

Sicurezza :100%

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.

1. Ridotto calibro del catetere

2. Ridotta sedazione del paziente

3. Apparecchi elettromedicali

Ultrasound-guided cannulation of the brachiocephalic vein in newborns: A novel approach with a supraclavicular view for tip navigation and tip location

Ferdinando Spagnuolo JVA 2021

Target zone corresponding to the lower third of the SVC or at the cavoatrial junction (CAJ) or in the upper third of the RA.

100% target zone con ECG IC
CICC 3 FR

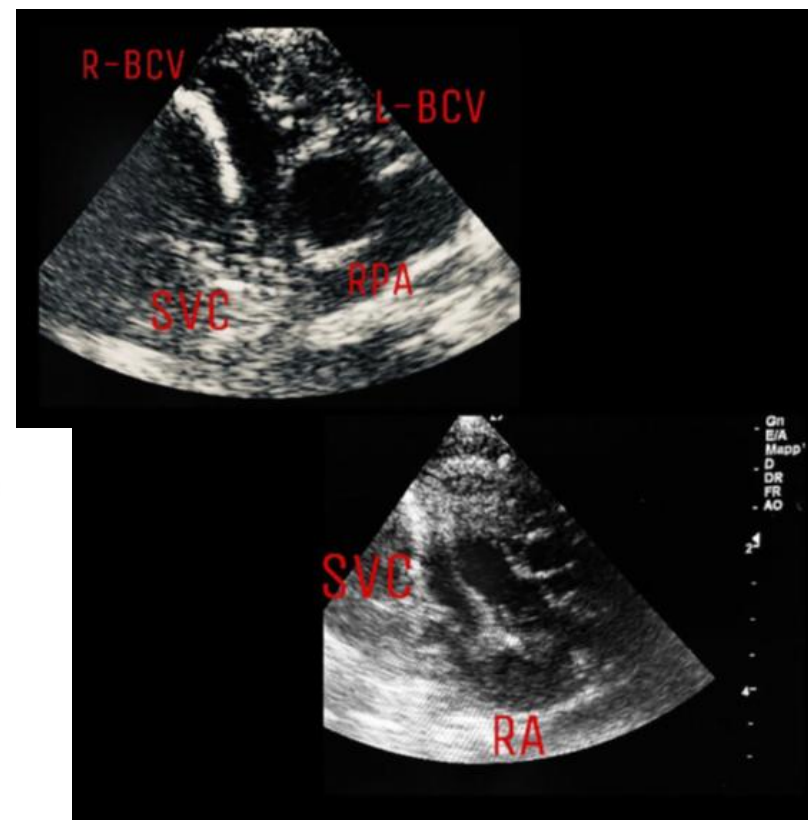
Original research article

Centrally inserted central catheters in preterm neonates with weight below 1500 g by ultrasound-guided access to the brachio-cephalic vein

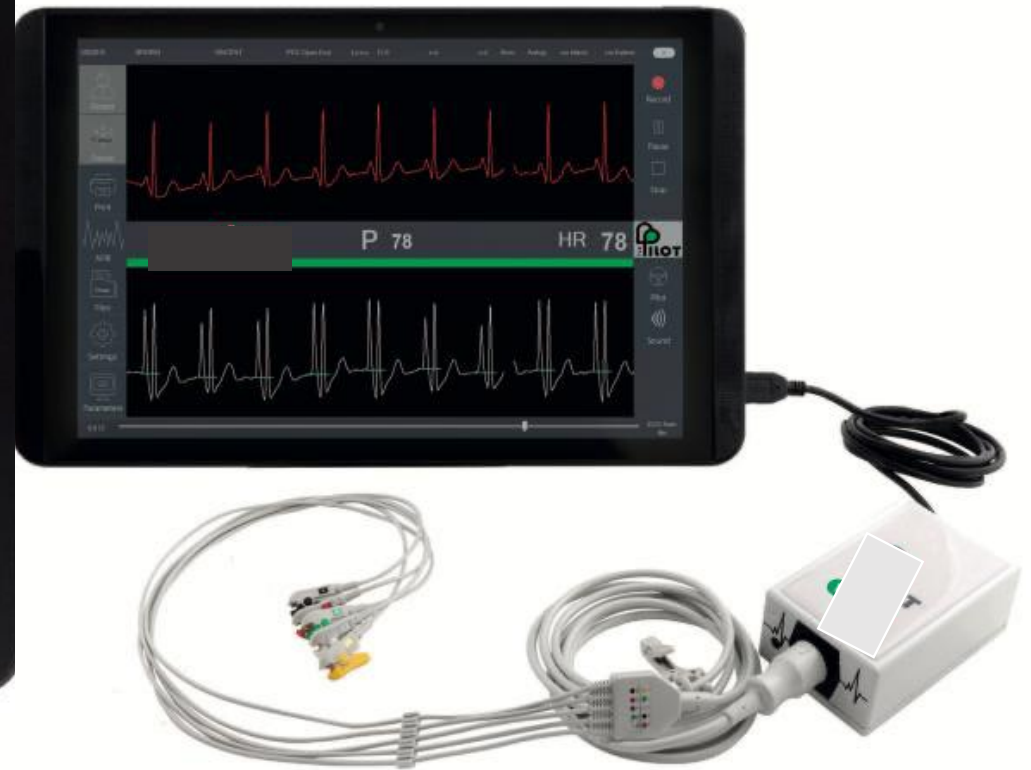
Giovanni Barone¹, Mauro Pittiruti², Gina Ancora¹, Giovanni Vento³, Francesca Tota⁴ and Vito D'Andrea³

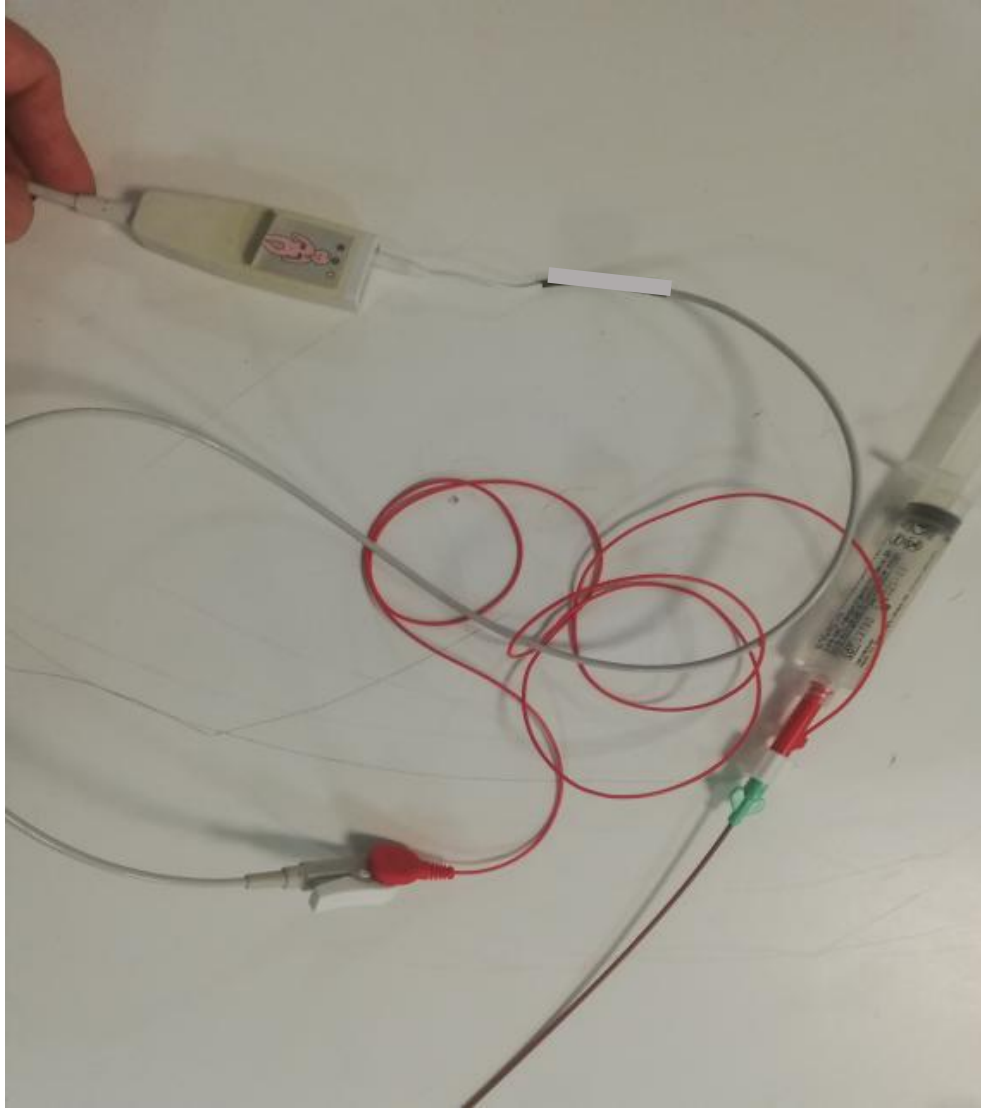
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Problem solving





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

A.Capasso,R.Mastroianni,G.Ausanio



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

Take home messages

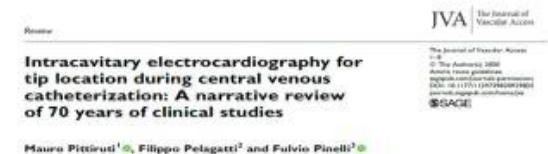
IC-ECG can be applied in UVC and in ECC

The use of IC -ECG

for tip location of ECC and UVC may be limited by the observation that ultrasound-based tip location by TTE is particularly easy and accurate in neonates

In children, IC-ECG is the ideal tip location method, being simpler than TTE, but safer, more accurate, and less expensive than CXR or fluoroscopy

Use TTE and IC – ECG for doubtful cases



Thanks

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