



XIII 13TH PICC Day



***Nuova possibilità: utilizzo dei PICC
per la misurazione della gittata cardiaca
in Terapia Intensiva***

Sonia D'Arrigo, MD, PhD

UOC Rianimazione, terapia intensiva e tossicologia clinica

Verona, 4 dicembre 2019



Gemelli



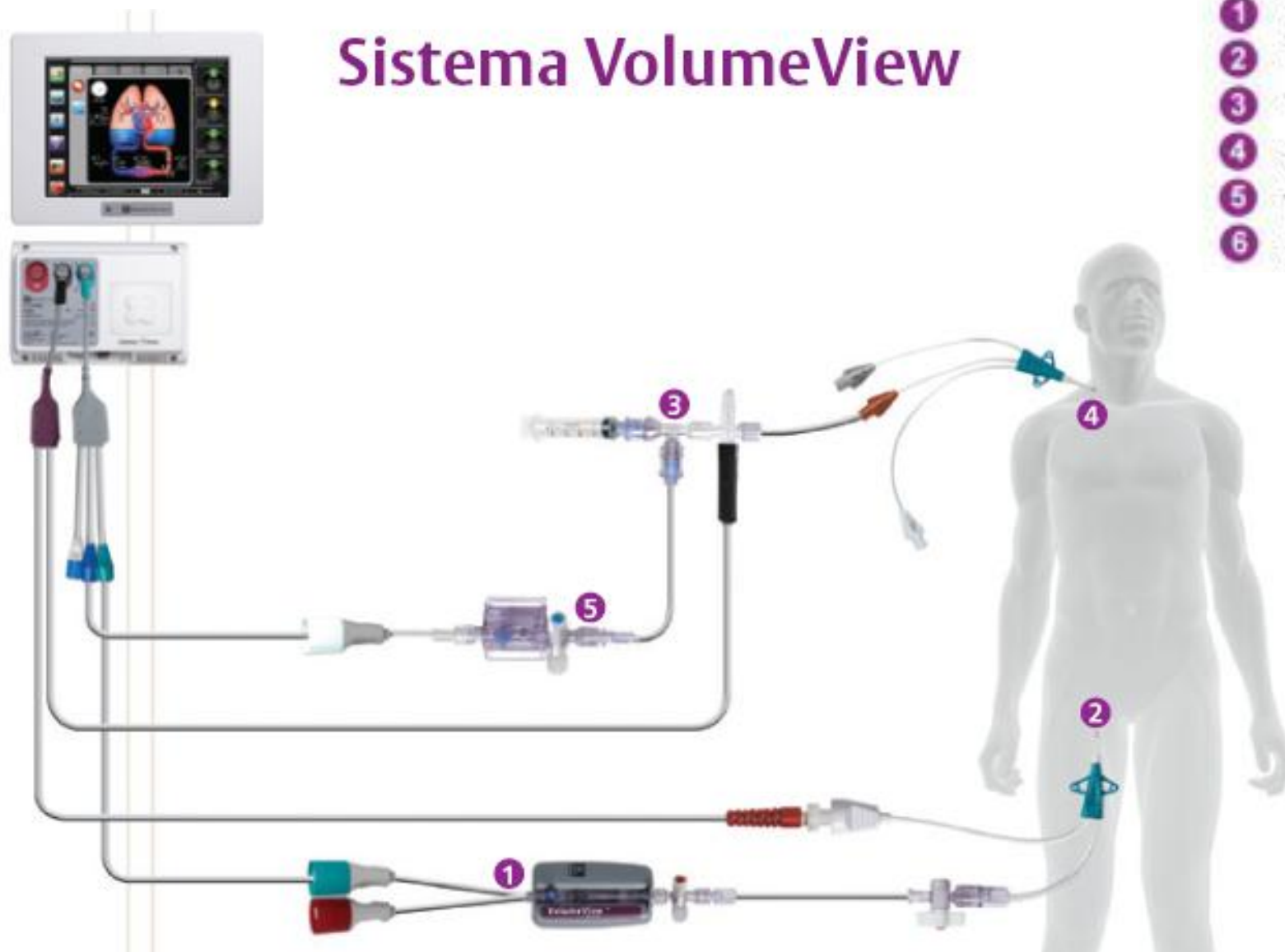
Fondazione Policlinico Universitario Agostino Gemelli IRCCS
Università Cattolica del Sacro Cuore

Are Peripherally Inserted Central Catheters Suitable for Cardiac Output Assessment With Transpulmonary Thermodilution?

Sonia D'Arrigo, MD, PhD¹; Claudio Sandroni, MD²; Sofia Cacciola, MD¹; Antonio Maria Dell'Anna, MD¹; Mauro Pittiruti, MD³; Maria Giuseppina Annetta, MD¹; Cesare Colosimo, MD⁴; Massimo Antonelli, MD²

Crit Care Med. 2019 Oct;47(10):1356-1361

Sistema VolumeView



- 1 VolumeView sensor
- 2 VolumeView femoral arterial cathete
- 3 VolumeView thermistor manifold
- 4 CVC standard
- 5 TruWave pressure transducer
- 6 EV1000 clinical platform

Curva di termodiluizione trans-polmonare: determinazione della gittata cardiaca

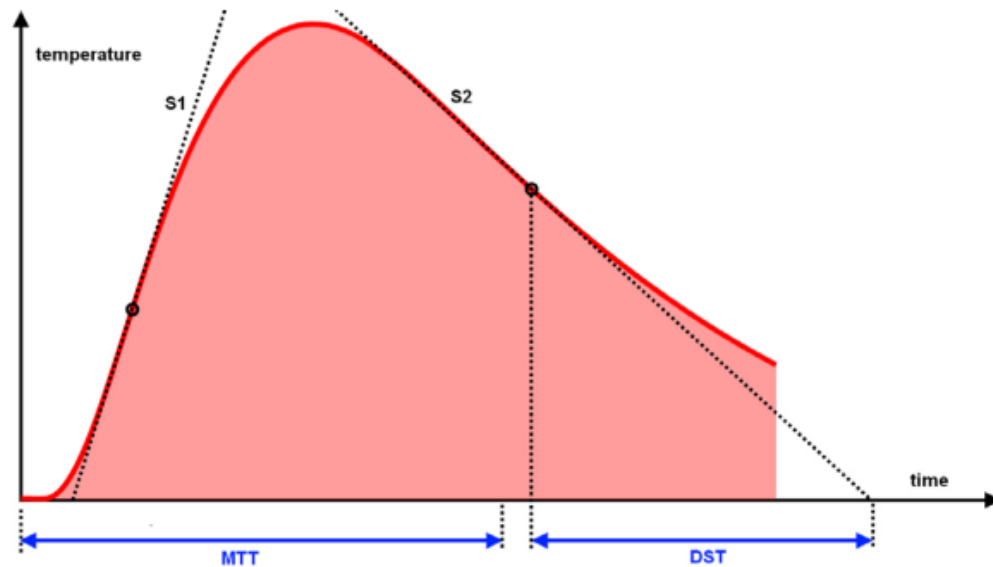
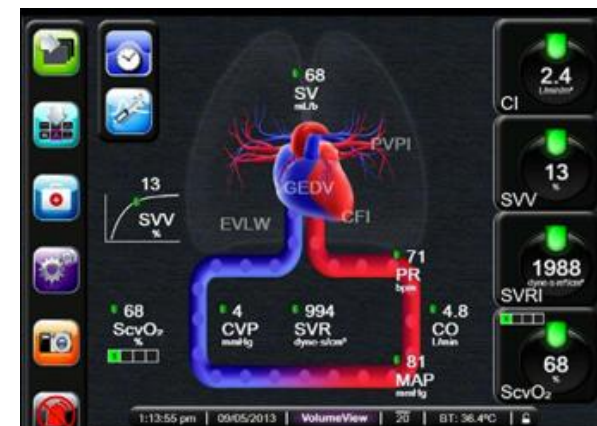


Figure 1 Transpulmonary thermodilution curve. The assessment of global end-diastolic volume (GEDV) by the PiCCO™ system is based on the mean transit time (MTt) and exponential downslope time (DSt), while the assessment of GEDV by the new VolumeView™ method is based on MTt, maximum ascending slope (S1) and maximum descending slope (S2).

$$CO = V_i (T_b - T_i) / AUC$$

$$GEDV = CO \times MTt \times f (S2/S1)$$

$$EVLW = (CO \times DSt) - (0.25 \times GEDV)$$



Sistema VolumeView





*Possiamo utilizzare il PICC per
la determinazione della gittata
cardiaca?*





Measurement of Cardiac Index by Transpulmonary Thermodilution Using an Implanted Central Venous Access Port: A Prospective Study in Patients Scheduled for Oncologic High-Risk Surgery

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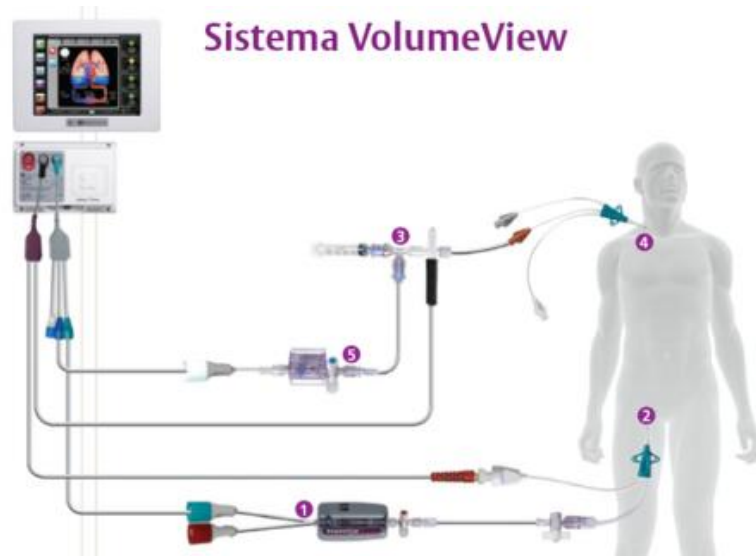
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- Prospective study (mar-jun 2012)
- 27 oncologic patients
- Bias 0.14 (-0.59 to 0.88) L/min/m²
- Percentage of error 22%
- Concordance 92%
- R=0.7



Criteri di inclusione

- Pazienti adulti (> 18 anni) con necessità di monitoraggio emodinamico
- Presenza contemporanea di un PICC (monolume 4Fr e bilume 5Fr)



Protocollo

CICC

PICC

CICC

PICC



Phase 1 (manual)



5 ml/sec

Phase 2 (injector)

Rapid injection system

MEDRAD
Salient Contrast Injection System
Imaxeon, Bayer



Determinazioni effettuate

**80
CICC**



**80
PICC**



Phase 1 (manual)

**80
CICC**



**80
PICC**



Phase 2 (injector)

TABLE 1. Patient Population: Demographic and Clinical Characteristics

Characteristics	All Patients (n = 20)
Age, yr, mean (sd)	62 (11.9)
Male, n (%)	12 (60)
Body mass index, kg/m ² , mean (sd)	25.6 (3.8)
Simplified Acute Physiology Score II, mean (sd)	47 (17)
Diagnosis at admission in ICU, n (%)	
Septic shock	11 (55)
Acute respiratory failure	5 (25)
Major trauma	4 (20)
Centrally inserted central catheter characteristics	
Triple-lumen 7F, n (%)	20 (100)
Catheter length, cm	20
Extension length, cm	14
Total device length, cm	34
Size of the lumen, gauge	16
Approach, n (%)	
Internal jugular vein	19 (95)
Axillary vein	1 (5)

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Peripherally inserted central catheter characteristics

Single-lumen 4F, n (%)	10 (50)
Trimmed length 4F, cm, mean (sd)	41.8 (4.0)
Extension length 4F, cm	11.5
Total device length 4F, cm, mean (sd)	53.3 (4.0)
Double-lumen 5F, n (%)	10 (50)
Trimmed length 5F, cm, mean (sd)	43.5 (5.6)
Extension length 5F, cm	11.5
Total device length 5F, cm, mean (sd)	55 (5.6)
Size of the lumen, gauge	18
Approach, n (%)	
Brachial vein	6 (30)
Basilic vein	14 (70)

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CCM 2019

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TABLE 2. Comparison of Transpulmonary Thermodilution Measurements Using Centrally Inserted Central Catheter Versus Peripherally Inserted Central Catheter (Manual Injection)

Variables	Centrally Inserted Central Catheter	Peripherally Inserted Central Catheter	<i>p</i>	Bias (LoA)	% Bias (LoA)
Measurements, <i>n</i>	80	80	—	—	—
Cardiac index, L/min/m ²	3.5 (0.8)	4.4 (1.1)	< 0.0001	0.88 (−0.36, 2.11)	22.0 (−5.4, 49.4)
Global end-diastolic volume index, mL/m ²	688 (175)	853 (240)	< 0.0001	165 (−81, 411)	20.6 (−6.0, 47.2)
Extravascular lung water index, mL/kg	9.4 (2.9)	12.2 (4.2)	< 0.0001	2.8 (−1.6, 7.3)	24.6 (−6.4, 55.5)
Stroke volume index, mL/m ²	39.5 (9.6)	49.6 (14.9)	< 0.0001	10.1 (−6.0, 26.2)	21.3 (−6.7, 49.2)
Central venous pressure, mm Hg	9.9 (4.9)	9.8 (4.8)	0.845		
Delta temperature, °C	0.34 (0.10)	0.27 (0.09)	< 0.0001	−0.07 (−0.18, 0.04)	24.0 (−58.8, 10.8)

LoA = limits of agreement.

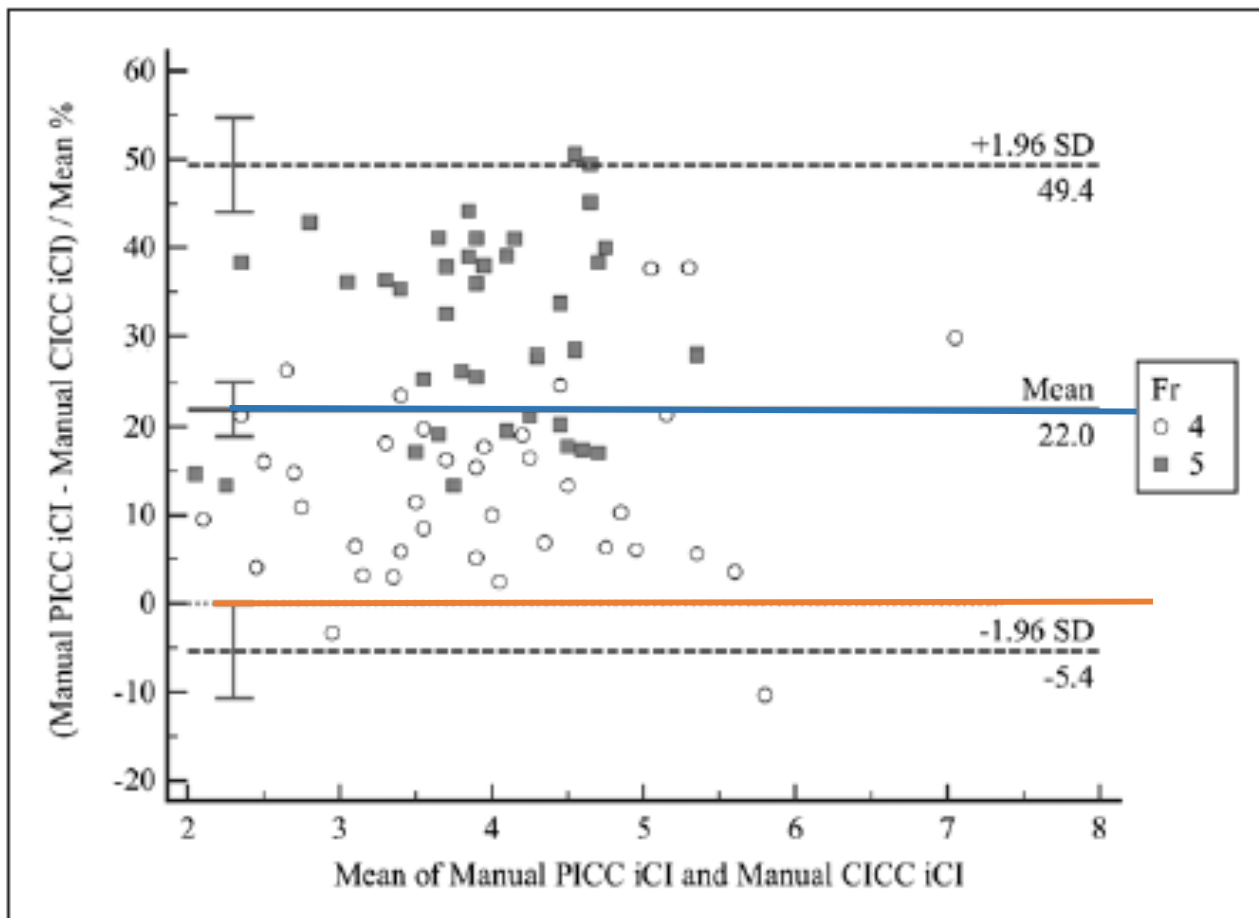
TABLE 3. Comparison Between Single-Lumen 4F Peripherally Inserted Central Catheter Versus Centrally Inserted Central Catheter and Double-Lumen 5F Peripherally Inserted Central Catheter Versus Centrally Inserted Central Catheter (Manual Injection)

Variables	CICC	4F Single-Lumen PICC	<i>p</i>	Bias (LoA)	% Bias (LoA)
Measurements, <i>n</i>	40	40	—	—	—
CI, L/min/m ²	3.7 (1.0)	4.2 (1.2)	0.043	0.51 (−0.53, 1.55)	12.7 (−7.2, 32.6)
GEDVI, mL/m ²	691.3 (171.8)	772.4 (207.9)	0.061	81.1 (−73.3, 235.5)	10.6 (−7.2, 28.5)
EVLWI, mL/kg	9.1 (3.3)	10.5 (3.8)	0.087	1.4 (−0.9, 3.7)	13.6 (−5.2, 32.5)
SVI, mL/m ²	39.0 (9.5)	44.5 (12.4)	0.031	5.5 (−5.2, 16.1)	12.3 (−7.4, 31.9)
CVP, mm Hg	9.5 (4.9)	9.1 (5.1)	0.754		
ΔT, °C	0.36 (0.1)	0.32 (0.09)	0.080	−0.04 (−0.11, 0.03)	11.2 (−29.1, 6.6)

Variables	CICC	5F Double-Lumen PICC	<i>p</i>	Bias (LoA)	% Bias (LoA)
Measurements, <i>n</i>	40	40	—	—	—
CI, L/min/m ²	3.3 (0.6)	4.5 (0.9)	< 0.0001	1.24 (0.27, 2.22)	31.4 (10.6, 52.1)
GEDVI, mL/m ²	685.0 (181.0)	934.1 (245.8)	< 0.0001	249.1 (41.2, 457)	30.6 (12.6, 48.6)
EVLWI, mL/kg	9.6 (2.5)	13.9 (4.0)	< 0.0001	4.3 (0.2, 8.5)	35.5 (10.2, 60.9)
SVI, mL/m ²	39.9 (9.8)	54.7 (15.6)	< 0.0001	14.8 (−0.8, 30.4)	30.3 (6.9, 53.8)
CVP, mm Hg	10.5 (4.9)	10.5 (4.4)	0.962		
ΔT, °C	0.33 (0.09)	0.23 (0.06)	< 0.0001	−0.10 (−0.21, 0.0)	36.8 (−65.8, −7.9)



Cardiac Index - CICC vs PICC



31.4%



12.7%

Differenza di calibro e forma



Più precoce riscaldamento del bolo

Should We Dismiss Peripherally Inserted Central Catheters for Monitoring Cardiac Output? Maybe Not*

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pulmonary arterial occlusion pressure, right arterial pressure, and the mixed venous oxygen saturation. Due to the invasiveness and the possible complications of the PAC, noninvasive or less invasive techniques, such as echocardiography or transpulmonary thermodilution (TPTD) devices have been proposed (4). The TPTD intermittently measures both the cardiac output and the extravascular lung water, a quantitative index of pulmonary edema by the detection of the changes in blood temperature in the femoral artery after a cold bolus injection into a central venous catheter. Sakka et al (5) found in patients with septic shock a good correlation between the cardiac output measured by PAC and TPTD.

The TPTD devices avoid the difficulty of the positioning of the catheter in the right side of the heart but still require the insertion of a central venous catheter, which can be associated to

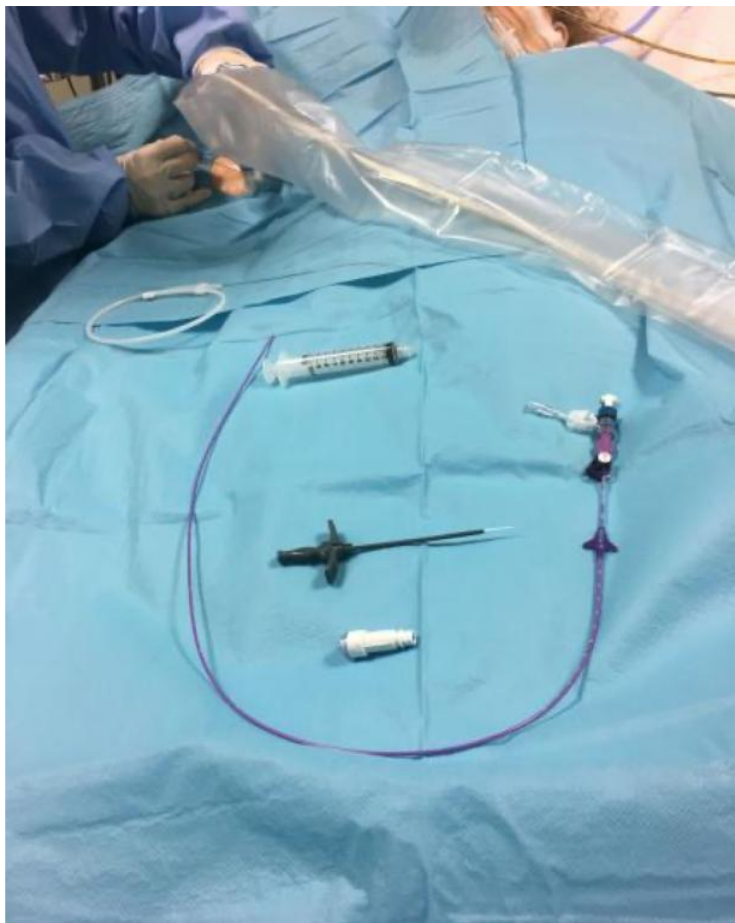
*E se utilizziamo un PLCC con un
calibro interno maggiore?*



Dati preliminari....

Criteri di inclusione

- ❖ Età ≥ 18 anni;
- ❖ Necessità di un **monitoraggio emodinamico** con **EV1000**;
- ❖ Presenza in contemporanea di un **CICC** e di un **PICC**



Risultati preliminari

Pazienti arruolati= 15



320 misurazioni



5Fr monolume



6Fr trilume



Characteristics	All patients (n=15)
Age, y, mean (SD)	62.5 (14.4)
Male, n (%)	8 (53.3)
Body Mass Index, kg/m ² , mean (SD)	26.3 (5.5)
SAPS II, mean (SD)	59.8 (17.1)
Diagnosis on admission in ICU, n (%)	
Septic shock	10 (66.6)
Acute respiratory failure	3 (20)
Cardiogenic shock	2 (13.4)
CICC characteristics	
Triple lumen 7Fr, n (%)	15 (100)
Catheter length, cm	20
Extension length, cm	14
Approach, n (%)	
Internal jugular vein	15 (100)
PICC characteristics	
Single-lumen 5Fr, n (%)	8 (53.3)
Trimmed length 5Fr, cm, mean (SD)	40.6 (3)
Extension length 5Fr, cm	11.5
Triple-lumen 6Fr, n (%)	7 (46.6)
Trimmed length 6Fr, cm, mean (SD)	38.8 (2.9)
Extension length 6Fr, cm	11.5
Approach, n (%)	
Brachial vein	3 (20)
Basilic vein	8 (53.3)
Axillary vein	4 (26.7)



CICC vs single-lumen 5Fr



Variables	CICC	5 Fr single lumen PICC	p-value	Bias [LoA]	% bias [LoA]	% error
Measurements, n	40	40	-	-	-	-
CI, L/min/m ²	3.2 (1.06)	3.2 (1.04)	0.824	0.005 [-0.42;0.52]	2.2	14.7
GEDVI, mL/m ²	694 (156)	716 (169)	0.539	22.5 [-122;167]	3.0	20.5
EVLWI, mL/Kg	10.4 (2.9)	10.6 (2.5)	0.805	0.1 [-2.0;2.3]	2.5	21
SVI, mL/m ²	35 (9.5)	36.1 (9.9)	0.582	1.2 [-5.2;7.6]	3.3	18
CVP, mmHg	10.1 (5.8)	10.1 (5.3)	0.823	-	-	-
ΔT, °C	0.31 (0.06)	0.32 (0.006)	0.611	-0.007 [-0.027;0.041]	2.3	10.8

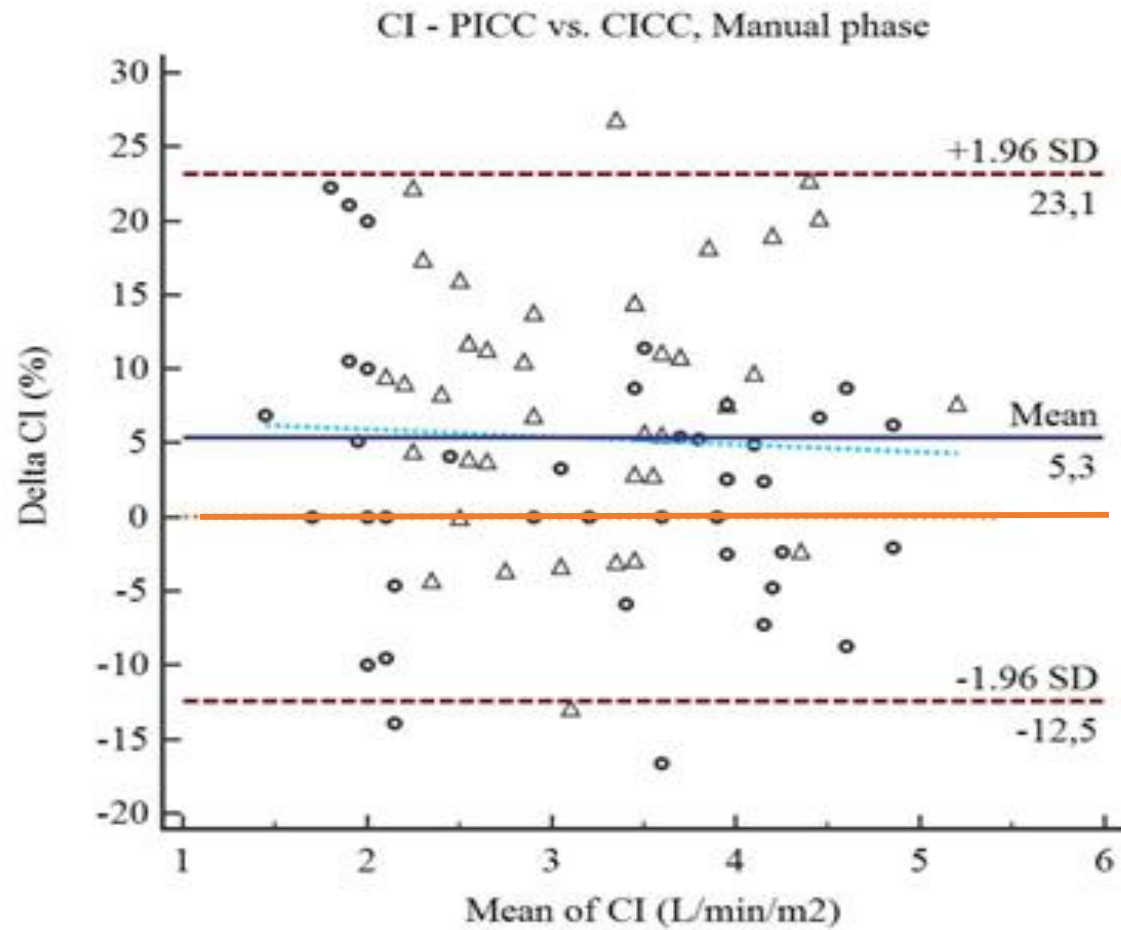


CICC vs triple-lumen 6Fr



Variables	CICC	6 Fr triple-lumen PICC	p-value	Bias [LoA]	% bias [LoA]	% error
Measurements, n	40	40	-	-	-	-
CI, L/min/m ²	3 (0.7)	3.3 (0.8)	0.107	0.28 [-0.32;0.88]	8.5	19
GEDVI, mL/m ²	632 (102)	685 (133)	0.05	52.8 [-75.7;181]	7.4	19.5
EVLWI, mL/Kg	12.2 (4.9)	14 (5.1)	0.178	1.5 [-2.2;5.2]	12.8	28.2
SVI, mL/m ²	40.6 (8.5)	44.4 (10.4)	0.077	3.8 [-4.2;1.8]	8.5	18.8
CVP, mmHg	11.7 (5.5)	11.3 (4.8)	0.764	-	-	-
ΔT , °C	0.32 (0.08)	0.30 (0.07)	0.514	-0.01 [-0.06;0.03]	-4	12.9

Indice cardiaco – CICC vs PICC



**PICC 5Fr
monolume**



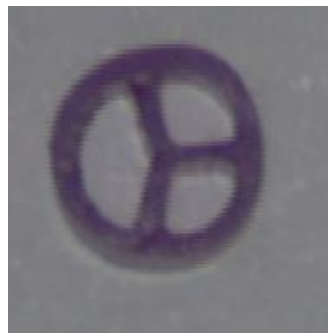
Bias 2,2%

**PICC 6Fr
trilume**



Bias 8,5%

Uno sguardo al microscopio..



	5 Fr monolumen	6 Fr trilumen	4 Fr monolumen	5 Fr bilumen
CI bias (L/min/m ²)	0.005 L	0.28 L	0.5 L	1.24 L
CI bias (%)	2.2%	8.5%	12.7%	31.4%



Conclusioni

- PICC 4 Fr monolume e 5Fr bilume sovrastimano la gittata cardiaca e le altre variabili emodinamiche derivate in maniera statisticamente significativa.
- Valutare la *trending ability* potrebbe essere utile per il loro utilizzo nella pratica clinica.
- I dati sull'utilizzo dei cateteri di calibro più grande, quali il 5Fr monolume e il 6Fr trilume sembrerebbero interessanti, tali da poterli suggerire nella pratica clinica.





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