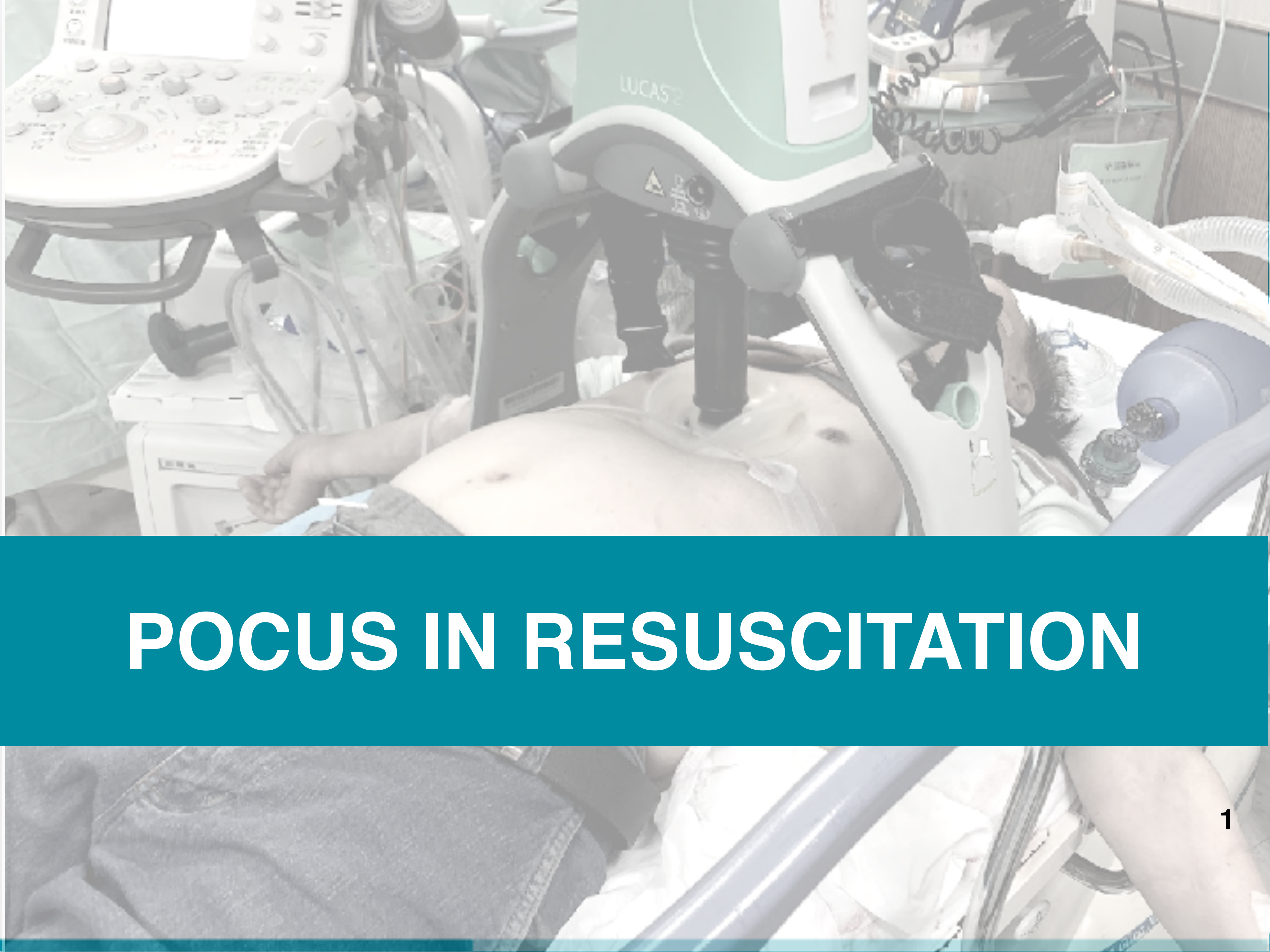
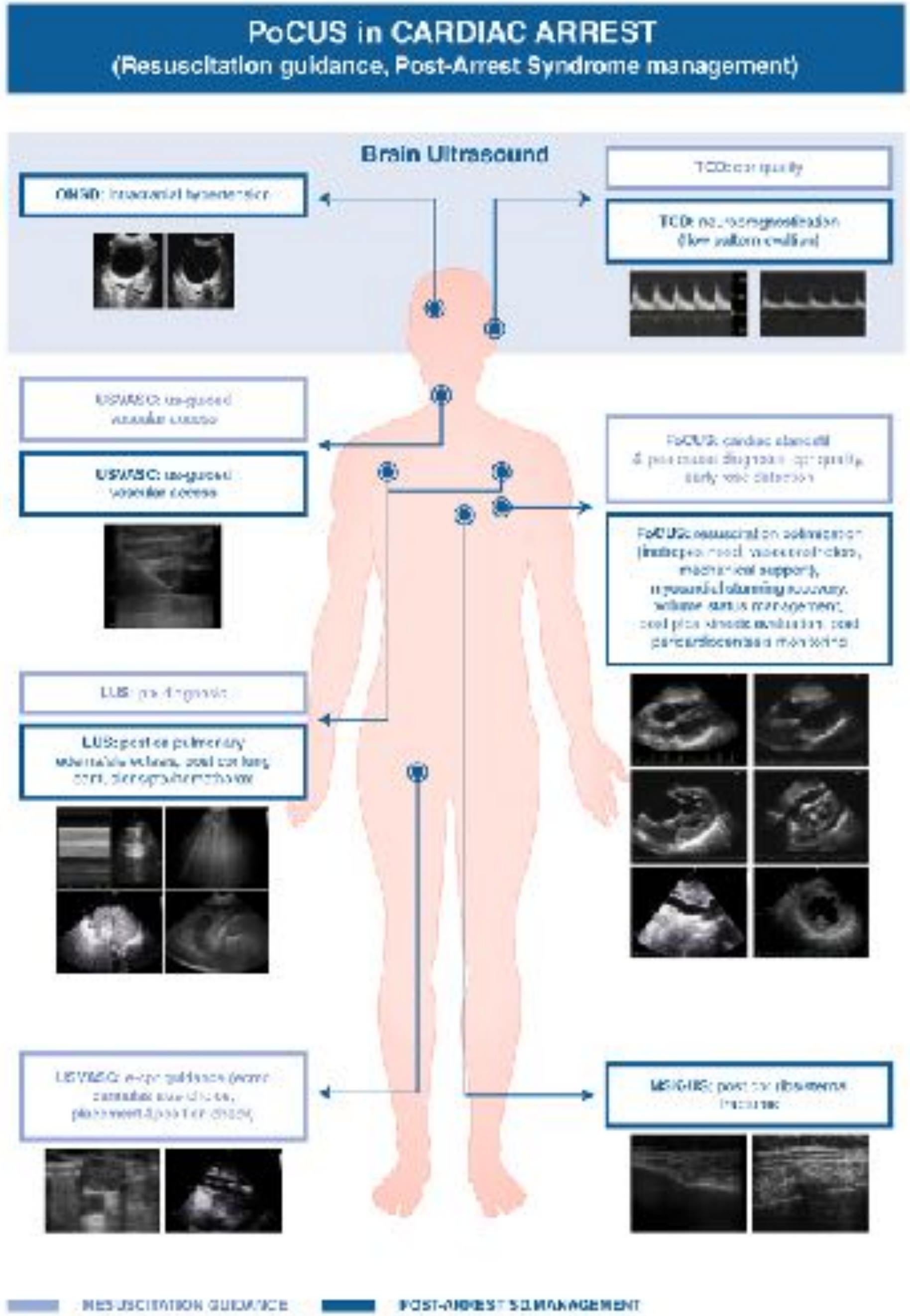
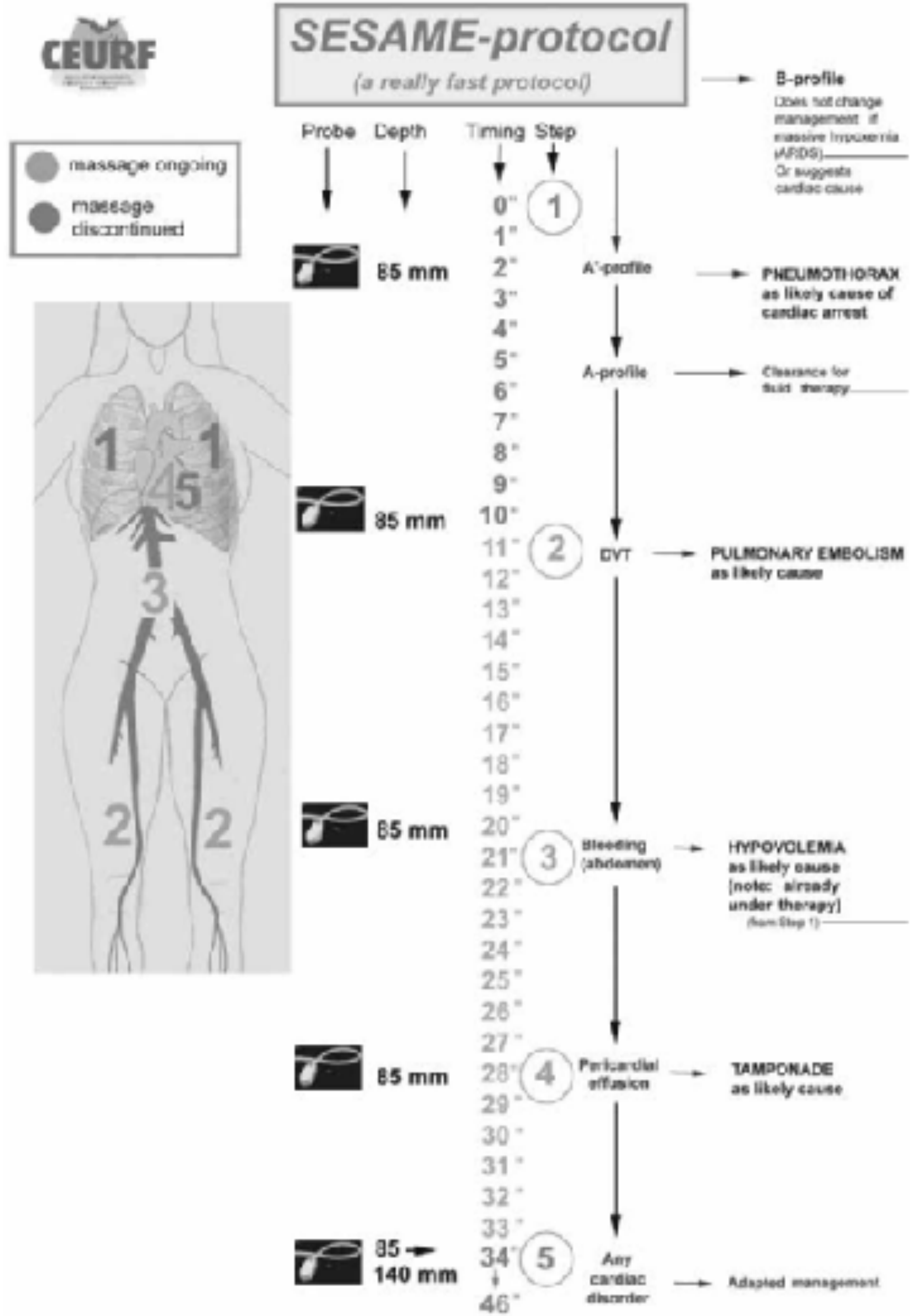


POCUS IN RESUSCITATION


PoCUS in CARDIAC ARREST
(Resuscitation guidance, Post-Arrest Syndrome management)
Brain Ultrasound
USVASC: us-guided vascular access



Critical care ultrasound in cardiac arrest. Technological requirements for performing the SESAME-protocol — a holistic approach

Daniel Lichtenstein[1], Manu L.N.G. Malbrain[2]

DOI: 10.5603/AIT.a2015.0072

POCUS >> longer pulses

Point-of-care ultrasound use in patients with cardiac arrest is associated prolonged cardiopulmonary resuscitation pauses: A prospective cohort study

Eben J Clattenburg[a,*], Peter Wroe[a], Stephen Brown[b], Kevin Gardner[a], Lia Losonczy[a], Amandeep Singh[a], Arun Nagdev[a,b]

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Keywords:
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Point-of-care ultrasound

ABSTRACT

Objective: We aim to evaluate if point-of-care ultrasound use in cardiac arrest is associated with CPR pause duration.
Methods: This is a prospective cohort study of patients with cardiac arrest (CA) presenting to an urban emergency department from July 2016 to January 2017. We collected video recordings of patients with CA in designated code rooms with video recording equipment. The CAs recordings were reviewed and coded by two abstractors. The primary outcome was the difference CPR pause duration when POCUS was and was not performed.
Results: A total of 110 CPR pauses were evaluated during this study. The median CPR pause with POCUS performed lasted 17 s (IQR 13 – 22.5) versus 11 s (IQR 7 – 16) without POCUS. In addition, multiple regression analysis demonstrated that POCUS was associated with longer pauses (6.4 s, 95%CI 2.1 - 10.8); ultrasound fellowship trained faculty trended towards shorter CPR pauses (-4.1 s, 95%CI –8.8–0.6) compared to non-ultrasound fellowship trained faculty; and when the same provider led the resuscitation and performed the POCUS, pause durations were 6.1 s (95%CI 0.4 – 11.8) longer than when another provider performed the POCUS.
Conclusion: In this prospective cohort trial of 24 patients with CA, POCUS during CPR pauses was associated with longer interruptions in CPR.

POCUS >> prolonged interruption

Ultrasound use during cardiopulmonary resuscitation is associated with delays in chest compressions☆

Maite A. Huis in 't Veld[a], Michael G. Allison[b], David S. Bostick[a], Kiondra R. Fisher[c], Olga G. Goloubeva[d], Michael D. Witting[e], Michael E. Winters[e,*]

[a] E-Department of Emergency Medicine, University of Maryland Medical Center, Baltimore, MD, United States
[b] Critical Care Medicine, Saint Agnes Hospital, Baltimore, MD, United States
[c] University of Maryland School of Medicine, Baltimore, MD, United States
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Keywords:
Point-of-care ultrasound
POCUS
Cardiac arrest
CPR
Interruptions
Delay

ABSTRACT

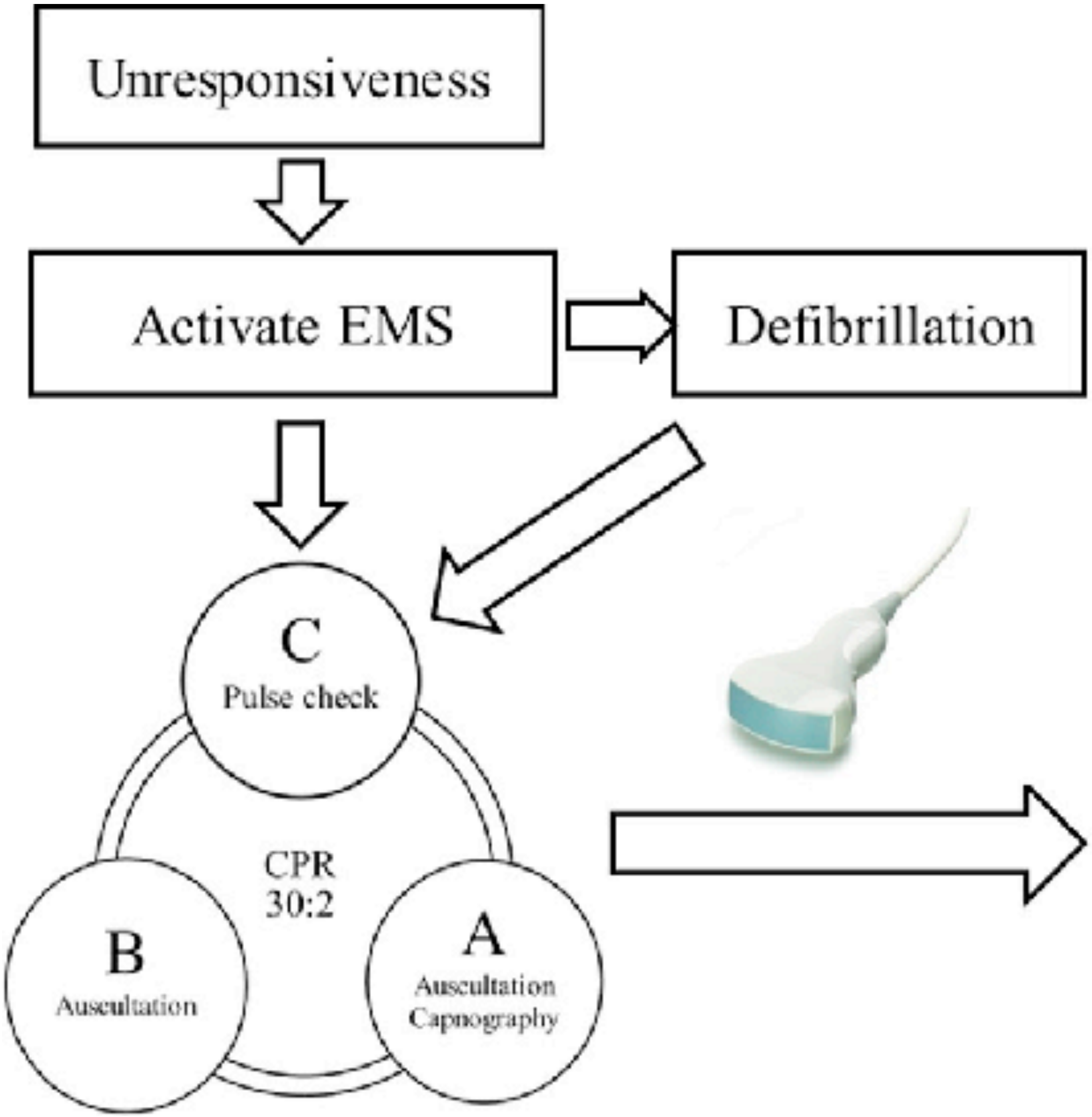
Aim: High-quality chest compressions are a critical component of the resuscitation of patients in cardiopulmonary arrest. Point-of-care ultrasound (POCUS) is used frequently during emergency department (ED) resuscitations, but there has been limited research assessing its benefits and harms during the delivery of cardiopulmonary resuscitation (CPR). We hypothesized that use of POCUS during cardiac arrest resuscitation adversely affects high-quality CPR by lengthening the duration of pulse checks beyond the current cardiopulmonary resuscitation guidelines recommendation of 10 s.

Methods: We conducted a prospective cohort study of adults in cardiac arrest treated in an urban ED between August 2015 and September 2016. Resuscitations were recorded using video equipment in designated resuscitation rooms, and the use of POCUS was documented and timed. A linear mixed-effects model was used to estimate the effect of POCUS on pulse check duration.

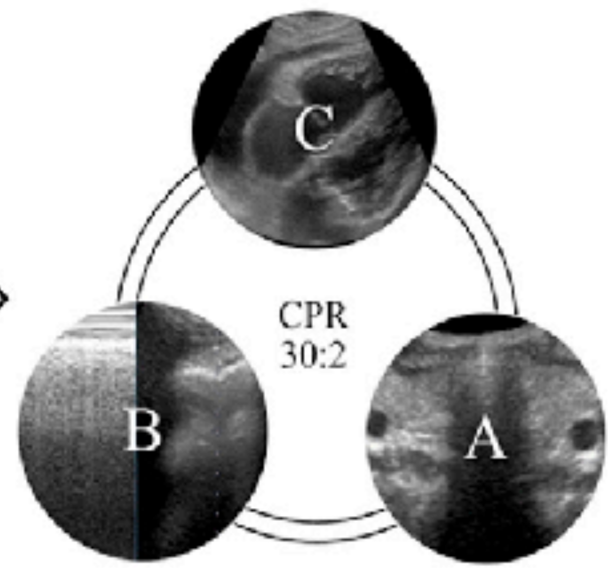
Results: Twenty-three patients were enrolled in our study. The mean duration of pulse checks with POCUS was 21.0 s (95% CI, 18–24) compared with 13.0 s (95% CI, 12–15) for those without POCUS. POCUS increased the duration of pulse checks and CPR interruption by 8.4 s (95% CI, 6.7–10.0 [$p < 0.0001$]). Age, body mass index (BMI), and procedures did not significantly affect the duration of pulse checks.

Conclusions: The use of POCUS during cardiac arrest resuscitation was associated with significantly increased duration of pulse checks, nearly doubling the 10-s maximum duration recommended in current guidelines. It is important for acute care providers to pay close attention to the duration of interruptions in the delivery of chest compressions when using POCUS during cardiac arrest resuscitation.

US-CAB protocol

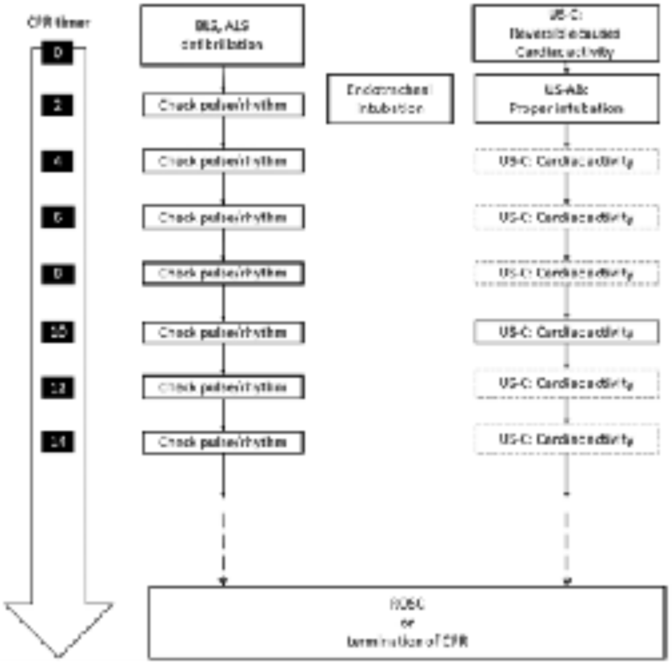


		C	A	B (left)	B (right)	C-A-B
All participants	Mean ± SE (s)	16.4 ± 7.2	10.5 ± 5.6	11.3 ± 4.7	12.1 ± 5.9	46.5 ± 15.0
n=70	Median (s)	13.0	10.0	12.0	11.8	43.0
	IQR (s)	10.0,20.0	8.0, 13.0	8.0, 20.0	7.0, 15.0	36.0,55.0
Senior physicians	Mean ± SE (s)	15.9 ± 6.7	12.1 ± 5.7	11.8 ± 5.5	11.0 ±4.4	44.5 ± 13.4
n=32	Median (s)	15.0	10.0	10.0	10.5	44.5
	IQR (s)	10.0,20.0	9.0, 14.0	7.0, 15.0	6.5, 15.0	37.0,50.0
Junior physicians	Mean ± SE (s)	16.9 ± 7.6	9.2± 3.8	14.7 ± 7.3	13.0 ±6.8	48.1 ± 16.3
n=38	Median (s)	18.0	8.0	15.0	12.0	50.0
	IQR (s)	10.0,22.0	6.0, 10.0	9.0, 20.0	7.0, 23.0	35.0,59.0



Resuscitation 2017. DOI: 10.1016/j.resuscitation.2017.03.016

US-CAB protocol



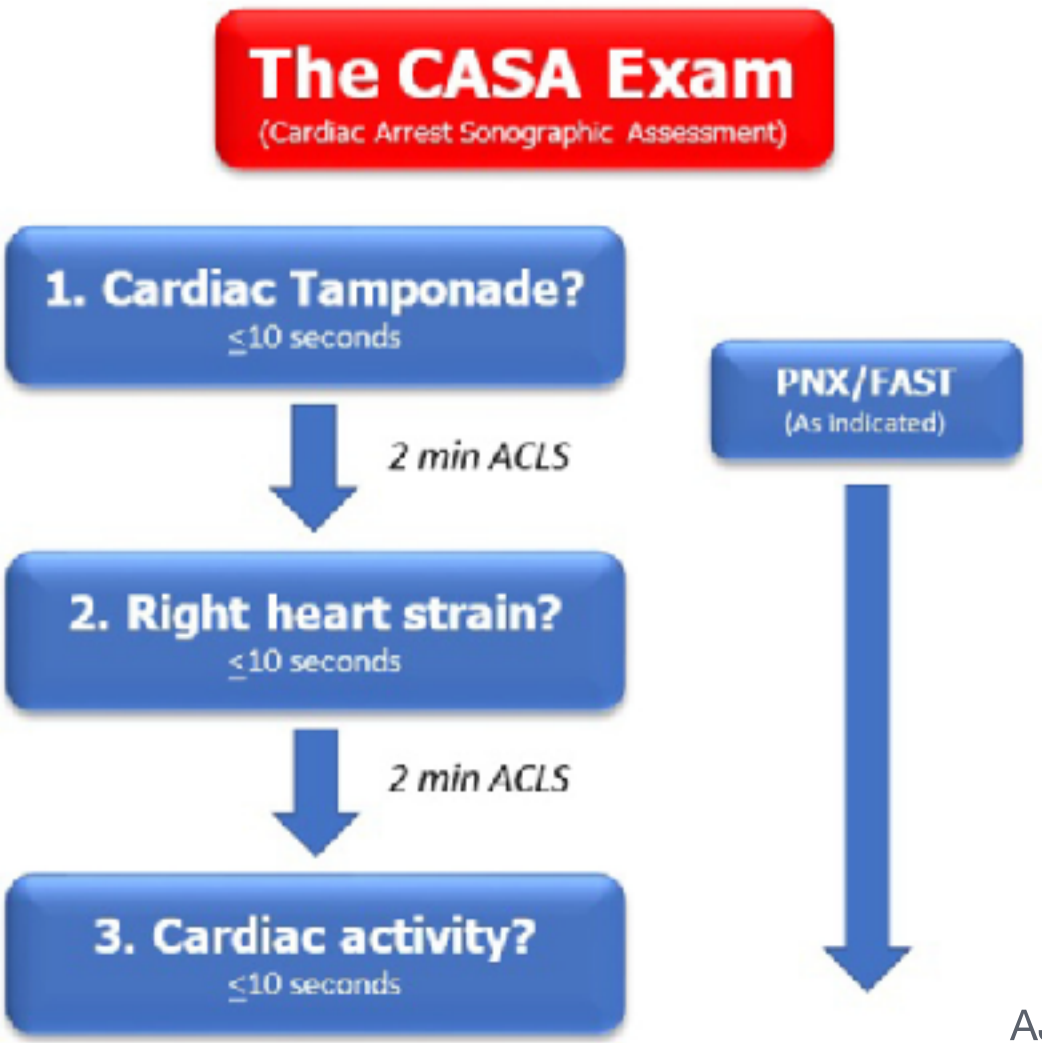
	Total	ROSC	non-ROSC	
Operation duration (sec)[†]				
C: cardiac ultrasonography	9.0 ± 1.4	9.1 ± 1.5	8.9 ± 1.2	.216
A: tracheal ultrasonography	7.5 ± 1.5	7.4 ± 1.4	7.6 ± 1.5	.505
B: left lung sliding	8.5 ± 2.0	8.4 ± 1.9	8.6 ± 2.0	.654
B: right lung sliding	7.5 ± 1.8	7.6 ± 1.8	7.4 ± 1.7	.288
Ultrasonographic findings, n (%)				
Cardiac activity	47 (26.6%)	45 (61.6%)	2 (1.9%)	< .0001
Cardiac tamponade	8 (4.5%)	2 (2.7%)	6 (5.8%)	.340
Esophageal intubation	21 (11.9%)	8 (11.0%)	13 (12.5%)	.755
One-lung intubation	3 (1.7%)	2 (2.7%)	1 (1.0%)	.367

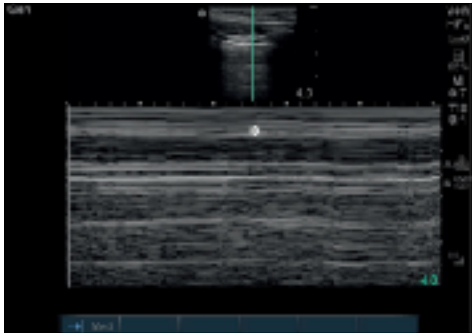
	Reference		Sen[*], % (95% C.I.[*])	Spe[*], % (95% C.I.)	PPV[*], % (95% C.I.)	NPV[*], % (95% C.I.)
US-C	ROSC[*]	Non-ROSC				
Presence of cardiac activity, n	45	2	62 (50–73)	98 (95–100)	96 (90–100)	78 (71–85)
Absence of cardiac activity, n	28	102				
US-A	Tracheal intubation[†]	Esophageal intubation				
Sonographic tracheal intubation, n	156	0	100 (100)	100 (100)	100 (100)	100 (100)
Sonographic esophageal intubation, n	0	21				
US-B	Proper ventilation[‡]	Improper ventilation				
Sonographic proper ventilation, n	174	0	99 (98–100)	100 (100)	100 (100)	67 (13–100)
Sonographic improper ventilation, n	1	2				

Resuscitation 2018. DOI: 10.1016/j.resuscitation.2018.01.051

CASA

Cardiac Arrest Sonographic Assessment

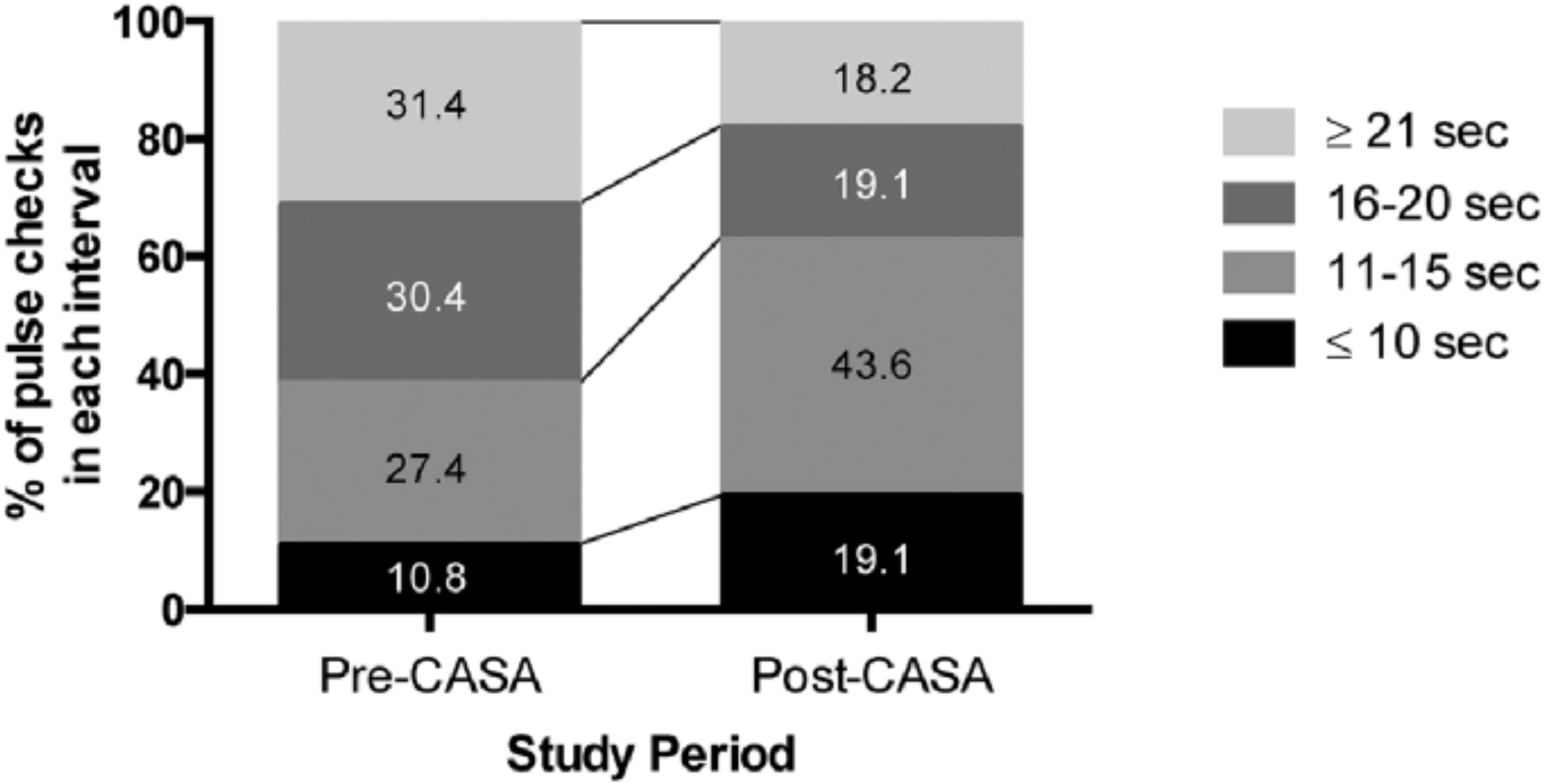




AJEM 2018; doi: 10.1016/j.ajem.2017.08.052.

CASA implementation

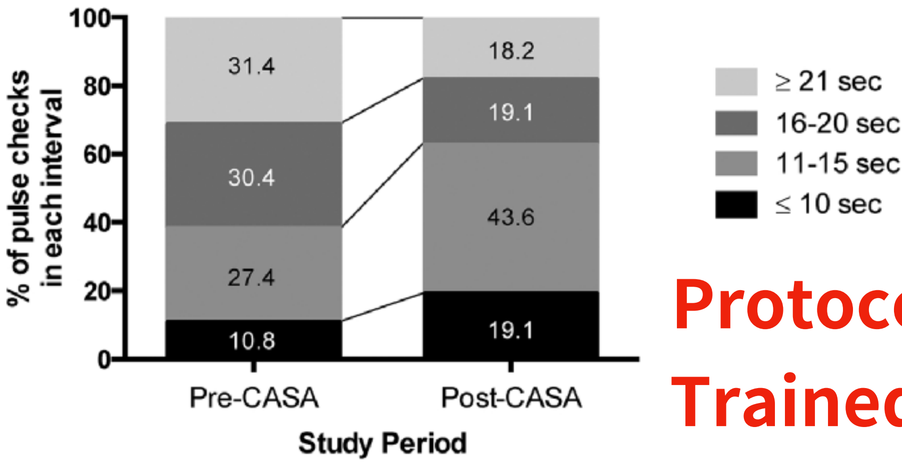
Cardiac Arrest Sonographic Assessment



Resuscitation 2018; DOI: 10.1016/j.resuscitation.2018.07.030

CASA implementation

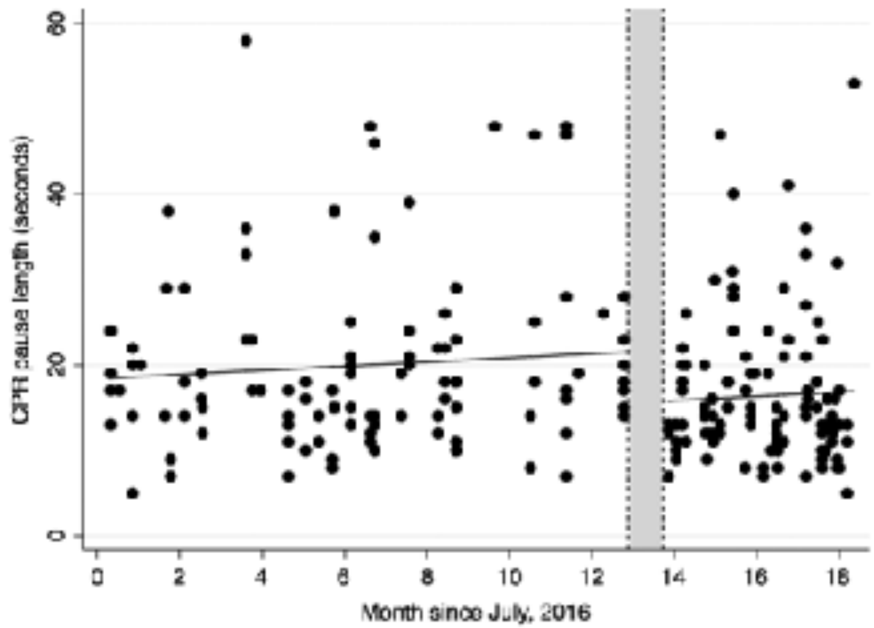
Cardiac Arrest Sonographic Assessment



Protocol

Trained

Standby



Multivariable linear regression analysis of predictors associated with CPR pause duration for pulse checks with ultrasound performed.

Predictor variable[a]	Coefficient (sec)	SE	p-value
Post intervention time period	−3.3	1.2	0.007
Resident year			
2	REF		
3	1.1	1.4	0.45
4	0.2	1.5	0.89
Attending	−3.0	4.0	0.45
Any procedure performed	1.9	1.8	0.28
Attending ultrasound fellowship trained	−3.1	1.3	0.02
Ultrasound on chest before CPR paused	−3.1	1.3	0.01

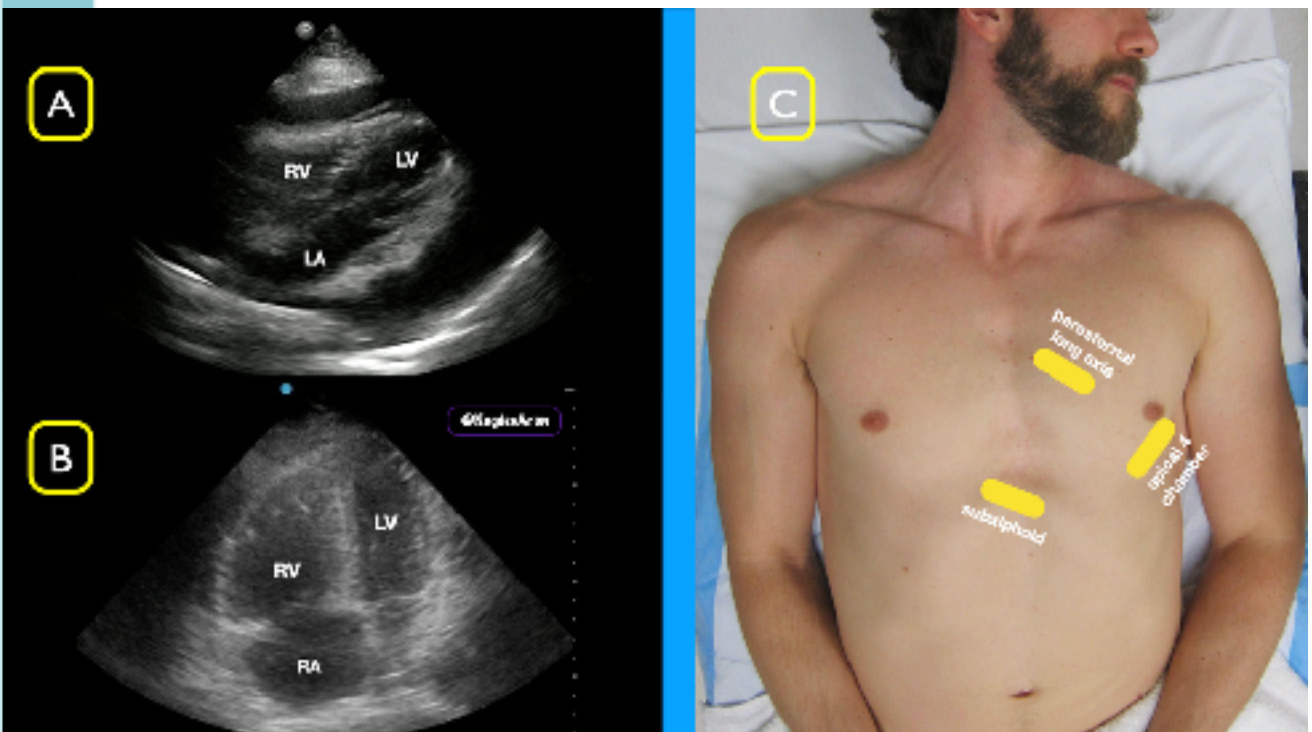
	Pre (sec)	Post (sec)	Difference (sec)	p-value
CPR pulse check pause duration, mean (SE)[a]	18.1 (0.8)	15.1 (0.6)	3.0 (1.0–5.0)	0.003
CPR pulse check pause duration with POCUS, mean (SE)[b]	19.8 (1.0)	15.8 (0.7)	4.0 (1.7–6.3)	0.0008
CPR pulse check pause duration without POCUS, mean (SE)[c]	15.4 (1.0)	12.8 (0.7)	2.6 (−1.2 to 6.4)	0.18

Resuscitation 2018; DOI: 10.1016/j.resuscitation.2018.07.030

CASA implementation

ACEP Nows

Check時錄 > CPR時看 > AB後只看C (Activity ~ ROSC)



Standby window

10s clock

Review clip during CPR

Stay off chest

Activity

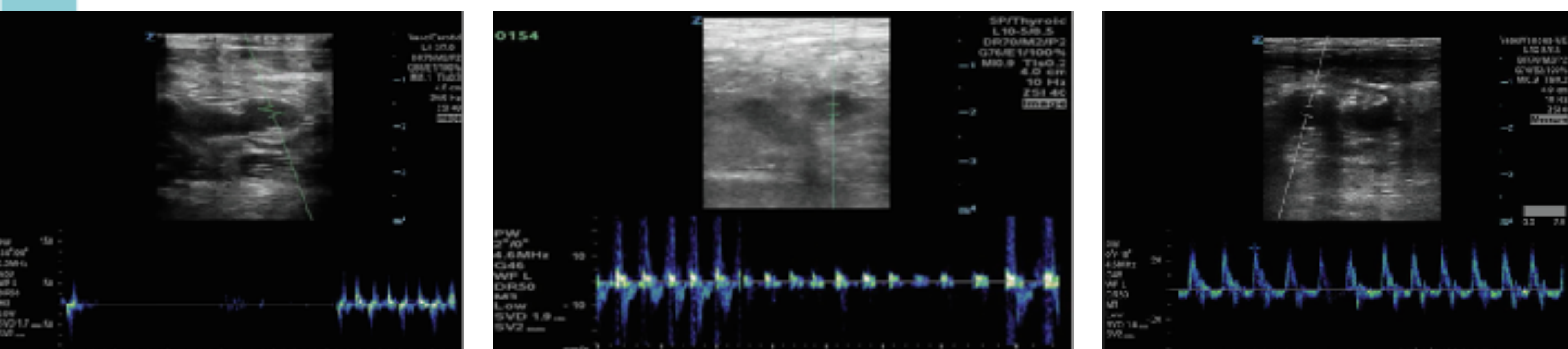
Clinical paper

Femoral artery Doppler ultrasound is more accurate than manual palpation for pulse detection in cardiac arrest

Allison L. Cohen [a,b], Timmy Li [a,b], Lance B. Becker [a,b,c], Casey Owens [b,c], Neha Singh [c], Allen Gold [d], Mathew J. Nelson [a,b], Daniel Jafari [a,b], Ghania Haddad [b], Alexander V. Nello [a,b], Daniel M. Rolston [a,b,], Northwell Health Biostatistics Unit [1]*

[a] *Department of Emergency Medicine, Donald and Barbara Zucker School of Medicine at Hofstra/Northwell, Hempstead, NY, United States*
[b] *Department of Emergency Medicine, North Shore University Hospital, Northwell Health, Manhasset, NY, United States*
[c] *Feinstein Institutes for Medical Research, Northwell Health, Manhasset, NY, United States*
[d] *Department of Emergency Medicine, St. Vincent Hospital, Alleghany Health Network, Erie, NY, United States*

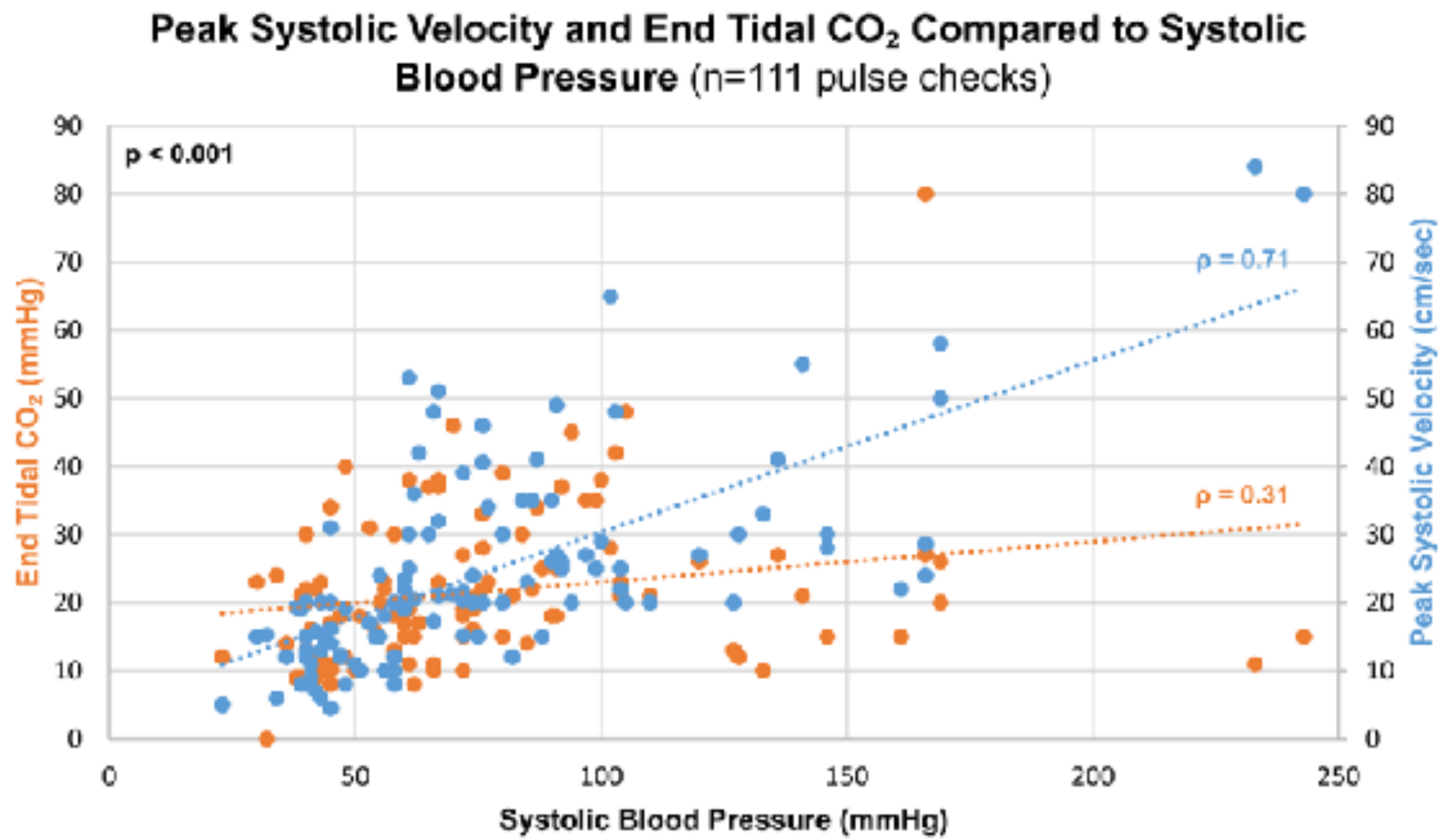
PSV ≥ 20 cm/s ~ SBP ≥ 60 mmHg (AUC 0.975)



Resuscitation 2022; DOI: 10.1016/j.resuscitation.2022.01.030

Doppler ultrasound peak systolic velocity versus end tidal carbon dioxide during pulse checks in cardiac arrest

Ghania Haddad [a,*], *Deanna Marglus* [a,b], *Allison L. Cohen* [a,b], *Margaret Gorlin* [c], *Daniel Jafari* [a,b,d], *Timmy Li* [a,b], *Casey Owens* [a], *Lance Becker* [a,b,c], *Daniel M. Rolston* [a,b,d]



Resuscitation 2023; DOI: 10.1016/j.resuscitation.2023.109695

Doppler ultrasound peak systolic velocity versus end tidal carbon dioxide during pulse checks in cardiac arrest

Ghania Haddad[a,], Deanna Marglus[a,b], Allison L. Cohen[a,b], Margaret Gorlin[c], Daniel Jafari[a,b,d], Timmy Li[a,b], Casey Owens[a], Lance Becker[a,b,c], Daniel M. Rolston[a,b,d]*

PSV ≥ 20 cm/s ~ SBP ≥ 60 mmHg

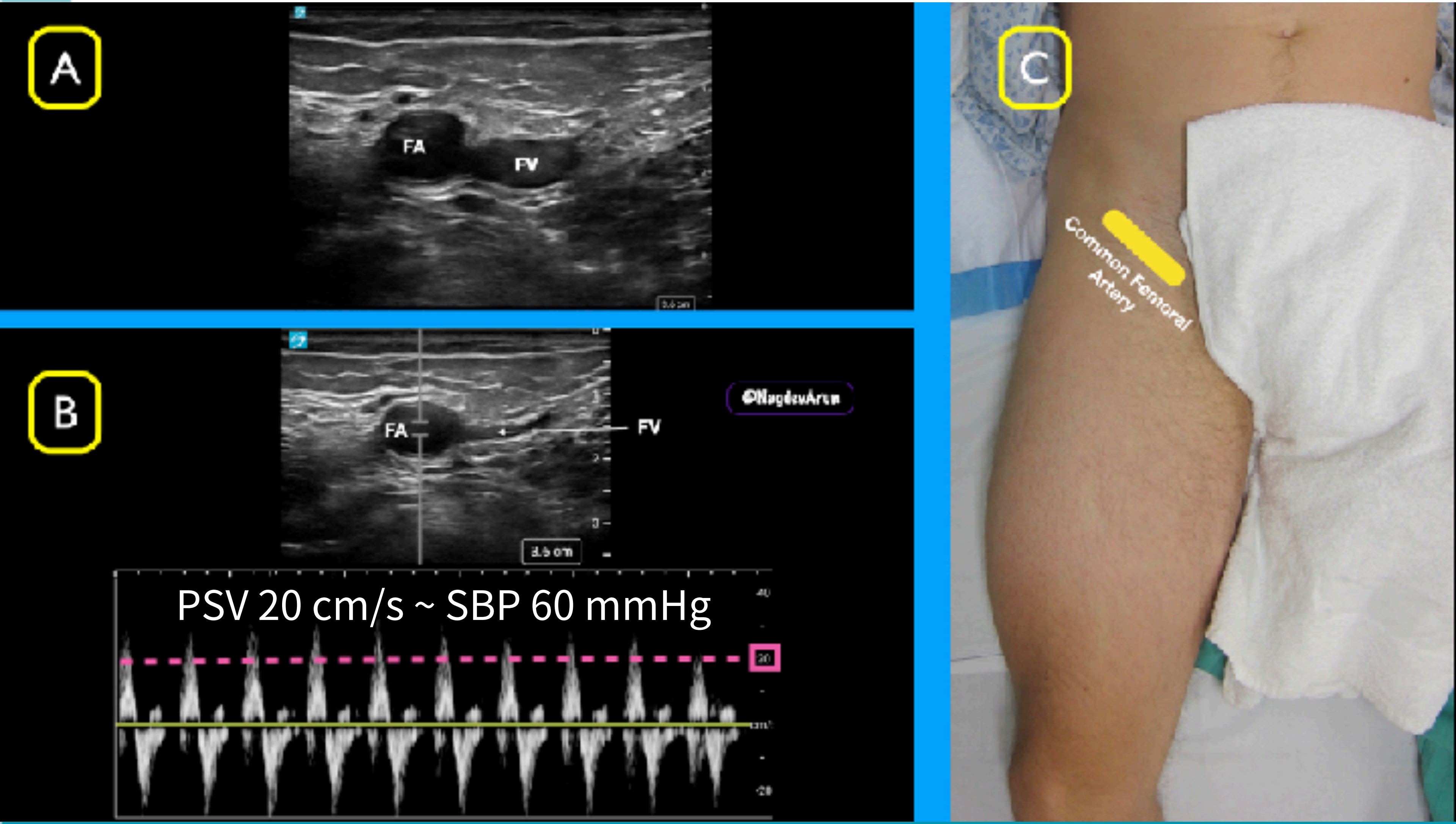
89% accuracy

Detection of ROSC with SBP ≥ 60 mmHg	Doppler Ultrasound PSV ≥ 20 cm/sec	$ETCO_2$ ≥ 20 mmHg	$ETCO_2$ ≥ 25 mmHg
Accuracy	89.2% (81.9%-94.3%)	58.6% (48.8%-67.8%)	57.7% (47.9%-67.0%)
Sensitivity	91.0% (84.2%-97.8%)	56.7% (44.8%-68.5%)	38.9% (27.1%-50.4%)
Specificity	86.4% (76.2%-96.5%)	61.4% (46.9%-75.7%)	86.4% (76.2%-94.7%)
Positive Predictive Value	91.0% (84.2%-97.8%)	69.1% (56.8%-81.3%)	81.3% (37.0%-59.1%)
Negative Predictive Value	86.4% (76.2%-96.5%)	48.2% (35.1%-61.3%)	48.1% (37.0%-59.1%)
Positive Likelihood Ratio	6.68 (3.16–14.10)	1.47 (0.96–2.25)	2.85 (1.28–6.35)
Negative Likelihood Ratio	0.10 (0.05–0.22)	0.71 (0.49–1.01)	0.71 (0.57–0.89)

Resuscitation 2023; DOI: 10.1016/j.resuscitation.2023.109695

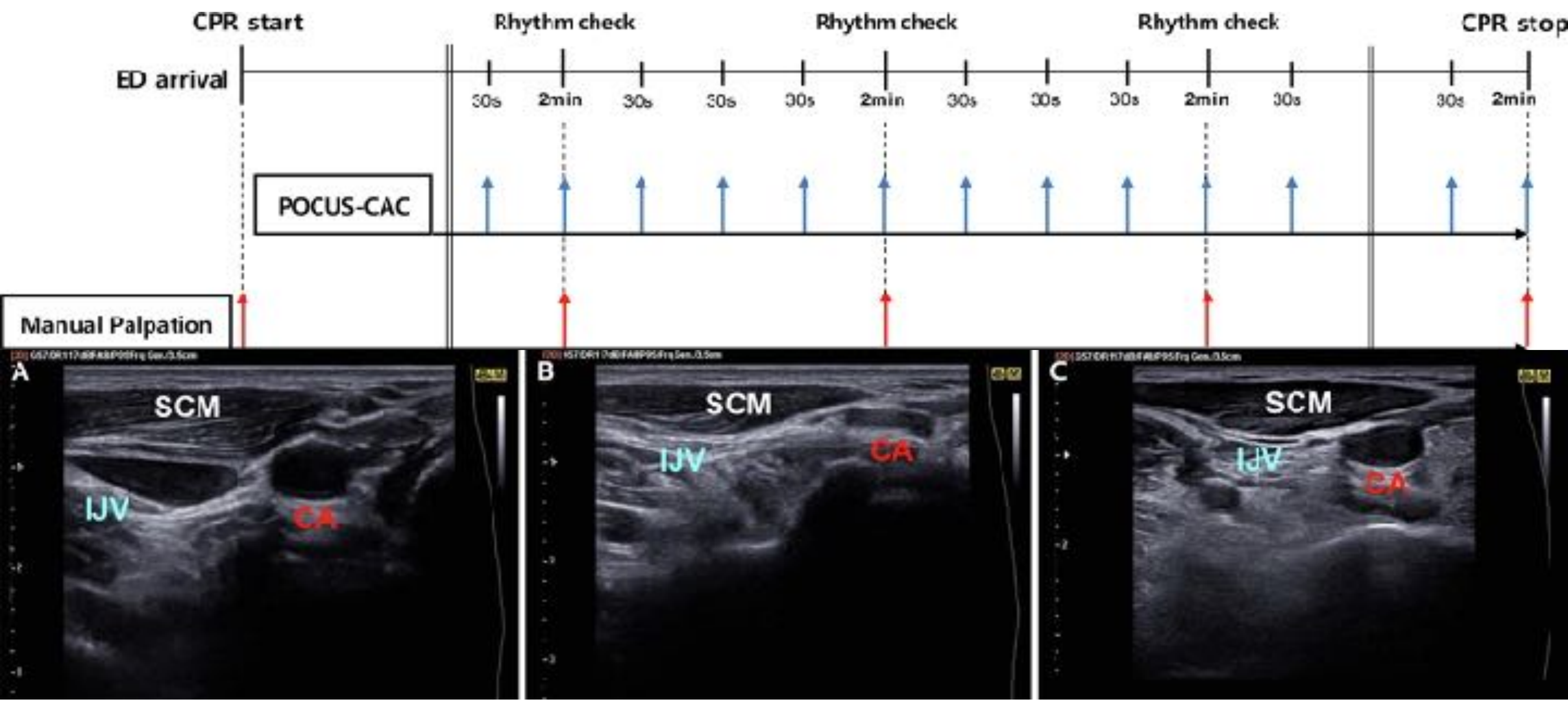
CASA modification

ACEP Nows



Point-of-care ultrasound compression of the carotid artery for pulse determination in cardiopulmonary resuscitation

Soo Yeon Kang[a,b], *Ik Joon Jo*[a], *Guntak Lee*[a], *Jong Eun Park*[a], *Taerim Kim*[a], *Se Uk Lee*[a], *Sung Yeon Hwang*[a], *Tae Gun Shin*[a], *Kyunga Kim*[c,d,e], *Ji Sun Shim*[c], *Hee Yoon*[a,*]



Resuscitation 2022; DOI: 10.1016/j.resuscitation.2022.06.025

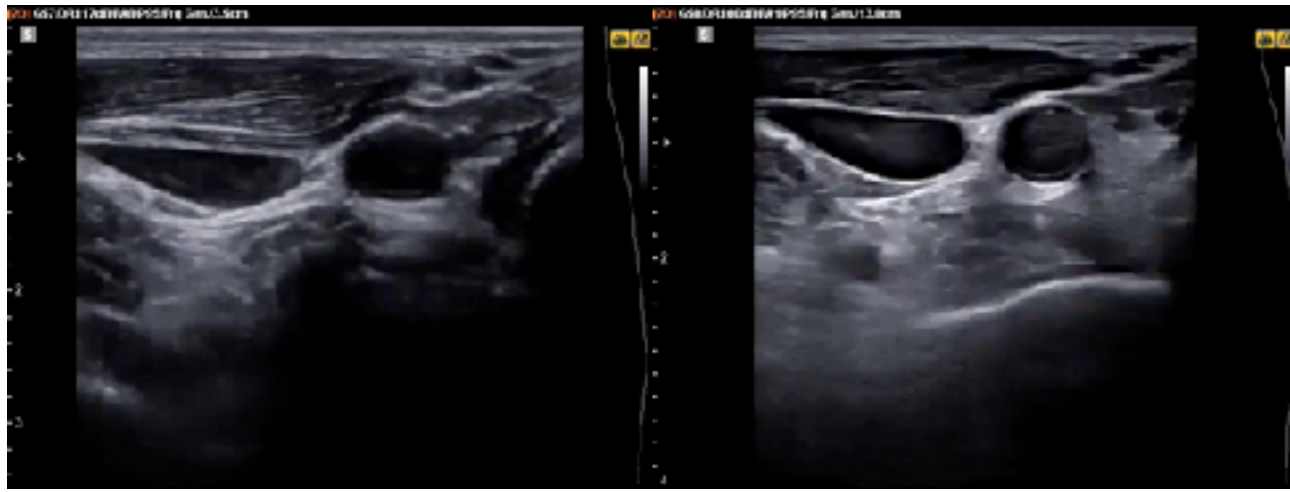
Point-of-care ultrasound compression of the carotid artery for pulse determination in cardiopulmonary resuscitation

Soo Yeon Kang[a,b], *Ik Joon Jo*[a], *Guntak Lee*[a], *Jong Eun Park*[a], *Taerim Kim*[a], *Se Uk Lee*[a], *Sung Yeon Hwang*[a], *Tae Gun Shin*[a], *Kyunga Kim*[c,d,e], *Ji Sun Shim*[c], *Hee Yoon*[a,*]

POCUS-CAC

Pulsation

Incomplete compression



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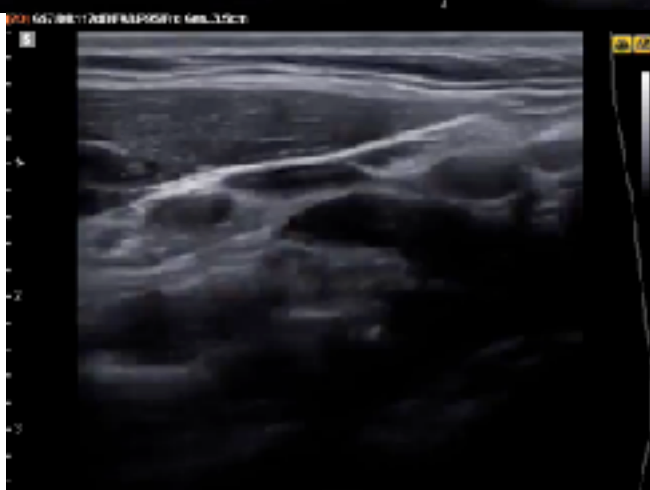


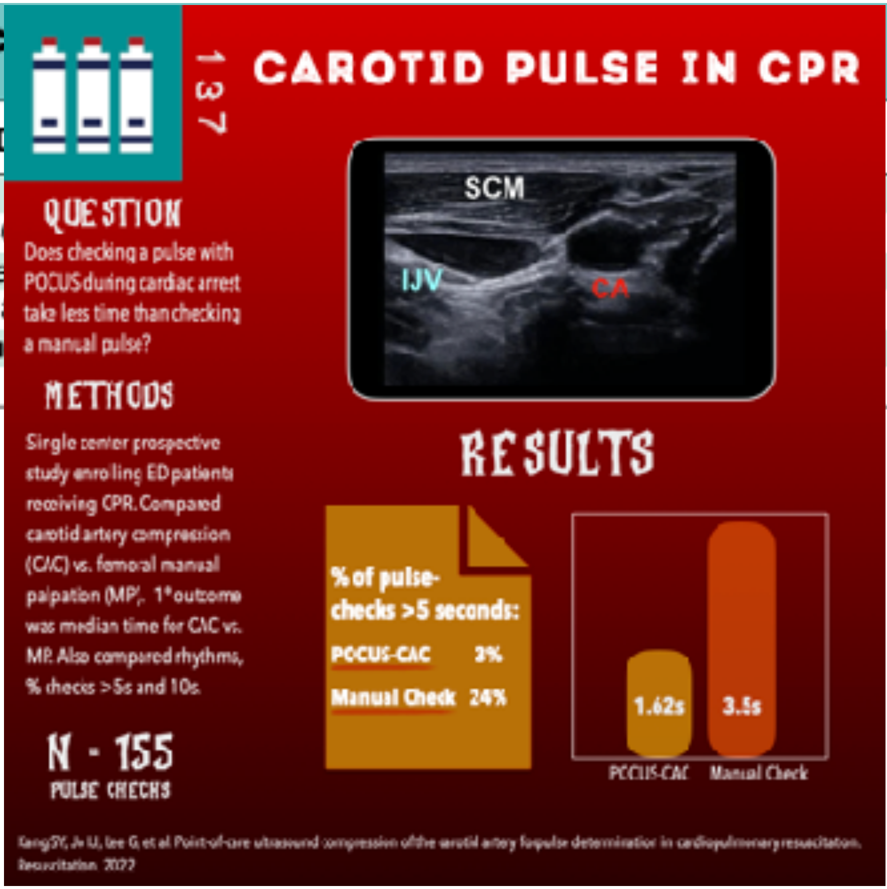
itation 202 … 22.06.025

Point-of-care ultrasound compression of the carotid artery for pulse determination in cardiopulmonary resuscitation

Soo Yeon Kang [a,b], Ik Joon Jo [a], Guntak Lee [a], Jong Eun Park [a], Taerim Kim [a], Se Uk Lee [a], Sung Yeon Hwang [a], Tae Gun Shin [a], Kyunga Kim [c,d,e], Ji Sun Shim [c], Hee Yoon [a,*]

Table 2 – Differences in time for pulse assessment with POC

	POCUS-CAC	MP	Time D
Average time per patient	1.62 s	3.50 s	Mean
(*n* = 25)	(1.14–2.14 s)	(2.99–4.99 s)	–0.83
All pulse check	1.31 s	3.00 s	Estima
(*n* = 155)	(1.00–2.12 s)	(2.19–4.91 s)	–0.82
Case > 5 s, n (%)	5 (3)	37 (24)	P-valu
Case > 10 s, n (%)	0	5 (3)	-



Resuscitation 2022; DOI: 10.1016/j.resuscitation.2022.06.025

A new method to evaluate carotid blood flow by continuous Doppler monitoring during cardiopulmonary resuscitation in a porcine model of cardiac arrest

Xiaoli Zhao[a], Shuo Wang[b], Wei Yuan[c], Junyuan Wu[c], Chunsheng Li[a,*]

Abstract

Aim: We used a wearable carotid Doppler patch to study carotid blood flow patterns in a porcine model of cardiac arrest to identify return of spontaneous circulation (ROSC) and hemodynamics associated with different arrhythmias and the quality of compressions.

Methods: Twenty Landrace pigs were used as models of cardiac arrest following a standard protocol. Carotid blood flow was monitored continuously using noninvasive ultrasound. Carotid spectral waveforms were captured during various arrhythmias and CPR. Typical carotid blood flow waveforms were recorded at the time of ROSC, and hemodynamic changes were compared with carotid blood flow parameters.

Results: The results showed that the carotid blood flow waveforms varied with ventricular arrhythmia type. During CPR, compression depth correlated significantly with carotid maximal velocity (Vmax) (Spearman correlation coefficient (r) = 0.682, $P < 0.001$) and velocity–time integral (VTI) ($r = 0.794$, $P < 0.001$). Vmax and VTI demonstrated moderate predictive value for survival. The regular carotid blood flow pattern towards the brain was observed during ROSC, concurrent with compression waveforms. After ROSC, VTI and carotid pulse volume (cPV) showed similar trends as stroke volume (SV). The carotid minute volume (cMV) exhibited a similar trend as cardiac output (CO).

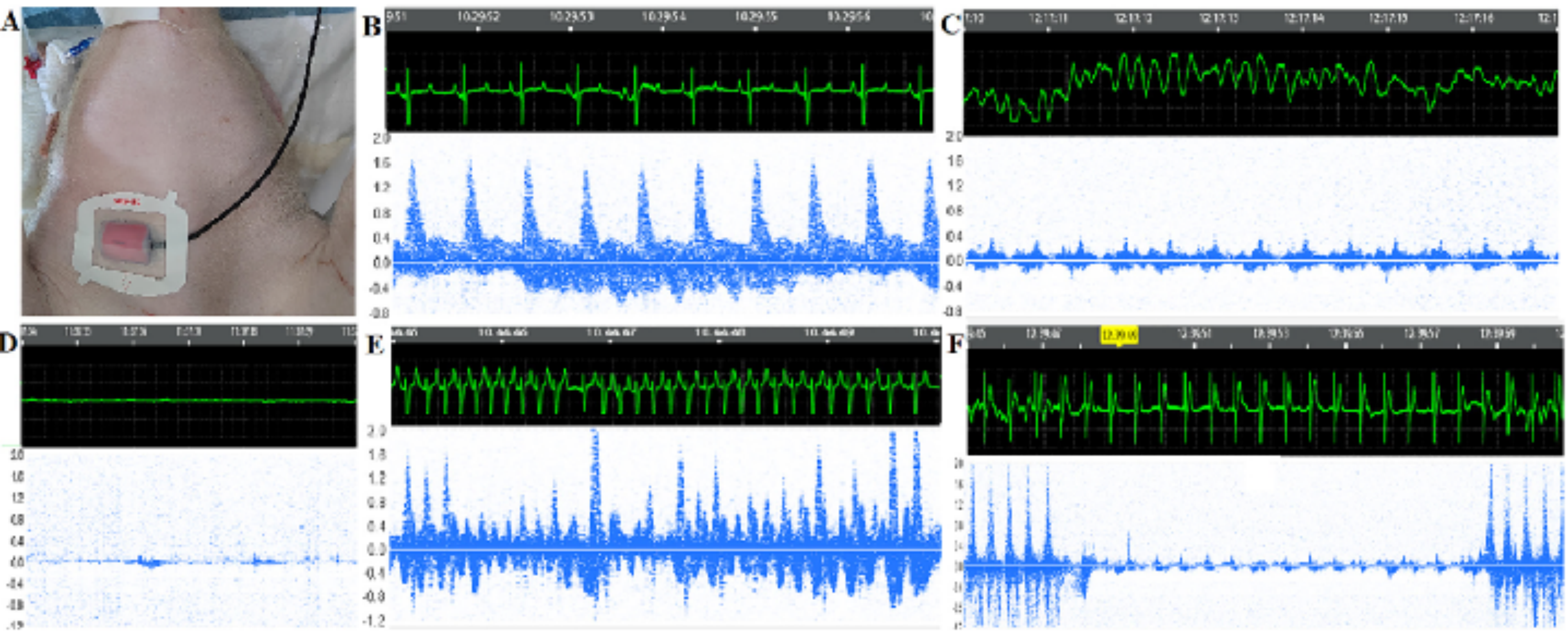
Conclusions: Carotid blood flow monitoring could provide valuable information about different arrhythmias as well as the quality of CPR. Carotid flow monitoring allows for timely and effective identification of ROSC. In addition, it may provide valuable hemodynamic information after ROSC.

Keywords: Cardiac arrest, Cardiopulmonary resuscitation, Porcine model, Deployable ultrasound, Carotid blood flow monitoring, Return of spontaneous circulation

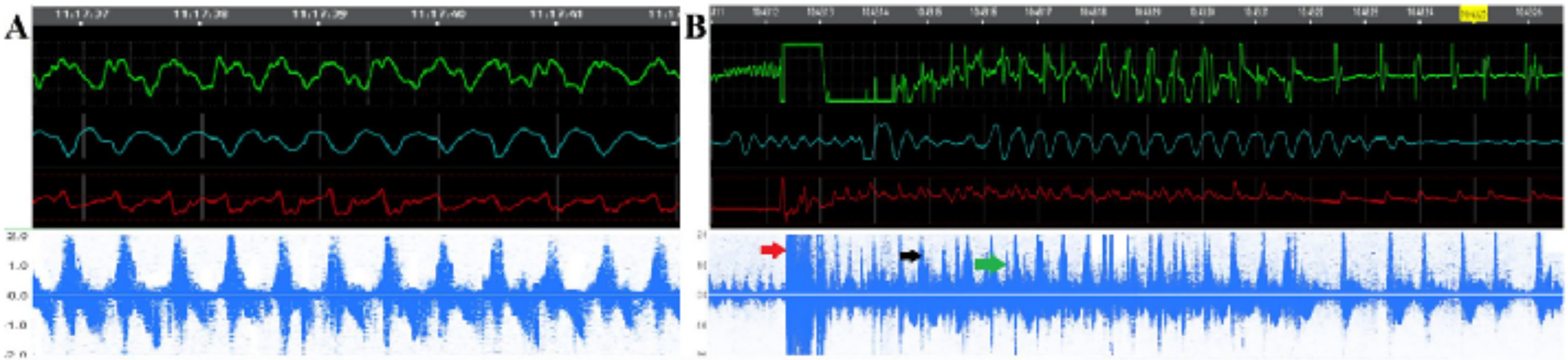
Resuscitation 2024; DOI: 10.1016/j.resuscitation.2023.110092

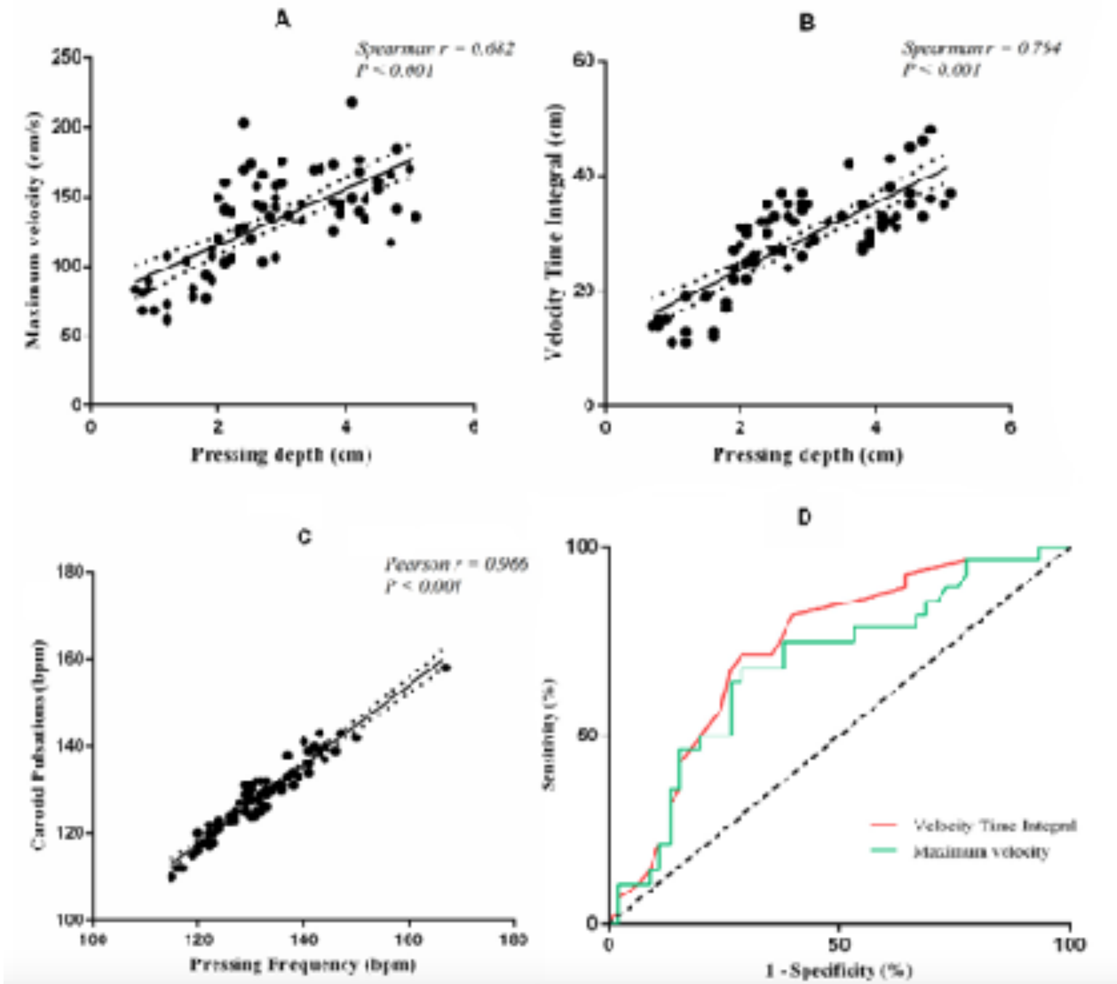
A new method to evaluate carotid blood flow by continuous Doppler monitoring during cardiopulmonary resuscitation in a porcine model of cardiac arrest

Xiaoli Zhao[a], Shuo Wang[b], Wei Yuan[c], Junyuan Wu[c], Chunsheng Li[a,]*

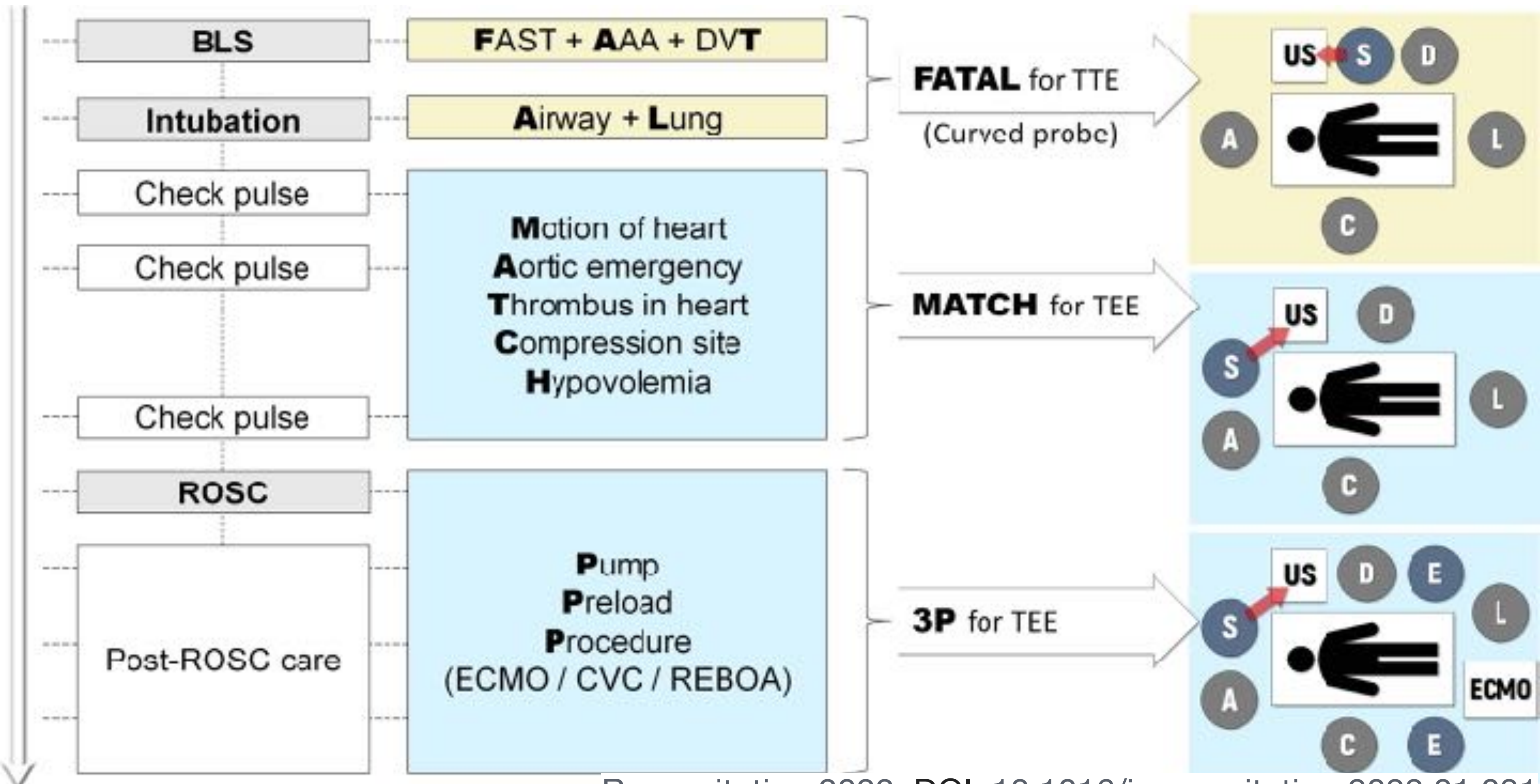


Resuscitation 2024; DOI: 10.1016/j.resuscitation.2023.110092

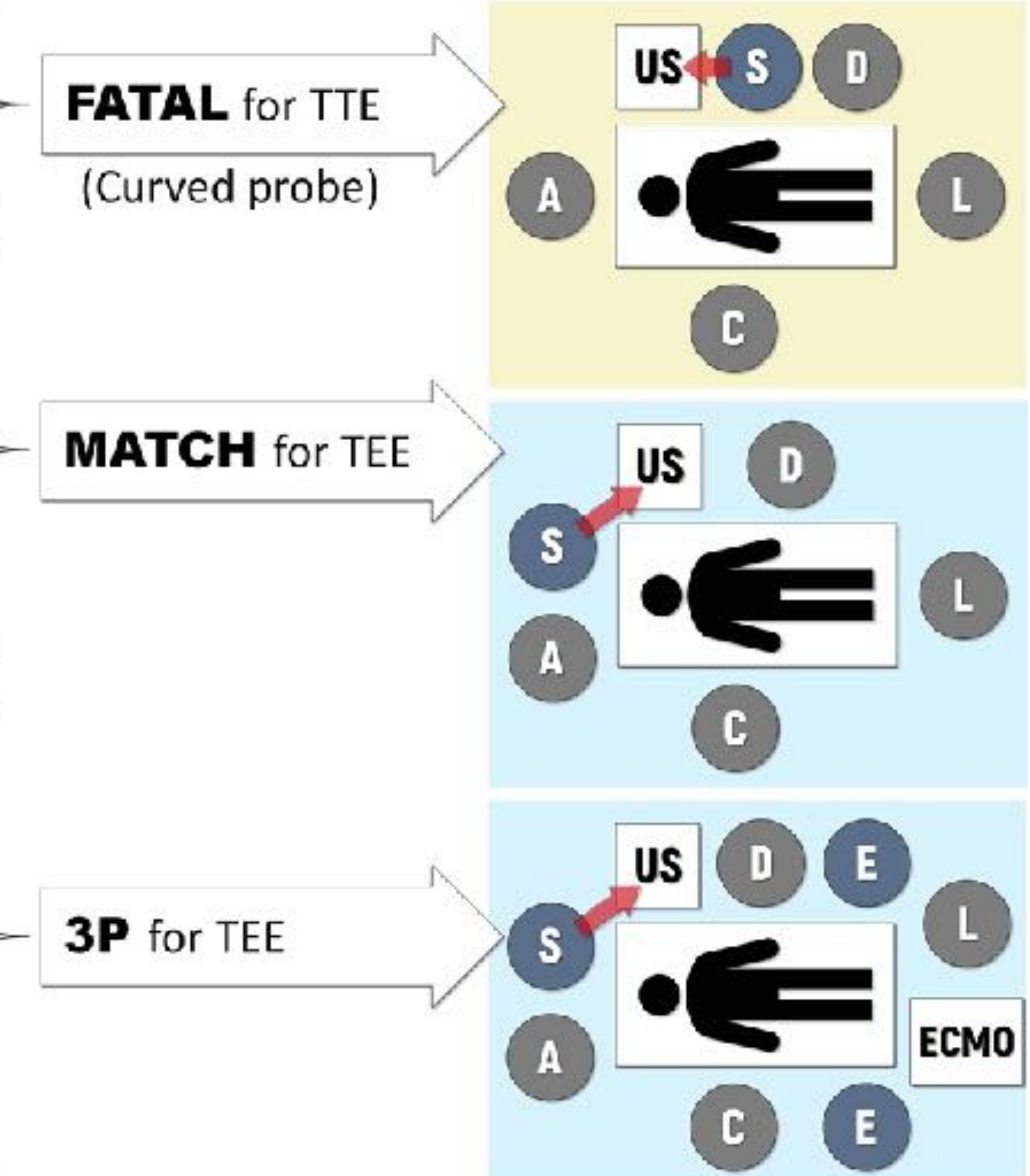

A
B
2.0
1.0
0.0
-1.0
-2.0


A
Spearman r = 0.662
P < 0.001
Maximum velocity (cm/s)
Pressing depth (cm)
B
Spearman r = 0.754
P < 0.001
Velocity Time Integral (cm)
Pressing depth (cm)
C
Pearson r = 0.966
P < 0.001
Carotid Pulsations (bpm)
Pressing Frequency (bpm)
D
Sensitivity (%)
1 - Specificity (%)
Velocity Time Integral
Maximum velocity

Core Ultrasound in REsuscitation (CURE): A novel protocol for ultrasound-assistant life support via application of both transesophageal and transthoracic ultrasound



Resuscitation 2022; DOI: 10.1016/j.resuscitation.2022.01.031

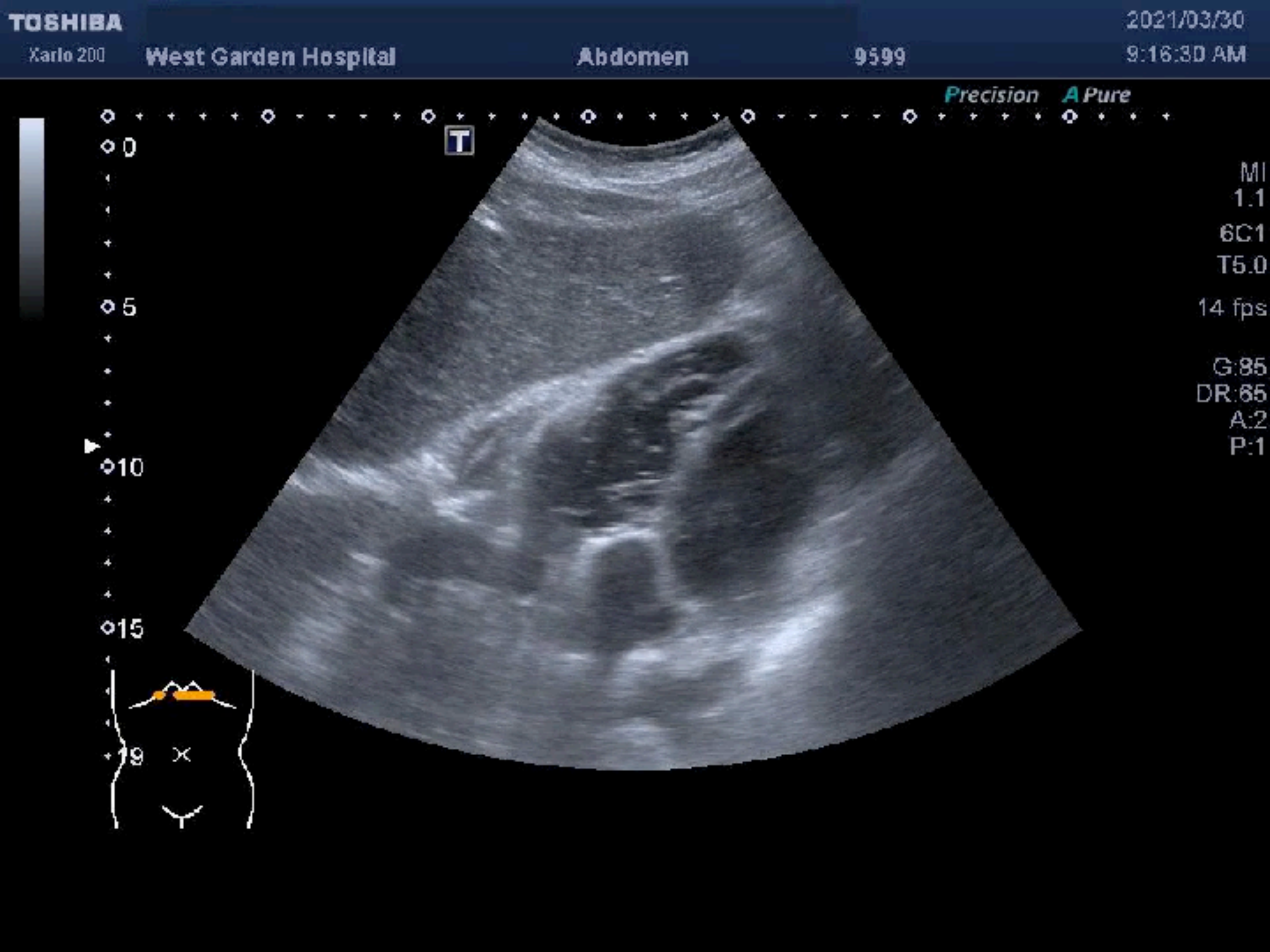


US location

mCASA

A line

TEE


TOSHIBA
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West Garden Hospital
Abdomen
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9:16:30 AM
Precision
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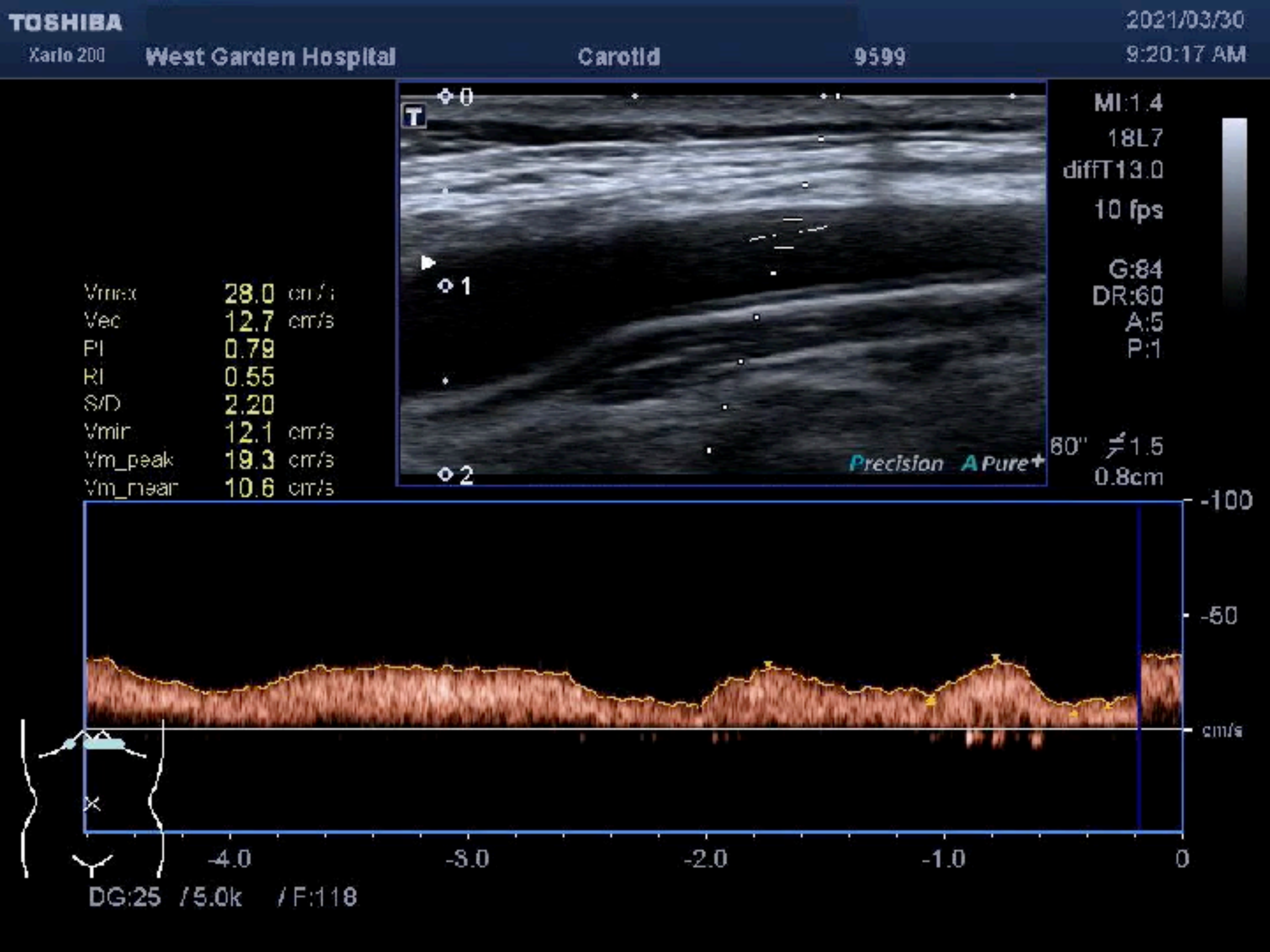
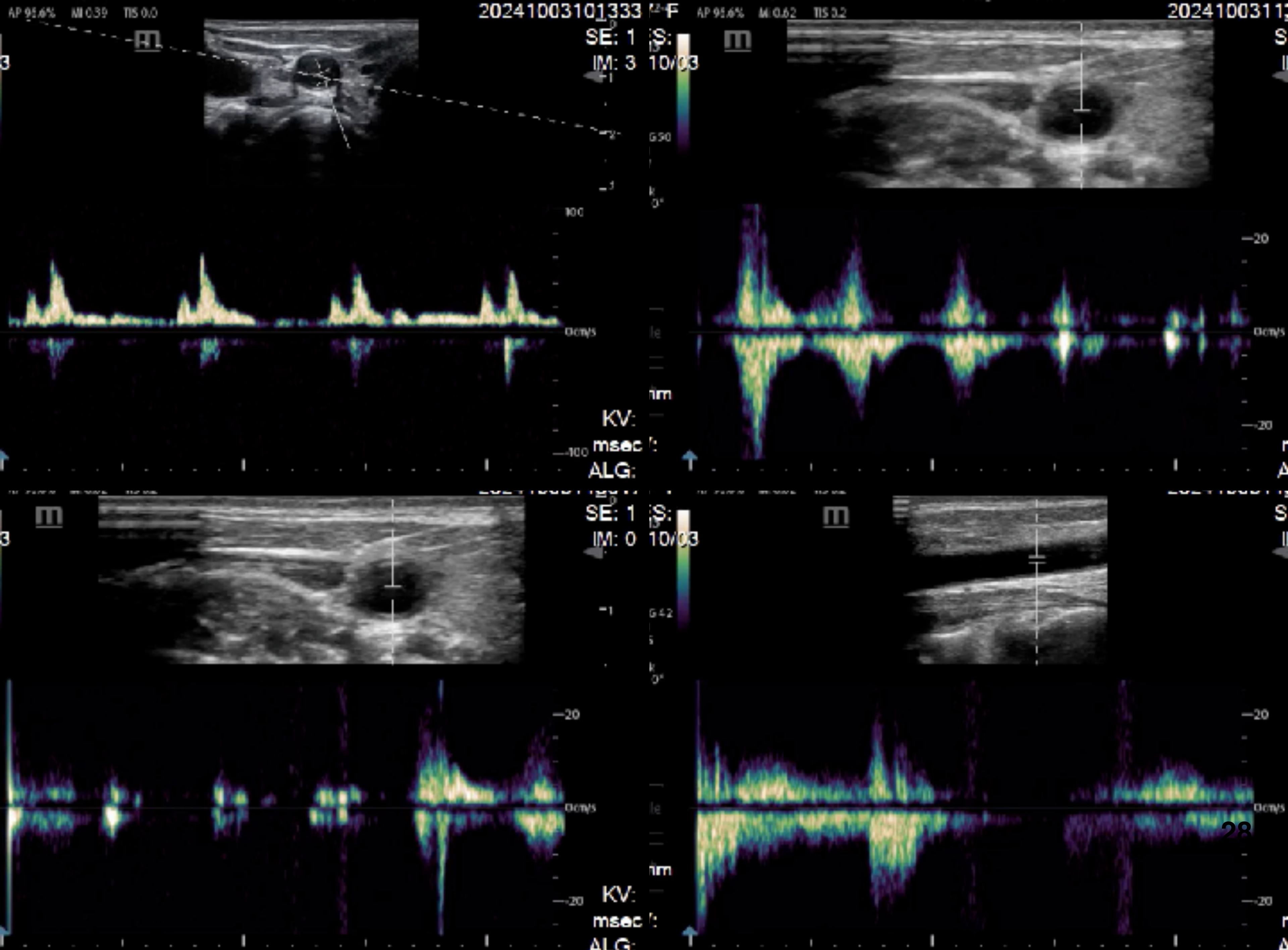
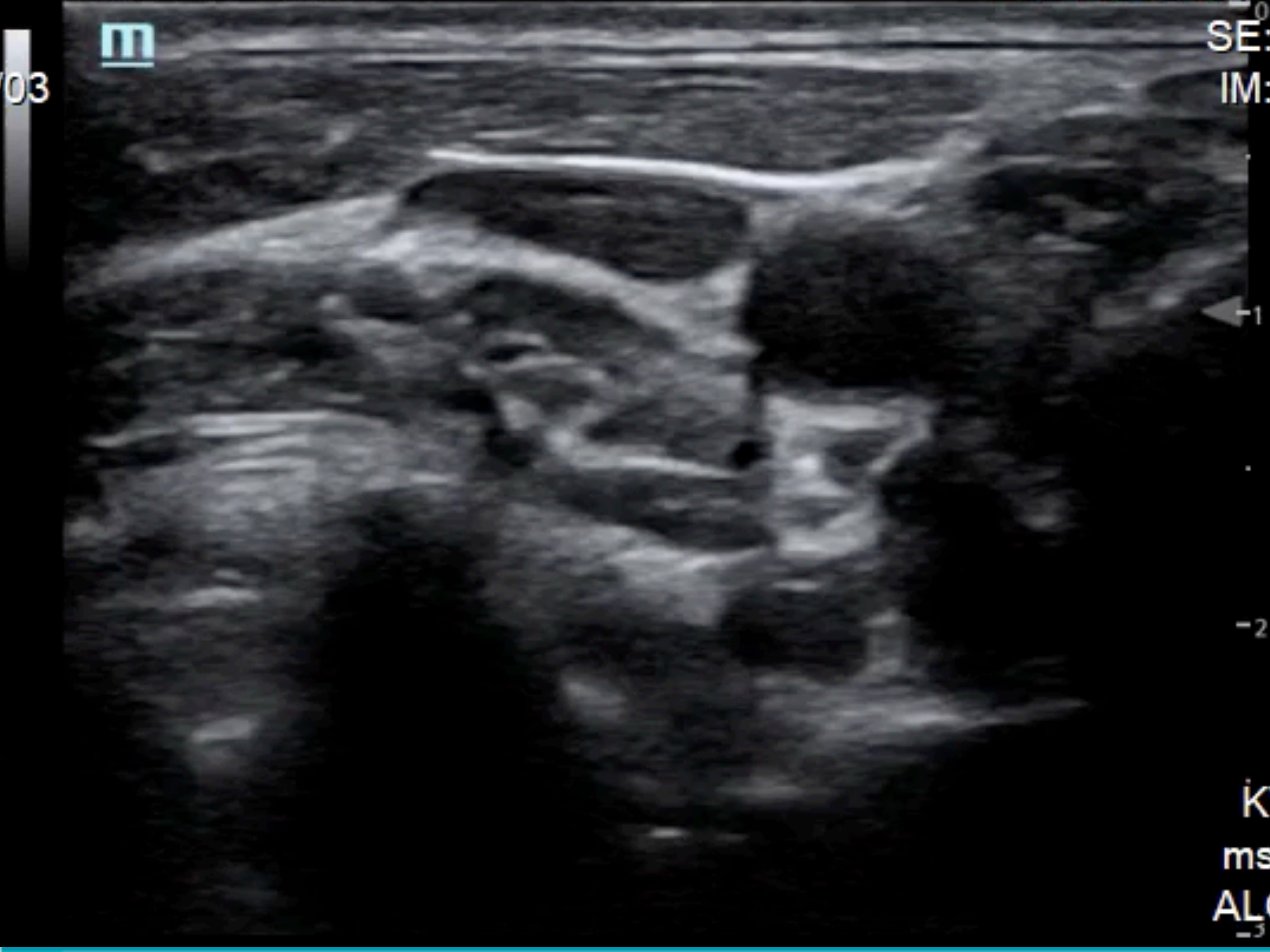
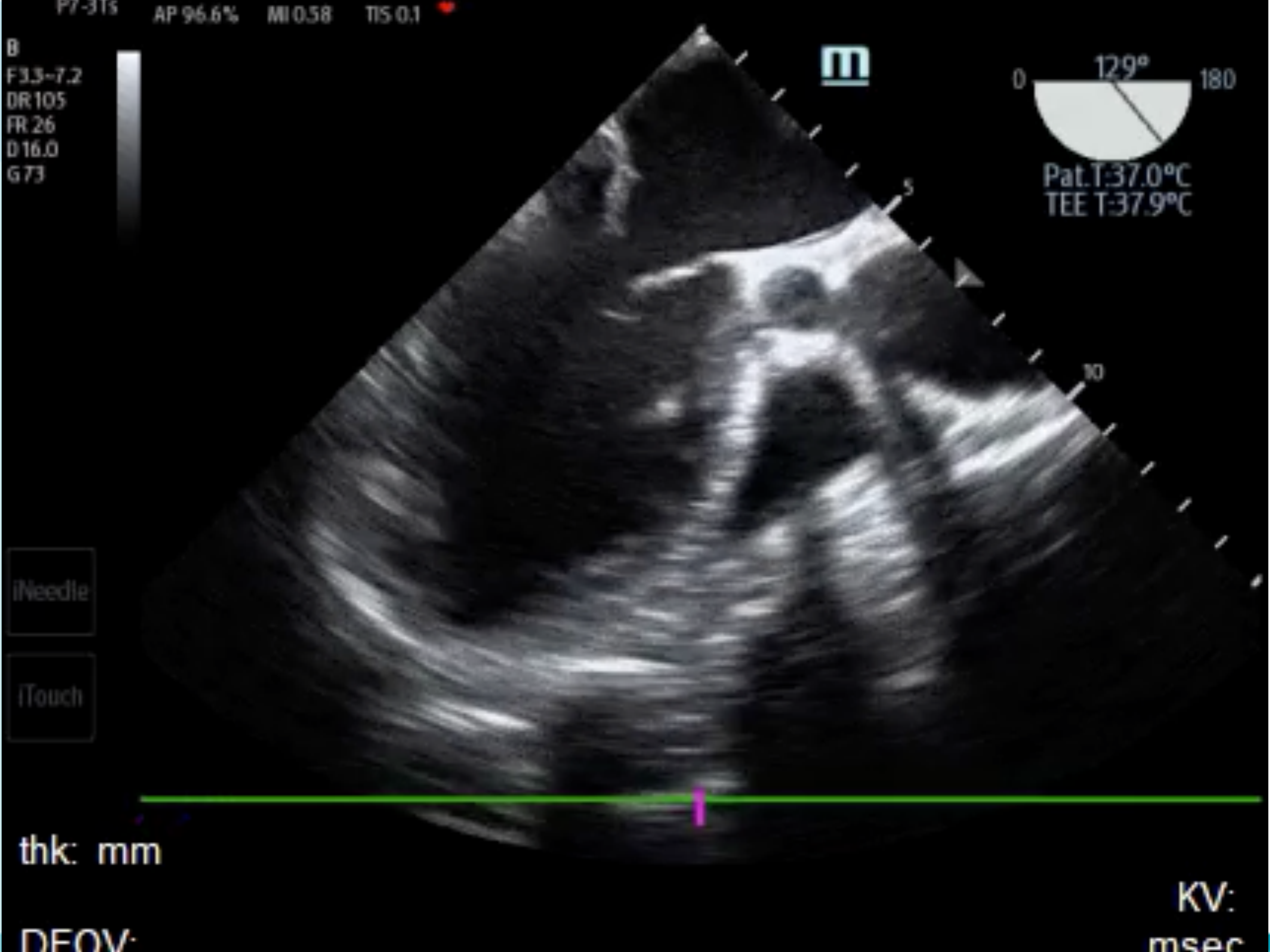
14 fps
G:85
DR:65
A:2
P:1


TOSHIBA
Xario 200
West Garden Hospital
Carotid
9599
2021/03/30
9:20:17 AM
MI:1.4
18L7
diffT13.0
10 fps
G:84
DR:60
A:5
P:1
60° 1.5
0.8cm
Vmax 28.0 cm/s
Ved 12.7 cm/s
PI 0.79
RI 0.55
S/D 2.20
Vmin 12.1 cm/s
Vm_peak 19.3 cm/s
Vm_mean 10.6 cm/s
Precision
Pure+
-100
-50
cm/s
-4.0
-3.0
-2.0
-1.0
0
DG:25 / 5.0k / F:118


20241003101333
SE: 1
IM: 3
10/03
KV:
msec
ALG:
SE: 1
IM: 0
10/03
KV:
msec
ALG:


SE:
IM:
1
2
K
ms


AP 96.6%
MI 0.58
TIS 0.1
B
F3.3-7.2
DR 105
FR 26
D 16.0
G 73
0
129°
180
Pat.T:37.0°C
TEE T:37.9°C
5
10
iNeedle
iTouch
thk: mm
KV:


PHILIPS
TemporaryID-20240318182922
24-03-18-182922
SKH ER
MI 1.1
TIS 0.1
3/18/2024
6:39:06 PM
Arterial
L12-3
37 Hz
4.0cm
2D
HGen
Gn 96
C 41
3/3/2
P
R
4.0cm