

# A Novel Non-Invasive Technology to Assess Right Atrial Pressure. A Report from SICA-HF

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## Background & Aims

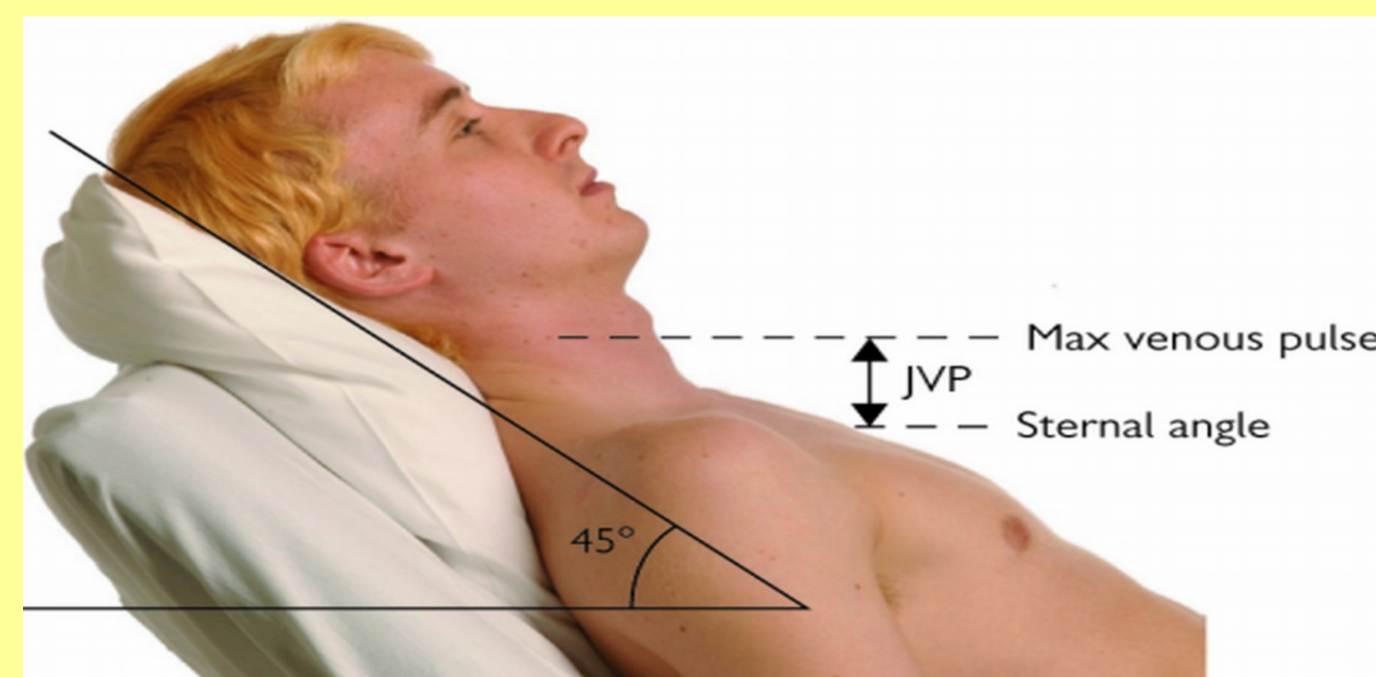
Increased jugular venous pressure (JVP) reflects increased hydrostatic pressure in the right atrium (RA) and is a fundamental clinical sign in heart failure. Clinical assessment is often difficult and can be very subjective.

We aimed at evaluating agreement amongst different doctors during their specialist training in assessing JVP and how novel invasive technologies could identify volume overload amongst patients with a spectrum of severity of heart failure and in control subjects without important myocardial or valve disease.

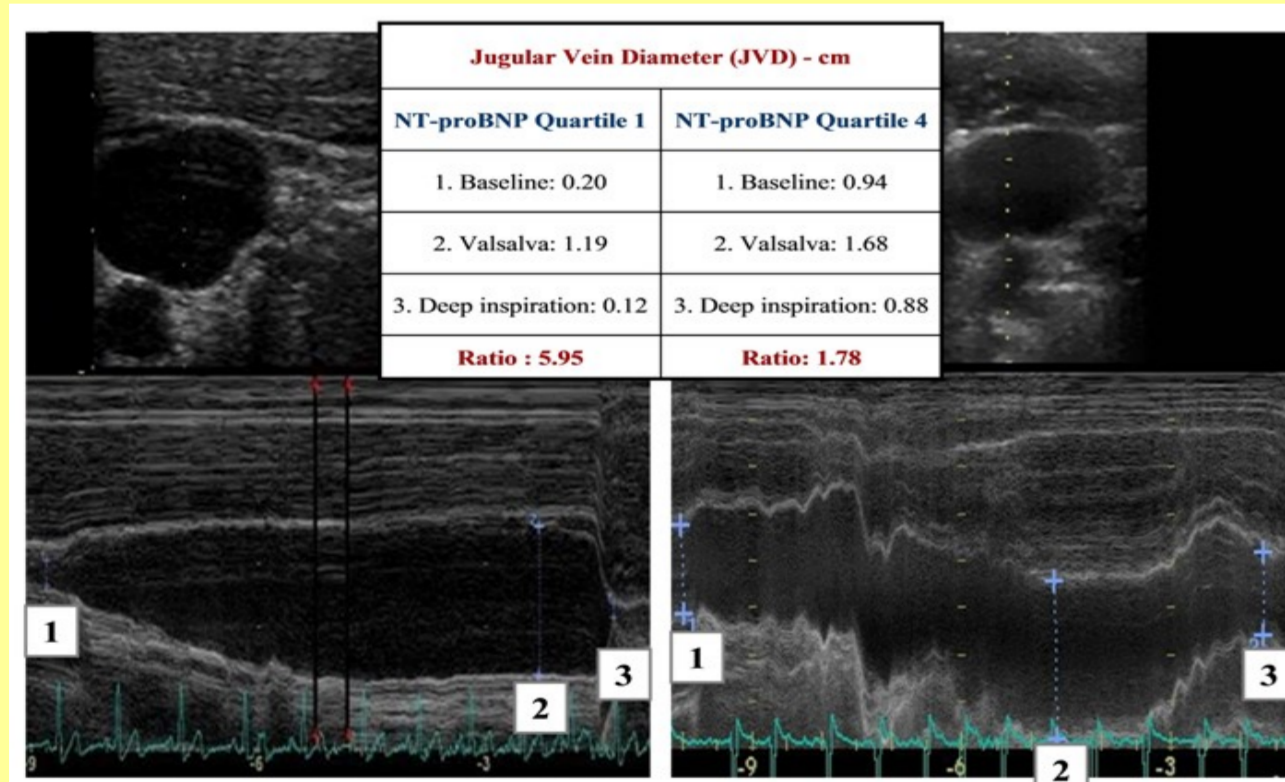
## Methods - 1

Consecutive out-patients with heart failure and controls enrolled in the "Studies Investigating Co-morbidities Aggravating Heart Failure" (SICA-HF) were assessed.

With the patient semi-recumbent at 45°, the internal jugular vein pressure (JVP) was assessed by 3 doctors at different stages of training and clinically estimated as not raised/unremarkable (0), borderline/marginally raised (1), elevated (2).



## Methods 2



With the patient reclining with head elevated 45°, the internal jugular vein (JV) is identified and then JV dimension and its changes measured continuously by M-mode ultrasound using a linear high frequency probe (10 MHz) at rest and during a Valsalva manoeuvre. The ratio between maximum JV diameter and diameter at rest was calculated (JVD ratio).

JVD changes and JVD ratio in different patients with HF are shown in the figure above (on the left side, for a patient in the lowest NT-proBNP quartile and on the right side for a patient in the highest NT-proBNP quartile).

## Methods -3



Using near-infrared spectroscopy (NIRS), the right atrial pressure is estimated over the external jugular vein (Venus 1000, Mespere LifeSciences Inc., Canada).

## Results 1 – Clinical JVP Assessment

Junior Registrar				Junior Doctor				Senior Registrar			
Assessment	0	1	2	Assessment	0	1	2	Assessment	0	1	2
0 (not raised)	4	3	0	0 (not raised)	3	2	0	0 (not raised)	4	0	1
1 (borderline)	2	2	1	1 (borderline)	3	3	1	1 (borderline)	2	4	1
2 (raised)	0	1	2	2 (raised)	1	0	2	2 (raised)	0	2	1

Kappa=0.27 (95% CI=-0.09,0.64)      Kappa=0.28 (95% CI=-0.08,0.64)      Kappa=0.36 (95% CI=0.01,0.74)

Statistical agreement for JVP measured on a 0, 1, 2 scale by different physician was higher between the senior grades (right) and weaker between junior grades (left).

Variables	Controls (n=22)	Heart failure (n=30)	P-value
Age – yr	70 (8)	70 (10)	0.986
Men – no. (%)	12 (54)	20 (67)	0.375
NYHA class – no. (%)			
I	21 (96)	6 (20)	<0.001
II	1 (4)	13 (43)	
III	0 (0)	11 (37)	
IHD – no. (%)	3 (14)	21 (70)	<0.001
DM – no. (%)	18 (82)	11 (37)	0.001
Hypertension – no. (%)	16 (75)	9 (30)	0.002
AF – no. (%)	0 (0)	13 (43)	<0.001
COPD – no. (%)	1 (4)	1 (3)	0.822
SBP – mmHg	146 (17)	119 (20)	<0.001
Heart rate – bpm	70 (14)	70 (20)	0.922
Urea – mmol/l	5.4 (1.7)	9.2 (7.0)	0.007
eGFR – ml/min/m <sup>2</sup>	96 (30)	63 (25)	<0.001
Haemoglobin – g/dl	14.0 (1.7)	13.0 (1.3)	0.067
NT-proBNP** – ng/l	105 (44-157)	1351 (442-2520)	<0.001
Beta-blocker	6 (27)	25 (83)	<0.001
ACE inhibitor or ARB	12 (55)	27 (90)	0.004
Loop diuretic	3 (14)	23 (77)	<0.001

Table 1: Characteristics of patients by diagnosis. List of abbreviation used: SBP - systolic blood pressure; eGFR - estimated Glomerular Filtration Rate; NTproBNP - N-terminal B-type natriuretic peptide.

## Results 2 - Echocardiographic Characteristics

Variables	Controls (n=22)	Heart failure (n=30)	P-value
LVEDD – mm	4.7 (0.5)	5.8 (0.9)	<0.001
LVEDV – ml	89 (25)	168 (69)	<0.001
LVEF - %	58 (4)	41 (13)	<0.001
LAVI - ml/m <sup>2</sup>	28 (19)	42 (17)	0.011
E/E' lateral	9 (4)	15 (8)	0.006
TAPSE – mm	2.3 (0.4)	1.7 (0.4)	<0.001
TR gradient - mmHg	22 (6)	29 (10)	0.010
IVC - mm	1.5 (0.3)	2.1 (0.5)	<0.001
MR - Mild	3 (14)	14 (47)	0.003
MR -Moderate/Severe	0 (0)	4 (13)	
TR – Mild	3 (14)	14 (47)	0.019
TR - Moderate/Severe	1 (4)	3 (10)	

List of abbreviation used: LVEDD - left ventricle end-diastolic diameter; LVEDV - left ventricle end diastolic volume; LVEF - ejection fraction; LAVI - left atrial volume index; TAPSE - Tricuspid Annular Plane Systolic Excursion; TR gradient- Trans-Tricuspid systolic gradient, IVC: inferior Vena Cava; MR : Mitral Regurgitation; TR: Tricuspid Regurgitation.

## Results 3 – Non invasive assessment of right atrial pressure

Variables	Controls (n=22)	Heart failure (n=30)	P-value
JVD Ratio	6.4 (5.6-7.9)	5.4 (3.7-6.7)	0.020
RAP (NIRS) – mmHg	5.5 (4.0-9.3)	10.0 (5.0-15.0)	0.004

Compared to controls, JVD ratio was lower and RA pressures measured using NIRS higher in patients with HF.

## Conclusions

In out-patients with chronic HF, measurement of RA pressures using a novel non-invasive device was strongly related both to an echocardiographic measures right ventricular overload and to NT-proBNP.

This contrasts with poor agreement amongst clinicians in estimating JVP.

## Results 4 - Correlations

	NIRS	JVD ratio	LVEF	NTproBNP	TR Gradient	IVC
JVD ratio	-0.475 (<0.001)		0.201 (0.152)	-0.372 (0.007)	-0.515 (<0.001)	-0.595 (<0.001)
NIRS		-0.475 (<0.001)	-0.290 (0.037)	0.587 (<0.001)	0.562 (<0.001)	0.718 (<0.001)

JVD ratio and RA pressures strongly correlated with other echocardiographic measurements of right ventricle (RV) overload and NTproBNP plasma levels.



Conflict of interest : none declared.