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ORIGINAL ARTICLE

# Cardiac effects of positive pressure ventilation in ARDS assessed by NT-proBNP, Troponin T and Troponin I

**Yasser Sadek Nassar** *, **Dina Monsef, Sanaa Abdelshafy, Gamal Hamed**

*Cairo University, Critical Care Department, Cairo, Egypt*

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**KEYWORDS**

Cardiac markers;
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Troponin I;
PEEP;
ARDS

**Abstract** *Introduction:* Positive pressure ventilation may potentially affect the heart in ARDS patients with structurally normal hearts and maybe correlated with respiratory parameters.

*Aim:* We aimed at observing NT-proBNP, Troponin I and Troponin T levels in relation to respiratory parameters and positive pressure ventilation during the first week of ARDS (day 0, 2, 7).

*Patients and methods:* The study comprised 20 patients with mean age of 58.9 ± 20.69 years, 11 men vs. 9 women ($p > 0.05$). Inclusion criteria were any adult patient diagnosed to have ARDS according to the criteria of the American–European Consensus Conference in 1994. Exclusion criteria were any structural heart disease by echo, pulmonary embolism, atrial fibrillation, renal insufficiency, age less than 18. All patients were placed on a lung protective ventilation strategy. Plasma NT-proBNP, Troponin I and Troponin T were measured on day 0 and on day 2 and day 7 of ARDS diagnosis. PH, $PaCO_2$, $PaO_2$, $PaO_2/FiO_2$ ratio, PEEP, PIP (peak airway pressure), Pmean, Pplat (plateau pressure) and Ceff (effective compliance), RaW (airway resistance) were monitored daily.

*Results:* NT-proBNP was negatively correlated with PH on day 2 ($p$ 0.008, $r$ −0.53) and day 7 with ($p$ 0.02, $r$ −0.50). NT-proBNP was positively correlated with PEEP on day 2 ($p$ 0.05, $r$ 0.46) and day 7 ($p$ 0.035, $r$ 0.48). NT-proBNP was negatively correlated with $PaO_2/FiO_2$ ratio on day 7 ($p$ 0.0035, $r$ 0.60). However, there was no significant correlation between NT-proBNP and other respiratory indices including $PaCO_2$, $HCO_3$, $PaO_2$, $SaO_2$, $FiO_2$ ($p > 0.05$). Neither Troponin I nor Troponin T showed any significant correlation with any respiratory indices PH, PEEP, $PaO_2/FiO_2$, $PaCO_2$, $HCO_3$, $PaO_2$, $SaO_2$, $FiO_2$ at any day ($p > 0.05$). None of the cardiac markers NT-proBNPP, Troponin I or Troponin T showed any significant correlation with lung mechanics parameters Cdyn, RaW, Ceff, PIP, Pplat, Pmean ($p > 0.05$).

* Corresponding author.
E-mail address: ysnassar@kasraliny.edu.eg (Y.S. Nassar).
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*Conclusions:* In patients with ARDS positive pressure ventilation may adversely affect the heart as reflected by elevations of NT-proBNP. High NT-proBNP level was correlated with high PEEP, low PH and low $PaO_2/FiO_2$ ratio while Trop T and Trop I did not show significant correlations with respiratory parameters. None of the cardiac markers NT-proBNP, Troponin I or Troponin T showed any significant correlation with lung mechanics parameters (Cdyn, RaW, Ceff, PIP, Pplat, Pmean, $p > 0.05$) in ARDS patients with structurally normal hearts.

Although the increase in cardiac markers are insignificant, yet they point to the potentially harmful role played by high PEEP, low PH and low $PaO_2/FiO_2$ ratio on the heart. Currently, no clinically relevant conclusion can be drawn apart from the recommendation to attempt to lower PEEP and shorten the duration of positive pressure ventilation, even in patients with structurally normal hearts.



## Introduction

Studies have shown that cardiac injury may occur in ARDS patients with structurally normal hearts and this maybe correlated with the underlying respiratory changes [25]. B-type natriuretic peptide (BNP) and N-terminal brain natriuretic peptide (NT-BNP) are amino acid hormones that are synthesized in the ventricular myocardium and released into the bloodstream primarily under conditions of ventricular dilatation and pressure overload. Serum half-lives of the NT peptides (NT-proANP and NT-proBNP) are considerably longer than those of other natriuretic peptides, resulting in plasma levels that are at least 5–15 times larger. Thus, they are less influenced by the conditions under which the sample is drawn and may therefore be more appropriate in critical care settings. Moreover, although BNP and NT-proBNP have equal predictive values for heart failure, the latter is probably more sensitive in predicting death. Mueller et al. (2005) compared head to head the diagnostic accuracy of B-type natriuretic peptide (BNP) and the amino terminal fragment of its precursor hormone (NT-proBNP) and showed that BNP and NT-proBNP may be equally useful as an aid in the diagnosis of CHF in short of breath patients presenting to the emergency department [1]. According to the Canadian Cardiovascular Society 2012, NT-proBNP is recommended to be obtained to rule in acute heart failure if its symptoms are suspicious (900 pg/mL if age 50–75 years, 1800 if age 75 years) or to be ruled out if NT-proBNP $< 300$ pg/mL.[32]

## Aim of the study

To assess the levels of biomarkers of cardiac injury (NT-proBNP, Trop I and Trop T) and observe its relationship with respiratory parameters and positive pressure ventilation during the first week of ARDS (days 0, 2 and 7).

## Patients

We performed the study prospectively on 20 adult patients admitted to Critical Care Medicine Department, Cairo University Hospital, who were diagnosed to have acute respiratory distress syndrome (ARDS) from June 2008 until April 2009.

### *Inclusion criteria*

Any adult patient diagnosed to have ARDS according to the criteria of the American–European Consensus Conference in 1994 in which the disease is to be confirmed by the combination of following diagnostic criteria:

- An initiating clinical condition (e.g. sepsis, burns).
- Acute onset.
- Bilateral infiltrates documented by chest radiograph at end-inspiratory position.
- Pulmonary artery wedge pressure $\leqslant 18$ mmHg or absence of clinical evidence of left atrial hypertension by echocardiography.
- ARDS: $PaO_2/FiO_2$ ratio $\leqslant 200$ in a stable state after the patient has adapted to standardized ventilation (regardless of the level of PEEP).

### *Exclusion criteria*

- Congenital heart diseases.
- Ischemic heart disease.
- Cardiomyopathies.
- Chronic Cor pulmonale.
- Atrial fibrillation.
- Pre-existent renal insufficiency.
- Pulmonary embolism.

## Methods

All patients were subjected to full history taking, thorough clinical examination and transthoracic echocardiography to exclude structural heart diseases. All patients benefited from mechanical ventilation with Lung protective ventilation strategy according to NHBLI ARDS Network Treatment Protocol. Daily arterial blood gases were analyzed (PH, $PaCO_2$, $HCO_3$, $PaO_2$, $SaO_2$, $FiO_2$, $PaO_2/FiO_2$), and mechanical ventilatory mechanics parameters were recorded: Positive End Expiratory pressure (PEEP), effective compliance (Ceff), dynamic compliance (Cdyn), airway resistance (RaW), peak inflation pressure (PIP), Plateau pressure (Pplat), mean airway pressure (Pmean).

Cardiac markers N-terminal pro-brain natriuretic peptide (NT-proBNP), cardiac Troponin I (Trop I) and Troponin T (Trop T) plasma level measurement were taken on days 0, 2 and 7. Venous blood samples were collected in 10-ml vacutainers containing heparin. The samples were centrifuged at 3000*g*