# Targeted Neonatal Echocardiography in Neonatal Intensive Care Unit In Sohag University Hospital: A prospective hospital-based study

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## Abstract:

**Background**: Targeted neonatal echocardiography (TNE) is proposed to describe the use of targeted neonatal echocardiography to assess systemic and pulmonary blood flow, myocardial function, intracardiac and extracardiac shunts, organ blood flow and tissue perfusion. It gives non-invasive information on the underlying cardiovascular pathophysiology causing hemodynamic instability and the response to treatment in an individual patient over time.

Objective: Our main objective in this study is to delineate the impact of echocardiography in the management of unstable neonates at neonatal ICU at Sohag University Hospital.

Methods: A prospective hospital-based study included 191 neonates. TNE was done for all included infants as indicated by the clinical team. TNE used to assess PDA regarding diagnosis of patency and hemodynamic significance. Right ventricular systolic pressure and Pulmonary artery pressure were assessed for diagnosis, management and follow up pf pulmonary hypertension. The main outcome was measured by the impact of TNE on the management plane of the included infants and their short term outcome.

Results: there were 60 (31.41%) preterm newborns have PDA, 45 (75%) of them were hemodynamically significant, of them 28 were closed by medical treatment, 15 needed surgical ligation and 2 infants died. There were 28 (14.65%) newborns had pulmonary hypertension, 27 cases were improved using medical treatment and one case died.

**Keywords:** targeted neonatal echocardiography, PDA, Pulmonary hypertension.

## Introduction:

The role of echocardiography in the neonatal intensive care unit (NICU) has changed over the past few years. Previously, nearly all echocardiographic studies in the NICU were performed by pediatric cardiologists to diagnose or monitor congenital heart disease (CHD) and to screen for patent ductus arteriosus (PDA). Recently, neonatologists have become interested in the echocardiographic assessment of hemodynamic instability in infants. The terms functional echocardiography and point-of-care echocardiography have been introduced to describe the use of echocardiography as an adjunct in the clinical assessment of the hemodynamic status in neonates (Sehgal and McNamara, 2008)(١) .

Targeted neonatal echocardiography is proposed to describe the bedside use of echocardiography to longitudinally assess myocardial function, systemic and pulmonary blood flow, intracardiac and extracardiac shunts, organ blood flow and tissue perfusion. The primary goals of targeted neonatal echocardiography are to provide non-invasive information on the underlying cardiovascular pathophysiology causing hemodynamic instability and

the response to treatment in an individual patient over time (Kluckow et al., 2007)(٢) .

The use of point-of-care focused ultrasound for evaluation of the cardiovascular system within the context of clinical decision making is gaining wide interest. In the acute care setting, non-ultrasound specialists can be trained to provide focused imaging and measurements. This approach does not aim to replace the detailed structural assessments provided by consultative services such as cardiology or radiology. It is designed to support clinical judgment and provide a better understanding of the physiological processes, and monitor the response to treatment. This approach, which combines both clinical examination and bedside echocardiography, has been shown to improve clinical diagnosis and patient management. The point-of-care ultrasound examination is usually directive and focused towards a specific clinical problem (Beaulieu, 2007)(٣) .

Our aim in this study is to delineate the impact of echocardiography in the management of unstable neonates at neonatal ICU at Sohag University Hospital

## Material and methods:

A prospective hospital-based study was conducted during the 12-month period, the period from October 2016 to September 2017. During the study period550 newborns babies were admitted in NICU at Sohag university hospital and 191 of them were evaluated by TNE and enrolled in the study after obtaining written informed consent from the caregivers. The patients were clinically assessed regarding history and examination for Apgar score, heart rate, respiratory rate, $O_2$ saturation, blood pressure, and Cardiac examination. Full cardiac examination included heart rate and presence of murmur and femoral pulsation .

Standard targeted neonatal echocardiography was done in this study by using an echocardiogram imaging system (Vivid T8 pro S/W China) with neonatal probe 5-8 MHz; all echocardiographic examinations were performed with infants asleep or quietly awake. No sedation was used and TNE was done by single operator.

Assessment of the PDA: according to our protocol for preterm infants was done at the 3rd day of life or at any time of appearance of clinical signs of hemodynamically significance shunt like (murmur or wide pulse pressure). In this study, we used 2D and color Doppler in modified left parasternal 'ductal' view and suprasternal view to visualize the PDA. Keeping the head in neutral position or using small shoulder roll to place the patient in a mildly extended or mildly left lateral decubitus and this facilitates imaging of PDA in its entirety. Ductal size measured by 2D imaging at the narrowest point, which usually is toward pulmonary end of the duct. For shunt direction and gradient calculation, we used pulsed-wave or continuous-wave Doppler interrogation parallel to the direction of the ductal flow jet. LA/AO ratio was measured in the parasternal long-axis using M-Mode. We considered that PDA is of hemodynamically significance when PDA diameter ≥1.5 mm and LA/AO ratio ≥1.5 mm. (McNamara and Sehgal, 2007)(٤). The selection of treatment options either giving intravenous paracetamol or oral Ibuprofen was based on decision of the clinical team.

Right ventricular systolic pressure and Pulmonary artery pressure were assessed through three methods. Firstly, measuring tricuspid regurgitation by continuous-wave

Doppler in Apical four-chamber view and then RVSP was calculated using the Bernoulli equation: RVSP = right atrial pressure + (4 × $v^2$), where $v^2$ is tricuspid regurgitation jet peak velocity. Right atrial pressure was considered equal to 5mmHg in absence of right atrial dilation. Pulmonary regurgitation early diastolic velocity in Parasternal short-axis view assessed by Pulsed-wave or continuous- wave Doppler was used to assess pulmonary diastolic pressure. Lastly, trans ductal flow direction was used also to estimate the severity of pulmonary hypertension (Mori, 2004)[6].

Follow up echocardiography was done for cases with PDA after 3 days from receiving a specific treatment regimen for hemodynamically significant shunt and repeated thereafter as indicated. In cases with pulmonary hypertension serial echocardiographic examination was done for follow up of pressure gradient and response to treatment with average 1 to 3 scans. Cases with suspected structural cardiac abnormalities; other than PDA, were evaluated by a cardiologist for definitive diagnosis and management.

The impact of TNE was assessed by deciding for or modification of the management plane, patient response according's and short term outcome regarding survival and morbidities on discharge

## Statistical analysis:

Data were analyzed using STATA version 12.1 (Stata Statistical Software: Release\... 14.2 College Station, TX: StataCorp LP.). Quantitative data were represented as mean, standard deviation, median, and range. Qualitative data were presented as number and percentage and compared using Chi-square test. Graphs were produced by using Excel or STATA program. P-value was considered significant if it was less than 0.05.

## Results:

550 newborns babies were admitted to NICU at Sohag university hospital. 191 of them were evaluated by TNE; 58 (30.37%) babies were full-term and 133 (69.63%) preterm babies (Table 1). Of the preterm babies, 52 was had a gestational age from 28 to 31.9 weeks and 81 near term babies with gestational age ranging from 32 to 36.9 weeks. TNE was done and (table 1) shows distribution of demographic data and anthropometric measures of the studied babies. The mean age of studied babies was 3.51±5.27 days ranging from 1 to 26 days. From studied babies there were 67 (35.08%) females and 124 (64.92%) males.

| **Variable** | **Number** | | **%** |
|---|---|---|---|
| Gender | Females | 67 | 35.08 |
| | Males | 124 | 64.92 |
| Gestational age | 28-31.9 weeks | 52 | 27.22 |
| | 32-36.9 weeks | 81 | 42.40 |
| | Full term (37-41.9) | 58 | 30.37 |
| Postnatal age (days) | 1 (1-26) | | |
| Weight / g | < 1٠٠٠ g | 9 (4.71%) | |
| | 1000-1499 g | 40 (20.94%) | |
| | 1500-2499 g | 63 (32.98%) | |
| | 2.500 -3499 g | 66 (34.55%) | |
| | ≥3500 g | 13 (6.80%) | |

**Table (1):** Distribution of demographic data of studied newborns.

From studied newborn there were 60 (31.41%) preterm newborns having PDA, its mean diameter was 2.18 ±0.97 mm ranging from 1 to 5 mm, the mean left atrium to aortic orifice ratio (LA/AO) was 1.50±0.28 cm ranging from 0.8 to1.9 cm, shunt direction over PDA was left to right in 59 cases and 45(75%) newborns had hemodynamically significant PDA **(Table 2)**

| Variable | Number (%) |
|---|---|
| PDA<br>No<br>Yes | <br>131 (68.59%)<br>60 (31.41%) |
| Diameter of PDA (mm)<br>Mean ± SD<br>Median (range) | N=60<br>2.18±0.97<br>2 (1-5) |
| LA/AO ratio (cm)<br>Mean ± SD<br>Median (range) | N=60<br>1.50±0.28<br>1.6 (0.8-1.9) |
| Shunt direction<br>Left to right shunt<br>Right to left | N=60<br>59<br>1 |
| Hemodynamically significant<br>No<br>Yes | N=60<br>15 (25.00%)<br>45 (75.00%) |

**Table (2):** Distribution of PDA and its features in studied newborns.

55 (28.8%) newborns improved and discharged after received treatment according to TNE finding, 28 (26.16%) newborns of these having PDA, their PDA closed after receiving treatment, 15(14.01%) newborns their PDA did not respond to medical treatment and needed surgical ligation (Table 3).

| Variable | Number | P value |
|---|---|---|
| Impact type<br>PDA need surgical ligation<br>Improved and referred to surgical correction<br>Closed PDA | <br>15(14.01%)<br>2 (25.23%)<br>28 (26.16%) | <br><br><0.0001 |

**Table (3):** Distribution of studied newborns according to the impact of target echo on outcome.

From the studied newborn, there were 28 newborns had pulmonary hypertension with mean pulmonary pressure 69.89 ±15.82 mmHg ranging from 44 to 110 mmHg (table 4) and all of them were improved using medical treatment except one case died after failure of response to treatment.

| Variable | Number (%) |
|---|---|
| Pulmonary hypertension<br>No<br>Yes | <br>163 (85.34%)<br>28 (14.66%) |
| Pulmonary pressure measurement<br>Mean ± SD<br>Median (range) | N=28<br>69.89 ±15.82<br>68 (44-110) |

**Table (4):** Distribution of pulmonary hypertension in studied newborns.

## Discussion:

TNE is bedside tools used for evaluation of hemodynamic instability in neonates and give non-invasive information on the cardiovascular pathophysiology causing hemodynamic unsteadiness. Standard targeted neonatal echocardiography was done by using an echocardiogram imaging system assessing mainly PDA patency and hemodynamic significance and pulmonary hypertension.

In present study, there were 60 (31.41%) newborns had PDA that was lower compared with the patients who conducted in Anilkumar et al., 2015(٦), EL-Khuffash et al(٧)., 2013 and Corredera et al., 2013 (٨) studies which were 93(50%), 261 (51%) and 29(58%) newborns respectively, and higher compared with the patients who conducted in O'Rourke et al., 2008(٩) study which was 20 (22.9%) newborns. There were 45(75%) cases of total of 60 cases with PDA had a hemodynamically significant shunt which was lower compared with the patients who conducted in Corredera et al., 2013 (٨)study which was 5(17.4%) cases of total 29 cases with PDA.

In this study, 45 (37.50%) newborns received medical treatment for trial of closure of hemodynamically significant PDA that was higher than the result shown in EL-Khuffash et al., 2013 (٧), Anilkumar et al., 2015 (٦), Orme et al., 2009 (١٠) and Corredera et al., 2013 (٨)studies which was (39%), (39.6%), 111 (51.2%) and 19 (36.9%) cases respectively.

There were 28 (14.66%) newborn had pulmonary hypertension that was lower compared with the patients who conducted in EL-Khuffash et al., 2013(٧) study which was 81 (15.8 %) newborns and higher compared with the patients who conducted in

Corredera et al., 2013 (٨)study and Anilkumar et al., 2015 (٦)which was 4 (7.5%) and 12 (6.6%) newborns respectively.

The limitations of this study might be the operator-dependent errors during echocardiographic examination and variability in measurement. Moreover, treatment modification following TNE ultimately depended on the decision of the physician and not only on the data obtained from the ultrasound, which may have affected the perceived influence of this technique on the management of neonates. Hence, the clinical community should be aware of the significant role of such advancing measurements for better patient outcomes.

**Conclusion:** we concluded that targeted neonatal echocardiography is an essential tool in NICU to diagnose various conditions like PDA in preterm newborns and pulmonary hypertension. There is a big impact in management of critical neonates after TNE examination.

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## Conflict of Interest:

There is no conflict of interest to be declared.

## Authors contributions:

All authors contributed to this project and article equally. All authors read and approved the final manuscript.

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