British Journal of Healthcare and Medical Research - Vol. 12, No. 04
Publication Date: August 12, 2025
DOI:10.14738/bjhr.1204.19186.
Bulbulia, B. A. & Essop, A. R. (2025). Pulmonary Hypertension in Adults with Congenital Heart Disease (ACHD): Case Study of Undetected Atria Septal Defect. *British Journal of Healthcare and Medical Research, Vol - 12(04).* 246-253.

Pulmonary Hypertension in Adults with Congenital Heart Disease (ACHD): Case Study of Undetected Atria Septal Defect

Dr B A Bulbulia. DA FCA (SA)
Milpark Hospital, Cardiac Cath Lab. Johannesburg. SA

Dr Anisa R Essop. MB BCh. (Wits)
Edenvale Hospital, Johannesburg. SA.

ABSTRACT

Patients with Congenital Heart Diseases (CHD) in developed economies reach adulthood (ACHD) due to early detection and medical advances. CHD may go undetected in developing nations during early childhood and present in later years as a result of complications. These include pulmonary hypertension (PH), right heart failure, atrial fibrillation, and stroke resulting from congenital heart conditions such as atrial (ASD) /ventricular septal defects (VSD). These debilitating illnesses have a high morbidity and mortality. A significant dilemma is the optimal management of patients with ASD complicated by PH. Echocardiography, with Right(R) and Left(L) heart studies are essential in evaluating these conditions. Therapeutic advances and newer pharmacological agents have improved survival in patients with PH. Failure of medical treatment may require surgical intervention. Operability and repair require expert opinion and specialist assessment. Lung transplant and closure of the ASD are remaining options.

Keywords: CHD in adults, Atrial septal defect, Pulmonary hypertension, Right heart dysfunction, Complications, Therapeutic advances, Operability.

INTRODUCTION

Pulmonary Hypertension (PH) is a rare disease, affecting 1% of the global population (1). PH is defined as a mean pulmonary artery pressure (PAP) of > then 20 mmHg measured at rest during cardiac catheterization (2). The definition includes a pulmonary vascular resistance (PVR) > 3 Wood units. The incidence and prevalence of pulmonary arterial hypertension (PAH) associated with CHD is 2.2 and 15.6 per 1 million respectively (2).

Clinical Classification of PH Comprises (1).

a) Pulmonary Arterial Hypertension (PAH) (Catergory1). This included idiopathic (IPAH), congenital heart disease (CHD) amongst other clinical syndromes.
b) PH due to left heart disease.
c) PH due to lung disease.
d) PH due chronic thrombo-embolic disease.
e) PH with multiple mechanisms.

This report examines PH in an adult from an unrecognized congenital heart condition (ASD) and discusses an approach to the diagnosis and management of this difficult group of patients. PH is the most feared complication of this condition and a consistent predictor of poor survival

(3). ASD is the second most common congenital heart defect after bicuspid aortic valve and comprise 13% of all CHD (4) Anatomically, ASDs may be classified as primum, secundum or sinus venosus defects.

This condition causes an increase in blood flow to the lungs (volume overload) resulting from a Left to Right shunt (Systemic to Pulmonary). The pulmonary circulation is characterized by low resistance and high capacitance and may initially accommodate a large increase in flow without an increase in pressure. Furthermore, the signs of ASD may be subtle and patients are often not diagnosed at birth. While some patients may survive even into their seventh and eight decades of life with no adverse consequences, others may develop PHT in their teens. The reasons are not clearly understood and may be related to as yet unclear mechanisms.

With severe shunting there is remodeling of the pulmonary vasculature, pulmonary arterial hypertension (PAH) and shunt reversal. Over time (R) heart pressure may equal (L) heart pressure. With severe increase in pulmonary vascular resistance (PVR), flow is reversed becoming R-L (Pulmonary to Systemic) (5)(6). This may lead to Eisenmenger's Syndrome (ES). The clinical manifestations are chest pain, shortness of breath, fatigue leading to right heart failure and cyanosis. This has a huge impact on health-related quality of life (HRQoL) and survival. The paper further examines risk stratification, pharmacological and supportive measures in PH. Closing comments relate to closure or repair of ASDs and summarizes current concepts in the evaluation and management of these patients.

CASE STUDY

A 34-year-old single female presented with flu-like symptoms and a low saturation. On examination she was phenotypically normal and hypoxic with saturations of 84% on room air. She had shortness of breath, poor effort tolerance and was classified (NYHC) functional class 3. There was no cyanosis or clubbing. She had a left parasternal heave with a loud P2 and a grade 1/6 ejection systolic murmur over the pulmonary area. Lung fields were clear and the abdominal examination unremarkable.

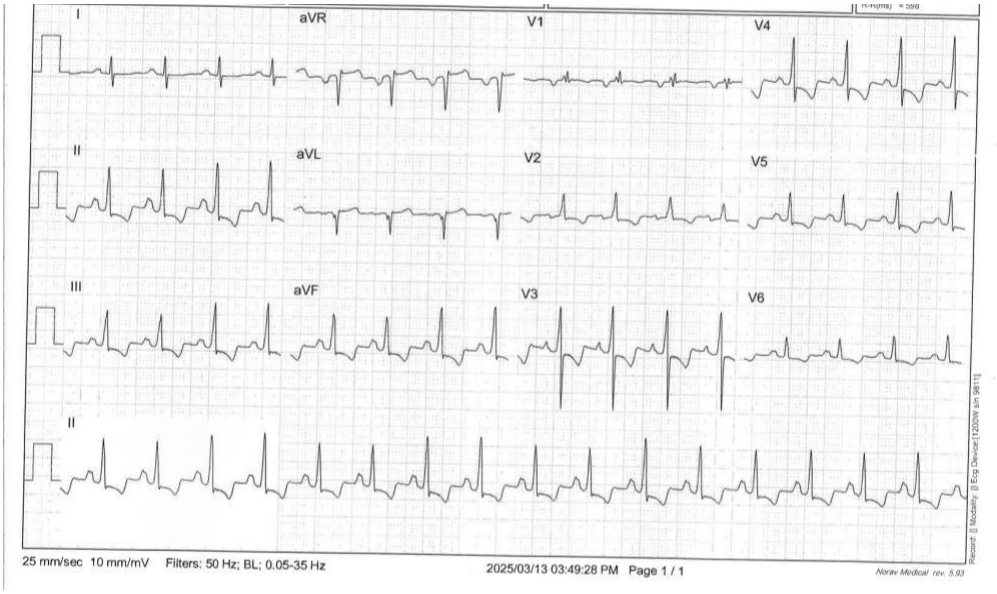

Figure 1: ECG showing right axis deviation and RV hypertrophy

URL: http://dx.doi.org/10.14738/bjhr.1204.19186.

Her chest X-ray showed cardiomegaly with an enlarged right ventricle and prominent pulmonary artery. She required high flow oxygen and nitric oxide to relieve her respiratory distress and maintain saturation above 90%. ECG changes were in keeping with R ventricular strain, R axis deviation, a sinus rhythm with prominent P waves (P-pulmonale) (Fig.1). On echocardiography R ventricular function was normal with an estimated right ventricular pressure (RVSP) of 64 mmHg.

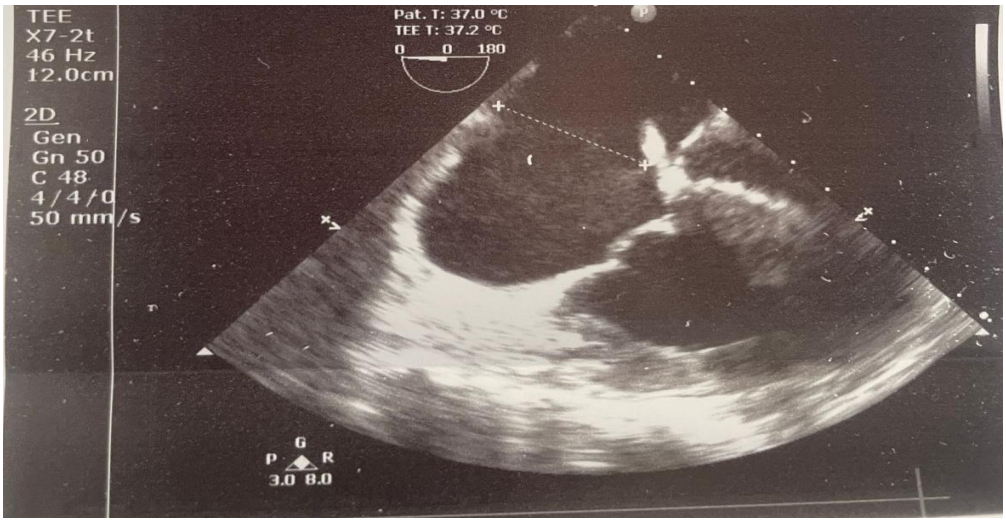

Fig 2: Patient Echo Cardiogram Pulmonary hypertension with Right Ventricular Hypertrophy
Note: Right Atrial Enlargement and large secundum ASD.

Trans-esophageal echocardiography (TEE) confirmed a dilated R atrium and R ventricle as well as a large atrial septal defect measuring 35 mm (secundum type) with bi-directional flow (Fig.2). Further blood investigation showed polycythemia with Hb of (15 gm/dl) and hematocrit of 52%. The patient was **acyonotic and had no history of hemoptysis.**

Past medical history: She was a preterm infant at (5 ½) months and had frequent chest infections as a child. She coped at school and participated in sports. At age 13 she was seen by a cardiologist and was reassured. No further follow-up consultations were done. In view of her history and physical findings cardiac catheterization with (R) and (L) heart studies were done.

The PA pressure on average was 79/34/56 mmHg but fluctuated widely and the aortic pressure was 128/83/103 mm Hg (figure 4). The ratio of PA systolic pressure to aortic systolic pressure was 0.62. The left atrial (LA) pressure was identical to the right atrial (RA) pressure with no gradient on pull back and a mean PA pressure of 38 mmHg. Pulmonary blood flow (Qp) was estimated at 3.03 l/min and systemic blood flow (Qs) was 5.50 l/min. Qp:Qs was 0.55 and there was a net right-to-left shunt of 2.47 l/min. PVR was 16.5 WU, systemic vascular resistance (SVR) was 17.27 WU with PVR:SVR equal to 0.95.

RV systolic pressure at times equal LV systolic pressure. LA saturation was identical to RA saturation and pulmonary venous saturation 65%. She was extremely sensitive to hypoxia and PA pressure would rise to systolic pressure. PA pressure was reduced with higher Oxygen concentration (%) alone and a further decline seen with the addition of Nitric Oxide.

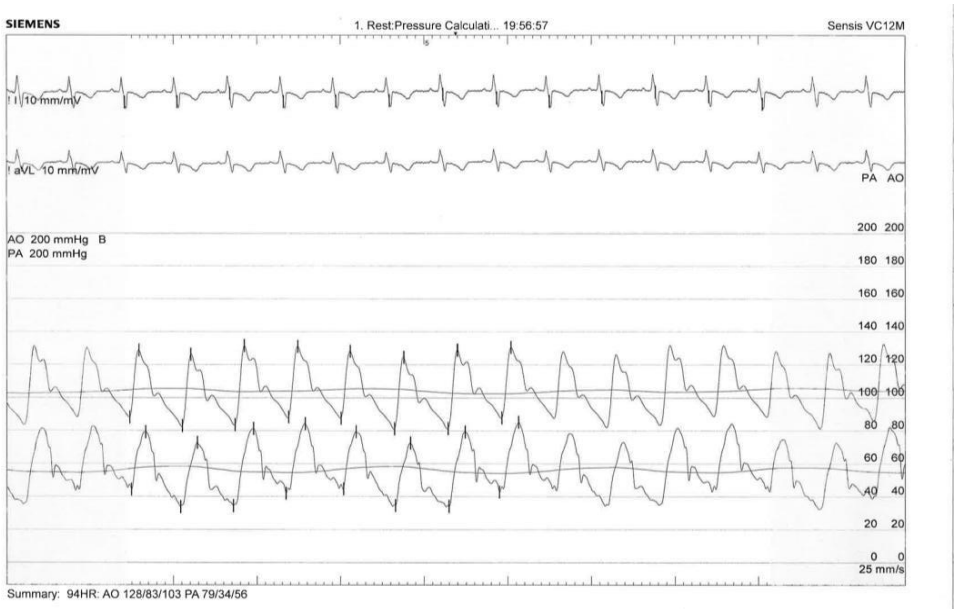

Figure 3: Hemodynamic tracing of simultaneous aorta and PA

Cardiac assessment concluded that the patient had an Eisenmenger's ASD pathophysiology and some reversibility but not enough to consider closure of the ASD. Intensive dual therapy for PH was begun with home oxygen as needed. Lung functions also showed reversibility and inhaled bronchodilators were prescribed. In addition, a direct acting anticoagulant (DAOC) (rivaroxaban) was added to prevent clot formation and embolism as well as iron supplements given.

DISCUSSION

Medical advances and early recognition of CHD has resulted in increasingly more CHD patients reach adult age (ACHD). ASD cause left to right shunts and an increase in pulmonary artery pressure (PAP). When (L) Heart and (R) Heart pressure equalize, reverse or bi- directional shunting occurs (pulmonary to systemic). The end of this spectrum is ES with chronic hypoxemia, cyanosis and erythropoiesis (2). Other complications include RV hypertrophy and failure causing organ hypo-perfusion, stasis and multi organ dysfunction (7).

Hypoxemia related complications are (5).

- Pulmonary: hemoptysis, pulmonary thrombosis.
- Gastrointestinal: gallstones, cholecystitis.
- Brain: stroke, hyper viscosity syndrome.
- Kidney: reduced eGFR.
- Vascular: secondary erythrocytosis, iron deficiency, coagulopathy.
- Musculoskeletal: reduced exercise capacity, clubbing.
- Endocrine: thyroid dysfunction.

Management Strategies in PH

Investigations and Risk Stratification:

History, clinical examination with chest radiograph and ECG aid diagnosis. Echocardiography gives insight into heart functions. Cardiac catheterization with (L) and (R) heart studies remain

URL: http://dx.doi.org/10.14738/bjhr.1204.19186.

the gold standard in measuring hemodynamic parameters. Vaso-reactivity testing with inhaled nitric oxide (20-80 ppm) at room air (21%) or with raised oxygen concentrations tests reversibility and planning treatment protocols (2).

Risk Stratification:
Patients may be low- intermediate- or high-risk (1).

Prognostic criteria include (8).

- functional class (WHO). Class I- IV.
- 6-minute walk test
- pro BNP, BNP,
- cardiac index (CI)
- R atrial pressure

Other factors are the presence of (R) sided Failure, saturation at rest, age and absence of sinus rhythm. Pharmacological strategies in PH will depend on risk stratification (5). General measures are the use of vasodilators, diuretics, anti-coagulants and oxygen for Right heart failure. Specific therapy in PH involves class specific agents targeting different pathological pathways (5).

Treatment may be single, dual or triple agent therapy.

- Endothelin receptor antagonists (ERAs. Ambrisentan). Improves hemodynamics and exercise capacity, oxygen saturation and long-term survival.
- Phosphodiesterase inhibitors (PDE-5i. Tadalafil). Improve exercise capacity, functional class, and hemodynamics.
- Prostacyclin analogs. Inhaled, intravenous or subcutaneous improve exercise capacity, hemodynamics and oxygen saturation.
- Cyclic guanosine monophosphate agonist are stimulators of the nitric oxide pathway.

The study patient was classified as NYHA 3 functional class having marked limitation in physical activity but comfortable at rest. (R) heart pressures were elevated with bi-directional flow on (TEE). She remained **acyonotic** which is a hallmark of established ES. Treatment was started with dual PH therapy including Tadalafil 40mg. daily and Ambrisentan 10 mg. daily (ERA and PDE-5i) with monthly assessments of therapeutic efficacy, reviewing risk stratification and functional class.

Correcting or Repair of ASD Defects
The development of PHT is slowly progressive and may eventually result in a net right-to-left shunt and severe systemic desaturation known as Eisenmenger's syndrome. Previous studies have shown that amongst patients with ASD, those operated on before the age of 25 have a survival same as that of a normal control population whereas those having surgery after the age of 40 have a reduced survival and high morbidity (9). However, the criteria to surgery will depend on clinical and hemodynamic evaluation based on expert opinion and require individual specialist assessment (10). Surgical correction may be open heart surgery or minimally invasive techniques, using a patch or device to close defects.

The criteria for shunt closure in patients with PAH are different between the (AHA) American heart association and the (ESC) European society of cardiology with the ESCs being more restrictive (11). However, the clinical outcomes after ASD closure were not significantly different between these guidelines (11).

The hemodynamic parameters amongst other parameters (size, location) include the ratio of pulmonary blood flow (Qp) to systemic blood flow (Qs) and (PVR): Both guidelines are consistent in recommending **a class I** indication for surgical or percutaneous closure in symptomatic patients with a Qp:Qs more than 1.5 and no PHT.

However, they differ in patients in whom PHT is more significant. The **AHA guidelines** give a class IIb recommendation that closure of the ASD may be considered when net left-to-right shunt is 1.5:1 or more, PA systolic pressure is 50% or more of systemic arterial systolic pressure, and/or PVR is greater than one third of the SVR.

ASD Closure for ACHD. Guidelines**: ESC 2020** (12) are:

- Qp:Qs >1.5:1 and Pulmonary Vascular Resistance (PVR):
- <3 Wood unit (WU**): Class** I recommendation for ASD closure
- 3-5 WU**: Class IIa** recommendation for ASD closure
- 5 WU but decreasing to <5 WU after targeted pulmonary arterial hypertension (PAH) treatment**: Class IIb** recommendation for ASD closure (fenestrated closure only)
- ≥5 WU despite targeted treatments for PAH: **Class III** recommendation against ASD closure.

These determine operability and shunt closure and is supported by other expert sources on ASDs and pulmonary hypertension. The Japanese consensus highlights similar thresholds.

Discouraging shunt closure is the more likely outcome in severe ES and medical management prioritized. With shunt reversal from right to left (Qp:Qs) < 1 and bi-directional as seen in established ES and irreversible PAH, closure may result in poorer outcomes (13)(14). Surgical complications encountered are incomplete closure with residual shunting, arrythmias and infection (endocarditis). Successful outcome implies patients having fewer symptoms, improved heart function and improved (HRQoL).

In our patient the ESC recommendation is to treat the patient with vasodilator therapy and if the PVR can be reduced to a target of 5 WU or less and careful consideration of risk factors a fenestrated closure of the ASD recommended. This has been termed **the treat and repair strategy**. In our patient the wide fluctuation in PA pressure with hypoxia and its immediate relief with inhaled NO prompted us to start dual PAH therapies with a PDE-5 inhibitor and an endothelin receptor antagonist (ERA). We plan to reexamine her pulmonary hemodynamics invasively with a (R) heart study in six months and make a final decision regarding closure of the ASD. Should her hemodynamics still be adverse, the only alternative management would be bilateral sequential lung transplantation with concomitant closure of the ASD.

Supportive Measure in PH (6).

- Regular immunization against influenza and pneumococcal infections.

URL: http://dx.doi.org/10.14738/bjhr.1204.19186.

- Avoiding pregnancy and providing appropriate contraceptive advice. Pregnancy has high risks with regard to maternal mortality (6) and obstetric complications due to the hemodynamic and pro-thrombotic changes in pregnancy.
- Endocarditis prophylaxis for surgical and dental procedures.
- Staying active and exercising under supervision within symptom limits.
- Ensuring adequate fluid balance.
- Anticoagulant therapy if indicated and managing hyper-viscosity and hematopoiesis.

CONCLUSION

PH is a debilitating disease and continues to have high morbidity and mortality. Regular assessments to monitor treatment efficacy is recommended. Patients may require dual/triple therapy and early surgical intervention. Progressive heart failure, sudden death and infectious diseases are leading causes of death in ES (14). Those with continuing deterioration in functional class, and imminent risk of death, (lung) or (heart- lung) transplant are remaining options. (15).

While early surgery prior to the onset of PHT is usually curative with restoration of survival similar to that of a normal population, closure of an ASD with already severe pulmonary vascular disease can result in high perioperative mortality. In high-risk patients the 1-year mortality is between 10-20 % (15). The availability and access to PH specific therapy has proven to be a significant factor in improving the HRQoL of PH patients. In addition, the early recognition of CHD and referral to PH specialist centers will improve outcome, and more ACHD patients are likely to be encountered in the future.

Take Home Points:

- Early recognition to ameliorate PH in CHD.
- PH causes Right heart failure and hypoxemia, affecting multiple organ systems.
- Targeted therapy and early referral to a specialist center for PH disease is recommended with surgical intervention a last resort.

Declaration. The authors have no conflict interest to report.

B A B. Author. Email: bash786@absamail.co.za
A R E. Researcher and 2nd Author

Thanking Professor R Essop (Cardiologist) Millpark Hospital for reviewing the manuscript and advice on patient management protocols.

References

1. Humbert, Marc, Gabor Kovacs, Marius M Hoeper, Roberto Badagliacca, Rolf M F Berger, Margarita Brida, Jørn Carlsen, Andrew J S Coats, Pilar Escribano-Subias, and Pisana Ferrari. 2022. “2022 ESC/ERS Guidelines for the Diagnosis and Treatment of Pulmonary Hypertension: Developed by the Task Force for the Diagnosis and Treatment of Pulmonary Hypertension of the European Society of Cardiology.” *European Heart Journal* 43 (38): 3618–3731. https://academic.oup.com/eurheartj/article/43/38/3618/6673929
2. Jone, Pei-Ni, D Dunbar Ivy, Amanda Hauck, Tara Karamlou, Uyen Truong, Ryan D Coleman, Juan Pablo Sandoval, María Jesús del Cerro Marín, Pirooz Eghtesady, and Kathryn Tillman. 2023. “Pulmonary

Hypertension in Congenital Heart Disease: A Scientific Statement from the American Heart Association." *Circulation: Heart Failure* 16 (7): e00080.

3. Takaya Y, Akagi T, Sakamoto I, Kanazawa H, Nakazawa G, Murakami T, Yao A, Nanasato M, Saji M, Hirokami M, Fuku Y, Hosokawa S, Tada N, Matsumoto K, Imai M, Nakagawa K, Ito H. Efficacy of treat-and-repair strategy for atrial septal defect with pulmonary arterial hypertension. Heart. 2022 Mar;108(5):382-387. doi: 10.1136/heartjnl-2021-319096. Epub 2021 Jun 15. PMID: 34415851; PMCID: PMC8862039.
4. Nashat H, Montanaro C, Li W, Kempny A, Wort SJ, Dimopoulos K, Gatzoulis MA, Babu-Narayan SV. Atrial septal defects and pulmonary arterial hypertension. J Thorac Dis. 2018 Sep;10(Suppl 24):S2953-S2965. doi: 10.21037/jtd.2018.08.92. PMID: 30305956; PMCID:PMC6174141
5. Banerjee, Ranjan, and Alexander R Opotowsky. 2024. "Update on Eisenmenger Syndrome – Review of Pathophysiology and Recent Progress in Risk Assessment and Management." *International Journal of Cardiology Congenital Heart Disease* 17: 100520. https://doi.org/https://doi.org/10.1016/j.ijcchd.2024.100520.
6. D'Alto, Michele, and Gerhard-Paul Diller. 2014. "Pulmonary Hypertension in Adults with Congenital Heart Disease and Eisenmenger Syndrome: Current Advanced Management Strategies." *Heart* 100 (17): 1322 LP – 1328. https://doi.org/10.1136/heartjnl-2014-305574.
7. Rosenkranz, Stephan, Luke S Howard, Mardi Gomberg-Maitland, and Marius M Hoeper. 2020. "Systemic Consequences of Pulmonary Hypertension and Right-Sided Heart Failure." *Circulation* 141 (8): 678–93. https://doi.org/10.1161/CIRCULATIONAHA.116.022362.
8. Thomas, Christopher A, Ryan J Anderson, David F Condon, and Vinicio A de Jesus Perez. 2020. "Diagnosis and Management of Pulmonary Hypertension in the Modern Era: Insights from the 6th World Symposium." *Pulmonary Therapy* 6 (1): 9–22.
9. Murphy JG, Gersh BJ, McGoon MD, Mair DD, Porter CJ, Ilstrup DM, McGoon DC, Puga FJ, Kirklin JW, Danielson GK. Long-term outcome after surgical repair of isolated atrial septal defect. Follow-up at 27 to 32 years. N Engl J Med. 1990 Dec 13;323(24):1645-50. doi: 10.1056/NEJM199012133232401. PMID: 2233961.
10. Dimopoulos, Konstantinos, and Andrew Constantine. 2024. "Pulmonary Hypertension in Adults with Congenital Heart Disease." In *Pediatric Cardiology: Fetal, Pediatric, and Adult Congenital Heart Diseases*, 2793–2842. Springer.
11. Tangcharoen, T., Ngernsritrakul, T., Chandavimol, M., Kamsorn, C., Apakuppakul, S. and Yamwong, S., 2024. Discordance between the European and the United States guideline criteria for atrial septal defect closure in adult patients with pulmonary hypertension and its clinical impact. *Current Problems in Cardiology*, *49*(12), p.102869.
12. Baumgartner H, De Backer J, Babu-Narayan SV, Budts W, Chessa M, Diller GP, et al. 2020 ESC guidelines for the management of adult congenital heart disease. *Eur Heart J*. 2021 Feb 7;42(6):563–645. doi:10.1093/eurheartj/ehaa554.
13. Forlemu, Arnold Nongmoh, Muhammad Ajmal, and Mehrdad Saririan. 2020. "Atrial Septal Defect with Eisenmenger Syndrome: A Rare Presentation." *Case Reports in Cardiology* 2020 (1): 8681761.
14. Diller, Gerhard-Paul, Astrid E Lammers, and Erwin Oechslin. 2021. "Treatment of Adults with Eisenmenger Syndrome-State of the Art in the 21st Century: A Short Overview." *Cardiovascular Diagnosis and Therapy* 11 (4): 1190–99. https://doi.org/10.21037/cdt-21-135.
15. Bulbulia, Bashir Ahmed. n.d. "An Overview of Pulmonary Hypertension (PH) and Vaso-Reactivity Testing with Inhaled Nitric Oxide; Available Therapies and the Anaesthetic Management of a PH Crises."