MEDICAL SCIENCES

CLINICAL EXPERIENCE IN MANAGING PATIENTS WITH PULMONARY HYPERTENSION IN A CARDIAC SURGERY CENTER: RETROSPECTIVE ANALYSIS OF A CASE SERIES

Mashkunova O.
Professor, Head of the Department of Internal Medicine, Research Institute of Cardiology and Internal Diseases, Almaty, Kazakhstan
Baimolda A.
2nd-year Internal Medicine Resident, Department of Internal Medicine, Research Institute of Cardiology and Internal Diseases, Almaty, Kazakhstan

КЛИНИЧЕСКИЙ ОПЫТ ВЕДЕНИЯ ПАЦИЕНТОВ С ЛЁГОЧНОЙ ГИПЕРТЕНЗИЕЙ В УСЛОВИЯХ КАРДИОХИРУРГИЧЕСКОГО ЦЕНТРА: РЕТРОСПЕКТИВНЫЙ АНАЛИЗ СЕРИИ СЛУЧАЕВ

Машкунова О.В.
Профессор, Заведующая кафедрой внутренних болезней, Научно-исследовательский институт кардиологии и внутренних болезней, Алматы, Казахстан
Баймолда А.О.
Резидент-терапевт 2-го года обучения, Кафедра внутренних болезней, Научно-исследовательский институт кардиологии и внутренних болезней, Алматы, Казахстан
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Abstract

Introduction: Pulmonary hypertension (PH) is a progressive disease of the pulmonary vasculature characterized by significant morbidity and mortality. Managing patients with PH in a specialized cardiac surgery center involves comprehensive hemodynamic assessment, determination of indications for surgical interventions, and selection of specific therapy.

Objective: To conduct a retrospective analysis of clinical characteristics, results of invasive hemodynamic evaluation, and treatment approaches for a series of patients with various types of pulmonary hypertension hospitalized in a cardiac surgery center.

Methods: Retrospective analysis of a series of 10 clinical cases of patients with verified PH. All patients underwent standard clinical, laboratory, and instrumental examinations (ECG, echocardiography); right heart catheterization (RHC) with vasoreactivity testing was performed in some patients.

Results: The mean patient age was 39.8 ± 14.1 years, with males comprising 60% (n = 6). Pulmonary arterial hypertension (Group 1) was diagnosed in 50% (n = 5), PH due to left heart disease (Group 2) in 40% (n = 4). RHC was performed in 60% of patients (n = 6); mean pulmonary artery pressure (mPAP) ranged from 10 to 74 mm Hg, pulmonary vascular resistance (PVR) from <0.9 to 9.8 Wood units. Vasoreactivity testing was negative in all examined patients. Specific PAH therapy was prescribed in accordance with the 2022 ESC/ERS guidelines.

Conclusion: A comprehensive approach, including invasive hemodynamic assessment, multidisciplinary discussion, and personalized selection of specific therapy, is a key condition for the successful management of patients with PH in a cardiac surgery center.

Аннотация

Введение: Лёгочная гипертензия (ЛГ) — прогрессирующее заболевание лёгочных сосудов, характеризующееся значительной заболеваемостью и смертностью. В условиях специализированного кардиохирургического центра ведение пациентов с ЛГ сопряжено с комплексной оценкой гемодинамики, определением показаний к хирургическим вмешательствам и подбором специфической терапии.

Цель: Провести ретроспективный анализ клинических характеристик, результатов инвазивной гемодинамической оценки и подходов к лечению серии пациентов с различными типами лёгочной гипертензии, госпитализированных в кардиохирургический центр.

Методы: Ретроспективный анализ серии из 10 клинических случаев пациентов с верифицированной ЛГ. Всем пациентам проводились стандартные клинические, лабораторные и инструментальные исследования (ЭКГ, эхокардиография); части пациентов выполнена катетеризация правых отделов сердца (КПОС) с тестом вазореактивности.

Результаты: Средний возраст пациентов составил 39,8 ± 14,1 года, мужчины составили 60% (n = 6). Лёгочная артериальная гипертензия (группа 1) диагностирована у 50% (n = 5), ЛГ вследствие патологии левых отделов сердца (группа 2) — у 40% (n = 4). КПОС выполнена у 60% пациентов (n = 6); среднее давление в лёгочной артерии (ДЛА ср.) варьировало от 10 до 74 мм рт. ст., лёгочное сосудистое сопротивление (ЛСС) — от менее 0,9 до 9,8 ед. Вуда. Тест вазореактивности оказался отрицательным у всех обследованных пациентов. Специфическая ПАГ-терапия назначалась в соответствии с рекомендациями ESC/ERS 2022.

Заключение: Комплексный подход, включающий инвазивную оценку гемодинамики, мультидисциплинарное обсуждение и персонализированный выбор специфической терапии, является ключевым условием успешного ведения пациентов с ЛГ в условиях кардиохирургического центра.

Keywords: pulmonary hypertension, pulmonary artery pressure, pulmonary vascular resistance, right heart catheterization, Eisenmenger syndrome, specific PAH therapy, cardiac surgery

Ключевые слова: лёгочная гипертензия, лёгочное артериальное давление, лёгочное сосудистое сопротивление, катетеризация правых отделов сердца, синдром Эйзенменгера, специфическая ПАГ-терапия, кардиохирургия

INTRODUCTION. Pulmonary hypertension (PH) is a pathological condition defined as an increase in mean pulmonary artery pressure (mPAP) ≥ 20 mmHg, as determined by right heart catheterisation at rest [1]. According to the current ESC/ERS 2022 classification, there are five clinical groups of PH, differing in aetiopathogenesis, diagnostic approaches and treatment [3]. The prevalence of PH in the general population is approximately 1%, whilst among those aged 65 years and older, this figure reaches 10% or more [15]. Pulmonary arterial hypertension (PAH, group 1) is significantly less common — 15–50 cases per 1 million population — but is characterised by an extremely poor prognosis without specific treatment: the median survival without therapy does not exceed 2.8 years [13]. PAH associated with congenital heart defects (CHD) and Eisenmenger syndrome as its most severe manifestation are of particular clinical significance [8]. The diagnosis of PH requires a stepwise approach, including non-invasive methods (echocardiography, CT angiography, ventilation-perfusion scintigraphy) and mandatory invasive confirmation via right heart catheterisation (RHC) [3]. Treatment of LAH includes general measures, supportive therapy and specific medications: endothelin receptor antagonists (ERAs), type 5 phosphodiesterase inhibitors (PDE5-5), soluble guanylate cyclase stimulators (sGC), prostanoids and IP receptor agonists [3, 4].

In Kazakhstan, the problem of PH is becoming increasingly pressing due to the high prevalence of VSD, late diagnosis and insufficient availability of specific PAH therapy. The country's cardiac surgery centres play a key role in the diagnosis and treatment of this patient group, determining surgical management and patient referral pathways.

The aim of this study is to conduct a retrospective analysis of the clinical characteristics, results of invasive haemodynamic assessment and treatment approaches in a series of patients with various types of PH admitted to a cardiac surgery centre.

MATERIALS AND METHODS. A retrospective analysis was conducted of a series of clinical cases involving 10 patients with confirmed LVH who were consecutively admitted to a cardiac surgery centre in 2024. The inclusion criteria were: the presence of any type of PH, confirmed by echocardiography and/or CPOS data; the presence in the medical records of a comprehensive description of the clinical picture, laboratory results and findings from diagnostic tests.

All patients underwent: collection of complaints and medical history, physical examination, measurement of blood pressure (BP) and SpO_2, determination of functional class (FC) according to the NYHA classification and stage of chronic heart failure (CHF) according to the ACC/AHA guidelines, determination of serum C-reactive protein (CRP) levels, electrocardiogram (ECG) recording, and transthoracic echocardiography (TTE).

Right heart catheterisation (RHCT) was performed in 6 out of 10 patients (60%) based on clinical indications. During RHP, the following were measured: pressure in the right atrium (RA), right ventricle (RV), pulmonary artery (PA), and pulmonary artery wedge pressure (PAWP); Cardiac output (CO) was calculated using the Fick method or thermodilution, pulmonary vascular resistance (PVR), pulmonary and systemic blood flow indices (Qp, Qs), and their ratio (Qp/Qs). If vasoreactivity was suspected, an acute vasodilator test was performed with inhalation of iloprost (10 μg/ml, 2 ml, 10 min).

Echocardiography was performed according to a standard protocol, assessing the dimensions and volumes of the heart chambers, left ventricular ejection fraction (LVEF) using the Simpson method, calculated pulmonary artery systolic pressure (pSAP) based on tricuspid regurgitation velocity, and assessment of right ventricular function (TAPSE, FAC).

Data were collected from the medical records of inpatients. Data are presented as absolute values, relative frequencies, means with standard deviation (M ± SD) and medians with interquartile range (Me [Q1; Q3]). The study was conducted in accordance with the principles of the World Medical Association's Declaration of Helsinki. All patients' personal data have been

RESULTS. The study included 10 patients: 6 men (60%) and 4 women (40%). The mean age was 39.8 ± 14.1 years (range 21–62 years). The median age was 37.0 [28.0; 47.0] years. The clinical and demographic characteristics of the patients are presented in Table 1.

Table 1.

Clinical and demographic characteristics of patients

No.	Sex / Age (years)	SpO_2 (%)	HR (bpm)	CRP (mg/L)	Primary diagnosis	NYHA Class	HF Stage (ACC/AHA)	CPOS
1	F / 34	97	65	1.8	Primary PH. Idiopathic PH. HF with preserved EF 58%. Bronchial asthma	III	C	—
2	F / 21	68	94	2.0	CHD: VSD. Eisenmenger syndrome. PH type 1. Cor pulmonale. HF with preserved EF 58%	III	C	—
3	M / 60	92	86	12.6	Congestive HF. Ischemic cardiomyopathy. CAD. Angina class III. HF with reduced EF 21%. INTERMACS 3	IV	D	+
4	M / 34	94	88	4.4	PAH type 2, class IV (WHO). CHD. VSD. Eisenmenger syndrome. Tricuspid regurgitation grade 4. HF with preserved EF 58%	III	C	+
5	M / 47	96	68	1.1	Sporadic HCM without LVOT obstruction. Myocardial bridge of LAD. ICD implantation. HF with preserved EF 53%	III	C	+
6	M / 43	95	93	19.3	Dilated cardiomyopathy. Status post valve surgery. Permanent AF. HF with reduced EF 12%. NYHA IV, stage D	IV	D	+
7	M / 22	99	72	0.6	CHD. ASD. Moderate PH. HF with preserved LVEF 58%, stage B. Chronic viral hepatitis C	I	B	+
8	F / 47	97	82	1.1	Idiopathic PH class III (WHO). Cor pulmonale. HF with preserved LVEF 57%. Hypertension grade 2. Post-stroke/TIA	III	—	—
9	F / 28	98	68	1.5	Primary PH. HF with preserved EF 60%. Hypertension grade 2, risk 4. Antiphospholipid syndrome?	II	C	—
10	M / 62	98	78	3.1	CAD. Prior MI. Ischemic cardiomyopathy. HF with reduced EF 21%, stage C. ICD. Hypertension grade 1. Type 2 diabetes. Obesity grade 1	II	C	+

Note: F – female; M – male; SpO_2 – blood oxygen saturation; HR – heart rate; CRP – C-reactive protein; FC – functional class; CHF — chronic heart failure; RCC — right heart catheterisation; '+' — performed; '—' — not performed.

According to the WHO/ESC classification, patients were categorised as follows: PAH (Group 1) – 5 patients (50%), including 3 (30%) associated with VSD and 2 (20%) idiopathic; PAH due to left-sided heart disease (group 2) — 4 patients (40%); PAH of unspecified aetiology — 1 patient (10%).

According to the NYHA functional class, patients were distributed as follows: FC I — 1 (10%), FC II — 2 (20%), FC III — 5 (50%), FC IV — 2 (20%). Thus, 70% of patients (n = 7) had FC III–IV, indicating the severity of this cohort's condition.

The median SpO_2 was 96.5% [94.0; 98.0]; a decrease in SpO_2 below 94% was recorded in 3 patients

(30%), of whom the most severe hypoxaemia (SpO_2 68%) was observed in a patient with Eisenmenger syndrome against a background of VSD.

The median HR was 80.0 [68.0; 88.0] bpm. The mean CRP level was 4.66 ± 6.24 mg/L (range 0.6–19.3 mg/L); elevated CRP levels above the normal range were recorded in 5 patients (50%), reflecting the presence of a systemic inflammatory response against a background of chronic heart failure and concomitant pathology.

The left ventricular ejection fraction was preserved in 6 patients (60%) (EF ≥ 50%), moderately reduced in 1 patient (10%) (EF 53%), and significantly reduced in 3 patients (30%) (EF 12–21%).

Transesophageal echocardiography (TEE) was performed in 6 out of 10 patients (60%). Indications included: verification of the severity of left heart failure, assessment of the operability of the pulmonary valve, evaluation of haemodynamics prior to surgical intervention, and assessment of the adequacy of mechanical circulatory support.

The main haemodynamic parameters according to TEE data are presented in Table 2.

Table 2.

Results of right heart catheterisation

Parameter	**Patient No. 4 (CHD VSD, Eisenmenger)**	**Patient No. 7 (CHD ASD)**	**Patient No. 5 (HCM with LVOT obstruction)**	**Patient No. 6 (DCM, LVAD)**
PAP syst./diast. (mean), mmHg	95/62 (74)	55/28 (37)	70/30 (45)	18/6 (10)
RAP (mean), mmHg	2	14	11	1
RV pressure syst./diast., mmHg	98/15	58/4	72/8	20/10
PCWP (PW), mmHg	4	n/a	n/a	7
CO (L/min)	9.3	12.1	4.0	3.2
PVR (Wood units)	7.6	2.2	6.2	<0.9
Qp/Qs	1.3	1.6	n/a	n/a
Vasoreactivity test	Negative	Not performed	Not performed	Not performed
Conclusion	PAH high risk. CHD correction contraindicated	ASD 5.5 cm, common atrium. PAH type 1 high risk	PH type 2. Septal myectomy indicated	After LVAD, PVR normalized (<0.9 Wood units)

Note: PAP — pulmonary artery pressure; PVR — pulmonary vascular resistance; RA — right atrium; RV — right ventricle; PAP — pulmonary artery pressure; CO — cardiac output; Qp/Qs — ratio of pulmonary to systemic blood flow; n/a — not available.

Among the 4 patients who underwent a full haemodynamic assessment, the mean PVR (mean) ranged from 10 to 74 mmHg, reflecting a wide spectrum of PAH severity in the study cohort. The LSS ranged from less than 0.9 to 7.6 Wood units in patients with precapillary PH, reaching 9.8 Wood units in one patient with LAG and VSD (patent ductus arteriosus), who also underwent a vasoreactivity test with a negative result.

In patient No. 4 with PDA (VSD) and Eisenmenger syndrome in the context of CHD, a significant increase in PVR (mean 74 mmHg) and PVR (7.6 Wood units) was detected with moderate left-to-right shunting (Qp/Qs 1.3). Additionally, defects in the interatrial and interventricular septa were detected. The vasoreactivity test with iloprost inhalation proved negative (mean PVR decreased from 74 to 69 mmHg, whilst PVR increased from 7.6 to 8.2 Wood units), which ruled out the possibility of surgical correction of the VSD.

Patient No. 7, with a large (5.5 cm) atrial septal defect (ASD), was diagnosed with high-risk type 1 pulmonary hypertension (PH) with a mean PAF of 37 mmHg and a PVR of 2.2 Wood units. Patient No. 5, with hypertrophic cardiomyopathy and left ventricular outflow tract obstruction, was diagnosed with type 2 left heart failure (mean LA pressure 45 mmHg, LVEF 6.2 Wood units), which required surgical treatment (septal myectomy). In patient No. 6 with DCM and an implanted HeartMate III LVAD, normalisation of LVEF (<0.9 Wood units) was noted, confirming the adequacy of mechanical circulatory support.

Patients were treated on an individual basis in accordance with the 2022 ESC/ERS clinical guidelines. Recommendations for specific PAG therapy depending on functional class are presented in Table 3.

Table 3.

Recommendations for specific PAG therapy according to functional class (ESC/ERS 2022)

Drug / Combination	FC I (WHO)	FC II (WHO)	FC III (WHO)	FC IV (WHO)
ERAs: Bosentan, Ambrisentan, Macitentan	—	I B	I B	IIa C
PDE-5 inhibitors: Sildenafil	—	I A	I A	IIa C
Soluble guanylate cyclase stimulators: Riociguat	—	I B	I B	IIa C
Prostanoids (inhaled): Iloprost	—	IIb B	I B	I B
IP receptor agonists: Selexipag	—	I B	I B	—
Calcium channel blockers (only with positive vasoreactivity test)	—	I C	I C	—
Dual combination therapy (ERA + PDE-5i)	—	I A	I A	IIa C
Triple combination therapy	—	IIb C	IIa C	IIa C
Lung transplantation / heart–lung transplantation	—	—	I C	I C

Note: I — class of recommendation; A/B/C — level of evidence; ERA — endothelin receptor antagonists; PDE5-I — phosphodiesterase type 5 inhibitors; VRT — vasoreactive test; '—' — not indicated or no data available.

Patients with PAH (group 1, n = 5) were prescribed specific PAH therapy: patients with severe CHF (Class III–IV) and a negative vasoreactivity test received combination therapy comprising bosentan (ARA), riociguat (PGE2 agonist) and/or iloprost (prostanoid) administered by inhalation. In particular, one patient with FC IV and marked precapillary PH was prescribed a triple-combination regimen: bosentan 125 mg twice daily, riociguat 2.5 mg three times daily, and iloprost 20 μg by inhalation 6–9 times daily as required.

Patients with Group 2 PH (n = 4) received optimal medical therapy for CHF with correction of surgical valve and septal abnormalities. One patient with DCM and refractory CHF (INTERMACS 3) underwent implantation of a HeartMate III LVAD as a 'bridge' to heart transplantation.

DISCUSSION. The data obtained are consistent with current understanding of the epidemiology and clinical presentation of PH. The predominance in our series of patients with PAH associated with CHD (30%) is explained by the specific nature of the centre's cardiac surgery profile and reflects the global trend of late referral of such patients [8]. Eisenmenger syndrome represents the terminal stage of untreated PAH in VSD and is characterised by irreversible changes in the pulmonary vasculature [7, 8].

Negative vasoreactivity tests in all examined patients are consistent with the literature: true vasoreactivity in PAH is found in only 10–15% of patients, predominantly in the idiopathic form of the disease [4]. This justifies the use of combined specific therapy as the preferred approach in severe PAH (FC III–IV) [3].

Haemodynamic parameters — mean PVR ranging from 37 to 74 mmHg and LVEF ranging from 2.2 to 9.8 Wood units — meet the criteria for severe PAH and are consistent with data from major international registries, including the REVEAL Registry [18]. The use of echocardiography as the diagnostic standard allowed not only the diagnosis to be verified, but also an informed decision to be made regarding treatment strategy, including the decision against surgical correction of the mitral valve in cases of irreversible LAH.

The use of the HeartMate III LVAD in one patient with DCM and refractory CHF resulted in normalisation of the left ventricular ejection fraction (<0.9 Wood units), which opens up the possibility of heart transplantation [6]. This case demonstrates the effectiveness of modern mechanical circulatory support strategies in overcoming post-capillary PH.

It should be noted that in patients with Group 2 PH (due to left-sided heart disease), specific PAG therapy is not indicated: the priority remains optimal treatment of the underlying disease and, if necessary, surgical correction [3]. The use of specific PAH drugs in Group 2 PH outside clinical trials is not recommended due to the lack of evidence and the risk of a worsened prognosis.

STRENGTHS AND LIMITATIONS. The strengths of this study include: real-world clinical practice at a cardiac surgery centre, the use of invasive haemodynamic assessment (CPOS) in a significant proportion of patients (60%), complete anonymisation of clinical data, and the use of modern specific PAG agents in accordance with the current ESC/ERS 2022 guidelines.

Limitations include: a small sample size (n = 10), a retrospective design, the absence of data on long-term follow-up and outcomes, and the inability to perform a comprehensive statistical analysis. The descriptive nature of the case series does not allow conclusions to be drawn regarding causal relationships. Nevertheless, the detailed description of diagnostic and therapeutic approaches is valuable in terms of sharing practical experience.

CONCLUSION

1. A retrospective analysis of a series of 10 patients demonstrated a wide spectrum of aetiologies for pulmonary hypertension in a cardiac surgery centre: PAH (group 1) accounted for 50%, and PH due to left-sided heart disease (group 2) for 40%.

2. The majority of patients (70%) had severe functional status (NYHA Class III–IV), highlighting late presentation and the need for early screening for PH.

3. Right heart catheterisation, performed in 60% of patients, is an indispensable tool for accurate haemodynamic assessment, determining the PH group and selecting a treatment strategy.

4. A negative vasoreactivity test in all patients examined justifies the need for early initiation of combined specific PAG therapy.

5. A personalised approach to treatment, based on CPOS results, functional class and comorbidities, allows for the optimisation of management of this complex patient group within a specialist cardiac surgery centre.

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