Establishing a remote monitoring service for patients with pulmonary hypertension

Alex Rothman and Jennifer Middleton on behalf of the Sheffield Pulmonary Vascular Disease Unit

The University of Sheffield and Sheffield Teaching Hospitals NHS Foundation Trust, Sheffield, United Kingdom

Pulmonary hypertension is a rare disease that leads to right heart failure. Patients experience significant morbidity and mortality at 5-years is less than 50%.[1] Approved therapies reduce vasoconstriction through modulation of three distinct biological pathways at a cost of £30-150k/patient/year.[2,3] Due the range of investigations required and the high cost of therapies diagnosis, treatment and annual review for the 6,244 patients in the UK are commissioned through seven National Centers.[1] To increase patient contact between annual visits, identify disease worsening early and optimise therapy we established the world's first remote monitoring service for patients with pulmonary hypertension at the National Centre in Sheffield.

Objectives

Establish a remote monitoring multi-professional team

Embed the use of remote monitoring devices in clinical practice for the purpose of:

- Improved clinical decision making
- Early identification of disease worsening
- Therapeutic optomisation

Emerging Leaders Programme
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Methods

Multi-professional team and patient population

A remote monitoring multi-professional team made up of a cardiologist, respiratory physician, nurse consultant and pharmacist was established in January 2020. The team reviewed potential patients to identify the clinical question and match to appropriate monitoring devices. Data was relayed via secure online systems and reviewed twice weekly with therapeutic changes made at the discretion of the responsible physician. Clinical events are reviewed at the monthly multi-professional team meeting.

Table 1: Baseline demographics fo the 60 patients managed by the remote monitoring multi-professional team.

	Mean
Age, mean (SD), years	49.1 (18.5)
Female, n (%)	16 (80)
Race, n (%)	
Caucasian	17 (85)
Asian	3 (15)
Time from Diagnosis, years	3.7 (4.1)
Type of PAH, (%)	
Heritable	10
Idiopathic	60
Connective tissue disease	30
WHO functional class III, (%)	100

	Mean
6WT, mean (SD)	307 (282)
NTproBNP, mean (SD)	2095(4254)

Disease specific therapy	N (%)
Dual oral	65
Dual oral + inh prost	15
Dual oral + iv prost	15

Haemodynamics		Baseline (mean +/-SD)
Right atrial pressure (mmHg)		9.9 (5.5)
Pulmonary artery pressure (mmHg)	Systolic	79.5 (22.4)
	Mean	51.6 (9.8)
	Diastolic	33.6 (9.9)
PCWP (mmHg)		11.3 (5.4)
Cardiac output (L/min)		4.5 (1.3)
PVR (dyn.sec/cm^5)		695 (363)
Systemic blood pressure (mmHg)	Systolic	118 (32)
	Diastolic	75 (16)

Device implantation

Patients receiving a pulmonary artery pressure monitor (CardioMEMS, Abbott) were in WHO functional class III with a heart failure hospitalisation in the preceding 12-months and devices were implanted at diagnostic right heart catheterisation undertaken via the right internal jugular or femoral vein.[4] Patients receiving an insertable cardiac monitor (LinQ, Medtronic) were at increased risk of cardiac arrhythmias or had experience transient symptoms that may suggest a cardiac arrhythmia with devices implanted in the clinic setting.[5]

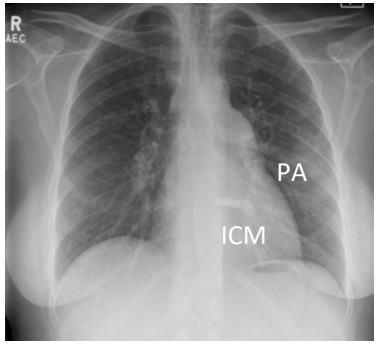


Figure 1: Chest x-ray showing pulmonary artery pressure monitor (PA) and insertable cardiac monitor (ICM) post-implantation.

Results

Between January 20th and December 31st 2020 no device related adverse events were reported. The number of therapeutic changes in the 12-months preceding device implantation was 10 compared with 68 changes in the same period following implantation. The area under the curve of pulmonary artery pressure following device implantation was reduced and the number of disease related hospitalisation events reduced from 21 in the 12-months preceding implantation to 4 in the post-implantation period.

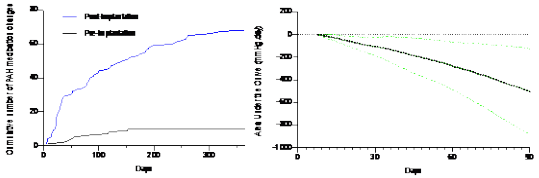


Figure 2: A: number of therapeutic changes made before and after device implantation. B: Area under the curve of pulmonary artery pressure following device implantation.

Case 1 – Remote Therapeutic Optomisation

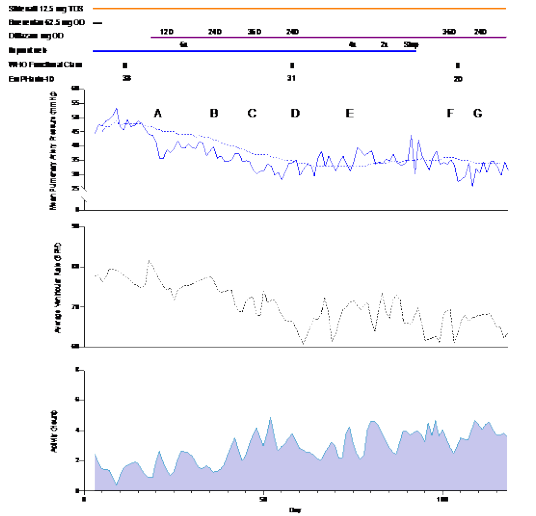
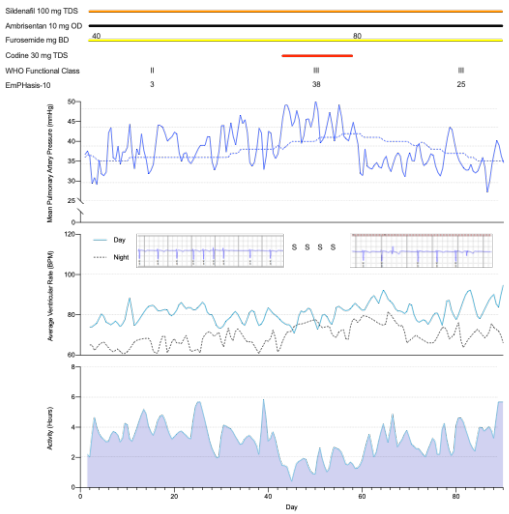


Figure 3: Remote personalised therapy during COVID-19 lockdown: a 55 year-old lady with pulmonary arterial hypertension in WHO functional class III was looked at a local hospital with beta blockers preventing initial use of calcium channel antagonist. At the time of device implantation (day 0) there has been an inadequate haemodynamic and functional response to dual oral therapy with nebulised iloprost. Following withdrawal of beta blocker, diltiazem (calcium channel blocker indicated due to positive nitric oxide response) is started and up-titrated resulting in a substantial reduction in mean pulmonary artery pressure, heart rate and improved activity, WHO functional class and quality-of-life. Point A – initiation of diltiazem 120 mg OD; B – increase of diltiazem to 240 mg OD; C – increase of diltiazem to 360 mg OD; D – reduction of diltiazem to 240 mg OD due to side effects; E – reduction and withdrawal of nebulised iloprost; F – increase of diltiazem to 360 mg OD; reduction of diltiazem to 240 mg OD due to side effects. Combination therapy cost at day 0 ~£40k and day 120 <£7k (National policy for targeted therapies for the treatment of pulmonary hypertension in adults: May 2014. Updated with current BNF list price)

Case 2 – Remote Detection of Clinical Worsening



S - premature atrial and ventricular ectopic beats

Figure 4: Remote detection of clinical decompensation: a 67 year-old female with PAH in WHO functional class II previously stable and established on dual oral therapy. Pulmonary artery pressure increases and at point of clinical deterioration is associated with an increase in night heart rate and a reduction in functional heart rate reserve (day heart rate – night heart rate), a fall in activity and worsening of quality-of-life and WHO functional class with new atrial and ventricular ectopic beats (S). Following remote intervention physiology returns to baseline.

Conclusions

Through the course of the COVID-19 pandemic remote monitoring of high-risk patients with pulmonary arterial hypertension has increased therapeutic changes, improved pulmonary artery pressure, facilitated therapeutic optimisation and early detection of disease worsening from the patient's home.

References

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