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Effects of COVID-19 Pandemic on the Management of Pulmonary Hypertension

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Title: Effects of COVID-19 Pandemic on the Management of Pulmonary Hypertension

Abstract:
The coronavirus of 2019 (COVID-19) disrupted delivery of healthcare. Patients with pulmonary hypertension (PH), especially pulmonary arterial hypertension (PAH), require significant resources for both diagnosis and management and are at high risk for decompensation due to disruption in their care. A survey consisting of 47 questions related to the care of patients with PH was designed by the American College of Chest Physicians 2020-2021 Pulmonary Vascular Disease (PVD) NetWork Steering Committee and sent to all members of the PVD NetWork, as well as the multiple other professional networks for PH. Participation was voluntary and anonymous. Responses were collected from November 2020 through February 2021. Ninety-five providers responded to this survey. The majority (93%) believe that care of PH patients has been affected by the pandemic. Sixty-seven percent observed decreased referrals for PH evaluation. Prior to the pandemic, only 15% used telemedicine for management of PH patients compared to 84% during the pandemic. Telemedicine was used most for follow up of selected low-risk patients (49%). While 22% respondents were completely willing to prescribe new PAH therapy via telemedicine, 11% respondents were completely unwilling. Comfort levels differed based on type of medication being prescribed. Over 90% of providers experienced disruptions in obtaining testing and 31% experienced disruptions in renewal or approval of medications. Overall, providers perceived that the COVID-19 pandemic caused significant disruption of care for PH patients. Telemedicine utilization increased but was used mostly in low-risk patients. Some providers had a decreased level of comfort prescribing PAH therapy via telemedicine encounters.
Abbreviations:

6MWD: 6-minute walk distance

ACCP: American College of Chest Physicians

ATS: American Thoracic Society

BNP: B-type natriuretic peptide

COVID-19: coronavirus disease of 2019

Echo: transthoracic echocardiogram

FPHR: French Pulmonary Hypertension Registry

ISHLT: International Society for Heart and Lung Transplantation

NT-proBNP: N-terminal prohormone B-type natriuretic peptide

PAH: pulmonary arterial hypertension

PFTs: pulmonary function tests

PH: pulmonary hypertension

PHA: Pulmonary Hypertension Association

PHCR: Pulmonary Hypertension Clinicians and Researchers

PHPN: Pulmonary Hypertension Professional Network

PRO: patient-reported outcome

PVD: pulmonary vascular disease

PVRI: Pulmonary Vascular Research Institute

RAP: right atrial pressure

RHC: right heart catheterization

RIGHT-NET: RIGHT Heart International NETwork

V/Q: ventilation/perfusion
WHO: World Health Organization
Introduction

The coronavirus disease of 2019 (COVID-19) has caused significant disruption in non-COVID related medical care since its debut. A significant decrease in healthcare utilization occurred in March of 2020, when the World Health Organization (WHO) first announced pandemic status, with dramatic drops in office visits in the following weeks\(^\text{1,2}\). Estimates of missed or delayed care ranged from 20% to over 40% of adults in the United States\(^\text{3,4}\). In one study, basic laboratory testing during the early pandemic decreased by 81-90% and new medication therapy prescriptions for even common drugs decreased by 52-60%\(^\text{5}\). There is an increased likelihood of healthcare delays among women and patients who had greater perceived risk from COVID-19 infection\(^\text{3}\).

Patients with pulmonary hypertension (PH) are a particularly high-risk group for disruption of care due to their extensive care needs and highly specialized care teams. Current guidelines for pulmonary arterial hypertension (PAH) in particular recommend updated risk assessment with tools such as the REVEAL 2.0 calculator at every clinical encounter\(^\text{6,7}\). These calculators include laboratory and echocardiographic values and pulmonary diagnostic assessments which require frequent healthcare contact. PAH therapies include medications with potent hemodynamic effects that need careful and frequent monitoring for titration. Delays in diagnosis and referral to PH centers is well documented and has been further compounded by the pandemic\(^\text{8,9}\).

PH patients are considered a high risk group for increased morbidity and mortality from COVID-19\(^\text{10,11}\). Ryan et al published general recommendations for the management of PH during the COVID-19 pandemic, which include suggestions to limit testing in select patients to decrease exposure to risks from healthcare encounters\(^\text{10}\). Similar recommendations were made
for patients with left heart failure, the most common cause of PH, as well as the use of cardiac imaging in general. In line with general healthcare trends, use of telehealth services among PH patients has increased. A recent review discusses how risk assessment for PH patients can be adapted to increasing usage of telehealth during the COVID-19 pandemic. It is unclear if this initiative was sufficient in counterbalancing the decrease in access to in-person care.

While a portion of the pandemic disruption is from decreased patient-initiated contact with healthcare, it has not been well-described in what other ways the care of patients with PH has been disrupted. There are scant data on how PH providers changed practice patterns in response to the challenges posed by the COVID-19 pandemic. This survey was designed to evaluate how respondents perceived care of PH patients changed during the pandemic.

Methods

The survey was designed and reviewed by the American College of Chest Physicians (ACCP) 2020-2021 Pulmonary Vascular Disease (PVD) NetWork Steering Committee. In total, the survey consisted of 47 questions regarding the care of PH patients during the COVID-19 pandemic.

The survey was then sent to providers involved in the management of PH via multiple routes, including the ACCP PVD NetWork, the American Thoracic Society (ATS) DocMatter Community, Pulmonary Hypertension Clinicians and Researchers (PHCR), Pulmonary Hypertension Professional Network (PHPN), International Society for Heart and Lung Transplantation (ISHLT), Pulmonary Vascular Research Institute (PVRI), and the RIGHT Heart International NETwork (RIGHT-NET). No patient specific information was obtained. This
survey did not require IRB submission or approval. Responses were collected from November 2020 through February 2021. There were a total of 95 respondents to the survey. Respondents were allowed to abstain from any question and therefore not all questions were answered by all respondents. The number of responses to each question ranged from 53 to 94, with one question garnering only 23 responses due to being contingent on the prior question. Percentages were calculated using the number of responses per question as the denominator (Supplement 1).

Results

Demographics

There were a total of 95 respondents to the survey. Of these, 44 (47%) were female and 72 (83%) were physicians. The primary specialty of respondents was pulmonary (63%), followed by cardiology (32%). Most respondents were from the United States (87%). Respondents were primarily from academic hospitals (77%) and in urban settings (78%). The majority of respondents (65%) had been in practice for 11 years or more, and 67% of respondents had an outpatient PH practice with over 100 patients. Over a third (37%) of respondents practiced at a Pulmonary Hypertension Association (PHA) Comprehensive Care Center with another 11% practicing at a PHA Regional Clinical Program. These demographics are summarized in Table 1.

Decreasing Risk of COVID-19 Transmission

Seventy-nine (93%) respondents believe the way they provided care for patients with PH has been affected by the COVID-19 pandemic. Most providers observed a reduction in in-person office visits, with 39 (46%) respondents estimating less than 50% of their patients are being seen in-person, and another 26 (31%) respondents estimating less than 75% of their patients are being
seen in person. Of the patients being seen in-person, 69 (82%) respondents screened patients for COVID-19 prior to the visit, with the most common screening measures being symptom questionnaires and temperature assessments, used by 66 (100%) and 47 (71%) respondents respectively (Figure 1). Patients who screen positive were primarily transitioned to telehealth visits by 36 (55%) respondents and sent to a centralized testing site for further testing and triaging by 23 (35%) respondents.

Within outpatient clinics, the primary measures used to decrease risk of COVID-19 transmission to patients were masking of both patients and staff (99%), physical distancing between patients (88%), sanitizing rooms between patient visits (83%), physical distancing between patients and providers (72%), and only allowing patients into the clinic at time of visit to limit time in a common waiting area (62%). Primary measures to decrease risk of transmission between staff members were encouraging self-quarantine in the event of exposure or symptom onset (90%), daily symptom screening prior to start of clinic (80%), daily temperature checks (59%), testing staff with recent exposures (58%), and testing staff if daily screening is positive (56%). These preventative measures are summarized in Table 2.

Usage of Telemedicine

Prior to the COVID-19 pandemic, only 12 (15%) respondents used telemedicine for patients with PH (Table 3). This shifted dramatically to 69 (84%) respondents using telemedicine during the pandemic with varying rates of use. For 27 (33%) respondents, less than 25% of their patients with PH were seen via telemedicine, whereas 17 (21%) respondents saw over 50% of their patients with PH via telemedicine. Many providers had a period of time during which they saw patients with PH only via telemedicine, primarily in March and April of 2020.
with 24 (29%) respondents only using telemedicine during that time. Utilization of telemedicine services has varied since early in the pandemic, with 30 (37%) respondents reporting increased use and 43 (53%) respondents reporting decreased use. Despite this, 24 (30%) respondents still reported seeing over 50% of patients with PH via telemedicine. The most popular platforms for performing telemedicine visits were Zoom (43%), electronic medical record based video clients (40%), telephone (35%), or Doximity (28%).

Respondents varied in patient selection for telemedicine visits. For patients who specifically requested telemedicine services, 63 (77%) respondents provided them. Telemedicine was used most commonly for select low risk follow up patients (49%), followed by intermediate risk follow-up patients (38%). A quarter of providers (26%) used telemedicine for all follow-up encounters, and a small portion (15%) used telemedicine for all new patient visits.

Respondents also varied in comfort level with managing patients with PH using telemedicine (Figure 2). While 16 (22%) respondents were completely willing to prescribe new PAH therapy via telemedicine, 8 (11%) respondents were completely unwilling to do so. The rest had varying levels of comfort with 20 (27%) being somewhat willing, 18 (25%) being somewhat unwilling, and 11 (15%) being neutral regarding prescribing new PAH therapy via telemedicine. Comfort levels differed based on type of medication being prescribed. While 18 (25%) respondents were completely willing to initiate oral PAH therapy via telemedicine, only 11 (15%) respondents were completely willing to initiate inhaled prostacyclin and 8 (11%) respondents were completely willing to initiate parenteral therapy. Likewise, only 5 (7%) respondents were completely unwilling to initiate oral PAH therapy via telemedicine, compared to 12 (16%) for inhaled prostacyclin and 35 (48%) for parenteral therapy.
Disruption of Care

Over 90% of respondents reported difficulties obtaining routine tests for diagnosis and monitoring of patients with PH during the pandemic. This appears primarily related to difficulties with limited test availability followed by patient choice. Respondents were asked to rank 8 tests in order of which were most impacted by the COVID-19 pandemic with 1 being the most impacted and 8 being the least. The most significantly impacted test was pulmonary function tests (PFT), followed by ventilation/perfusion (V/Q) scans, right heart catheterizations (RHC), 6-minute walk distance (6MWD), and transthoracic echocardiograms (ECHO), in order. While most respondents still performed 6MWD, the portion of patients being evaluated decreased, with 33 (48%) respondents assessing less than 50% of their patients with a 6MWD. Most 6MWD tests were conducted in clinic, with masks. In replacement of 6MWD, 63 (93%) respondents used questions to assess functional status, whereas 7 (10%) respondents requested a 6MWD to be completed at home.

Certain tests, such as PFTs, generate aerosols, and have thereby undergone changes in how they are conducted. While most respondents were still able to obtain PFTs, 9 (13%) respondents were not. Others obtained them only after negative pre-procedural testing for COVID-19 (60%), with providers wearing N95 masks and other personal protective equipment (54%), using expiration filters on PFT machines (37%), or in rooms with negative pressure or HEPA filters (21%). RHCs were unavailable only to 3 (4%) respondents and required similar precautions as PFTs with pre-procedural testing (83%), patients wearing surgical masks (58%), and providers wearing N95 masks (38%).

Most respondents (69%) did not experience disruptions to renewal or approval of medications for patients with PH. For those that did, disruptions were primarily due to logistical
delays related to the pandemic (74%), limited patient assessment due to decreased clinic visits (70%), and inability to obtain required testing for medication approval or renewal (57%). For patients on teratogenic medications, 28 (38%) respondents allowed substitution with home pregnancy tests to continue renewing medication prescriptions, whereas 22 (30%) respondents required mandatory laboratory testing as usual. Others (32%) encouraged laboratory testing but allowed occasional missed tests.

Referral rates generally decreased, although 5 (7%) respondents had increased referral volume and 19 (26%) had no change. Otherwise, 25 (34%) respondents had a decrease in referral volume of up to 25% and 17 (23%) experienced a decrease up to 50%. Similar trends were seen in follow-up visit volume, with 5 (7%) respondents reporting increased volume, 16 (22%) reporting no change, 23 (31%) reporting a decrease up to 25%, and 24 (32%) reporting a decrease up to 50%. Respondents did not report large changes in how COVID-19 affected the time they had in clinic to see patients, with 13 (18%) reporting increased time, 30 (41%) reporting no change, and 19 (26%) reporting a decrease of less than 25%.

**Effect on Research**

For 60 (81%) of respondents, the COVID-19 pandemic affected research activities for patients with PH in their clinic. Of those affected, 31 (53%) respondents reported a pause on all new research activities and 30 (51%) reporting inability to obtain tests as required per research protocols. Conversion of research patient encounters to telemedicine visits occurred for 15 (25%) respondents.

**COVID-19 Infections**
Over 80% of respondents reported having patients with PH infected with COVID-19. Respondents reported an average of 8 patients in their practice testing positive for COVID-19, 4 requiring outpatient symptomatic management, 3 requiring inpatient admission, and 1 requiring intensive care. There was an average of 1 death from COVID-19 per respondent.

Discussion

Provider and institutional response to the COVID-19 pandemic in regards to the care of patients with PH was notably varied. This survey is the first to evaluate both how PH providers perceive the care for patients with PH has been disrupted and how they perceive practice patterns have adapted to the challenges of this pandemic.

Following national trends, PH providers perceived significant disruption to the care of patients with PH, primarily in obtaining diagnostic tests. The two most impacted tests were PFTs and V/Q scans, likely related to the risk of aerosolizing COVID-19. RHCs were still available to almost all respondents, although we did not ask about delays in obtaining RHCs specifically. The addition of pre-procedural COVID-19 testing to reduce transmission risk, recommended as best clinical practice during the pandemic, also unfortunately adds an extra step to the process for patients. Usage of N95 masks was mixed, likely reflecting the at-times conflicting recommendations as to their necessity from national organizations. The decrease in referral rates is particularly concerning, as patients with PH already suffer from late referrals, which negatively affects prognosis.

Of note, most respondents did not experience disruptions related to medication renewal or approval. Similarly, while there have been disruptions in the available healthcare workforce, only a portion of respondents reported a decrease in their clinic availability. This implies that
disruptions to care were largely based around diagnostic testing and is reflected in the pandemic’s effects on research activities, where 51% of respondents reported an inability to obtain tests required by research protocols. Ultimately, this highlights a need for the development of improved remote monitoring of patients with PH. Telemedicine has already and will likely continue to play a large role in filling this need.

As expected, there was a dramatic increase in rates of telemedicine use from 15% to 84%, although rates of usage and how telemedicine visits were utilized varied significantly. Most interestingly, a number of respondents were comfortable initiating PAH therapies via telemedicine. Variation in willingness to do so likely has a multifactorial basis, including availability of access to other kinds of healthcare services, such as laboratory or echocardiographic testing, and the provider-patient relationship. The variation highlights the question of what parameters are necessary for the initiation of PAH therapies. CHEST guidelines for PAH therapy are based primarily on WHO functional classes, with clinical goals primarily being improvement of functional class or 6MWD\textsuperscript{21}. European Respiratory Society guidelines are based on risk categories, which can be calculated using a variety of risk assessment tools, with WHO functional class generally being a consideration\textsuperscript{6,7}.

The simplest risk assessment tool was developed from the French Pulmonary Hypertension Registry (FPHR) with only 4 variables, utilizing WHO functional class, 6MWD, right atrial pressure (RAP), and cardiac index\textsuperscript{22}. Within the same study, Boucly \textit{et al.} demonstrate that RAP and cardiac index could be replaced with B-type natriuretic peptide (BNP) or N-terminal prohormone BNP (NT-proBNP) measurements, creating a 3-variable version with only WHO functional class, 6MWD, and BNP/NT-proBNP. Likewise, REVEAL Lite 2 truncates the 13-variable REVEAL 2.0 into just 6 variables: WHO functional class, systolic blood
pressure, heart rate, 6MWD, BNP/NT-proBNP, and renal insufficiency\textsuperscript{23}. This is important as per our survey, serum bloodwork was the least impacted of all the different types of testing used to monitor and evaluate patients with PH. Risk assessment tools that rely on more easily obtainable measurements will likely be preferable in the foreseeable future.

In Italy, a scoring system for heart failure patients was implemented in a small cohort as they transitioned to telemedicine, relying on home measurements of vital signs and patient reports of medication adherence and symptomatology for the titration of medical therapy\textsuperscript{24}. Although most PAH therapies have more potent hemodynamic effects as compared to the components of goal-directed medical therapy for heart failure, development of a structured telemedicine system may be a way to increase provider comfort and willingness to initiate at least oral PAH therapy, thereby improving patient access to care. Caution should be used when relying on physician gestalt, as a prior study by Sahay \textit{et al.} has showcased its unreliability\textsuperscript{25}. Instead, multiple patient-reported outcome (PRO) questionnaires have already been developed for use in PAH patients, including CAMPHOR, PAH-SYMPACT, and emphasis-10, although they are not currently utilized in PAH guidelines\textsuperscript{26–28}. Implantable devices like CardioMEMS will also likely have significant effects on remote management of PAH, but it is unclear how widespread their implementation would be or if they will be utilized in lower-risk patients\textsuperscript{29}. The utility of other biometric wearable devices has yet to be ascertained. In the meantime, encouraging use of home blood pressure cuffs or pulse oximeters, PRO questionnaires, and risk assessment tools that rely on easily obtainable variables may improve management of many patients with PAH via telemedicine.

This study has several limitations. This is anonymous survey and thus likely has selection bias. Although several providers from non-US countries responded, the vast majority of
respondents were based in the US. The practice patterns shown here are thus largely representative of US providers. Although there were a total of 95 respondents, not all respondents answered every question, decreasing the utility of certain questions. We asked questions about referral volume and infection rates, but it is unclear if respondents answered based off known numbers or gestalt estimates.

It will be some time before the full effects of the COVID-19 pandemic can be reviewed. In the meantime, our survey has highlighted some key areas in which COVID-19 has already impacted the care of patients with PH, as well as areas of needed improvement. Disruptions in care were primarily related to obtaining diagnostic testing, with aerosolizing and invasive testing being the most heavily impacted. Overall, this showcases the need to improve remote monitoring and clinical assessment of patients with PH with validated metrics that rely on easily obtainable data. Adapting to the challenges that COVID-19 has presented will ultimately simplify the care of patients with PH by necessity, thereby increasing accessibility and hopefully improving patient outcomes.
References


Figure 1. Provider Screening Effects on Usage of Telehealth

Percentages provided indicate the proportion of respondents who performed each option. For providers still seeing patients in clinic, the majority utilized some form of screening for patients who were higher risk of transmitting COVID in the clinic. Screening measures varied, although all used some form of symptoms questions. If a patient screening positive, measures taken also varied, with more than half of respondents transitioning the patients to telemedicine appointments.

Figure 2. Provider Willingness and Comfort Level in Managing PAH via Telemedicine

Respondents were asked how willing or comfortable they were in initiating pulmonary arterial hypertension (PAH) specific therapy after evaluating a patient through telemedicine. Answers varied based on the type of therapy.
Table 1. Respondent Demographics

<table>
<thead>
<tr>
<th>Category</th>
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<th>%</th>
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<tr>
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<tr>
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<td>11-20 years</td>
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<tr>
<td>&gt; 250 patients</td>
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<td>PHA RCP</td>
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<td>10.6</td>
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</table>

VA: Veteran's Health Administration; PHA: Pulmonary Hypertension Association; CCC: Comprehensive Care Center; RCP: Regional Care Program
Table 2. Common Precautions Taken with Patients or Staff Members to Reduce Transmission of COVID

**Requirements for Patients**

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<thead>
<tr>
<th>Type</th>
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<tr>
<td>Patient wears mask</td>
<td>80</td>
<td>99</td>
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<tr>
<td>Distancing between patients</td>
<td>71</td>
<td>88</td>
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<tr>
<td>Sanitizing exam rooms between visits</td>
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<td>83</td>
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<tr>
<td>Distancing between patient and provider</td>
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<tr>
<td>Restricted access to waiting room</td>
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<td>62</td>
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<tr>
<td>Distancing with plexiglass between patients and staff</td>
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<td>54</td>
</tr>
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</table>

**Requirements for Staff**

<table>
<thead>
<tr>
<th>Type</th>
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<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff wears mask</td>
<td>80</td>
<td>99</td>
</tr>
<tr>
<td>Encourage self-quarantine if exposed or symptomatic</td>
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<td>90</td>
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<tr>
<td>Daily verbal symptom screening</td>
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<tr>
<td>Daily temperature checks</td>
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<td>59</td>
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<tr>
<td>Testing staff if recent exposure</td>
<td>47</td>
<td>58</td>
</tr>
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<td>Testing staff if screening positive</td>
<td>45</td>
<td>56</td>
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</table>
Table 3. Change in Telemedicine Use Throughout the Pandemic

*Prior to the current CoVID-19 pandemic, did you provide care for PH patients in your practice using telemedicine? (n=82)*

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>12</th>
<th>14.6%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>70</td>
<td>85.4%</td>
</tr>
</tbody>
</table>

*For providers using telemedicine, what percentage of patients are seen via telemedicine? (n=75)*

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Yes</th>
<th>27</th>
<th>33.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 25%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-50%</td>
<td></td>
<td>25</td>
<td>30.5%</td>
</tr>
<tr>
<td>50-75%</td>
<td></td>
<td>11</td>
<td>13.4%</td>
</tr>
<tr>
<td>&gt; 75%</td>
<td></td>
<td>6</td>
<td>7.3%</td>
</tr>
<tr>
<td>Not using</td>
<td></td>
<td>6</td>
<td>7.3%</td>
</tr>
</tbody>
</table>

*How has the current percentage of PH patients seen with telemedicine changed since early in the pandemic? (n=81)*

<table>
<thead>
<tr>
<th>Change</th>
<th>Yes</th>
<th>17</th>
<th>21.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased to &gt; 50%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased but &lt; 50%</td>
<td>13</td>
<td>16.0%</td>
<td></td>
</tr>
<tr>
<td>No change</td>
<td></td>
<td>8</td>
<td>9.9%</td>
</tr>
<tr>
<td>Decreased to &lt; 50%</td>
<td>36</td>
<td>4.4%</td>
<td></td>
</tr>
<tr>
<td>Decreased but &gt; 50%</td>
<td></td>
<td>7</td>
<td>8.6%</td>
</tr>
</tbody>
</table>
Screen patient for COVID risk?

Yes (82.14%)

Symptom questions (100%)
Temperature check (71%)
Online questions (17%)
Written questions (12%)
Mandatory COVID testing (12%)

No (17.86%)

Patient seen in clinic

Positive screen

Transition to telehealth (55%)
Sent to centralized testing site for testing (35%)
Tested in clinic (9%)

Negative screen
Pulmonary hypertension is a complex medical condition that requires close monitoring and management for optimal outcomes.

The COVID pandemic caused a significant disruption in routine patient care. Patient referral volumes decreased, access to testing was interrupted and telemedicine interactions with patients increased significantly.

The CHEST Pulmonary Vascular NetWork Steering Committee was very interested in better understanding the provider response and the impact of COVID 19 on the day to day management of pulmonary arterial hypertension patients. A survey was created and sent to participants in the CHEST Pulmonary Vascular NetWork as well as many other pulmonary focused organizations.

This survey elucidated providers response and changes in management due to COVID-19. This survey was created by the Pulmonary Vascular NetWork and published to increase awareness of the impact of the pandemic on this complex patient group, to improve our understanding of the effects of change in management as well as identify areas for improvement.
Declarations of interest: None