CHEST

Pulmonary Hypertension Care Center Network

Improving Care and Outcomes in Pulmonary Hypertension

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Pulmonary hypertension (PH) is a chronic, progressive, life-threatening disease that requires expert multidisciplinary care. To facilitate this level of care, the Pulmonary Hypertension Association established across the United States a network of pulmonary hypertension care centers (PHCCs) with special expertise in PH, particularly pulmonary arterial hypertension, to raise the overall quality of care and outcomes for patients with this life-threatening disease. Since the inception of PHCCs in September 2014, to date 35 centers have been accredited in the United States. This model of care brings together physicians and specialists from other disciplines to provide care, facilitate basic and clinical research, and educate the next generation of providers. PHCCs also offer additional opportunities for improvements in PH care. The patient registry offered through the PHCCs is an organized system by which data are collected to evaluate the outcomes of patients with PH. This registry helps in detecting variations in outcomes across centers, thus identifying opportunities for improvement. Multiple tactics were undertaken to implement the strategic plan, training, and tools throughout the PHCC network. In addition, strategies to foster collaboration between care center staff and individuals with PH and their families are the cornerstone of the PHCCs. The Pulmonary Vascular Network of the American College of Chest Physicians believes this to be a positive step that will improve the quality of care delivered in the United States to patients with PH. CHEST 2017; 151(4):749-754

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Pulmonary hypertension (PH) is a chronic, progressive disease characterized by a variety of symptoms that often lead to disability and ultimately death. Multidisciplinary consensus group efforts have established an accepted algorithm for diagnosis and treatment. Despite the widespread delivery of this information and better understanding of this disease in the medical community, the prognosis of PH continues to be suboptimal.

ABBREVIATIONS: CHEST = American College of Chest Physicians; CTEPH = chronic thromboembolic pulmonary hypertension; OC = oversight committee; PAH = pulmonary arterial hypertension; PH = pulmonary hypertension; PHA = Pulmonary Hypertension Association; PHAR = Pulmonary Hypertension Association Registry; PHCC = pulmonary hypertension care center; RC = review committee; REVEAL = Registry to Evaluate Early and Long-term PAH Disease Management; SLC = Scientific Leadership Council

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Most recently, the Fifth World Symposium on Pulmonary Hypertension classified pulmonary hypertension into five groups: Group 1 PAH, which includes heterogeneous diseases that result in common pathobiologic characteristics within the pulmonary vasculature[1]; this group includes idiopathic, familial, and drug- and toxin-induced PAH associated with systemic sclerosis, portal hypertension, congenital heart disease, and human immunodeficiency virus infection. The remaining four groups of PH are described as PH resulting from multiple other conditions and usually referred to as secondary PH. Treatment choices for these subgroups are typically aimed at correction or attenuation of the original disease. Group I PAH has received significant attention in research efforts worldwide, which has resulted in improved outcomes; however, long-term survival and cure continue to be unmet challenges. Five-year survival in the Registry to Evaluate Early and Long-term PAH Disease Management (REVEAL) study from the timing of right heart catheterization was 57%.[2] Most importantly, this information reflects incident and prevalent cases of PAH in both community and experienced centers for the diagnosis and treatment of PH. With the goal to standardize care and to improve research efforts and outcomes in PH, the Pulmonary Hypertension Association (PHA) started an initiative to create pulmonary hypertension care centers (PHCCs) in the United States.

Current Challenges: Need for PHCCs

In the National Institutes of Health registry published in 1987, the mean time between symptom onset and diagnosis was 24 months,[3] 27 months in the French registry,[4] and 33 months in the 2012 REVEAL registry.[5] These registry-based data reflect that a quarter of a century of knowledge and research has not been sufficient to narrow the commonly seen late diagnosis and the associated unwanted prognostic consequences. A variety of factors can account for this delay. Most notably is the insidious and nonspecific nature of the symptoms.[6] These factors result in significant delay and not infrequently in misdiagnosis at early stages of the disease. Ideally, early recognition and timely referral will facilitate confirmation of the correct diagnosis and potentially the most adequate treatment choices. This persistent delay in diagnosis highlights the importance of increasing awareness regarding this disease as well as the dire need for a comprehensive multidisciplinary approach to these patients' care.

With the increasing awareness of and wide availability of pharmacologic therapies for PAH, the majority of patients referred to tertiary centers have already been initiated on specific therapies.[7] This has shifted the momentum of treatment of PH from tertiary referral centers to community-based clinical settings. As a result, the modality of care delivery is less uniform, with different degrees of adherence to guidelines and level of expertise, and a variable amount of clinical support. Moreover, PAH-specific therapies are increasingly being inappropriately used for PH outside of group 1. The RePHerral study,[8] conducted at three large university-based tertiary-level referral centers, showed that 98 of 140 patients (70%) were assigned a definitive diagnosis of PAH prior to referral. Of these, 32 patients (33%) were considered to have an incorrect diagnosis of PAH. Fifty-nine of 140 patients (42%) did not undergo a confirmatory right, left, or dual heart catheterization; 42 (30%) were started on PAH-specific therapies before referral, with 24 (57%) of the medications prescribed without adhering to published treatment guidelines. As a result, early access for patients to obtain an experienced second opinion and assurances that optimal care is provided to all patients has become a relevant concern.

The PAH-QuERI[9] (Pulmonary Arterial Hypertension-Quality Enhancement Research Initiative) project was created to help physicians use the guidelines-based approach to the diagnosis and treatment of PAH. A total of 791 patients were enrolled in the PAH-QuERI project, and findings revealed that all American College of Chest Physicians (CHEST) guidelines-recommended tests were performed only in 6% of patients at the time of enrollment, as reported by participating physicians using an electronic data management record. Interestingly, only 7% of patients who received calcium channel blockers for PAH met the criteria for acute vasoreactivity on right heart catheterization. This study highlighted the underutilization of diagnostic tests along with a wide gap between the recommendations from guidelines and clinical practice. Badagliacca and colleagues[10] described patients with PAH receiving oral medications for a longer duration in spite of clinical worsening. In this study, patients who died were more frequently referred while receiving oral therapy (83% vs 36%; $P < .01$) and had a higher rate of urgent need for prostanoid treatment (69% vs 17%; $P < .0001$). The referenced data support the overreliance on and use of oral therapies at the nonexpert centers in comparison with the tertiary-level referral centers. This report also highlighted that the patients who died were in a more

advanced functional class and had worse pulmonary hemodynamics at the time of referral. Survivors had a significant response to prostanoid, improving New York Heart Association class from 2.8 ± 0.4 to 2.3 ± 0.5 ($P = .002$), 6-minute walk distance from 354 ± 91 to 426 ± 82 m ($P = .0001$), and pulmonary hemodynamics. It was concluded, therefore, that the timing of referral of these patients to a tertiary-level PH center is critical in affecting their prognosis. Data from the REVEAL registry reflect similar findings.[11] Of patients who died of a PAH-related cause, only 56% were receiving intravenous prostacyclin before death. Among those who died in the PAH-related death cohort, 60% and 16% of patients were most recently assessed as functional classes III and IV, respectively. Only 57.7% of the patients in functional class IV had received intravenous prostacyclin. Nevertheless, the REVEAL study presented data originating from both community and experienced centers.

Tonelli and colleagues[12] reported from their high-volume, expert program the circumstances surrounding the death of patients with PAH: All but one patient (83 of 84) received some form of PAH-specific therapy and 57.2% were receiving dual or triple combination therapy at the time of death. Of patients with PAH who died of right heart failure, 70% received parenteral prostanoid therapy. There were valid reasons why 30% of the patients did not receive parenteral prostanoids, such as refusal of parenteral therapy or being poor candidates for this therapy. The authors concluded that at their center most patients received appropriate therapy as indicated by the guidelines. High-volume specialized centers have been successful in providing the best outcomes for patients in various disease states, while maintaining the greatest patient satisfaction, lowest complication rates, shortest hospital stay, and best value for health care payers.[13] Moreover, the results of surgical therapy for chronic thromboembolic pulmonary hypertension (CTEPH) have also supported the concept of improved outcomes from high-volume centers: operative mortality has declined as centers gained greater experience through higher procedure volume.[14,15]

Pulmonary Hypertension Care Centers

It has long been recognized that the care of patients with PH requires organized and structured programs with defined goals. Established and accredited programs such as those that provide care for patients with cystic fibrosis or organ transplantation have demonstrated advantages that have resulted in standardized and ultimately improved specialized patient care. Therefore, in 2011, the Scientific Leadership Council (SLC) of the Pulmonary Hypertension Association (PHA) recommended the development of a nationwide accreditation program for PH centers.[16] The PHA is now focusing on the accreditation of PH centers along with improving disease awareness and patients' access to care. Two committees, the PHCC Oversight Committee (OC) and the PHCC Review Committee (RC), were established to carry out the administrative functions of the PHCC accreditation program. The OC comprises physicians, allied health professionals, a patient, a member of the board of trustees, an attorney, and PHA staff members. The OC is charged with analyzing and updating the PHCC accreditation criteria, program evaluation tools, and the accreditation scoring system. The OC is also responsible for establishing and governing the PHCC RC and reports to the PHA Board of Trustees. The OC currently comprises seven selected members, with each serving a 3-year term. The RC consists of 22 members including physicians and allied health professionals serving 2-year terms, supported by PHA PHCC staff. The responsibilities of the RC include reviewing site applications, conducting site visits, and determining accreditation status. This initiative resulted in a two-center system: pulmonary hypertension centers of comprehensive care and regional clinical programs. The SLC of the PHA stipulated that a PHCC, along with providing expert clinical care, should also develop basic and clinical research expertise and educate the next generation of providers.

The PHCC accreditation committee developed standards for care, research, and teaching, which became the basic criteria that care centers must implement and sustain for PHCC accreditation. The initial standards of care required that PHCCs use a team of multidisciplinary experts to address inpatient and outpatient clinical needs, adhere to care practices developed by PH clinical experts, and maintain a sufficient patient volume to advance the expertise of the center's care providers. The SLC, at the outset, came up with admirable yet challenging goals for PHCCs to improve the overall care of patients, which should translate into better long-term patient outcomes (Table 1).

In July 2014, the PHA launched the PHCC program. Since the time of institution of this program, the PHA has accredited 35 centers as centers of comprehensive

TABLE 1] Goals for Pulmonary Hypertension Care Centers

1. Increasing disease awareness
2. Improving access to expert care
3. Raising the level of care at *all* centers through increased adherence to published guidelines and consensus statements
4. Providing a blueprint to prospective programs for becoming PHCCs
5. Fostering collaboration among expert centers for treating individual patients and cultivating new research opportunities in the field
6. Conducting center-specific and national quality improvement projects with the aid of a national patient registry

PHCCs = pulmonary hypertension care centers.

care. Pulmonary hypertension care centers (PHCCs) are designated as either a PHA-accredited center of comprehensive care or as a PHA-accredited regional clinical program, based on a number of factors including quality and depth of resources available for the expert care of their patients with PH, as well as the array of therapies offered by the center. This two-level system stems from an acknowledgment that some PH care providers are qualified to correctly diagnose and initiate first-line treatment in less sick patients with PH with subsequent referral to a comprehensive care center for more advanced therapies, when necessary. Research, both clinical and basic, is an integral component of comprehensive care centers but not required for a regional clinical program. e-Tables 1-3 highlight the role and features of the center director, coordinator, and program staff. and facility for a comprehensive care center and regional clinical program. It should be stressed that both comprehensive care centers and regional clinical programs will be accredited by the PHA only after undergoing a thorough evaluation and satisfactorily meeting the respective criteria set forth. While comprehensive care centers are expected to teach and mentor the next generation of health care professionals, regional clinical programs are focused more on providing the same level of clinical care as comprehensive care centers. The PHA initiative will promote a uniform standard of care at the tertiary-level care centers as well as at community hospitals and private practices. This will help all individuals with PH to receive appropriate care within a reasonable distance from their home.

In turn, all PHA-accredited centers will be expected to uphold the principles of delivering appropriate and effective care to patients with PH as outlined by the PHCC committee. To ensure that PHCCs sustain accreditation standards, they undergo a site visit by members of the center committee at least every 3 years. PHCCs provide a unique, sustainable approach to treatment of a complex chronic disease throughout the life span of patients. The goal of the accreditation process is not only to ensure that basic standards are met, but also to promote optimal care. For this reason, the accreditation process supports and fosters continuous improvement efforts within care centers. The mission of the PHCC committee is to foster exemplary care for all individuals with PH through the promotion of standards of care, accreditation of care centers, education of providers, and the advancement of research in all aspects of PH.

A recent interim analysis of the data obtained from the 34 accredited PH centers of comprehensive care was done, and the results were presented at a national meeting. This highlighted the structure of the accredited programs along with their deficiencies. A review of patient charts revealed nocturnal oximetry testing as the most frequent deficiency followed by documentation of pulmonary function and vasodilator testing at the accredited centers. It also showed in the past 3 years how many patients were treated with oral, inhaled, or intravenous/subcutaneous prostacyclin at these centers.[17] Highlighting such data will help in self-improvement of each center and long term will improve the care delivered to patients with pulmonary hypertension.

Pulmonary Hypertension Association Registry

The creation of this new Pulmonary Hypertension Association Registry (PHAR) is a key advancement in the ability to achieve improvements in PH health outcomes nationally. One of the requirements for accreditation as a PHCC is to enroll patients with PH into the PHAR. The patient registry became a web-enabled database and is deployed throughout the entire care center network as an institutional review board-approved, longitudinal, observational study. The PHAR collects data from World Health Organization (WHO) group 1 patients with PH (ie, those with PAH) and WHO group 4 patients with PH (chronic thromboembolic pulmonary hypertension [CTEPH]) who are starting evaluation and/or treatment at a PHCC. PAH is a "rare disease" and as per the United States-based REVEAL registry, the prevalence of PAH is 2.0 to 10.6 cases per million adults.[18] Since there are so few patients with PH, looking at data for patients from just

one PHCC will not provide meaningful information for researchers. Thus, it is necessary to compile data from as many patients as possible to share with other health professionals and create best practices and standards of care. The usefulness of the PHAR, akin to the Cystic Fibrosis Foundation Registry, cannot be underemphasized as the importance of future quality improvement, comparative effectiveness, and other registry-based research will evolve from this important venture. There may not be as much guidance available to publish on the structure of the PHAR to date, but any information regarding data capture, data security, assurance of informed consent and data quality, and so on, would be of interest.

Recommendations for PH Care From Current Guidelines

Based on the success of expert care centers in many countries[19] and improved access to emergent PAH treatment,[20] the Fifth World Symposium on Pulmonary Hypertension recommended the expert/specialized center referral for patients with PAH as a grade 1-C recommendation[21] (evidence and/or general agreement that a given treatment or procedure is beneficial, useful, or effective based on consensus of opinion of the experts and/or small studies, retrospective studies, registries).

The latest guidelines for PAH published by the European Society of Cardiology/European Respiratory Society[22] recommend early referral and treatment of patients with PAH at a referral center. It is recommended that referral centers provide care by a multiprofessional team (cardiology and respiratory medicine physicians, clinical nurse specialist, radiologists, psychological and social work support, appropriate on-call expertise) and have direct links and quick referral patterns to other services (such as connective tissue disease, family planning, pulmonary endarterectomy, lung transplantation, adult congenital heart disease) (class I-C recommendation). These guidelines also highlighted that referral centers should have sufficient patients receiving chronic therapy as well as new referrals to warrant this status. The ideal number of patients seen by an adult referral center each year is recommended to be no fewer than 200, of which at least 50% should have a final diagnosis of PAH.

In countries with a population of more than 10 million, adult centers should ideally expand to accommodate more than 300 patients annually. It is recommended that a referral center, at a minimum, should monitor at least 50 patients with PAH or CTEPH and receive at least two new referrals per month with documented PAH or CTEPH.[22] These numbers can be adapted according to specific country characteristics (population distribution, geographical constraints, etc.). Pediatric centers should monitor at least 30 to 50 patients annually.

PHA: Having the Will to Change

The PHA scientific leadership committee started the PHCC initiative in 2011 under the guidance of the PHA board of trustees and PHA oversight committee. The committee felt a sense of urgency to address the variation in outcomes and delay in diagnosis as well as a need to close the gap between the care centers with the best outcomes and other PH centers. The goal of the PHCC initiative has been to improve care for everyone in the United States with PH, by embracing and spreading quality improvement processes and principles for the delivery of care within the PH care centers. The PH association leadership believes that additional years, or even decades, could be added to the lives of those with PH by enhancing care delivery. The recent PHAR initiative has added transparency to the PHCC network. Publically available data in the online registry will be a key driver for improving care center staff, the lives of people with PH, and their families and institutions.

Changing the Culture

The vision of the PHA leadership is that exemplary care should be delivered at all accredited PH care centers to further extend the quality and length of life for people affected by the disease. Simply developing standards of PH clinical care and disseminating the health outcome data have been demonstrated to be insufficient in improving care for this group of patients. Over time, multiple improvement strategies need to be implemented by the PHCCs and should be shared with the other care centers. The teams at each PHCC should provide a learning environment for peers at other care centers. New physicians who are recruited to PH care centers should focus on increasing opportunities related to both research and clinical practice. Initiatives to build and strengthen the partnership between patients, their families, and care center staff, such as patient and family advisory councils, should be used to improve PHCCs.

Conclusion

The CHEST endorsed the Pulmonary Hypertension Association's Pulmonary Hypertension Care Center

(PHCC) accreditation program in 2014. As part of this endorsement, the College is a nonvoting member of the PHCC oversight committee. The CHEST's endorsement is an important step as it will give the College a role in the development, implementation, and evolution of this program.

The PHCC is a model of chronic care delivery, with clear aims to improve outcomes for patients who suffer from PH. The PHA has taken the lead to develop a system to accredit practice programs for PH via an integrated, multidisciplinary, and high-quality approach. These are the comprehensive care centers, regional clinical program, and patient registry. The PHA, while providing leadership, sets a framework for improved PH care, dissemination of knowledge, research tools, and maintenance of clinical expertise that can improve care for a complex chronic disease at multiple clinical care sites across the United States. In addition, the development of a PH registry at the care centers allows additional treatment, demographic, diagnostic, and outcome data. However, this approach is possible only with a strong partnership between patients, families, and the multidisciplinary health care providers needed to care for individuals with PH.

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Additional information: The e-Tables can be found in the Supplemental Materials section of the online article.

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