

REVIEW ARTICLES

Multidisciplinary Approaches to Sleep Apnea Management: Historical Review and Future Recommendations

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Abstract

Obstructive sleep apnea (OSA) is one of the more common, yet least appreciated of the common chronic conditions in the United States. OSA is a syndrome with multifactorial pathophysiology, and is associated with increased morbidity and mortality, with many patients living with OSA for years before diagnosis. Because of the efficacy of CPAP, it has been considered a first-line therapy and OSA care has been primarily organized around it. However, several factors are converging that provide a sound argument for a multidisciplinary approach to OSA management. Over 35 therapeutic options exist for OSA, but they tend to be underutilized especially for patients with mild-to-moderate OSA. Most OSA care is provided by pulmonary physicians with specialty training in sleep medicine, with limited inclusion of other disciplines in the evaluation and therapeutic process. Finally, with increased recognition of both OSA phenotypes and non-anatomical causes of OSA, the field is now starting to better understand defined subgroups of OSA patients, and the new era of personalized, tailored treatment approach has begun. OSA healthcare services will need to either organize multidisciplinary clinics physically, virtually, or via some combination to adequately care for the large number of OSA patients in the United States.

Keywords: behavioral sleep medicine; chronic illness; patient-centered; sleep apnea syndromes; therapeutics.

1. Obstructive Sleep Apnea

Obstructive sleep apnea (OSA) is a sleep-related breathing disorder (SRBD) that is characterized by repeated cessation or reduction in breathing during sleep that causes sleep fragmentation and oxygen desaturations. In the United States, OSA is highly prevalent in middle-aged to older adults, with estimates of up to 30 million.¹ Higher prevalence rates are seen in the elderly (~24%),^{2,3} Veterans (~17%),⁴ African Americans,⁵ and Hispanics.⁶ An early global estimate from the World Health Organization in 2007 was 100 million,⁷ but the most recent estimate was nearly ten-fold at 950 billion affected individuals worldwide.⁸

1.1. Costs of OSA. Untreated OSA in the U.S. is estimated to contribute \$3 billion in additional medical costs with a total economic burden greater than \$100 billion including loss of workplace productivity, occupational injury, and greater health care utilization.⁹ Estimates of health care costs for OSA patients are approximately twice that of matched, healthy controls.¹⁰ This increased cost of care is directly related to OSA severity and is evident several years prior to the diagnosis.¹¹ OSA is associated with shortened survival in prospective studies of coronary artery disease patients¹² and community dwelling elderly,¹³ as well as in large retrospective studies.¹⁴

1.2. Cardiovascular consequences of OSA. OSA is associated with several cardiovascular diseases, most notably, hypertension, ischemic heart disease, heart failure, stroke, cardiac arrhythmias, and pulmonary hypertension. Compared to the general population, OSA patients have twice the risk for hypertension, three times the risk for ischemic heart disease, and four times the risk for cerebrovascular

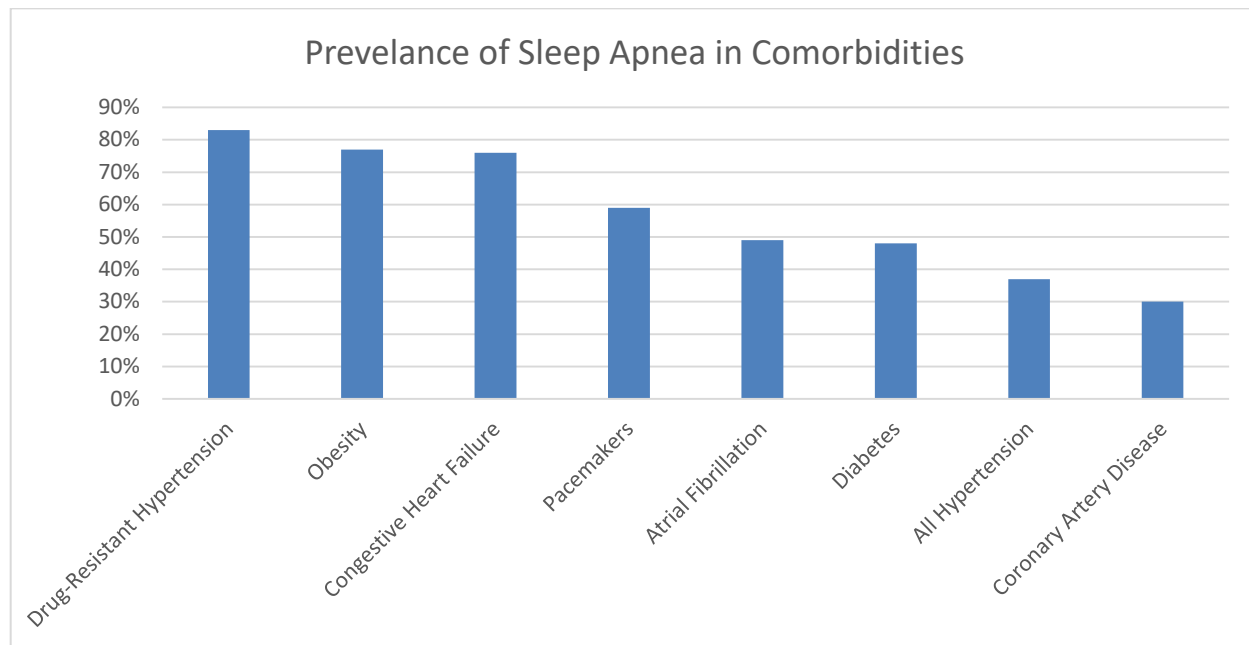
disease.¹⁵⁻¹⁷ The evidence supporting the link between OSA and hypertension is compelling, with OSA now officially recognized as an identifiable cause of hypertension.¹⁸ Evidence shows that OSA bears a dose-response relationship to hypertension independently of other known risk factors;¹⁹ the incidence of hypertension in OSA patients is as high as 53%;²⁰ and OSA is highly prevalent in drug-resistant hypertension patients.²¹

1.3. Sleep quality impairment due to OSA. OSA generally results in poor sleep quality, characterized by short sleep latency (*i.e.*, time to sleep onset), increased stage 1 sleep, decreased rapid-eye movement (REM) and slow-wave sleep (SWS), poor sleep efficiency, and frequent sleep fragmentation caused by transient arousals.^{22,23} Poor sleep quality causes sleep to be non-restorative, resulting in mild to severe daytime sleepiness (commonly referred to as excessive daytime sleepiness, or EDS). EDS and/or hypoxia secondary to OSA are associated with a number of neurocognitive, mood, and behavioral consequences, including lowered health-related quality of life (HRQOL),²⁴ impaired cognitive performance,²⁵ impaired driving ability (2 to 7 times increased risk of a motor vehicle accident),²⁶ dysphoric mood,²⁷ psychosocial disruption (*e.g.*, more impaired work performance and productivity, and higher divorce rates),²⁸ and disrupted sleep and impaired quality of life of spouses of OSA patients.²⁹

1.4. OSA Comorbidities. OSA is associated with several other medical comorbidities. Figure 1 shows the high prevalence rates of OSA in a variety of other medical conditions. Obesity is a major risk factor for OSA, as the risk of OSA increases significantly with increased weight.³⁰ Over 75% of OSA patients

are reported to be more than 120% of ideal body weight.³¹

Figure 1. Prevalence of Obstructive Sleep Apnea in Other Medical Conditions.



1.5. Multifactorial Pathophysiology of OSA. Given the heterogeneity of clinical presentation, it is not a surprise that we continue to learn more about the multifactorial nature of OSA pathophysiology. In the simplest terms, there are anatomical and non-anatomical causes of OSA. Until relatively recently, the focus has been on pharyngeal anatomy and craniofacial structure, which appears to have an evolutionary basis.³² Recent advances in our understanding of the non-anatomical factors are playing an important role, and include: impaired pharyngeal dilator muscle functioning, low respiratory arousal threshold (*e.g.*, premature awakening secondary to airway narrowing), and high loop gain (*e.g.*, unstable control of breathing).³³ How these non-anatomical factors interact with the anatomical factors represent the cutting-edge of

research.^{34,35} It is clear that the more we learn, the future of OSA management will be based on more comprehensive diagnostic testing that will lead to more personalized, tailored therapies for patients with OSA.

1.6. Summary. Obstructive sleep apnea is one of the more common, yet least appreciated of the common chronic conditions in the United States. Because of it is considered a syndrome that is characterized by multiple causes and typically unknown duration when first presented to the sleep clinic, it is incumbent that the medical system strives to provide improved multidisciplinary assessment and moves away from its current reliance on minimal testing and fallback on providing a “CPAP trial.” While it is most commonly initially identified and referred out to specialty

care from primary care, it is often not followed up on in primary care. Depending on the sleep medicine physician, their training, and the health care system and availability of other sleep-related disciplines, patients may not be informed about all the treatment options available to them, or the benefits and harms of each option available to them. The next section covers the therapeutic options for OSA.

2. Therapeutic Approaches to OSA

2.1. CPAP Therapy. Nasal continuous positive airway pressure (CPAP)³⁶ is the first-line therapy for obstructive sleep apnea (OSA)³⁷ with meta-analytic reports showing improvement the apnea-hypopnea index,³⁸ daytime sleepiness³⁹ and health-related quality of life.⁴⁰ The standard prescription is to use CPAP whenever asleep, including during daytime naps. However, despite CPAP being the most *efficacious* treatment available to OSA patients, initial acceptance and adherence are limited (3 to 5 hours per night), thereby significantly limiting its *effectiveness*.^{41,42} There are a number of factors associated with CPAP acceptance and use levels, but perhaps the most important factors are level of OSA severity and perceptions of limitations in daytime functioning. It is well-known that CPAP is more effective in those with more severe OSA and less effective in those with mild-to-moderate OSA.

2.2. Other Medical Therapies. Other primary medical therapies for OSA include (a) oral appliance therapy and (b) hypoglossal nerve stimulation therapy.⁴³ (a) Oral appliances are typically considered a second-line therapeutic approach for OSA. They are custom-fitted by a dentist, are designed to protrude the mandible,

and are based on the notion that they enlarge the airway enough to avoid some partial and full closures of the airway during sleep. Oral appliances are considered less efficacious, but more effective, than CPAP therapy given that they lower the AHI less than CPAP but are used more each night relative to CPAP.⁴⁴ Custom-fit OAs appear to result in improved clinical effectiveness, patient preference, and adherence relative to read-made OAs.⁴⁵ (b) The hypoglossal nerve stimulates the intrinsic and extrinsic muscles of the tongue and improves airway patency during sleep.⁴⁶ Regular use appears to result in a reduction of the AHI by >50% and in patient-reported outcomes (e.g., sleepiness and quality of life) up to four years of follow-up.^{47,48} Because it requires the use of an implantable device, it is generally not considered a first-line therapy.

2.3. Surgical Procedures. Upper airway surgical approaches are considered a last-resort set of options for OSA patients, with varying rates of efficacy. However, certain surgical procedures are considered complementary to other therapeutic approaches. For example, surgery to reduce nasal resistance can lower CPAP pressure requirements⁴⁹ and can improve the tolerance of CPAP.⁵⁰

2.4. Behavioral Sleep Medicine Recommendations. Nearly all OSA patients are recommended to modify their behaviors, most commonly to lose weight. Additional adipose tissue in the airway area is a common factor associated with OSA, with excess body weight estimated to be responsible for 58% of moderate-severe OSA and 41% of mild OSA in US adults.⁵¹ As such, weight loss, modified diet and increased physical activity are recommended to nearly all OSA patients.

Weight loss is consistently associated with reduction in OSA severity.⁵²

A second behavioral approach is often recommended for patients with OSA, which is to modify the sleeping position. It is well known that sleep apnea is worse in the supine position. Therefore, positional therapy is often prescribed for patients who have a significant positional component to their OSA, and it can reduce OSA severity by over 50%.⁵³ An underappreciated aspect of positional therapy is the position of the head during sleep, with improved breathing when the head posture shifts from flexion to extension.⁵⁴ However, this therapy is underutilized by medical professionals because of the perceived lack of effectiveness in the home environment.

2.5. Beyond the Current Standard Treatment Approaches. While the brief review on therapeutic options above is considered standard,⁵⁵ it should be mentioned that there are quite a few more therapeutic options for OSA patients. In a recent review by Camacho and colleagues, 35 alternatives to CPAP were identified, including but not limited to surgeries, drugs, behavior modification, nonsurgical weight loss, medical devices, body positioning, and myofunctional therapy, with substantial variation in their effectiveness.⁵⁶ The review found that in general, isolated nasal therapies alone were the least effective while therapies that open the upper airway and/or address multiple levels of the upper airway were more effective. Clearly, given its efficacy, CPAP should continue to be the first-line therapy for patients with moderate-severe OSA severity combined with significant symptoms and impairment in daytime functioning. However, for patients with mild-to-moderate OSA who do not experience significant

symptoms, there are many other available therapeutic options.

2.6. How to Make Sense of it All? One approach to better understanding how to bring it all together might come from moving from an orientation focused on disease severity (with its primary focus on nocturnal breathing) to an orientation that appreciates the continuum (or spectrum) of a chronic illness (inclusive of nocturnal breathing, sleep quality and patient preferences) and its multimodal treatment.⁵⁷ The sleep medicine field has had difficulty agreeing upon a consensus definition for hypopnea,^{58,59} which has therefore limited the utility of the primary measure of OSA disease severity (*i.e.*, the Apnea-Hypopnea Index, AHI).^{60,61} Most OSA therapeutic efficacy assessments are based on the reduction of the AHI level, despite its significant limitations, and often take into limited consideration changes in sleep quality and patient-reported outcomes. Because patient-reported outcomes (PROs) for chronic illnesses are valid and reliable source of information for an individual patient, increasing our reliance on PROs as part of clinical decision-making, and moving to a recognition that OSA occurs on a spectrum or continuum as a medical syndrome is an important approach. Based on this perspective, therapeutic options can be viewed as falling on that spectrum as well. We may very well be past the time to stop recommending a complex treatment regimen like CPAP for someone with mild-to-moderate symptoms and limited symptoms. CPAP can be viewed as perhaps too burdensome of a therapeutic regimen for patients who are lower on the OSA illness spectrum. From this perspective it is little surprise that, for a not insignificant subset of OSA patients, initial acceptance of therapy is relatively low or that ongoing CPAP use levels

may not meet pre-determined, policy-related minimal “compliance levels.”⁶²

The “matching” of therapeutic options to OSA as a syndrome is an important step forward for our field. In fact, it is already being piloted.⁶³ Based on a comprehensive individualized assessment, either recommending targeted specific therapy, or combinations of multiple therapies, appears to be an ideal approach to OSA management. But for this approach to work well, multiple specialists with both knowledge of their own and other’s disciplines will need to work collaboratively with an individual patient. As a field, we need to move away from the burden that is currently placed on an individual to obtain sequential, siloed medical advice and recommendations, to a putting the responsibility on the medical professionals to work together on an individual patient.

2.7. *Summary.* OSA is a complex chronic illness with multiple causative factors, and the field has identified and studied over 35 therapeutic options developed for its management. Importantly, the therapeutic options for OSA are all designed to *manage*, but not necessarily to *cure*, this common chronic illness. Two areas that have received significantly more attention recently are OSA phenotyping^{64,65} and appreciating OSA as a syndrome.⁵⁷ With improved measurement and grouping of OSA characteristics, in combination with patient preferences, tailored, personalized therapies can then be prescribed. Now that the foundation and rationale for OSA multidisciplinary management has been reviewed, the history and some examples of multidisciplinary management approaches will be discussed next.

3. Review of Multidisciplinary Management Approaches for OSA

3.1. *An Early Approach to Multidisciplinary Management.* The multidisciplinary team approach is not new for OSA management. One of the first descriptions of this team approach was described in 1985 by a group from Presbyterian Hospital Sleep Disorders Center in Oklahoma City, OK.⁶⁶ Their sleep care team was comprised of a sleep physiologist, an otolaryngologist, a pulmonologist, and a neurologist. Their report describes how, at that time, the otolaryngologist was the primary medical resource for individuals with snoring problems, but that with the recent increase in the understanding of the consequences of snoring, as well as the burgeoning recognition of OSA at the team, they felt the only way to meet the increased demand was to increase the size and expertise of the care team. The report goes on to describe the importance of diagnostic sleep studies (which was overseen by the sleep physiologist) and the acknowledgement of the increasing importance of non-surgical approaches to OSA (which was why the report describes bringing in both support from pulmonologists and neurologists). Written over 35 years ago, the core team of expertise and knowledge to manage OSA was first beginning to take shape.

3.2. *Prince Charles Hospital on the Importance of Multidisciplinary Clinics.* Another early publication described the experiences of a single center (Prince Charles Hospital, Brisbane, Australia) in 1996.⁶⁷ The thoracic physician and ENT surgeon worked in close collaboration with their dental colleagues, including an orthodontist, prosthodontist, and a maxillofacial surgeon. Their experiences were

important because of five important conclusions about the advantage of the multidisciplinary approach: (1) it is based on a comprehensive assessment with no aspects of the airway being omitted; (2) discussion of the factors for and against the various treatment options could be discussed and explored as a team; (3) group discussion among the disciplines facilitated a learning environment such that each learned about their colleague's criteria and methods of assessment and treatment; (4) in the event of litigation, the multidisciplinary approach afforded the advantage of a collective opinion; and (5) a database can be built to allow research and clinical learning.

3.3. Tripler Army Medical Center Multi-D Clinic. One of the few more recent descriptions of a multidisciplinary approach that can be found in the literature is based at the Tripler Army Medical Center (TAMC) in Honolulu, Hawaii and is called the TAMC Multi-D Sleep Clinic.⁶⁸ Originally comprised of an otolaryngologist, an oral surgeon, and a sleep medicine physician, the clinic expanded in 2016 to also include an orthodontist, a dental sleep medicine specialist, and as needed, a speech pathologist for provision of myofunctional therapy. There are several key features of TAMC's multidisciplinary approach to OSA. First, the subspecialists simultaneously evaluate the patient. Second, in addition to the traditional history and physical exam, some non-typical assessments are performed, including: dental evaluation, flexible fiberoptic nasopharyngolaryngoscopy with a Muller maneuver, and simulated snoring with and without mandibular protrusion. Finally, visits are 45 minutes in duration, and at the conclusion each subspecialist educates the patient on his or her specific treatment option.

It should be noted that this clinic has the capability to expand its offerings depending on the needs of a subset of patients. For example, in morbidly obese sleep apnea patients, the teams call upon endocrinologist, nutritionist and when needed, bariatric surgeon.

3.4. Dental and Sleep Medicine "Under One Roof." Sharma and colleagues described a model for integrating oral appliance therapy into the delivery of care for OSA, which was, and continues to be, a challenge for dental and sleep medicine care providers alike.⁶⁹ Importantly, the scope of practice for both disciplines is reviewed and detailed, as is the business model, physical structure and layout of the clinic, and key advantages of the arrangement. From the patient perspective, having the ability to go to one center to obtain one of the two main therapeutic options is appealing.

3.5. Multidisciplinary Sleep Centers (Beyond OSA Alone). Shelgikar and colleagues recently described the concept of Multidisciplinary Sleep Centers that are based on having multidisciplinary clinics within a multidisciplinary sleep center.⁷⁰ This approach is significantly broader than OSA alone, but the benefits are clear. One criticism of the current approach to OSA management is that the treatment focus is on the normalization of the AHI with little or no regard to the improvement in sleep quality. Indeed, there is an evolving literature showing that sleep quality is still impaired even in well-treated sleep apnea patients.⁷¹⁻⁷³ A multidisciplinary sleep center could overcome this issue by having dedicated behavioral sleep medicine professionals on staff. For example, insomnia is a common sleep complaint, and one clinic would be focused on "insomnia" with representation from behavioral

sleep medicine, psychiatry, and sleep medicine. Another clinic example is “OSA and neuromuscular disease”, which would include specialists from neurology, orthodontics, otolaryngology, pulmonology, plastic surgery and sleep medicine. Finally, because of the importance of ensuring that OSA patients who do not adjust to using CPAP are well cared for, the same team conceptualized the “ALT Clinic”, which is comprised of behavioral sleep medicine, dentistry, oral/maxillofacial surgery, otolaryngology, and sleep medicine.⁷⁴ Because the field of sleep medicine, at its core, is multidisciplinary, the idea of a Multidisciplinary Sleep Center is an extremely novel and intriguing, though ambitious, model.

3.6. Patient Experiences and Call for Multidisciplinary Approach. One of the underappreciated calls for the multidisciplinary approach to OSA management comes from the patient perspective. We often forget about this perspective because in the lives of care providers, there are many significant competing demands, including but not limited to: clinic responsibilities, administrative issues, organizational regulatory and compliance, insurance/coverage limitations, and Medicare requirements. There have been several pieces written from the patient perspective that document the challenges for patients in trying to obtain care from more than one OSA-related medical discipline.^{75,76} And last year a report was published on the challenges that face patients at each step of the care pathway, based on the AWAKE Sleep Apnea meeting.⁷⁷ Two of the key points discussed at the meeting was the need for better care coordination among the various OSA-related disciplines and discussion of a broader range of therapeutic options available to patients when first diagnosed with OSA.

In the end, patients have the greatest interest in their medical care, and ultimately their health and well-being. The patient is an underappreciated stakeholder in the care management for OSA, particularly if the sleep care team is “treating to the AHI” and not incorporating sleep quality, patient-reported outcomes, or patient preferences into the care process. Perhaps the greatest innovation of all in the OSA care pathway is to give the patient greater control in terms of both: (1) fostering shared decision-making between patient and their multidisciplinary care team members (as evidenced by the group visits at both Tripler Army Medical Center and Stanford’s Sleep Clinic) and (2) access to not only their full set of data, but access to increased control of their medical therapies. The data available to both the sleep care teams and the durable medical equipment staff are often underutilized.

3.7. Challenges of the Multidisciplinary Approach. There are many challenges to the multidisciplinary management of OSA. It is beyond the scope of this article to review all the key issues and their discussion; however, several issues should be mentioned. First, the cost of providing a multidisciplinary clinic for OSA patients is a key concern. Most of medicine appears to be going in the opposite direction, *i.e.*, group clinic visits where one provider sees multiple patients is a more cost-efficient approach from the healthcare system and third-party perspectives than a model where a group of providers sees one patient. Indeed, it not uncommon to hear of group visits with a 10:1 ratio (patient: provider), but we have also heard reports that an initial OSA educational session that routinely accommodates up to 100 patients. The key question is, what is the business model that might support an OSA

multidisciplinary clinic? Second, is there buy-in from both the physicians from the various disciplines as well as from healthcare administration? Assuming a business plan can be worked out, this issue may be difficult to overcome in some healthcare systems because of medical practice “turf” battles. Related to this point is the question of whether all relevant disciplines are represented within the healthcare system? If not, some amount of outsourcing may be required. And finally, significant logistical hurdles would need to be ironed out before the clinic could competently handle patient diagnostic and therapeutic activities in a multidisciplinary clinic. The next paragraph describes one article that helps address this issue.

While there is an evolving medical literature on the positive outcomes of multidisciplinary clinics in other medical conditions, there is very little in the medical literature about best practices and successful features of these clinics. However, one recent article described a framework for building successful multidisciplinary programs based on the experiences of the University of Colorado Hospital system in building five different multidisciplinary clinics.⁷⁸ Key points suggested by this framework include: (1) significant upfront effort and planning yields dividends; (2) a business plan should be developed from the organizational perspective, and ideally includes a variety of stakeholders; (3) the plan should be socialized with the key physicians and staff who will be responsible for carrying it out and are ultimately responsible for its success, with the support and collaboration of stakeholders; and (4) a multidisciplinary clinic manager should be hired who can oversee the day-to-day tasks and responsibilities. The remainder of the article

focused on the logistical challenges and recommendations on how to structure a multidisciplinary clinic, which can be complex.

4. Conclusions

CPAP was first described in the medical literature in 1981³⁶ and it continues to be the first-line therapy for OSA patients with significant disease severity and symptoms. The first description of the need for a multidisciplinary approach was less than 5 years later in 1985.⁶⁶ However, a wide variety of OSA therapies are now available to patients with this common chronic medical condition,⁵⁶ and there is an urgent need for healthcare delivery systems to be better organized to deliver the care that OSA patients need, particular patients with mild-to-moderate disease. Indeed, the call for a move from an acute care model to a chronic care model was identified by the Institute of Medicine well over 20 years ago.⁷⁹ Shared decision-making has been described as the pinnacle of patient care.⁸⁰ Given the recent advances in OSA phenotyping and the large numbers of therapeutic options available across a wide variety of specialty areas, multidisciplinary management through dedicated sleep centers (and/or clinics) appear to represent the future of sleep apnea management and is already underway. Improved outcomes and daytime functioning for our community OSA patients and their families may very well depend on it.

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