The tyranny of distance - mapping accessibility to polysomnography services across Australia

Woods C1,2,3, Usher K2,3, Edwards A4, Jersmann H5,6, Maguire G1,6,7

1School of Medicine and Dentistry, James Cook University, Cairns, Queensland, Australia
2Centre for Nursing and Midwifery Research, James Cook University, Cairns, Queensland, Australia
3School of Health, University of New England, Armidale, New South Wales, Australia
4Cartography Centre, School of Earth and Environmental Sciences, James Cook University, Townsville, Queensland, Australia
5Royal Adelaide Hospital, Adelaide, South Australia, Australia
6Alice Springs Hospital, Alice Springs, Northern Territory, Australia
7Baker IDI, Aboriginal Health Program, Alice Springs, Northern Territory, Australia

Corresponding author: Cindy Woods PhD1,2,3 Cairns Clinical School, James Cook University, PO Box 902, Cairns Qld 4870, ph: (07) 42266313, fax: (07) 42266831, email: cindy.woods@jcu.edu.au

Abstract

Objective: To identify service gaps by mapping accessibility to diagnostic sleep studies across Australia using a Geographic Information System (GIS).

Methods: Census-level data stratified by statistical areas were mapped to measure accessibility to polysomnography (PSG) based on geographical location of patients. All adult publicly funded home and laboratory-based PSG performed in Australia in 2012 were mapped to statistical areas based on patient address at the time of the sleep study.

Results: Sleep health care is extremely under-resourced in central and northern Australia. For those living in areas classified as remote and very remote, geographical distance appears to be a barrier to the accessibility of specialist sleep services.

Conclusions: Remote and very remote communities continue to experience inequity in health care in general and in accessibility to specialist services in particular. Attention needs to be given to barriers which may limit equitable accessibility.

Implications: Residing in remote communities with limited or no public transport options is likely to have a particularly significantly impact on Aboriginal and Torres Strait Islander peoples’ ability to access PSG.

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Introduction

To ensure equitable and efficient access to health care it is first necessary to understand how access varies across geography. Geographic Information Systems (GIS) can be used to assess access to health care using a variety of methods, for example: to measure access to health care based on distance to nearest outpatient facility, nearest hospital and number of annual hours of consultation with medical practitioners per person [1]; to measure geographical access to a range of community resources linked to health based on distance from resources [2]; to measure accessibility to general practitioner (GP) surgeries based on transport by bus and car [3]; the relationships between social disadvantage and the quality and quantity of GP services available [4]; and to determine health care access by mapping the home location of community health centre patients [5].

There are currently no published data regarding the accessibility to diagnostic sleep studies or polysomnography (PSG) services across different Australian geographic locations. The purpose of this study was therefore to identify and summarise how access to Medicare funded PSG varied by patient location stratified by census statistical areas throughout Australia. This study builds on our work identifying trends in PSG provision in Australia over time and the impact of the introduction of home-based sleep studies [6]. Such work, by identifying gaps in service provision and unmet need, can facilitate the realignment or expansion of diagnostic sleep services for all Australians no matter where they live.

Background

Obstructive sleep apnoea (OSA) is the most common form of sleep-disordered breathing (SDB) in Australia and elsewhere. OSA consists of recurrent episodes of upper airway collapse during sleep. In turn, this is associated with waking unrefreshed and excessive daytime sleepiness as sleep is disturbed by frequent brief arousals to initiate breathing [7]. OSA occurs when the muscles in the back of the throat relax which narrows the airway, reducing air intake and the level of oxygen in the blood. At this point the brain briefly rouses the person from sleep to reopen the airway. Arousals may occur many times per hour impairing the restful phases of sleep and leaving sufferers feeling excessively sleepy throughout the day. People who are overweight or obese have a larger neck circumference, smoke or consume alcohol, are at greater risk of OSA [8]. OSA impacts on overall patient health and well-being due to an increased risk of hypertension, diabetes, cardiovascular disease, stroke, daytime sleepiness, motor vehicle accidents, and diminished quality of life [8-10]. The standard treatment option for moderate to severe OSA is a continuous positive airway pressure (CPAP) machine that uses mild air pressure to keep the airways open whilst the patient sleeps.

A recent Australian population-based cohort study estimated a high prevalence of OSA among males, with risk increasing with older age (<50 yrs 41%, >70 yrs 63.2%) [11]. Although there is no OSA prevalence data available for the Australian Indigenous population, a recent review of OSA in adult Indigenous populations in Canada, USA and New Zealand found Indigenous peoples have a higher prevalence of OSA and a greater severity. However, the greater prevalence and severity is attributed to increased risk factors for OSA (obesity, alcohol and tobacco use) and higher levels of co-morbid medical conditions associated with low socioeconomic status rather than Indigeneity [12]. The Indigenous population is much younger than the non-Indigenous population (2010 median age: non-Indigenous = 32, Indigenous = 17) but obesity rates for Indigenous Australians are significantly higher than rates for non-Indigenous people in almost every age group [13]. The prevalence of OSA is predicted to increase as the Australian population ages and the prevalence of obesity and metabolic syndrome increases [11]. Given the significantly increased rates of obesity, Indigenous people are at risk of a greater burden of disease. Diagnosis of OSA requires PSG, a test which can either be performed at a sleep laboratory or at home using specialised monitoring equipment. PSG is the ‘gold standard’ method of OSA diagnosis [14].

Access to health services is complex and depends in part on the availability and adequate supply of health services. In the context of PSG access, equity of access is measured in terms of accessibility to this diagnostic service. Accessibility refers to the relative ease by which health care can be reached from a given location [16]. Access to health services varies across space, affected by the location of health services (supply) and patient location and disease burden (demand). Accessibility depends not only on the supply of resources in a community, but also on the supply of such resources in neighbouring communities and the distance and ease of travel between them [16].

Geographical access is a function of the time and distance needed to travel to access health care [17]. Geographical access also includes factors such as the mode and cost of travel and access to transportation. In regional and remote Australia, seasonal road access, variable road quality and greater distances to regional centres means the type of transportation required (road versus air or sea) can also influence access and cost.

The extent a population gains access to health services depends on overcoming financial, organisational, cultural or social barriers which may limit the utilisation of such services [15]. Accessibility of health care for Indigenous peoples and other disadvantaged groups within Australian society also involves other ‘costs’ to family (arranging care of dependents, time away from family and other responsibilities), work (taking time off work, managing the stigma associated with asking for time off work, having to take leave without pay if on casual employment or if the employment contract does not provide for paid leave), and other significant
stresses associated with transportation, accommodation, food etc. Importantly, issues related to engagement with health care professionals and clinicians who are unknown to the patient and/or recalling past negative experiences with health services also play a role.

Australians residing in regional, rural and remote areas do not have equal access to health services compared with those residing in metropolitan areas due to a lower supply of health care facilities and health care providers and greater distances required to travel to access care [18].

Australia is a vast country, the sixth largest in the world, with a total area of 7,686,850 square kilometres and a population of approximately 23 million [19]. Two-thirds of Australia’s population reside within major capital cities and metropolitan areas, as depicted in Figure 1(a).

Figure 1(a) Population density per square km throughout Australia (Australian Bureau of Statistics, 2013)

Source: Australian Bureau of Statistics – 3218.0 (http://www.abs.gov.au/ausstats/abs@.nsf/Products/3218.0–2012-13–Main+Features–Main+Features)

Figure 1(b) Home-based PSG (12250) per 100,000 Medicare enrollees in 2012

Figure 1(c) Laboratory-based PSG (12203) per 100,000 Medicare enrollees in 2012

Figure 1(d) Total PSG per 100,000 Medicare enrollees in 2012
The Accessibility Remoteeness Index Australia (ARIA) 2006 is a measure of geographic remoteness based on road distance from localities to service centres with a population greater than 5,000. The ARIA defines five categories of remoteness: highly accessible, accessible, moderately accessible, remote, very remote. ARIA categories reflect the ease or difficulty people face accessing services in non-metropolitan Australia (Figure 2).

The majority of Australia is classified as remote or very remote, and predominately consists of sparsely populated desert regions. Around one-quarter of Australia’s Indigenous population (total Indigenous population at 2011 census n = 548,370) reside in the most remote and sparsely populated areas of Australia (www.abs.gov.au). Of the Indigenous population, 27% reside in the Northern Territory, 4% in Tasmania, 3.6% in Queensland, 3.1% in Western Australia, 2.5% in New South Wales, 1.9% in South Australia, 1.5% in Australian Capital Territory and 0.7% in Victoria [20].

Remoteness of residence disproportionately impacts on accessibility of health care services for this population. Indigenous Australians residing in remote areas cite transport, distance and lack of health services in the area as the predominant difficulties they experience in accessing health care [21].

The burden of chronic disease in Australian Indigenous peoples is very high and Indigenous people have the highest rates of cardiovascular, respiratory, diabetes and renal morbidity compared with non-Indigenous peoples [22]. It is estimated that Indigenous Australians suffer a two-and-a-half times greater burden of disease than non-Indigenous Australians [23]. Indigenous Australians also have a higher prevalence of long-term chronic health conditions compared with non-Indigenous Australians [20,23] and chronic conditions such as heart and kidney disease, diabetes and respiratory diseases contribute to much of the ill health experienced by Indigenous people [21].

Geographic isolation, lack of health care services and accessibility issues are multidimensional problems [24]. There is a growing recognition that geographical inequalities to health care access intersect with those based on socioeconomic status and ethnicity leading to complex patterns of disadvantage [25]. Indigenous health status is closely related to social determinants of health; lower socioeconomic status, lower household incomes, and lower educational achievement is related to poorer health [21]. People living in non-metropolitan Australia are likely to have a lower income, lower socio-economic status, and lower educational achievement than people living in metropolitan Australia [24]. Thus greater levels of remoteness may lead to a clustering of adverse health determinants and risk factors which may in turn lead to a greater burden of disease which can compound the disadvantage inherent with poorer health service access.

Given that Indigenous Australian suffer a greater burden of disease than non-Indigenous Australians, have a higher prevalence of risk factors for OSA, and OSA increases the risk of hypertension, diabetes, cardiovascular disease, and stroke, it is important that Indigenous Australians have equitable access to specialist OSA diagnostic and treatment services to improve their overall health and quality of life, and reduce the health disparity between Indigenous and non-Indigenous peoples.

The objective of this study was to examine geographic variations in specialist sleep service utilisation, and identify gaps in service accessibility by describing access to laboratory-based and home-based sleep studies across all Australian states and territories. The secondary aim was to use this information to highlight areas in Australia that may benefit from initiatives to enhance access to in-home and/or laboratory-based PSG.

Methods

Australia has eight jurisdictions, six states and two territories, comprising Queensland (QLD), New South Wales (NSW), Victoria (VIC), Tasmania (TAS), South Australia (SA), Western Australia (WA), the Australian Capital Territory (ACT), and the Northern Territory (NT). Whilst there are other Australian Territories (Lord Howe Island, Antarctica etc.), these were excluded from analysis. Medicare is Australia’s national health care system and covers all citizens and permanent residents of Australia. Medicare is Australia’s national health care system and covers all citizens and permanent residents of Australia. Medicare is responsible for reimbursing to health practitioners or patients the costs of consultations, tests related to medical diagnosis, surgical procedures and hospitalisations. It is estimated that Medicare funds approximately 90% of all PSGs performed in Australia [26]. The Medicare Australia website provides statistical information regarding publically funded PSG in absolute numbers and per 100,000 Medicare enrollees, stratified by state and territory, per calendar and financial year (www.medicareaustralia.gov.au). This data is presented in Table 1.
The Medicare billing item number 12203 is used to designate a specified diagnostic service involving overnight investigation for SDB for an adult aged 18 years or over, in a sleep laboratory where a technician is in continuous attendance under the supervision of a qualified sleep medicine practitioner. Medicare billing item 12250 is for overnight investigation of SDB for an adult aged 18 years or over, where the monitoring occurs in the patient’s home. In Australia, Medicare-funded in-home PSG is required to incorporate a minimum of seven physiological parameters: continuous electro-encephalogram (EEG); continuous electro-cardiogram (ECG); airflow; thoraco-abdominal movement; oxygen saturation; and at least two or more of the following: electro-oculogram (EOG); chin electro-myogram (EMG); body position [27].

Data relating to in-home and in-laboratory PSG performed in 2012 were obtained from Medicare Australia by request with a fee attached. The provided data had been divided geographically by statistical local areas (SA3s) in each state and territory based on patient postcodes at the time the claim was made for the PSG service. Statistical Areas Level 3 (SA3s) are geographical areas designed to provide a regional breakdown of Australia and represent regions of between approximately 30,000 people and 130,000 (www.abs.gov.au). Medicare data were mapped to statistical areas in each state and territory per 100,000 adult population using GIS to illustrate accessibility to diagnostic sleep services across Australia. GIS is an information system designed to integrate, analyse and display all types of spatial or geographical data. GIS allows users to edit data in maps and represent the results graphically. Medicare data were converted to rates per 100,000 adult population with the numerator being the absolute number of PSGs performed in 2012 in each statistical area (SA3), and the denominator as the adult population (≥ 18 years) in each statistical area based on data from the 2011 Australian census. Utilisation rates were expressed per 100,000 adult population in each statistical area. This data is represented in Figure 1 (b), (c) and (d).

For the purpose of this study, the following qualitative cut-off points will be used when discussing PSG accessibility: low accessibility = < 200 sleep studies per 100,000 adult population, moderate accessibility = 200 - 400 sleep studies per 100,000 adult population, high accessibility = ≥ 400 sleep studies per 100,000 adult population.

Table 1 Medicare Australia 2012 adult PSG provision data stratified by Australian jurisdiction

<table>
<thead>
<tr>
<th>2012 Service</th>
<th>State</th>
<th>2012 Total</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>NSW</td>
<td>VIC</td>
</tr>
<tr>
<td>Per100,000 Medicare enrolles</td>
<td>In-laboratory PSG</td>
<td>360</td>
</tr>
<tr>
<td></td>
<td>In-home PSG</td>
<td>218</td>
</tr>
<tr>
<td>Total studies/100000</td>
<td></td>
<td>578</td>
</tr>
</tbody>
</table>
In-home PSG

Figure 1(b) demonstrates the distribution of in-home PSG per 100,000 adult population, divided by statistical areas (the borders for each statistical area have been removed to prevent them obscuring the colour coded data in and around capital cities). Access to in-home PSG was predominantly concentrated around metropolitan areas, with moderate access in regional areas of South Australia, Victoria, New South Wales, and coastal northern Queensland. Accessibility to in-home PSG was low (< 200 sleep studies per 100,000 adult population) across the rest of Australia, particularly Western Australia, Northern Territory, inner Queensland and Tasmania. Figure 1(a) highlights that a more remote place of residence resulted in reduced accessibility to in-home PSG even after controlling for the associated lower population.

In-laboratory PSG

Figure 1(c) depicts accessibility to in-laboratory PSG per 100,000 adult population, stratified by statistical area. As with in-home PSG, high accessibility was concentrated around the metropolitan areas of Adelaide, Melbourne, Sydney, and Brisbane. Although Queensland delivered the highest rate of in-laboratory PSG per 100,000 adult population (item number 12203), high accessibility (≥ 400 sleep studies per 100,000 adult population) to sleep services outside of the metropolitan area was mainly confined to major coastal regional centres located in northern Queensland.

Combined data

Figure 1(d) shows combined PSG utilisation data for in-home and in-laboratory sleep studies (items 12203 and 12250). This map clearly depicts areas where accessibility to PSG is limited. The resident population of the Northern Territory had limited access to PSG (< 200 sleep studies per 100,000 adult population), as did a majority of statistical areas in Tasmania. Large areas of Remote and Very Remote (ARIA) sites in Western Australia and South Australia also had limited access. The population centre of Brisbane in Queensland and east coast regional cities were well served with high accessibility (≥ 400 sleep studies per 100,000 adult population) to PSG. Nonetheless, the population of Cape York, the northern peninsula of Queensland, and central and western Queensland had very limited access to specialist sleep services.

Access to diagnostic sleep service did not relate to population density or distance from large centres alone. Sites adjacent to the large centre of Sydney in NSW demonstrated relatively limited access (200 - 400 sleep studies per 100,000 adult population) whilst more remote areas adjacent to the South Australia-Victoria border had a higher level of accessibility (≥ 400 sleep studies per 100,000 adult population).

Discussion

This is the first study to map accessibility to sleep studies in Australia or throughout the world. We have demonstrated how GIS mapping can be used to analyse accessibility to PSG based on geographic utilisation data. Such health service information can be used by health service funders and planners to optimise the location of future health services, to focus initiatives to address health service gaps and to evaluate the benefit of such initiatives on addressing geographical barriers to health service accessibility [28]. Although people are more likely to utilise health care services that are conveniently located in relation to their home, work or shopping activity patterns, most people are willing to travel further to obtain specialised diagnostic services or health care [25]. The key is ensuring such services are reasonably accessible and that the cost and reimbursement systems for accessing such services do not create significant barriers for people living outside major urban centres. Nonetheless this does not address the complexity of issues and other ‘costs’ related to health care accessibility for Indigenous peoples and other disadvantaged groups.

The geographic location of those accessing sleep studies is concentrated in the more densely populated areas around the coastline, and South East Australia in particular. Figure 1(d) demonstrates that for the majority of Australians residing in metropolitan areas or adjacent to most State or Territory capitals, geographical distance is not a barrier to accessibility for PSG. Figure 1(d) also demonstrates there are significant areas where this is not the case. PSG is extremely under-utilised in central, northern and western Australia; areas outside the major population centres [29]. However, without OSA prevalence data for Indigenous Australians there is no evidence available to indicate the level of services required in these areas.

For those living in areas classified as Remote and Very Remote (ARIA), geographical distance appears to be closely connected with PSG accessibility. The distance travelled by people in such areas to access health care adds to the disadvantages faced by remote residents. Areas that are disadvantaged in terms of accessibility to sleep services are also most disadvantaged in terms of travel distance. A significant number of remote areas face this ‘double jeopardy’ situation.

Of note was the greater utilisation of PSG in regional centres along the coast of central and northern Queensland. This particularly related to the uptake of laboratory-based PSG. Overall, some of these centres had levels of PSG uptake per 100,000 adult Medicare enrolees equivalent to that of Australian capital cities. Whilst it is unclear why this is the case in Queensland and not elsewhere, it may in part be related to the type of local industry in these areas. These include the mining and defence force sectors where OSA may be either prevalent or particularly relevant to work place health and safety. Nonetheless, this does not appear to be the
case in Western Australia, an area with similarly significant mining industry activity. In part this may be explained by a significant ‘fly-in fly-out’ itinerant workforce in Western Australia, who may be more likely to access care for OSA at their distant home address, compared with a greater proportion of local and/or adjacent ‘drive-in drive-out’ residents in Queensland who access PSG locally.

Marshall et al. speculated that the disparity may arise from a lower referral threshold, greater utilisation of PSG for CPAP follow-up, or a greater number of service providers in Queensland [26]. Accessibility to PSG may, in part, be a reflection of where specialist practices are located. Specialist health care providers are only available at a level of 45% and 30% in Inner and Outer Regional areas respectively, as in Major Cities, and are even less prevalent in remote areas [30]. The ratio of specialists to population in Remote and Very Remote areas is 15% and 6% of the rate in Major Cities respectively [30].

The issue of remoteness is a particular issue for Indigenous Australians given a significantly greater proportion of the Aboriginal and Torres Strait Islander population resides in Remote and Very Remote locations (23.3% compared with only 1.7% of non-Indigenous Australians) [20,26-31]. Indigenous health disadvantage is well documented and a significant proportion of this is attributable to respiratory disease [29]. Although a range of social determinants of health contribute to Indigenous health disadvantage, accessibility of health care is also a contributing factor to Indigenous Australian health inequality. A study of 12 US rural counties found that the geographical and spatial factors of having a drivers licence and distance to health care, and predisposing (age, gender, ethnicity) and enabling (socioeconomic status) factors were significantly related to rural health care use [28]. Thus, the results of the current study indicate that residing in remote communities with limited or no public transport options is likely to have a particularly significantly impact on Aboriginal and Torres Strait Islander peoples’ ability to access PSG.

The Australian government is committed to ‘Close the Gap’ by achieving equity in health status and life expectancy between Indigenous and non-Indigenous Australians [32]. Limited access to specialist sleep services by Indigenous peoples residing in remote areas contributes to continuing poor Indigenous health status. Improved access is vital for closing the gap for important health outcomes including chronic disease and respiratory illness. The provision of specialist medical services to residents of remote and sparsely populated Indigenous communities could contribute significantly to overcoming the inequity in Indigenous health outcomes. In addition, further research is needed to investigate potential issues surrounding accessibility to specialist sleep services for the 75% of Indigenous persons who do not reside in remote areas. Whilst access to PSG may reflect that of broader specialist service access this should not in itself be sufficient rationale for accepting reduced service delivery for residents of regional and remote centres. Nonetheless, enhancing PSG access is likely to require an approach combining innovative use of both specialist workforce and diagnostic PSG access.

In relation to the former, specialist access does not necessarily require greater numbers of specialists in SDB residing in more remote locations; indeed it is unlikely the small and dispersed population in many regions would support such an approach. More innovative approaches may include increasing the skills of the existing local specialist workforce, who frequently practice across a range of specialties, to encompass the management of SDB.

In addition, the expansion of existing specialist outreach programs from larger regional and urban centres (e.g., Rural Health Outreach Fund [RHOF], Medical Outreach Indigenous Chronic Disease [MOICD], Medical Specialist Outreach Assistance Program [MSOAP]) to incorporate specialist sleep care, and the support and greater utilisation of telehealth or web-based health services, are also both likely to facilitate greater accessibility to PSG for those in rural and remote locations.

Telehealth can increase the accessibility of health care delivery by bringing health care services into the home. Videoconferencing, phone calls or secure online chats with a health care provider is an ideal health solution for patients who are geographically isolated. Despite the uptake of telehealth services by health care providers, Indigenous Australians living in very remote locations may not benefit from the use of technology if they do not have access to a computer, internet access and a reliable source of electricity, or access to a landline or mobile phone and adequate mobile coverage.

Increasing accessibility to diagnostic services for OSA may also be achieved without necessarily enhancing local specialist sleep service access [33]. We have already shown that in-home PSG has expanded significantly in some areas of Australia and expanding this to other and more remote areas may enhance PSG accessibility [6]. Nonetheless, whether such increased use of in-home PSG translates to improved and appropriate uptake of OSA management remains a source of debate in Australia [6]. Finally, PSG access may be enhanced by utilising existing services more efficiently. In this case validation of screening protocols and the use of PSG only as a secondary confirmatory test could be considered in line with existing evidence of utility of screening systems [6,20,30]. A further option to consider is the potential wider use of Type 3 portable monitors (limited channel devices usually using 4–7 channels) as an alternative to in-laboratory PSG in carefully screened patients who have a moderate to high clinical likelihood of OSA and an absence of significant comorbid conditions [33,34].

Whatever initiatives are undertaken, whether based on specialist workforce or PSG access, the key requirement will be that these are
demonstrated to translate to cost-effective and equitable access and facilitate effective treatment and improved clinical outcomes.

Limitations

These results should be considered in the context of the limitations of this study. In 2013/2014 23.8 million people were enrolled in Medicare (www.humanservices.gov.au), and as of February 2015 the resident population of Australia is projected to be 23.7 million people (www.abs.gov.au) indicating a broad coverage of the Australian population. However, some data may be missing if Medicare reimbursement of PSG was not claimed. In terms of data quality and completeness, the data presented in the GIS maps is only as accurate as the Medicare data provided. Medicare data were not stratified by diagnostic PSG, repeat PSG studies or CPAP studies, therefore a proportion of the PSG provision data per 100,000 adult population includes repeat PSG studies and CPAP studies. PSG may need to be repeated due to patients being unable to sleep for an extended period or electrodes repeatedly pulling off. All home-based PSG studies are diagnostic only.

Conclusions

Regional and particularly remote communities in Australia experience inequity in health care in general and in relation to accessibility to specialist services in particular. Attention needs to be given to barriers which may limit equitable access. Diagnostic services such as PSG are relatively under-resourced and often unavailable in many of Australia’s more remote regions. For residents living in regional and remote areas with suspected OSA, the cost and time of transport required to access specialist and investigation facilities in metropolitan centres appears to be a major barrier [29]. We have demonstrated that remoteness itself is nonetheless not an invariable driver of reduced accessibility as some regions in Australia appear to have high levels of access in spite of lower population density and remoteness. A range of initiatives targeting specialist accessibility, PSG uptake and innovative approaches to OSA diagnosis has been outlined. Whichever of these approaches are pursued the key will remain ensuring a diagnosis of OSA translates to the uptake of effective treatment and improved patient outcome.

References


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