Sleep Disordered Breathing and Polysomnography in Australia: Trends in Provision from 2005 to 2012 and the Impact of Home-Based Diagnosis

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Study Objectives: To describe the growth of publicly funded polysomnography (PSG) in Australia since 2004 and to compare this with earlier growth.

Methods: Longitudinal census-level data stratified by jurisdiction were retrieved from the Medicare Australia online database.

Results: There has been a near doubling in provision of PSG since the introduction of publicly funded in-home PSG under the Australian national Medicare program available to all Australian citizens in 2008. Overall annual PSG rates have risen from 339 in 2005 to 608 in 2012 per 100,000. This growth has exceeded that of comparable diagnostic procedures and all Medicare services overall. Queensland remains the leading jurisdiction per 100,000 Medicare enrollees for accessing Medicare-funded PSG.

Conclusion: The continued growth in publicly funded PSG provision in Australia is unlikely to abate. The disparity in Australia between the estimated prevalence of sleep disorders, particularly obstructive sleep apnea, and the number of people having PSGs would suggest there remain a large number of undiagnosed cases. Support for the development of appropriate diagnostic and screening algorithms will be key in ensuring sustainable, effective, efficient, and accessible PSG services.

Keywords: Australia, diagnostic services, longitudinal study, Medicare, polysomnography, sleep apnea

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BRIEF SUMMARY

Current Knowledge/Study Rationale: This study describes the growth of PSGs performed in Australia since 2004. It also assesses the impact of the implementation of in-home PSG on service activity and overall funding.

Study Impact: This study is the first to provide contemporary data regarding PSG utilisation in Australia over the period from 2005 to 2012. PSG provision per 100,000 Medicare enrollees has increased by 79% from 2005 to 2012, with the majority of growth attributable to the introduction of Medicare funded in-home PSG in 2008.

Sleep disordered breathing (SDB) is recognized as a common but underdiagnosed health issue. Obstructive sleep apnea (OSA) is the most prevalent cause of SDB.¹ Bearpark estimated the prevalence of mild OSA (defined as a respiratory disturbance index [RDI] ≥ 5) at 26% of the Australian male population, and moderate-to-severe OSA (defined as a RDI ≥ 10) at 10% of the male Australian population.² In comparison, Olson et al. estimated the Australian prevalence of more severe and clinically significant OSA, based on an apnea-hypopnea index (AHI) ≥ 15 , as 5.7% of males and 1.2% of females.³ In contrast, a recent Australian population based cohort study (MAILES) reported an OSA prevalence (AHI ≥ 10) of 53% in males aged over 40 years.⁴ A significant increase in OSA prevalence occurred with older age (< 50 years 41.2%, > 70 years 63.2%).⁴ The risk of OSA increases with age and obesity, issues that are increasingly relevant as the Australian population ages and becomes progressively more obese.⁴ In the 20 years from 1995 to 2005, the percentage of Australians who are overweight or obese had doubled. In particular the rate of obesity (defined as a body mass index [BMI] ≥ 30) among Australians aged 55 and over has increased substantially over this period.⁵ In 2005, 46% of Australian males between the ages of 55-64 were classified as obese.⁵ Other risk factors for OSA include male sex, increasing neck circumference, snoring, witnessed apneas, alcohol consumption, and smoking.⁶⁻⁸

OSA is associated with increased risk of cardiovascular diseases such as coronary heart disease, heart failure, hypertension, pulmonary hypertension, stroke, and cardiac arrhythmia.⁹⁻¹¹ OSA affects health and well-being, with 6.2% of depression, 4.3% of motor vehicle accidents, and 0.6% of workplace injury attributed to OSA.¹ The percentage of workplace injuries is a conservative estimate, and other authors using the calculation of odds ratios have argued it may be higher.^{12,13} The financial burden of OSA and conditions attributed to it was estimated to be AUD2.6 billion in 2010.¹ The burden of OSA extends beyond health care system and economic costs. The human cost includes lower quality of life through increased morbidity and loss of healthy life.¹

Polysomnography (PSG) is the gold standard method for diagnosing and assessing the severity of SDB, particularly obstructive sleep apnea (OSA).¹⁴ The information in this study predominantly relates to diagnosis and management of OSA. In 2007, Marshall et al. published longitudinal data for Australian PSG provision between 1990 and 2004.¹⁵ Growth in PSG funded by Medicare (Australia's universal health insurance scheme) in Australia was greater than the growth in comparable diagnostic procedures and the overall growth in Medicare funding during the same period.¹⁵ Marshall reported that in the decade between 1995 and 2004, PSG provision per 100,000 Medicare enrollees increased by 150%. Marshall concluded that growth could be expected to continue to increase, given the disparity between provision and other similarly developed countries such as Canada and the United States. The purpose of this study was therefore to describe the growth of PSGs performed in Australia since 2004 to determine if this growth is continuing and to identify differences in service delivery between Australian jurisdictions and the impact of the introduction of reimbursement for home-based PSG.

The Medicare reimbursed procedure fee for PSG in Australia covers the cost of the procedure and interpretation of the results by a qualified adult sleep medicine practitioner. Medicare covers all citizens and permanent residents of Australia and is responsible for reimbursing to health practitioners the costs of consultations, tests related to medical diagnosis, and surgical procedures, but does not cover services performed on inpatients of public hospitals.¹⁵ The majority of PSG procedures are performed in private clinics or as outpatients in public hospitals; thus it is estimated that Medicare funds 90% of all PSGs performed in Australia.¹⁵

METHODS

Medicare Benefits Scheme (MBS) data were obtained from the Medicare Australia website (www.medicareaustralia.gov.au). Medicare billing item number 12203 is used to designate a specified diagnostic service involving overnight investigation for sleep apnea for an adult aged ≥ 18 years in a sleep clinic where a technician is in continuous attendance under the supervision of a qualified sleep medicine practitioner. In 2013, the Medicare recommended fee for PSG in this category was AUD588.00, of which Medicare funded 75% or 85%, depending on whether the service was provided in a private hospital/clinic or public hospital. Medicare billing item number 12207 is used for adjustment and/or testing of the effectiveness of a positive pressure ventilatory support device (other than nasal continuous positive airway pressure) in sleep in a patient with severe cardiorespiratory failure, and where previous studies have demonstrated failure of continuous positive airway pressure or oxygen. In 2008, Medicare billing item 12250 was added to the Medicare Benefits Scheme for overnight investigation of SDB for an adult aged ≥ 18 years, when the monitoring occurs in the patient's home. In Australia, Medicare-funded portable polysomnogram monitors are required to monitor a minimum of 7 physiological parameters: continuous electro-encephalogram (EEG); continuous electrocardiogram (ECG); airflow; thoraco-abdominal movement; oxygen saturation; and ≥ 2 of the following: electrooculogram (EOG); chin electromyogram (EMG); body

position.¹⁶ In 2013, the fee for this new category of PSG was AUD335.30. Comparable pediatric PSG item numbers are 12210, 12213, 12215, and 12217. Figures given include all of the above PSG billing item numbers for the period 2005 to 2012 inclusive unless otherwise stated. The majority of billing for PSG occurs in association with item numbers 12203 (in-laboratory PSG) and 12250 (home-based PSG) with a relatively small number of pediatric studies. Only 20 services were billed to the other item numbers combined in 2012. Dollar amounts are expressed in 2012 dollars adjusting for inflation based on the Australian Consumer Price Index (CPI) unless otherwise indicated (<http://www.rba.gov.au/calculator/annualDecimal.html>).

Australia has 8 jurisdictions (6 states and 2 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). Medicare data are based on the patient address (state or territory) at the time of claiming. Medicare Australia provides data for absolute numbers of services processed, as well as number of services per 100,000 Medicare enrollees rather than the absolute population. Medicare data can be further stratified based on age and sex. PSG was compared with the same common Medicare-claimable procedures that Marshall used as comparators, including respiratory function testing (item number 11503) which includes spirometry, electrocardiograph (item number 11700), exercise stress testing (item number 11712), and electroencephalography (item number 11003). Total costs for groups of diagnostic procedures (such as cardiovascular and respiratory) were extracted to compare gross spending and overall growth in diagnostic imaging and pathology. Total Medicare data were also extracted to compare gross expenditure and expenditure per 100,000 Medicare enrollees.

RESULTS

Overall PSG Provision

Over an 8-year period, the number of PSGs claimed through Medicare doubled from 69,543 in 2005 to 139,911 in 2012. Controlling for population growth, this represented an increase of 79% from 339/100,000 in 2005 to 608/100,000 in 2012. A total of 796,152 PSGs were provided in the 8-year period with a total cost to Medicare of AUD333.9 million. This represented a doubling in the unadjusted annual cost of PSGs to the Medicare Benefits Scheme from AUD28.9 million in 2005 to AUD58.7 million in 2012. Adjusting for inflation over this period, this still represents an increase of 67%. **Figure 1** demonstrates increasing growth per 100,000 Medicare enrollees in supply of PSG, with a particular increase of 35% occurring from 2008 to 2009. Overall the average increase in the number of PSG procedures per year from 2005 to 2012 has been 10,128 (SD $\pm$ 8,731).

Other common diagnostic procedures per 100,000 Medicare enrollees have steadily grown, but none have grown as fast as PSG (**Figure 2**). Adult PSG performed per 100,000 Medicare enrollees has grown by 81.4% over the period 2005 to 2012, compared with respiratory function tests (45.9% growth), all pathology services (34.6% growth), and diagnostic imaging (27.8% growth).

Figure 1—PSG services per 100,000 Medicare enrollees, 2005-2012 **Figure 2**—Growth per 100,000 Medicare enrollees in provision of common diagnostic procedures and groups of procedures compared with 2004 baseline.

PSG, polysomnography; ECG, electrocardiogram.

Table 1—Change in Medicare expenditure per 100,000 Medicare enrollees, 2005-2012

Medicare expenditure	Expenditure (/100,000 Medicare enrollees)		% change in expenditure 2005-2012 *
	2005 *	2012	
PSG	\$171,380	\$255,738	49%
All diagnostic	\$1,429,646	\$1,767,003	23%
Specific diagnostic			
Respiratory function	\$76,421	\$105,365	38%
ECG	\$211,752	\$258,511	22%
EEG	\$7,370	\$4,077	-45%
Exercise stress test	\$215,992	\$245,011	13%
Total expenditure	62.5 million	80.4 million	29%

*All dollar amounts presented as 2012 dollars adjusted for inflation. All diagnostic = all diagnostic procedures and investigations: Neurology, Ophthalmology, Otolaryngology, Respiratory, Vascular, Cardiovascular, Gastroenterology and Colorectal, Genito/Urinary physiological investigations, allergy testing, other diagnostic procedures and investigations and Nuclear Medicine (non-imaging).

PSG expenditure per 100,000 Medicare enrollees increased by 49% above the underlying inflation rate from 2005-2012 (**Table 1**), exceeding growth in expenditure on all diagnostic procedures, and growth in total Medicare expenditure over the same period.

In 2005, patients < 18 years accounted for 6.5% of all PSGs (combined item numbers 12210, 12213, 12215, 12217), but by 2012 this figure had fallen to 5.8%. In 2005, 31.3% of all PSGs were for female patients, and by 2012 this figure had risen to 38.26%. The age configuration of people receiving adult PSG has remained relatively stable across the time period. Patients provided with PSG in a sleep clinic or as a hospital outpatient are predominantly aged 45-64 years (item number 12203), as are patients provided with in-home PSG (item number 12250), but overall those who have in-home PSG are younger.

In-Home PSG

The introduction of Medicare funded in-home PSG in 2008 contributed to a rapid rise in annual PSG provision per 100,000

Medicare enrollees (**Table 2**). For the first time, in-home PSG allowed hospital-based sleep clinics, without overnight sleep laboratory facilities, to offer Medicare funded diagnostic sleep services to patients in their own homes. Excluding 2008, when in-home PSG (item number 12250) was first included on the Medicare Benefits Schedule, in-home PSG claims per 100,000 Medicare enrollees increased by 63% from 2009 to 2012 (**Figure 1**). Over the same period, Medicare expenditure per 100,000 Medicare enrollees for in-home PSG increased by 60% from AUD30,955 (adjusted for inflation) to AUD49,526.

In-Laboratory PSG

Medicare reimbursed in-laboratory PSG provision per 100,000 Medicare enrollees, including pediatric PSG, has steadily increased from 339 procedures per 100,000 Medicare enrollees in 2005 to 432 procedures per 100,000 Medicare enrollees in 2012, an increase of 27%. Over the same period, Medicare expenditure per 100,000 Medicare enrollees for in-laboratory PSG has increased by 20% from AUD171,396 (adjusted for inflation) in 2005 to AUD206,219 in 2012.

Table 2—2012 Adult PSG provision data stratified by Australian jurisdiction

2012	Service	State								
		NSW	VIC	QLD	SA	WA	TAS	ACT	NT	Total
Numbers	12203	26811	17987	31107	6488	6297	1478	1158	464	91790
	12250	16222	8050	7072	3537	3816	264	1096	380	40437
Total		43033	26037	38179	10025	10113	1742	2254	844	132227
Per 100,000	12203	360	316	671	389	262	283	304	201	399
Medicare enrollees	12250	218	141	152	212	159	51	288	165	176
Total		578	457	823	601	421	334	592	366	575

Figure 3—Growth in annual per 100,000 Medicare enrollees PSG provision (Item number 12203) stratified by Australian jurisdiction, 2005-2012.

Regional Variation in PSG Provision

Stratification of data by jurisdiction showed differing levels of growth in PSG provision (**Table 2**, **Figure 3**). Queensland had the highest rate of PSG claims per 100,000 Medicare enrollees in 2005 (444/100,000, item number 12203 only), while the Northern Territory had the lowest (81/100,000 Medicare enrollees). In 2012, the highest and lowest rankings were unchanged (Queensland 671/100,000, Northern Territory 201/100,000). While the Northern Territory had the lowest uptake of in-laboratory PSG, it also demonstrated the largest relative growth over this period (148%).

Excluding 2008, when an item number for in-home adult PSG (12250) was first introduced, in 2009 the Australian Capital Territory had the highest rate of PSG claims per 100,000 Medicare enrollees (261), whereas Tasmania had the lowest (29 per 100,000 Medicare enrollees), and both retained the same ranking in 2012. However, in terms of growth, New South Wales experienced the largest PSG provision growth per 100,000 Medicare enrollees between 2009 and 2012 (103.73%, item number 12250 only) and South Australia the lowest (0%). Overall, in 2012, for item numbers 12203 and 12250, Queensland had the highest rate of claims per 100,000 Medicare enrollees for adult PSG and Tasmania the lowest (**Table 2**). Between 2005 and 2012 Queensland has had the highest rate of growth in adult in-laboratory PSG (item number 12203)

services per 100,000 Medicare enrollees, and Northern Territory the lowest (**Figure 3**).

DISCUSSION

This study is the first to provide contemporary data regarding PSG utilization in Australia over the period from 2005 to 2012. It also assesses the impact of the implementation of in-home PSG on service activity and overall funding. Finally it updates Marshall's 2007 census-level description of longitudinal growth in the provision of PSG in Australia.¹⁵ Over an 8-year period (2005-2012) Medicare funded 796,152 PSGs, at a cost of AUD333.9 million. The unadjusted annual cost to the Medicare Benefit Scheme over this period has doubled from AUD28.9 million in 2005 to AUD58.7 million in 2012, and now represents 0.32% of the total Medicare budget of AUD18.5 billion. It should be noted that Medicare expenditure forms only a portion of total health care expenditure in Australia, estimated to be AUD140.2 billion in 2011-2012.¹⁷

Growth in supply of PSG sharply increased in 2008 when in-home PSG was included on the Medicare schedule, and continued to rise at a higher rate than in the preceding period. The introduction of home-based studies reduced but did not stop the ongoing increase in in-laboratory PSG. While in-home sleep studies are more cost-effective, it has been argued the main reason for the introduction of in-home sleep studies was to allow more patients to be assessed and treated, particularly those residing in rural and remote Australia.¹⁶

A contributor to the increase in home testing in Australia may be that a significant (but undefined) proportion of these studies are provided by private organizations with links to equipment manufacturers and/or distributors. Such organizations market broadly and can have close relationships with health care providers, which in turn can facilitate referral. Concern has also been raised that such providers may sometimes not strictly adhere to the requirements for reimbursement.¹⁸ While increasing access to diagnostic studies is encouraging this should only occur when there is a clear understanding by funders and referring practitioners of potential conflicts of interests. Diagnostic services must also integrate with clinical follow-up by health care providers with specialized knowledge regarding the diagnosis and management of sleep disorders, including an ability to identify conditions apart from OSA and treatments in addition to CPAP.

The significant reduction in in-laboratory PSG, which may have been expected after the introduction of in-home PSG,

did not occur. There are several reasons why the introduction of Medicare-funded in-home PSG may not have significantly reduced in-laboratory PSG. These include the relatively small cost differential between an in-home and in-laboratory sleep study. Individuals are also reimbursed only one home sleep study per year, whereas three in-laboratory tests are reimbursed by Medicare Australia, allowing for monitored titration studies for complex sleep disordered breathing. In addition in-home PSGs are generally performed on healthier patients without significant comorbidities as suggested by professional guidelines. Greater awareness of sleep disorders, particularly in patients with multiple comorbidities and complex disorders requiring in-laboratory study, are also probable drivers of service provision for in-laboratory studies. Finally, there has been no disincentive for in-laboratory providers to switch to home studies.

Between 1995 and 2004, Marshall reported the growth in Medicare reimbursed PSG rose by an average of 4,541 ($\pm 2,058$) procedures per year or 18.7 per 100,000 Medicare enrollees.¹⁵ By contrast, between 2005 and 2012, growth in supply of PSG rose by an average of 10,128 ($\pm 8,731$) procedures per year or 43.7 per 100,000 Medicare enrollees, a mean increase of 123%. This rate of growth exceeds the growth of the population each year (Australian population growth between 2011 and 2012 was 1.8%, www.abs.gov.au), and exceeds the growth in common diagnostic procedures, diagnostic imaging, pathology, and all Medicare items.¹⁵

The estimated Australian resident population in December 2012 was 22.9 million (www.abs.gov.au), and Medicare enrolment at 30 June 2012 was 22.9 million persons.¹⁹ Based on the 2011-12 number of Medicare enrollees, potentially 3.5% (796,152 procedures) of the Australian population have undergone Medicare funded PSG between 2005-2012, although as Marshall noted, the figure is probably lower because the major billing code 12203 can include up to three PSGs for each person per year. If a positive diagnosis is made after PSG, it is likely the patient will then undergo a CPAP titration study that is billed using the same code. In contrast, PSG billed under item number 12250 are primarily for diagnostic purposes, as only one test can be billed in a 12-month period. Thus the actual percentage of the adult Australian population who have received Medicare-funded PSG is likely to be closer to 2.5% than Marshall's earlier study and estimate of 0.86%.²⁰

The Australian prevalence of OSA remains unknown due to the high proportion of people with undiagnosed disease.¹⁵ In 2007, Marshall estimated the prevalence of OSA in the middle-aged Australian population as approximately 9% to 25%.²⁰ In contrast, the recent MAILES study indicates the prevalence of OSA (AHI ≥ 10) could be as high as 53% in Australian males aged over 40 years.⁴ Adams et al. also reported a prevalence of moderate (AHI 20-29) and severe OSA (AHI ≥ 30) of 14% and 12%, respectively.⁴ The MAILES study data clearly demonstrate a link between OSA and older age and obesity, indicating Australia's aging population and increasing levels of obesity are likely to be contributing to the increase in the prevalence of OSA and growth in PSG provision.^{4,21}

Marshall et al. attributed the high rate of PSG growth per 100 000 Medicare enrollees in Queensland to a lower threshold for referral and more service providers in the state. It is probable an increase in the number of private sleep clinics is contributing

to the level of in-home PSG service provision in Queensland. However, better recognition of SDB at the consumer and primary health care level associated with a higher profile of the condition may also be driving this increase. Given that Queensland has a less centralized population distribution than many other states, one would expect greater provision of home sleep studies. Medicare data disaggregated by geographical statistical areas shows that in-home PSGs occur in Queensland's main population center, Brisbane, and large regional centers geographically distant from Brisbane, at a similar rate per 100,000 Medicare enrollees. Nonetheless Queensland is unlikely to be the predominant driver of overall PSG Medicare expenditure, given the far greater influence of Victoria and NSW combined.

When PSG provision is stratified by sex, the male to female ratio is 3:2. The age stratification for PSGs remains relatively constant; however, when Medicare funding of home-based PSG was introduced in 2008, younger age groups were more likely to receive PSG by this modality. Continued national growth in PSG service provision was predicted in 2007, and our study supports this. PSG service provision per 100,000 Medicare enrollees has grown by 95.8% from 2003 to 2012.

The overall burden of sleep disordered breathing on the health system is increasing, rising from 0.29% of the Medicare budget in 2004¹⁵ to 0.32% in 2012. Medicare data show consistent growth in PSG, and the estimated prevalence of sleep disorders in Australia and our findings would suggest that this growth is likely to continue.²²

CONCLUSION

It is debatable whether the current and likely future increases in Medicare PSG expenditure require changes in systems for the diagnosis of SDB and reimbursement for PSG. While there is no doubt SDB, and particularly OSA, are important conditions, the expenditure on this element of health care delivery in an environment of competing health priorities must be considered. Given the likely significant levels of underdiagnosis (and thus treatment) of SDB, it may be that the cost of diagnosis rather than the number of procedures performed is more pertinent. In this case, initiatives to reduce cost including the validation of screening protocols and the use of PSG only as a secondary confirmatory test should be considered in line with existing evidence of utility of screening systems.²³⁻²⁵ A further option to consider is the potential use of type 3 portable monitors (limited channel devices usually using 4-7 channels), which are increasingly being mandated by insurers in the US, 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.^{26,27} The assessment of whether this greater access to and diagnosis of SDB in turn translates to the uptake of effective treatment and improved clinical outcomes and is cost effective will be important in informing future resourcing of such services.

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