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REVIEW

The Australian and New Zealand Cardiac Implantable Electronic Device Survey: Calendar Year 2017

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Background A cardiac implantable electronic device (CIED) survey was undertaken in Australia and New Zealand for calendar year 2017 and involved pacemakers (PMs) and implantable cardioverter-defibrillators (ICDs).

Results and Conclusions For 2017, there were 17,971 (15,203 in 2013) new PMs sold in Australia and 1,811 (1,641 in 2013) implanted in New Zealand. The number of new PM implants per million population was 745 for Australia (652 in 2013) and 384 for New Zealand (367 in 2013). In both Australia and New Zealand, the number of PM replacements fell as a result of improved power source service life. Pulse generator types implanted were predominantly dual chamber; Australia 73% (74% in 2013) and New Zealand 68% (59% in 2013). There were 1,247 biventricular PMs implanted in Australia (661 in 2013) and 118 in New Zealand (83 in 2013). Transvenous pacing leads were overwhelmingly active fixation in both the atrium and ventricle. In Australia there was an increase in ICD usage with 4,212 new implants (3,904 in 2013), but a small fall in New Zealand to 396 (423 in 2013). The new ICD implants per million population were 175 for Australia (167 in 2013) and 90 for New Zealand (95 in 2013). There was a small reduction in biventricular ICDs in both Australia (2,195) and New Zealand (111).

Keywords Australia and New Zealand Survey • Implantable cardiac pacemakers • Implantable cardioverter-defibrillators

Introduction

Cardiac pacemakers (PM) have been implanted in Australia and New Zealand since 1961. Implantable cardioverter-defibrillators (ICDs) were first used in Australia in 1984 and in New Zealand in 1988 with more recently, biventricular models for cardiac resynchronisation therapy being introduced. Each 3 or 4 years, since 1972, an Australian and New Zealand cardiac implantable electronic device (CIED) survey has been undertaken and to coordinate with previous surveys, the calendar year 2017 was selected as the survey period.

Methods

Survey Questionnaire

Previous comprehensive PM surveys have been conducted in Australia for calendar years 1972 [1,2], 1975 [3,4], 1978 [5], 1989, 1993 [6], 1997 [7], 2001 [8], 2005 [9], 2009 [10] and 2013

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[11]. New Zealand conducted surveys in 1972 [1,2], 1978 [5], 1981, 1993 [6], 1997 [7], 2001 [8], 2005 [9], 2009 [10] and 2013 [11]. Implantable cardioverter-defibrillators were included in the survey for the first time in 1993 [6], and biventricular pacing models in 2001 [8]. Newer CIEDs, including leadless pacemakers, subcutaneous defibrillators and implantable loop recorders are not separately listed in this survey as they are limited to a few manufactures and for proprietary reasons, the implant numbers are not available for publication. Leadless pacemakers, however, are included in the single chamber PM figures and subcutaneous defibrillators, under the single chamber ICD heading.

With significant increases in the number of Australian implanting centres over the last 25-years, it became obvious that the collection of separate data from each implanting institution had become impossible. Consequently, it was decided that, for the surveys after 1993, all CIED information would be obtained through pacing companies. Data from each Australian state was required. Although small numbers of CIED implants are performed in the Australian Capital and Northern Territories, a number of companies group their sales to the neighbouring State: South Australia for the Northern Territory and New South Wales for the Australian Capital Territory. Therefore, sales figures for the territories are included in those states.

The companies were sent a questionnaire on CIEDs sold and registered in Australian states during calendar year 2017. In some hospitals, there is a pacemaker and lead inventory remaining on the shelves from the previous calendar year. However, this inventory figure would remain relatively constant for all surveys since 1992 making the stated units sold essentially the same as those implanted. Although the data for biventricular and ICD devices are stated as units sold, nevertheless, they reflect the implant numbers as company representatives are generally present at all implants and complete the registration requirements. No attempt was made to determine individual hospital implant numbers.

The individual company data were received in plain, sealed envelopes, transcribed to a working sheet and individual forms destroyed after the data were collated and transferred to a separate unmarked sheet. All pacing companies cooperated with the survey and are listed in the acknowledgements. The data collection and analysis was performed without influence from any of the companies involved and all companies provided all the information asked in the survey form.

For the New Zealand survey, the data was extracted from the ANZACS-QI registry. This provided complete data for implant numbers and procedure type (new or replacement). Pacemaker pulse generator type data were 91% complete. For ICDs, the type data were 83% complete. Lead fixation data were obtained from pacing company sales data.

For each survey, an accurate number of the CIEDs sold or implanted was obligatory. For PMs and ICDs, this was divided into new implants, replacements and types. Information on PM leads and the number of implanting institutions in each country was also surveyed. Previously, information on lead polarity was collected, but unipolar leads are not used today and thus this information was not obtained. No attempt was made to obtain clinical and demographic information.

Results

During 2017, there were 141 Australian and 10 New Zealand centres implanting PMs. The breakdown of pacing numbers in each Australian state and the corresponding 2013 results for both Australia and New Zealand are listed in Table 1. As stated, Australian sales data reflect implant numbers as companies with improved company registration procedures can now more accurately differentiate between new implants and replacements [9,10].

In comparison with the 2013 survey, there was a modest rise in the total PM sales in Australia from 18,867 to 21,433 (12%) or actual implants in New Zealand from 2,135 to 2,19 (3%). For Australia, the PM sales increase was with new implants from 15,203 to 17,971 (15%) with a fall in replacements from 3,664 to 3,462 (-6%). Similarly, for New Zealand, there was a rise in new PM implants from 1,641 to 1,811 (10%) and a fall in replacements from 494 to 385 (-22%). Whereas, with previous surveys, the numbers of PM replacements always represented a significant proportion of the PM hardware budget, it is now only 16% for Australia and 18% for New Zealand.

As with previous surveys, the number of new implants per million population in 2017 increased 12% for Australia (745) and 22% for New Zealand (384). The changes in the Australia and New Zealand markets since the first PM survey in 1972 are graphed in Figure 1. Surveys were not conducted in Australia for 1981 and 1985 and in New Zealand for 1985 and 1989. For the 2017 survey, the individual states of Australia have been separately analysed and reported. All Australian states had an increase in new PM implant numbers with New South Wales being the largest implantation state. New implants per million population increased for all Australian states and with 933 new implants per million population, South Australia once again had the highest implant rate per population. The marked rise in the implant numbers in Tasmania is due to improved implant facilities in that State with less need to refer patients to other States.

Table 2 details the type of PM pulse generators sold in Australia and implanted in New Zealand in 2017. All pulse generators sold in Australia and New Zealand are programmable and rate adaptive (R). Single chamber models, designated SSI(R) are implanted almost exclusively in the ventricle and rarely in the atrium. They represent 21% of sales in Australia and 26% of implants in New Zealand. The main pulse generator type sold or implanted were the dual chamber DDD(R) models with 73% for Australia and 68% for New Zealand. The gap between the usages of dual chamber pulse generators in the two countries has been narrowing between surveys.

Table 1 **Pacemaker Sales Australia and Implants New Zealand, 2017 {2013}.**

	Total*	New	Replacement	Popn.	NIMP	Centres
AUSTRALIA						
New South Wales/Australian Capital Territory	6,615	5,467 {4,475}	1,148 (17%)	8.20	666 {599}	48 {42}
Victoria	5,721	4,736 {4,574}	985 (17%)	6.24	759 {710}	41 {41}
Queensland	4,184	3,528 {3,094}	656 (16%)	4.88	722 {660}	24 {20}
Western Australia	2,289	1,997 {1,339}	292 (13%)	2.57	777 {525}	12 {11}
South Australia/Northern Territory	2,127	1,829 {1,462}	298 (14%)	1.96	933 {870}	12 {10}
Tasmania	497	414 {214}	83 (17%)	0.52	796 {470}	4 {4}
Total	**21,433**	**17,971**	**3,462 (16%)**	**24.13**	**745**	**141**
{Total 2013	**18,867**	**15,203**	**3,664 (19%)**	**23.32**	**652**	**128}**
NEW ZEALAND						
Total 2017	**2,196**	**1,811**	**385 (18%)**	**4.71**	**384**	**10**
{Total 2013	**2,135**	**1,641**	**494 (23%)**	**4.47**	**367**	**10}**

Popn. = Estimated population in millions.
NIMP = New Implants per million population.
{} = 2013 survey.
() = Percentage of total sales.
* = Total sales or implants.

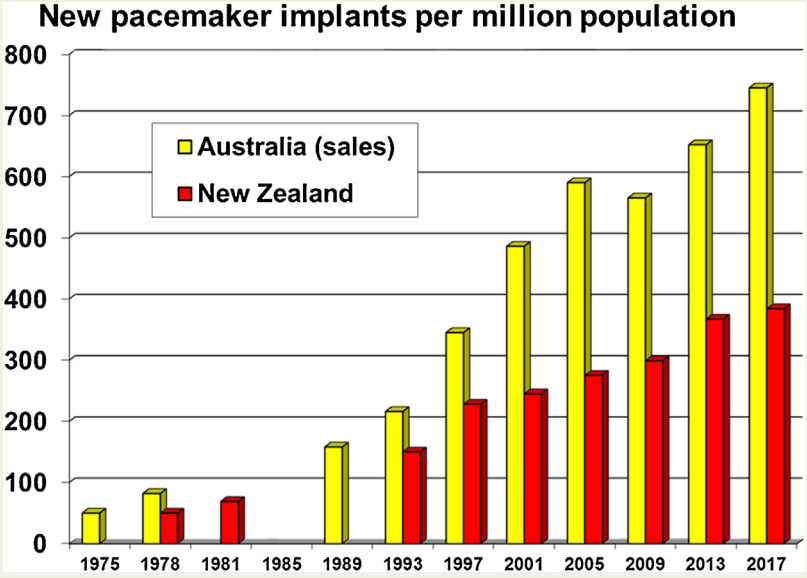

Figure 1 Number of new pacemaker (PM) implants per million population from all the Australian and New Zealand surveys since 1972.

Single lead, atrial sensing, ventricular pacing models (VDD) are no longer sold in Australia. With previous surveys, the very small numbers used were probably replacements. There is still rare usage in New Zealand. An important pulse generator type is the biventricular PM for cardiac resynchronisation therapy which has been surveyed since 2001. Compared to the 2013 survey, there was an increase from 661 to 1,247 (47%) implanted in Australia and 83 to 118 (28%) in New Zealand.

Previously, the major limitation of the pacing survey in Australia was the distribution of lead usage in the atrium or ventricle. Today, with improved implant registrations, the figures are more accurate. As all leads sold are now bipolar, lead polarity was not surveyed. During 2017, 15,175 atrial and 17,716 ventricular leads were implanted in Australia and 1,809 atrial and 2,231 ventricular leads in New Zealand. In both countries, there has been an overwhelming shift to active fixation steroid-eluting leads in both chambers.

Table 2 Pulse Generator Type (New and Replacement), 2017.

	SSI(R)	DDD(R)	VDD	BiVP
AUSTRALIA				
New South Wales/Australian Capital Territory	1,464 (22%)	4,819 (73%)	0 (0%)	332 (5%)
Victoria	1,063 (19%)	4,229 (74%)	0 (0%)	429 (7%)
Queensland	788 (19%)	3,183 (76%)	0 (0%)	213 (5%)
Western Australia	521 (13%)	1,651 (72%)	0 (0%)	117 (5%)
South Australia/Northern Territory	530 (25%)	1,468 (75%)	0 (0%)	129 (6%)
Tasmania	98 (20%)	372 (75%)	0 (0%)	27 (5%)
Total 2017	**4,464 (21%)**	**15,722 (73%)**	**0 (0%)**	**1247 (6%)**
{Total 2013	**4,131 (22%)**	**13,995 (74%)**	**79 (<1%)**	**661 (4%)}**
NEW ZEALAND				
Total 2017#	**518 (26%)**	**1,351 (68%)**	**9 (<1%)**	**118 (6%)**
{Total 2013	**772 (37%)**	**1,259 (59%)**	**5 (<1%)**	**83 (4%)}**

= 1996 completed entries of 2196 implants (91%).
{} = 2013 survey.
() = Percentage of total.
Abbreviations: SSI(R), atrial or ventricular pacing and sensing (rate adaptive); DDD(R), dual chamber pacing and sensing (rate adaptive); VDD, Single lead, atrial sensing and ventricular pacing and sensing; BiVent, Biventricular pacemaker.

Table 3 compares active and passive fixation in the atrium and ventricle. For Australia, there was an 89% atrial fixation usage and 91% ventricular usage with a similar distribution in all states. For New Zealand, the usage was 91% in the atrium and 93% in the ventricle. There was no attempt to survey coronary sinus leads for biventricular pacing because of the small numbers and the types and models available are often specific for one company.

The ICD market in both Australia and New Zealand remains relatively flat (Table 4). The units sold accurately reflect the implant numbers as a company representative is generally present at each implant and is responsible for the implanted hardware registration. For 2017, there were 4,212 new ICDs implanted in Australia (3,904 in 2013) and 396 ICDs in New Zealand (423 in 2013). The number per million population was 175 for Australia (167 in 2013) and 90 for New Zealand (95 in 2013). Figure 2 illustrates the number of new ICD implants per million population in Australia and New Zealand since the first survey in 1993.

Table 3 Lead Type Sold or Implanted 2017.

	Active Fixation		Ventricular Fixation	
	Active	Passive	Active	Passive
AUSTRALIA				
New South Wales/Australian Capital Territory	81%	19%	86%	14%
Victoria	96%	4%	97%	3%
Queensland	91%	9%	90%	10%
Western Australia	89%	11%	92%	8%
South Australia	90%	10%	90%	10%
Northern Territory				
Tasmania	98%	2%	92%	8%
Total 2017	**89%**	**11%**	**91%**	**9%**
{Total 2013	**78%**	**22%**	**77%**	**23%}**
NEW ZEALAND				
Total 2017	**91%**	**9%**	**93%**	**7%**
{Total 2013	**65%**	**35%**	**62%**	**38%}**

{} = 2013 survey.

Table 4 ICD Implants 2017 {2013}.

	Total	New	Rep.	NIMP	ICD Type (%)			Centres
					CD	DCCD	BiV CD	
AUSTRALIA								
New South Wales/Australian Capital Territory	2,067	1,407	660	172	614 (30%)	723 (35%)	730 (35%)	39
	{2,094	1,411	683	189	632 (30%)	730 (35%)	732 (35%)	35}
Victoria	1,548	1,030	518	165	409 (26%)	504 (33%)	635 (41%)	34
	{1,430	916	514	158	321 (23%)	49 (34%)	618 (43%)	33}
Queensland	1,291	885	406	181	404 (31%)	512 (40%)	375 (29%)	23
	{1,273	816	457	174	330 (26%)	510 (40%)	433 (34%)	20}
Western Australia	521	394	127	153	144 (28%)	170 (33%)	207 (39%)	11
	{495	338	157	133	183 (37%)	125 (25%)	187 (38%)	10}
South Australia/	580	407	173	208	221 (38%)	155 (27%)	204 (35%)	12
Northern Territory	{590	386	204	201	199 (34%)	159 (27%)	232 (39%)	11}
Tasmania	118	89	29	171	26 (22%)	48 (41%)	44 (37%)	4
	{44	37	7	73	13 (30%)	22 (50%)	9 (20%)	4}
Total 2017	**6,125**	**4,212**	**1,913 (31%)**	**175**	**1,818 (30%)**	**2,112 (34%)**	**2,195 (36%)**	**122**
{Total 2013	**5,926**	**3,904**	**2,022 (34%)**	**167**	**1,687 (28%)**	**2,037 (35%)**	**2,211 (37%)**	**113}**
NEW ZEALAND								
Total 2017 #	**576**	**396**	**180 (31%)**	**90**	**267 (56%)**	**101 (21%)**	**111 (23%)**	**7**
Total 2013	**603**	**423**	**180 (30)**	**95**	**325 (54%)**	**146 (25%)**	**118 (20%)**	**5}**

= 479 completed entries of 576 implants (83%).
{} = 2013 survey.
() = Percentage of total.
Abbreviations: Rep, replacements; NIMP, new implants per million population; CD, cardioverter defibrillator; DCCD, dual chamber cardioverter defibrillator; Bi V CD, biventricular cardioverter defibrillator.

For both Australia and New Zealand, the number of ICD replacements remains high at about one third of all implants and therefore a significant proportion of the ICD hardware budget. For Australia, the mix between single chamber (30%), dual chamber (34%) and biventricular ICDs (36%) is similar to the 2013 survey. New Zealand still implants predominantly single chamber models (56%). There has been an increase in hospitals implanting ICDs in Australia from 113 to 123, and in New Zealand from 5 to 7.

Discussion

With ongoing hospital budget constraints, surveys of medical procedures are becoming increasingly important to hospital administrators and government bureaucrats. When compared to previous surveys, the 2017 cardiac PM and ICD survey demonstrates once again an increase in the numbers of cardiac implanted electronic devices in Australia and New Zealand.

A major change from previous PM surveys has been the decrease in the percentage number of replacements in both Australia and New Zealand as compared to new implants. This likely reflects both improved longevity of power sources [12] as well as a concerted effort at PM testing to optimise settings in order to extend power source life. In contrast, ICD replacements remain at about one third of all implants in both Australia and New Zealand. The improvement in projected power source service life can be also extended to ICDs, but the reduction in replacement numbers will still take a number of years.

The use of biventricular PMs continues to rise. For Australia, 3,442 biventricular devices were used and 36% were PMs, whereas the figure for New Zealand was 229 biventricular devices with 52% being PMs. Most biventricular PM recipients would qualify for an ICD, but, for a number of reasons, including patient or physician preference, cost, prognosis or technical difficulties, a PM is preferred. There is also recent evidence that patients with a non-ischaemic cardiomyopathy may not benefit from coupling an ICD to cardiac resynchronisation therapy [13]. Therefore, with a better understanding of the indications for both cardiac resynchronisation therapy and ICDs, it is expected that in the future, the numbers of biventricular PM implants will remain strong.

There has been a significant increase in active fixation leads in both the atrium and ventricle. For the atrium, this provides a more secure fixation, without a deterioration in stimulation thresholds or sensing. This also applies to the ventricle, with

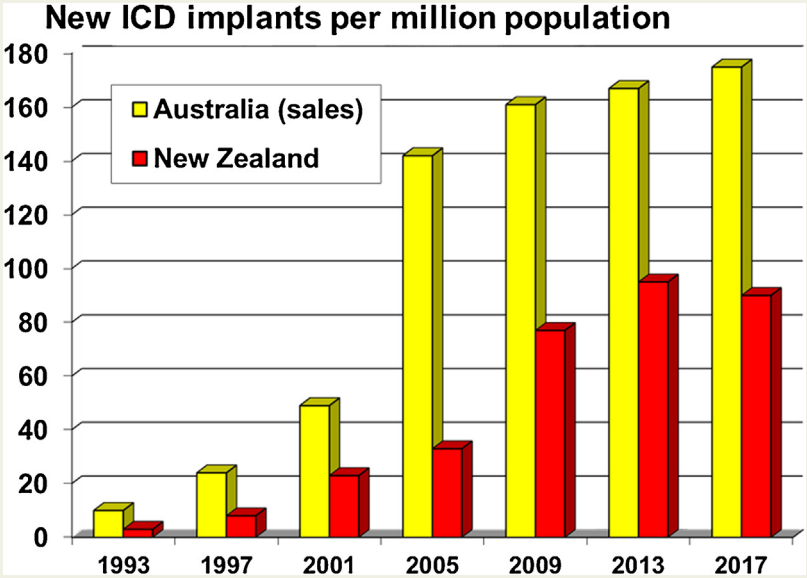

Figure 2 Number of new implantable cardioverter-defibrillator (ICD) implants per million population from all the Australian and New Zealand surveys since 1993.

the added advantage of being able to reliably pace in non-apical positions [14].

For both Australia and New Zealand, ICD usage has plateaued, suggesting that the increasing populations are predominantly from births and young immigrants, a group usually not requiring this therapy. A new type of defibrillator currently being implanted in both Australia and New Zealand uses subcutaneous chest electrodes and an implanted high voltage generator. Because of a single manufacturer, the numbers implanted are included with single lead ICDs.

There has been an increase in the number of Australian centres implanting both PM and ICDs, whereas in New Zealand the number of centres has remained relatively constant. It is surprisingly difficult to obtain accurate information on implanting centres. Some hospitals implant only a handful of devices a year, others may be private hospitals next to a public centre and patients from both hospitals are implanted in the same laboratory. In some cases, the hospital may be a large regional centre which conducts follow-up clinics, but does not implant. The centre numbers come from manufacturers and the final list was obtained by reviewing all companies list of centres when available.

How does Australian and New Zealand usage of cardiac implantable electronic devices compare with other countries? Previously, a pacing and ICD world survey was conducted by one of the authors (HM) for the same calendar year, but because of increasing difficulty receiving information, this was ceased in 2009 [15]. However, both Europe and the Asian Pacific region conduct annual CIED surveys through their heart rhythm societies [16,17]. Table 5 is comparative implant data over a period 2015 to 2017 from a selected group of countries that provided information. For PM, the highest new implants per million population was Germany (1,016), followed by Belgium (798), Denmark (711) and France (782), the latter three countries being comparable to Australia. For Asia, the new implants per million are much lower. For ICDs, the highest implanter was again Germany (223) with Australia being second on this list (175).

Table 5 Comparative Implant Data (2015-2017).

	New PMs		New ICDs	
	Implanted	NIMP	Implanted	NIMP
Australia	17,971	745	4,212	175
New Zealand	1,808	384	396	90
Belgium	9,094	798	1,081	95
Denmark	3,972	711	874	156
France	45,100	675	6,539	98
Germany	82,000	1,016	18,000	223
Russia	28,411	200	1,126	8
United Kingdom	36,354	568	5,291	83
China	62,508	45	2,986	2
India	39,754	31	3,114	2
Japan	40,318	318	4,208	33

Abbreviations: PMs, pacemakers; ICDs, implantable cardioverter-defibilators.

Survey Limitations

This CIED survey is critically dependent on all companies participating and providing accurate data. A single company rejection would completely invalidate the report. A

company-based CIED survey, although generally accurate in numbers, lacks important clinical, demographic and outcomes information. CIEDs are very expensive implantable devices and data on usage and outcomes are very important in allocating future resources particularly for the rapidly growing biventricular models. Comprehensive surveys and registries to address this are complicated, require public and private hospital cooperation and are extremely expensive. They require a concerted State or Federal Government initiative, possibly linked to legislation allowing public hospital or private health benefit funding to collect registry information. In the meantime, the responsibilities for use of this expensive therapy lie with the individual cardiology department and implanter.

A minor limitation, particularly with PMs, is that the survey depends on the hardware units sold rather than implanted. Because the numbers of pulse generators and leads on the hospital shelves remains relatively constant, the actual implant numbers each year reflect the numbers sold.

For the New Zealand data, device type (single, dual chamber or biventricular) was incomplete in the registry with information on 2,475 of 2,772 (89%) of all PM and ICD implants. Although the absolute numbers for device type presented are less than actual implants, nevertheless, the data allows for a good estimate of the relative percentage of device type.

There are a number of CIED items not separately listed in this survey. These include leadless pacemakers, subcutaneous defibrillators and implantable loop recorders. As more companies become involved, the manufacturers will, hopefully in the future, be prepared to provide separate data on their usage in Australia and New Zealand.

Conclusions

A CIED survey was undertaken in Australia and New Zealand for calendar year 2017. In comparison to a similar survey in 2013, there were increases in PM implants, but the ICD implant rate has plateaued. The number of PM replacements for both Australia and New Zealand have fallen reflecting improved power source service life. There is now a strong preference for bipolar active fixation leads in both the atria and ventricles.

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- Abbott (St. Jude Medical), Lane Cove, New South Wales.

New Zealand

- Biotronik, Auckland.
- Boston Scientific Australia and New Zealand, Auckland.
- Medtel New Zealand, Auckland.
- Medtronic New Zealand Limited, Auckland.

References

[1] Sloman G, Mond HG, Ramshaw J, Smith D, Twentyman R. Australian and New Zealand PM Survey. Med J Aust 1974;1:920–3.
[2] Sloman G, Mond HG, Ramshaw J, Smith D, Twentyman R. Cardiac pacemaking survey. Australia and New Zealand, 1972. In: Cardiac Pacing. Proceedings of the VIth International Symposium. Groningen, the Netherlands; 1973. p. 63–9.
[3] Mond HG, Sloman G. Cardiac PM survey — Australia 1975. Med J Aust 1976;1:592.
[4] Sloman G, Mond HG. Cardiac pacing survey. Australia 1975. In: Proceedings of the Vth International Symposium on Cardiac Pacing; 1976. p. 8–9. Exerpta Medica Series.
[5] Sloman JG, Sutton L, Mond HG. The Asian-Pacific cardiac pacing survey. In: Proceedings of the VIth World Symposium on Cardiac Pacing; 1979. Chapter 41-3.
[6] Mond HG, Whitlock RML. World survey: Australia and New Zealand 1993, vol. 8. Reblampa; 1995p. 125–6.
[7] Mond HG, Whitlock RML. The Australian and New Zealand cardiac pacing and implantable cardioverter-defibrillator survey. Intern Med J 2001;31:267–71.
[8] Mond HG, Whitlock RM. The Australian and New Zealand cardiac pacing and implantable cardioverter-defibrillator survey: calendar year 2001. Heart Lung Circ 2004;13:145–9.
[9] Mond HG, Whitlock R. The Australian and New Zealand cardiac pacing and implantable cardioverter-defibrillator survey: calendar year 2005. Heart Lung Circ 2008;17:85–9.
[10] Mond HG, Whitlock RML. The Australian and New Zealand cardiac pacing and implantable cardioverter-defibrillator survey: calendar year 2009. Heart Lung Circ 2011;20:99–104.
[11] Mond HG, Crozier I. The Australian and New Zealand cardiac pacemaker and implantable cardioverter-defibrillator survey: calendar year 2013. Heart Lung Circ 2015;24:291–7.
[12] Mond HG, Freitag G. The Cardiac implantable electronic device power source: evolution and revolution. Pacing Clin Electrophysiol 2014;37:1728–45.
[13] Kober L, Thune JJ, Nielson JC, Haarbo J, Videbaek L, Korup E, et al. Defibrillator implantation in patients with nonischemic systolic heart failure. NEJM 2016;375:1221–30.
[14] Harry HG, Vlay SC. Pacing the right ventricular septum: time to abandon apical pacing (editorial). Pacing Clin Electrophysiol 2010;33:1293–7.
[15] Harry HG, Proclemer A. The 11th world survey of cardiac pacing and implantable cardioverter-defibrillators: calendar year 2009. Pacing Clin Electrophysiol 2011;34:1013–27.
[16] European Heart Rhythm Association (EHRA). White book; 2016.
[17] Asian Pacific Heart Rhythm Society (APHRS). White book; 2017, http://www.aphrs.org/attachments/article/42/APHRS%20White%20Book%202017.pdf.