

Cardiac surgery in Australia 1998

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Preface

This report aims to present information on all cardiac surgery procedures performed in 1998. It is produced jointly by the Australian Institute of Health and Welfare and the National Heart Foundation of Australia. An advisory committee appointed by the Foundation oversees the cardiac surgery register, and the Institute collates, analyses and reports the data through its National Centre for Monitoring Cardiovascular Disease. The project is financed by the Foundation and by the Institute, through funds it receives for the National Centre from the Commonwealth Department of Health and Aged Care.

Under its Act, the *Australian Institute of Health and Welfare Act 1987*, the Institute is able to provide the legislative protection that is required to operate the cardiac surgery register and protect the data confidentiality interests of the participating cardiac surgery units and their patients.

This report is intended primarily for workers in the field so it uses technical terms widely. However, to make the contents more accessible to other interested readers, a brief explanatory introduction and a glossary have been included.

A report covering procedures performed in 1999 is in preparation and will be issued as soon as these data are made available by all participating units.

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Cardiac Surgery Advisory Committee

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The Australian Institute of Health and Welfare and the Cardiac Surgery Advisory Committee are very grateful to all participating units and members of the Australasian Society of Cardiac and Thoracic Surgeons for giving their time to the Register and ensuring that it retains its national coverage.

Summary

This report aims to provide details of cardiac surgery performed in Australia in 1998. It covers patterns and trends in the use of cardiac surgery procedures for acquired and congenital conditions, and associated mortality. Comparison is made with 1995, the most recent year for which data are available.

The main findings of the report are:

- During 1998 there were an estimated 22,253 cardiac surgery procedures performed in Australia, with an average case load of 445 patients per cardiac surgery unit.
- Cardiac surgery procedures in 1998 increased by an estimated 2.6% from 1995.
- The estimated national cardiac surgery rate was 1,188 per million population, with a 30-day mortality rate of 2.6%.
- There were 76 cardiac surgeons operating in 50 units throughout the country, compared with 40 units in 1995.
- There were 1,576 operations for congenital heart defects, with a 30-day mortality rate of 3.0%. Septal defects were the main single reason for congenital heart surgery.
- Among congenital defects, compared with 1995, the number of operations for valve defects, coarctation of the aorta and Tetralogy of Fallot increased, whereas those for transposition of great vessels, ventricular septal defects, persistent ductus arteriosus and atrial septal defects fell.
- Valvular heart defects accounted for an estimated 4,578 procedures, with a 30-day mortality rate of 3.2%. Sixty-five procedures were reoperations for bioprosthetic tissue valve failures, 59 procedures were reoperations for mechanical valve failures, 26 procedures were reoperations for allograft tissue valve failures and one procedure was for autograft tissue valve failure.
- Surgery was done most frequently for the aortic and mitral valves. Surgery involved a replacement in 74% of cases. Repairs were done in 17% of cases.
- There were an estimated 17,448 operations involving coronary artery bypass grafts (CABG), with a mortality rate of 2.1%. Six per cent of coronary artery bypass graft procedures were reoperations.
- The average number of bypass grafts was three per patient. Internal mammary artery grafts and saphenous vein grafts were the main types used in bypass graft operations, at 82% and 68% respectively.
- The age-standardised national average rate for coronary artery bypass graft surgery was 879 per million population. The rate varied across States, ranging from 650 per million population in Western Australia to 951 per million population in New South Wales and the Australian Capital Territory.
- Coronary artery bypass graft surgery is done three times more frequently in males than females. The difference in procedure rates between men and women is most marked in the age range 35–54 but is evident across all adult ages.
- There were 72 heart transplants, 83 lung transplants and 4 combined heart–lung transplants done in 1998.

Introduction

Heart disease is a major cause of morbidity and mortality, causing 29% of all deaths in Australia in 1998. The most common forms of heart disease affecting Australians are coronary heart disease, acquired valve disease, conduction defects, congestive heart failure and congenital heart defects. There is a wide range of treatments for heart disease, among which are cardiac surgery and electrophysiological treatments.

Coronary artery bypass grafting (CABG) was developed in the 1960s and is now a well-established procedure. Vessel grafts are used to construct new conduits from major arteries to points beyond obstructions in the coronary arteries to restore adequate blood supply to the heart muscle (myocardium). The procedure usually requires the chest to be opened and the circulation to be diverted from the heart and lungs to a cardiopulmonary bypass machine with a pump oxygenator. In most cases the graft material is obtained from the patient's saphenous vein in the leg or the internal mammary artery in the chest, or both. Less invasive techniques for performing the procedure are now being introduced. CABG is a treatment and not a cure for coronary artery disease, and there is a risk of recurrent disease. Reoperations are uncommon within the first five years but become more frequent later. Although coronary angioplasty has replaced some CABG procedures since it was introduced in the early 1980s, the techniques are regarded as complementary. The growth in the rate of CABG has flattened out in more recent years.

Valve surgery involves repairing or replacing the mitral, aortic, tricuspid or pulmonary valves. It usually requires cardiopulmonary bypass. Valve disease may be congenital, a result of disease such as rheumatic fever, or age-related. Most valve procedures done in Australia consist of replacing the damaged valve with a mechanical prosthesis, a pig bioprosthesis or a human graft. Reconstruction of the damaged valve by suturing techniques is less common. Simpler valve procedures can be undertaken with catheter-based techniques.

Congenital conditions include abnormalities of the heart or heart valves, defects of the great vessels such as the aorta and pulmonary artery, or combinations of defects. Most children with congenital defects are treated with open surgery, usually in infancy or early childhood.

Electrophysiology surgery involves removing sections of heart muscle tissue responsible for abnormal heart rhythms (arrhythmias) such as ventricular and supraventricular tachycardias, which can be serious or even life-threatening.

Other cardiac procedures include operations on the aorta, surgery for cardiac tumours and trauma, transplants and pericardiectomy.

Information on transmyocardial laser revascularisation procedures was collected for the first time in 1998. This is a new technique where small holes or channels are drilled through the myocardium using laser energy to improve blood supply to the heart in cases unsuitable for CABG or percutaneous transluminal coronary angioplasty.

The aim of this report is to provide details of cardiac surgery performed in Australia in 1998. The report covers patterns and trends in the use of cardiac surgery procedures for acquired and congenital conditions, and associated mortality.

This report is available on the Internet at the Institute's web site: <http://www.aihw.gov.au>

Methods

This report summarises all cardiac surgery performed in 1998. Statistics from previous years are also included, as changes over time in the numbers, rates and associated mortality of operations are of interest. Comparison is made with 1995 in most cases, the most recent year for which data are available. Information about the rate of reoperations for coronary artery bypass grafts and valve surgery is also presented. Cardiac surgery units operating in 1998 are listed in Appendix A. The list of units is reviewed each year, and new units are invited to join the register and submit their data.

Data collection and reporting

Generally, data collection forms are sent to all cardiac surgery units at the beginning of each year for procedures done in the previous calendar year. Units are asked to complete the forms with aggregate results (i.e. not individual patient details) and submit them within eight weeks. Reports are provided by each unit under the condition that results will be presented in aggregate form only, and that results from individual units will not be released unless the head of the unit agrees in writing.

Data are collected via a form presented here in Appendix B. This form is reviewed and updated by the Cardiac Surgery Advisory Committee each year to reflect changes in practice. Units' responses are reviewed, data are checked for consistency, any discrepancies are referred to the relevant unit, and data are then entered into a dedicated database at the Australian Institute of Health and Welfare (AIHW). Results are analysed and the annual report compiled and reviewed by members of the Advisory Committee before its publication.

Coverage

The register is believed to have almost full coverage of cardiac surgery procedures done in Australia to the end of 1998. However, for 1996 and 1997, details are too incomplete to allow analysis so that only totals are included in this report for those years. For 1998, five units in New South Wales did not provide data.

To provide a better national picture of cardiac surgery performed in 1998 despite the above limitation, the data from the register have been complemented with information from the National Hospital Morbidity Database held by the AIHW. This database contains demographic, diagnostic, procedural and duration of stay information on episodes of care for patients admitted to hospital. The collection is based on data on hospitalisations compiled by State and Territory health authorities and supplied to the AIHW. A record is included for each separation, not for each patient, so patients who were hospitalised more than once in the year have more than one record in the database.

Data held in the National Hospital Morbidity Database were found to correspond well with those reported directly to the register by participating units.

From 1 July 1998 the new International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification (ICD-10-AM) was adopted by New South Wales, Victoria, the Australian Capital Territory and the Northern Territory. The

remaining States continued to code using the existing ICD-9-CM codes. The two-stage implementation of ICD-10-AM made it necessary to map data forward to ICD-10-AM for those States that were using ICD-9-CM. Data from 1 January to 30 June 1998 are based on ICD-9-CM while data from 1 July to 31 December 1998 are based on ICD-10-AM.

Estimates for the total number of CABG procedures nationally and for each State, as well as the age and sex of patients undergoing CABG, were obtained from the National Hospital Morbidity Database. Records for separations with procedure codes for CABG (see Table 1 below) as principal or additional procedure and with separation dates between 1 January and 31 December 1998 were included, and likewise for the 1996 and 1997 calendar years. For the vast majority of CABG procedures, the National Cardiac Surgery Register supplied detailed information on associated mortality, number of anastomoses, type of graft used, concomitant procedures and reoperations.

The total number of operations for valvular heart defects nationally was estimated from National Hospital Morbidity Database records for separations with certain procedure codes (see Table 1 below) as principal or additional procedure and separation dates between 1 January and 31 December 1998. The National Cardiac Surgery Register provided details on the type of valve operated on, type of surgical procedure performed, associated mortality and reoperations for most of these operations.

The National Cardiac Surgery Register has full coverage of surgical procedures for congenital heart defects and transplants for 1998 so it was not necessary to access information from the National Hospital Morbidity Database.

For operations on the aorta and for miscellaneous acquired heart conditions, the information presented in this report is incomplete. However, as there are relatively few such operations performed each year, the missing data would have only a small effect on overall surgery totals and mortality rates.

To allow a more accurate estimate of trends than that possible from information held in the Cardiac Register alone, figures for previous years were revised using data from the National Hospital Morbidity Database and similar methods to those described above.

Table 1: International Classification of Diseases codes used in this report

Procedure	ICD-9-CM code	ICD-10-AM
Coronary artery bypass graft	36.1	Blocks [672–679]: codes 38497, 38500, 38503, 90201
Valvular heart defects	35.0, 35.1, 35.2	Blocks [621–23, 625–26, 628, 631–32, 634, 637]: codes 38456-01, 38456-10, 38456-11, 38480-00, 38480-01, 38480-02, 38481-00, 38481-01, 38481-02, 38487-00, 38488-00, 38488-01, 38488-02, 38488-03, 38488-04, 38488-05, 38488-06, 38488-07, 38489-00, 38489-01, 38489-02, 38489-03, 38489-04, 38489-05

ICD-9-CM = Australian version of the International Classification of Diseases, Ninth Revision, Clinical Modification.

ICD-10-AM = International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification.

Definitions

'Mortality' refers throughout the report to death within 30 days of the operation, or during the post-operative period in hospital.

The terms 'open' and 'closed' surgery are used in this report to indicate those operations performed with and without cardiopulmonary bypass support respectively. They do not allude to the use of catheter-based techniques. For the 1998 data, operations for acquired disease are no longer subdivided into open and closed categories, as has been done with earlier years. Congenital cases, however, continue to be divided into open and closed.

Surgery rates are calculated as the number of operations per million people in the Australian population. Death rates are given as percentages of those receiving the surgery.

The rates for bypass graft surgery have been calculated to include the Australian Capital Territory population with New South Wales, and the Northern Territory population with South Australia, since it is known from hospital morbidity data that those are the States where the vast majority of Australian Capital Territory and Northern Territory residents are treated. A unit commenced operation in the Australian Capital Territory during 1998 but since it was not operational for the full calendar year it is combined with New South Wales in this report. Age-standardised rates, which take account of differences in the age structure of the populations, have been included to provide a valid comparison of procedure rates across the States.

Total operations

Cardiac surgery units and surgeons

In 1998 there were 76 cardiac surgeons operating in Australia, as well as 14 overseas registrars, 5 service registrars and 44 trainees, 22 of whom were from other countries. There were 50 hospitals at which cardiac surgery was performed but five units did not supply data for inclusion in this report.

Operations

An estimated¹ total of 22,253 operations was performed in 1998. In 1998 there was an average case load of 445 patients per unit, with a range of 26 to 2,086. The estimated national cardiac surgery rate was 1,188 per million population.

The National Cardiac Surgery Register provides details for 19,712 operations for which information was available in 1998; overall mortality was 2.6%. Mortality has stabilised at just below 3% in the past few years even though surgery is now performed on a wider range of patients, including some previously considered unsuitable for surgery.

Table 2 presents a summary of all operations performed from 1989 to 1995 and for 1998, with associated death rates. Between 1995 and 1998 there was a small increase in the number of total operations, 2.6%. Compared with 1995, the number of procedures in patients aged six months or younger remained stable, and in patients aged over six months there was a rise in procedures of 1.4%.

1 Estimated number of operations for all units in Australia, based on data from the National Hospital Morbidity Database.

Table 2: Total heart operations and death rates, by age group, 1989–95 and 1998

Year	Age group						Total	
	≤ 6 months		> 6 months		Unspecified		Number of operations	Deaths (%)
	Number of operations	Deaths (%)	Number of operations	Deaths (%)	Number of operations	Deaths (%)		
1989	536	6.0	13,821	2.5	..	..	14,357	2.6
1990	526	5.9	14,600	2.6	..	..	15,126	2.7
1991	526	4.0	16,162	2.6	..	..	16,688	2.6
1992	540	6.7	16,560	2.7	..	..	17,100	2.9
1993	515	6.2	18,421	2.4	..	..	18,936	2.5
1994	544	5.7	20,389 ^(a)	2.8 ^(b)	..	..	20,933 ^(a)	2.8 ^(b)
1995	594	4.4	21,098 ^(a)	2.6 ^(b)	..	..	21,692 ^(a)	2.7 ^(b)
1998	595	5.2	21,402 ^(a)	2.2 ^(b)	256	7.4	22,253 ^(a)	2.6 ^(b)

.. not applicable.

(a) Estimated number of operations for all units in Australia, based on data from the National Hospital Morbidity Database.

(b) Based on the total number of procedures from the National Cardiac Surgery Register for which the information is available: 92% of procedures in 1994, 90% of procedures in 1995 and 89% of procedures in 1998. Data are unavailable for 1996 and 1997.

Sources: AIHW/NHF National Cardiac Surgery Register; AIHW National Hospital Morbidity Database.

Table 3 presents a more detailed summary of all operations performed in 1998 and associated deaths, compared with figures for 1995. Between 1995 and 1998, the total number of operations for congenital conditions declined by 4.4% and total operations for acquired conditions increased by 2.4%.

Table 3: Total heart operations, 1995 and 1998

		1995	1998
Congenital conditions^(a)			Number (deaths^(a))
Age	Under 1 month	284 (16)	275 (25)
	1–6 months	310 (10)	320 (6)
	Over 6 months	1,054 (15)	868 (10)
	Unspecified age	..	113 (7)
	<i>Subtotal</i>	<i>1,648 (41)</i>	<i>1,576 (48)</i>
Acquired conditions		20,044 ^(b) (484)	20,534 ^(b) (457)
Unspecified condition		..	143 (12)
Total		21,692^(b) (525)	22,253^(b) (517)

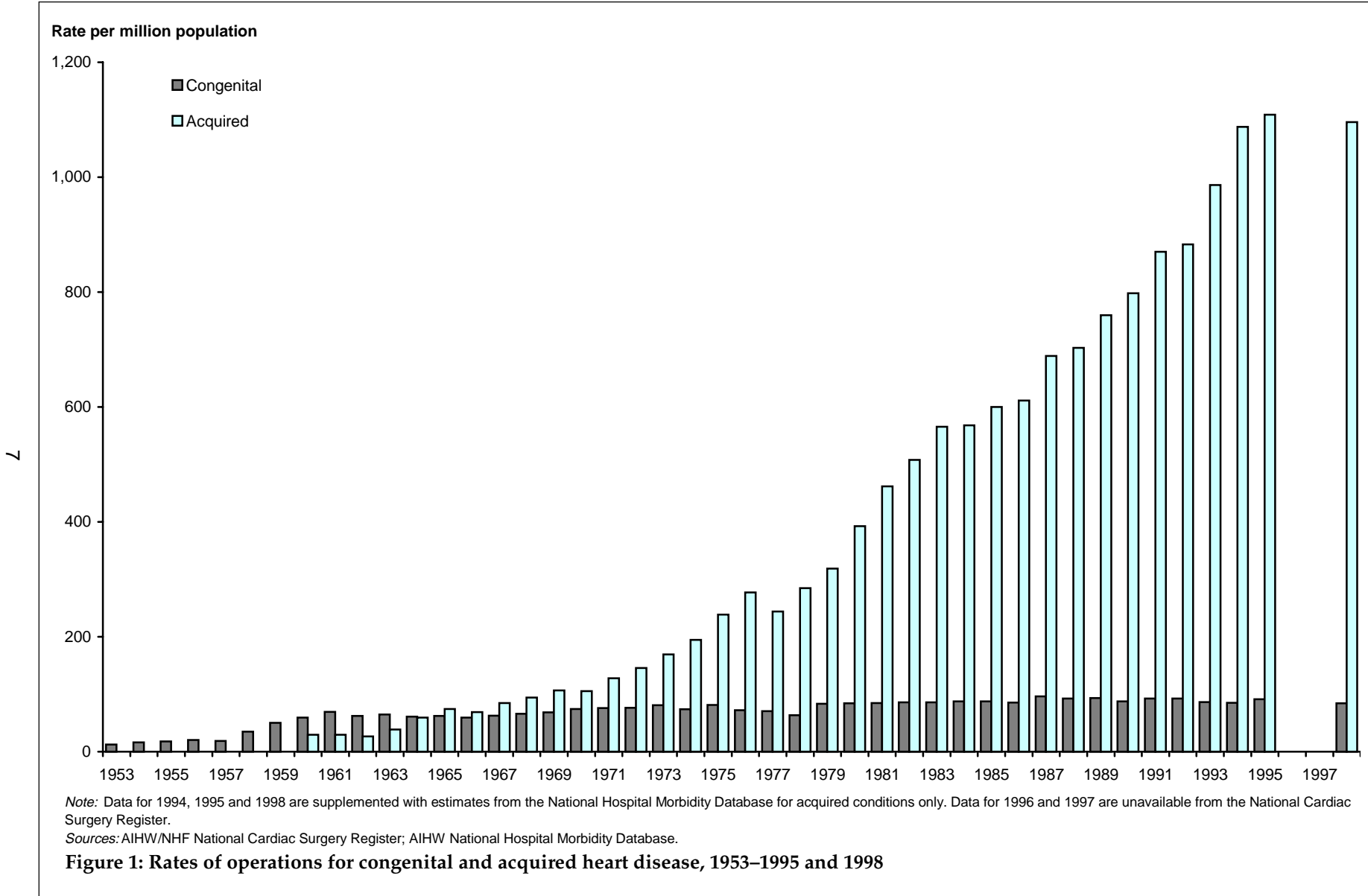
.. not applicable.

(a) Based on the total number of procedures from the National Cardiac Surgery Register for which the information is available: 90% of procedures in 1995 and 89% of procedures in 1998. Data for 1996 and 1997 are unavailable.

(b) Estimated number of operations for all units in Australia, based on data from the National Hospital Morbidity Database.

Sources: AIHW/NHF National Cardiac Surgery Register; AIHW National Hospital Morbidity Database.

Figure 1 illustrates trends in the rates of congenital and acquired operations since 1953. It can be seen that rates of surgery for acquired heart disease have increased dramatically until 1995, and remained stable since. The rates for congenital heart disease have increased only slightly over this period.



Surgery for congenital heart defects

Table 4 presents figures for a number of major congenital heart conditions, from 1989 to 1995 and for 1998. There were 1,576 operations for congenital heart defects in 1998, with a mortality rate of 3.0%.

Between 1989 and 1998, there was a general increase in the number of operations for valve defects, atrial septal defect and ventricular septal defect. Operations for persistent ductus arteriosus showed no marked change since 1990. Surgery for Tetralogy of Fallot showed a slight fall. Operations for transposition of great vessels, coarctation of the aorta and other conditions showed no clear pattern during this period.

Table 4: Number of operations for congenital conditions by major heart defect, 1989–95 and 1998^(a)

Congenital heart defect	1989	1990	1991	1992	1993	1994	1995	1998
Persistent ductus arteriosus	288	164	165	127	131	141	172	155
Valve defects	51	72	81	60	62	86	107	132
Coarctation of aorta	126	103	109	102	128	103	116	124
Atrial septal defect	232	245	249	265	228	258	288	280
Ventricular septal defect	218	231	252	254	270	260	306	240
Tetralogy of Fallot	140	116	144	169	154	133	111	116
Transposition of great vessels	98	108	108	93	107	108	106	83
Other conditions	472	455	496	549	438	431	442	446
Total	1,565	1,494	1,604	1,619	1,518	1,520	1,648	1,576

(a) Data are unavailable for 1996 and 1997.

Source: AIHW/NHF National Cardiac Surgery Register.

Figure 2 shows the proportion of total operations for congenital heart defects accounted for by a number of major conditions, in 1989 compared with 1998. Ventricular septal defect and atrial septal defect are the primary reasons for congenital heart surgery. In 1998, operations for persistent ductus arteriosus were relatively less common than in 1989.

Table 5 gives detailed figures on closed and open operations, and associated deaths, for congenital heart conditions.

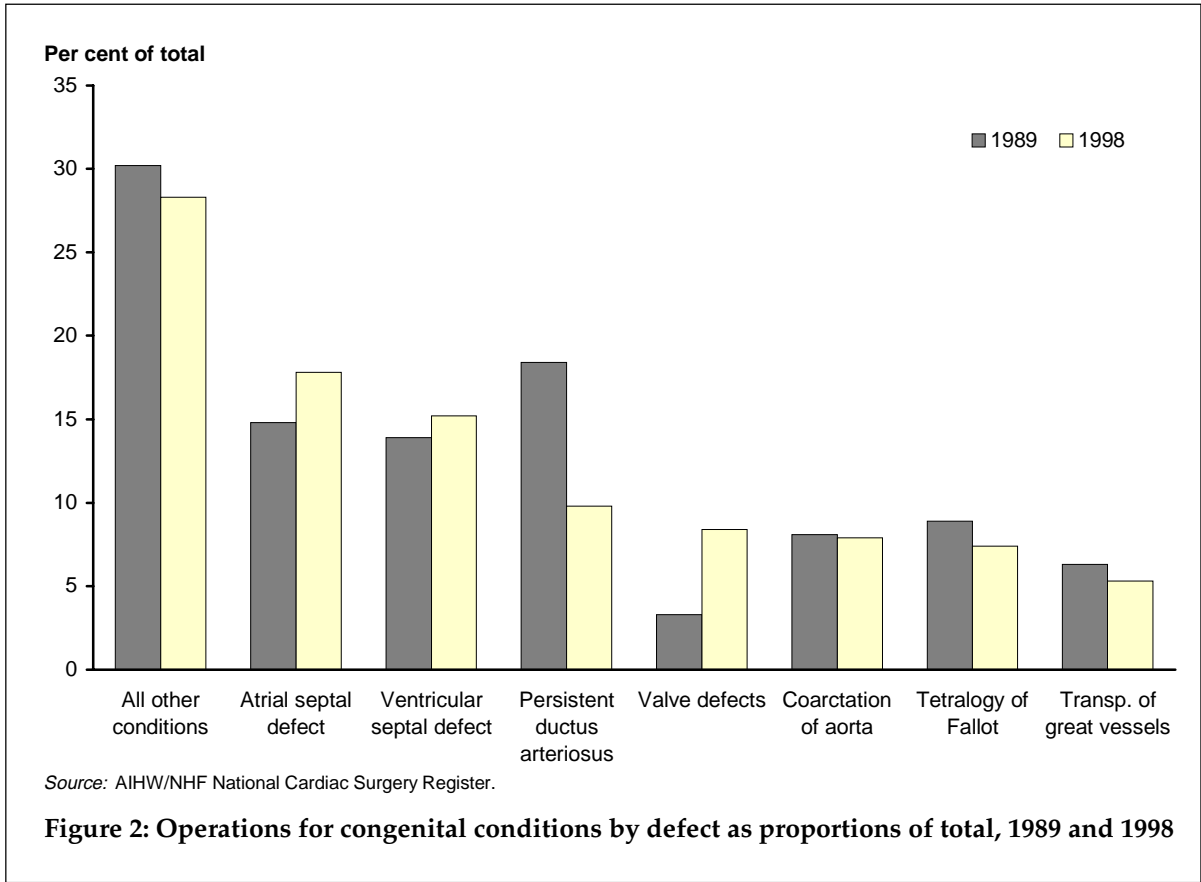


Table 5: Closed and open heart operations for congenital defects, by age group, 1998

Congenital heart operation			Closed operations				Open operations				Overall total
			≤ 1 month	1–6 months	≥ 6 months	Total	≤ 1 month	1–6 months	≥ 6 months	Total	
Number (deaths)											
Persistent ductus arteriosus			57 (1)	31 (0)	67 (0)	155 (1)	0	0	0	0	155 (1)
Valve defect			0	0	1 (0)	1 (0)	7 (0)	29 (0)	95 (3)	131 (3)	132 (3)
Coarctation of aorta	simple		24 (0)	46 (0)	18 (0)	88 (0)	0	0	2 (0)	2 (0)	90 (0)
	complex		10 (0)	9 (1)	4 (0)	23 (1)	8 (2)	0	3 (0)	11 (2)	34 (3)
Atrial septal defect			0	0	0	0	0	5 (0)	275 (1)	280 (1)	280 (1)
Ventricular septal defect	uncomplicated	palliative	4 (0)	0	1 (0)	5 (0)	0	0	3 (0)	3 (0)	8 (0)
		corrective	0	0	0	0	7 (0)	70 (1)	98 (0)	175 (1)	175 (1)
	with PS	palliative	0	0	0	0	0	0	0	0	0
		corrective	0	0	0	0	1 (0)	2 (0)	11 (0)	14 (0)	14 (0)
	with pulmonary atresia	palliative	10 (0)	2 (0)	4 (0)	16 (0)	2 (1)	0	7 (1)	9 (2)	25 (2)
		corrective	0	0	0	0	0	2 (0)	16 (0)	18 (0)	18 (0)
Tetralogy of Fallot	simple	palliative	3 (0)	5 (0)	0	8 (0)	0	0	0	0	8 (0)
		corrective	0	0	0	0	1 (0)	15 (0)	31 (0)	47 (0)	47 (0)
	complex	palliative	0	22 (0)	2 (1)	24 (1)	0	0	1 (0)	1 (0)	25 (1)
		corrective	1 (0)	0	0	1 (0)	0	4 (0)	26 (1)	30 (1)	31 (1)
	acquired pulmonary atresia	palliative	0	0	0	0	0	0	0	0	0
		corrective	0	0	0	0	0	0	5 (0)	5 (0)	5 (0)
Transposition of great vessels			3 (0)	0	4 (0)	7 (0)	57 (1)	7 (0)	12 (1)	76 (2)	83 (2)
Extra cardiac lesions	A-P window		0	0	0	0	4 (1)	1 (0)	0	5 (1)	5 (1)
	interrupted aortic arch		0	0	0	0	10 (1)	0	0	10 (1)	10 (1)
	vascular ring		3 (0)	3 (0)	5 (0)	11 (0)	0	0	0	0	11 (0)
Coronary artery defects			0	0	0	0	1 (0)	2 (0)	3 (0)	6 (0)	6 (0)

(continued)

Table 5 (continued): Closed and open heart operations for congenital defects, by age group, 1998

Congenital heart operation			Closed operations				Open operations				Overall total
			≤ 1 month	1–6 months	≥ 6 months	Total	≤ 1 month	1–6 months	≥ 6 months	Total	
Number (deaths)											
Right-sided lesions	Ebstein's anomaly	palliative	1 (1)	0	0	1 (1)	0	0	0	0	1 (1)
		corrective	0	0	0	0	0	0	1 (0)	1 (0)	1 (0)
	pulmonary atresia	palliative	15 (1)	2 (1)	2 (0)	19 (2)	2 (1)	0	14 (0)	16 (1)	35 (3)
		corrective	0	0	1 (0)	1 (0)	2 (1)	2 (0)	2 (0)	6 (1)	7 (1)
	tricuspid atresia	palliative	3 (1)	0	3 (0)	6 (1)	0	1 (0)	11 (0)	12 (0)	18 (1)
		corrective	0	2 (0)	0	2 (0)	0	0	7 (0)	7 (0)	9 (0)
Left-sided lesions	cor triatrium	0	0	1 (0)	1 (0)	0	1 (0)	0	1 (0)	2 (0)	
	hypoplastic left heart syndrome	0	2 (0)	0	2 (0)	11 (8)	0	10 (0)	21 (8)	23 (8)	
	mitral atresia	0	0	0	0	1 (1)	0	2 (0)	3 (1)	3 (1)	
	sub-aortic stenosis	0	0	0	0	1 (0)	0	27 (0)	28 (0)	28 (0)	
	supra valvular stenosis	0	0	0	0	0	0	5 (0)	5 (0)	5 (0)	
Defects of partitioning	AV canal partial	0	0	1 (0)	1 (0)	1 (0)	0	12 (0)	13 (0)	14 (0)	
	AV canal total	0	2 (1)	1 (0)	3 (1)	1 (0)	38 (1)	15 (1)	54 (2)	57 (3)	
	double outlet RV	3 (0)	1 (0)	1 (0)	5 (0)	3 (2)	4 (0)	8 (0)	15 (2)	20 (2)	
	truncus arteriosus	0	0	0	0	4 (1)	5 (1)	8 (1)	17 (3)	17 (3)	
	other	0	0	0	0	0	0	8 (0)	8 (0)	8 (0)	
Other	asplenia syndrome	0	0	0	0	0	0	0	0	0	
	other	1 (0)	0	4 (0)	5 (0)	1 (0)	1 (0)	14 (0)	16 (0)	21 (0)	
	total anomalous venous return	1 (1)	0	3 (0)	4 (1)	11 (0)	4 (0)	13 (0)	28 (0)	32 (1)	
Subtotal			139 (5)	127 (3)	123 (1)	389 (9)	136 (20)	193 (3)	745 (9)	1,074 (32)	1,463 (41)
Unspecified (detail on age and type of procedure unavailable)										113 (7)	
Total										1,576 (48)	

Source: AIHW/NHF National Cardiac Surgery Register.

Surgery for valvular heart defects

From the National Hospital Morbidity Database it is estimated that there were 4,578 operations for valvular heart defects in 1998. Details of 4,170 such operations are held in the National Cardiac Surgery Register and they are shown in this section. Please note that the estimate from the National Hospital Morbidity Database refers only to acquired, i.e. not congenital, valve defects.

Table 6 presents information about valve surgery performed from 1989 to 1998, and Table 8 gives more detailed figures for 1998 alone. Between 1989 and 1998, there has been a 79% increase in operations for valve defects.

In 1998, most valve surgery was done on the aortic and mitral valves, 53% and 33%, respectively. The vast majority of surgery was for replacement procedures (74%).

Figures 3 and 4 illustrate the trends in valve surgery over time. Between 1995 and 1998, repair and replacement procedures increased by 18% and 13%, respectively. The increase in replacement procedures is due to increases in xenografts (heterograft) (44%) and allografts (18%). Replacement of prostheses remained steady over this period. The increase in repair procedures is mainly due to mitral valve repair (Table 8).

The reasons for valve reoperations are given in Table 7. In 1998 there were 59 reoperations for mechanical valve failures, with three deaths; 65 bioprosthetic tissue valve failures, with seven deaths; 26 reoperations for allograft tissue valve failures, with no deaths; and one for autograft tissue valves, with no deaths.

Degeneration was the most frequent cause of reoperations to tissue valves, accounting for around 80% of all allograft replacements and bioprosthetic replacements. There was one reoperation for an autograft valve for annular dilation. For mechanical valves, reoperations were performed for mechanical failure (34% cases), endocarditis (36%) and paravalvular leak (31%) (Table 7).

Table 6: Number of operations for valve defects by type of valve and procedure, 1989–98

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Valve										
Mitral	987	963	1,075	1,188	1,346	1,391	1,336	n.a.	n.a.	1,529
Aortic	1,489	1,589	1,772	1,873	2,075	2,186	2,211	n.a.	n.a.	2,448
Tricuspid	67	62	51	73	106	83	79	n.a.	n.a.	142
Pulmonary	19	25	21	25	25	26	44	n.a.	n.a.	51
Estimate from NHMD ^(a)	..	..	..	..	..	..	220	4,038	4,447	408
Total	2,562	2,639	2,919	3,159	3,552	3,686	3,890	4,038	4,447	4,578
Type of surgery										
Repair ^(b)	405	461	477	590	661	602	656	n.a.	n.a.	778
Replacement										
Prosthesis	1,523	1,534	1,778	1,861	2,136	2,355	2,141	n.a.	n.a.	2,168
Allograft ^(c)	83	132	111	108	102	144	140	n.a.	n.a.	165
Xenograft ^(d)	551	512	553	600	653	585	733	n.a.	n.a.	1,059
<i>Total replacement</i>	<i>2,157</i>	<i>2,178</i>	<i>2,442</i>	<i>2,569</i>	<i>2,891</i>	<i>3,084</i>	<i>3,014</i>	n.a.	n.a.	3,392
Estimate from NHMD ^(a)	..	..	..	..	..	..	220	4,038	4,447	408
Total	2,562	2,639	2,919	3,159	3,552	3,686	3,890	4,038	4,447	4,578
Reoperations^(e)										
Tissue valve										
Allograft	..	..	..	..	..	..	12	n.a.	n.a.	26
Bioprosthetic	..	..	..	..	..	..	136	n.a.	n.a.	65
Autograft valve	..	..	..	..	..	..	..	n.a.	n.a.	1
Not specified	111	101	151	191	111	130	..	n.a.	n.a.	..
Mechanical valve	39	32	34	44	37	59	39	n.a.	n.a.	59
Total	150	133	185	235	148	189	187	n.a.	n.a.	151

.. not applicable.

n.a. not available.

(a) From 1995, estimates were made (for non-responding units) from the National Hospital Morbidity Database.

(b) Repair = valvotomy and reconstruction, as in Table 7.

(c) Allograft = homograft.

(d) Xenograft = heterograft.

(e) Not all units gave details on valve reoperations.

Source: AIHW/NHF National Cardiac Surgery Register.

Table 7: Reasons for reoperations^(a) for valve replacement, 1998

Reason for reoperation	Mechanical valves	Tissue valves		
		Bioprosthetic	Allograft	Autograft
		Number (deaths)		
Annular dilation	..	..	..	1 (0)
Degeneration	..	52 (6)	21 (0)	..
Endocarditis	21 (0)	8 (0)	4 (0)	..
Mechanical failure	20 (3)	..	..	..
Paravalvular leak	18 (0)	5 (1)	1 (0)	..
Total	59 (3)	65 (7)	26 (0)	1 (0)

.. not applicable.

(a) Not all units gave details on valve reoperations.

Source: AIHW/NHF National Cardiac Surgery Register.

Table 8: Operations for valve defects by type of valve and procedure, 1998

Valve	Procedure	Congenital		Acquired			Overall total	
		Single	Single	Double	Triple	Total		
				Number (deaths)				
Mitral	Valvotomy	2 (0)	33 (2)	2 (0)	0	35 (2)	37 (2)	
	Reconstruction	with support ring	0	401 (5)	24 (0)	3 (1)	428 (6)	428 (6)
		without ring	0	110 (2)	22 (2)	0	132 (4)	132 (4)
		not specified	34 (1)	0	0	0	0	34 (1)
	Replacement	repair paravalvular leak	0	2 (0)	0	0	2 (0)	2 (0)
		xenograft	0	80 (4)	20 (1)	1 (0)	101 (5)	101 (5)
		prosthesis	5 (1)	590 (24)	161 (6)	11 (0)	762 (30)	767 (31)
mitral allograft		0	28 (0)	0	0	28 (0)	28 (0)	
Aortic	Reconstruction	valvotomy	13 (0)	3 (0)	1 (0)	0	4 (0)	17 (0)
		decalcification	0	9 (0)	1 (0)	0	10 (0)	10 (0)
		for regurgitation	0	8 (0)	4 (0)	0	12 (0)	12 (0)
		other/unstated	10 (1)	3 (0)	3 (0)	0	6 (0)	16 (1)
		repair paravalvular leak	0	2 (0)	0	0	2 (0)	2 (0)
	Replacement	allograft not specified	10 (0)	0	0	0	0	10 (0)
		classical allograft	0	17 (0)	0	1 (0)	18 (0)	18 (0)
		'mini root' allograft	0	43 (2)	0	0	43 (2)	43 (2)
		'mini root' xenograft	0	117 (3)	3 (0)	1 (0)	121 (3)	121 (3)
		stent-mounted xenograft	0	762 (21)	30 (3)	0	792 (24)	792 (24)
		stentless xenograft	0	24 (1)	0	0	24 (1)	24 (1)
		xenograft not specified	1 (0)	4 (1)	0	0	4 (1)	5 (1)
		pulmonary autograft	0	32 (0)	0	0	32 (0)	32 (0)
		prosthesis	9 (0)	1,175 (31)	150 (5)	12 (1)	1,337 (37)	1,346 (37)

(continued)

Table 8 (continued): Operations for valve defects by type of valve and procedure, 1998

Valve	Procedure	Congenital		Acquired			Overall total	
		Single	Single	Double	Triple	Total		
				Number (deaths)				
Tricuspid	Reconstruction	with support ring	0	9 (3)	17 (0)	5 (0)	31 (3)	31 (3)
		without ring	0	11 (0)	24(0)	5 (0)	40 (0)	40 (0)
		not specified	1 (0)	0	0	0	0	1 (0)
	Replacement	xenograft	2 (0)	12 (0)	1 (0)	1 (0)	14 (0)	16 (0)
		allograft	0	0	0	0	0	0
		prosthesis	1 (0)	42 (1)	7 (1)	4 (1)	53 (3)	54 (3)
Pulmonary	Valvotomy	11 (0)	0	0	0	0	11 (0)	
	Reconstruction	2 (0)	4 (0)	0	0	4 (0)	6 (0)	
	Replacement	allograft	31 (0)	1 (0)	0	1 (0)	2 (0)	33 (0)
		xenograft	0	0	0	0	0	0
		prosthesis	0	1 (0)	0	0	1 (0)	1 (0)
Estimate from NHMD ^(a)	..	..	..	..	..	408		
Total valves		132	3,523	470	45	4,038	4,578	
Total patients		132 (3)	3,523 (100)	235 (9)	15 (1)	3,773 (110)	3,905 (113)	

16

.. not applicable.

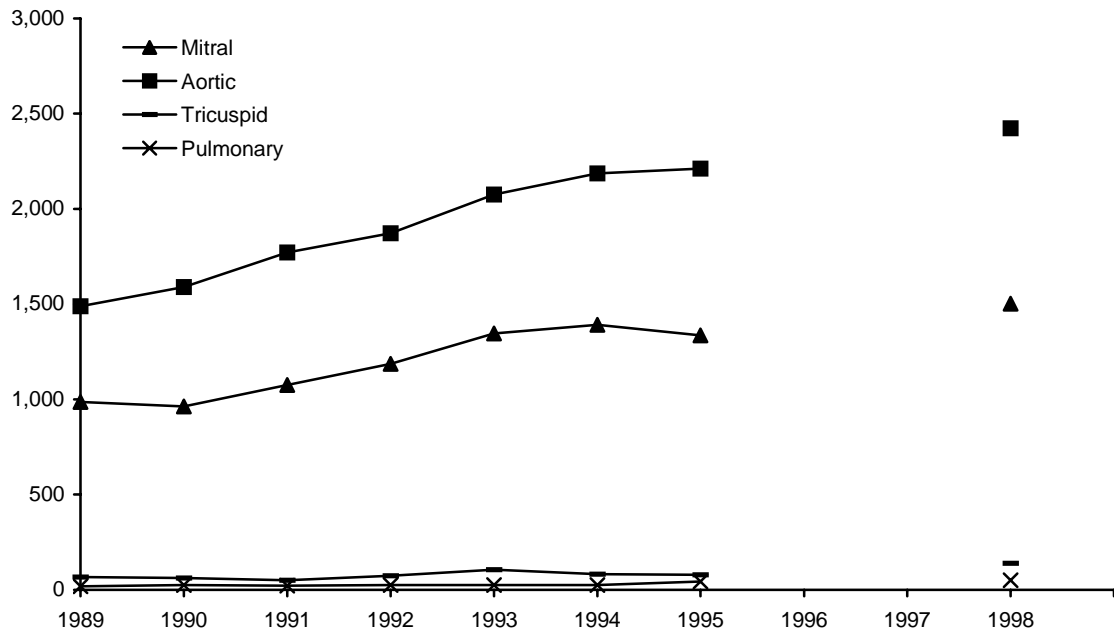
Allograft = homograft.

Xenograft = heterograft.

(a) Estimates were made (for non-responding units) from the National Hospital Morbidity Database.

Sources: AIHW/NHF National Cardiac Surgery Register and National Hospital Morbidity Database.

Number of operations

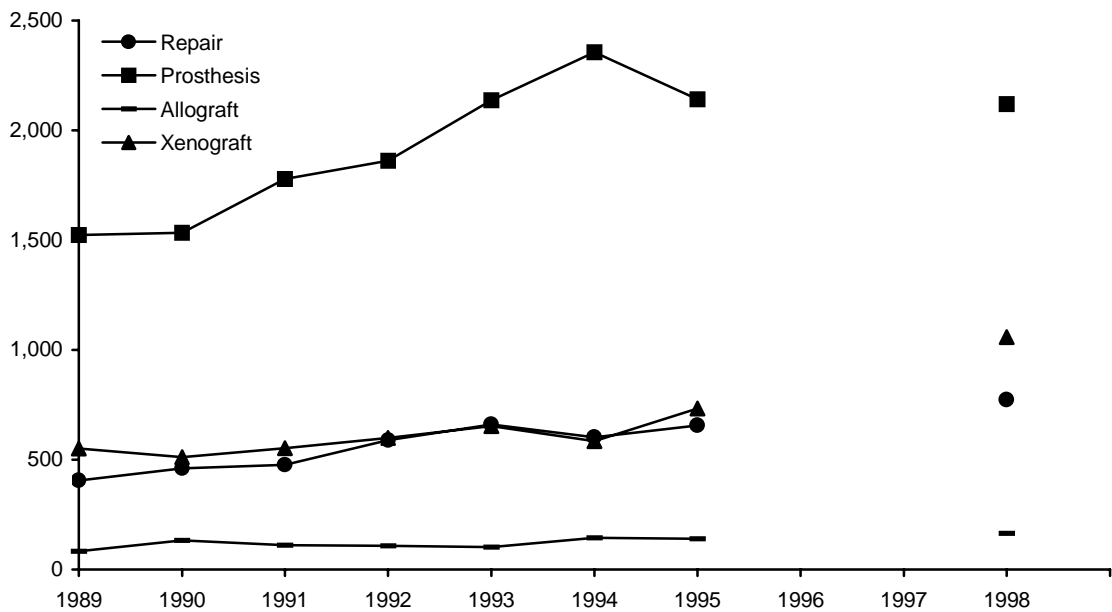


Note: Data available for 92% of procedures in 1994, 90% of procedures in 1995, and 89% of procedures in 1998. Data for 1996 and 1997 are unavailable.

Source: AIHW/NHF National Cardiac Surgery Register.

Figure 3: Valve surgery, 1989–95 and 1998

Number of operations



Notes

1. Data available for 92% of procedures in 1994, 90% of procedures in 1995, and 89% of procedures in 1998. Data for 1996 and 1997 are unavailable.

2. Allograft = homograft, xenograft = heterograft.

Source: AIHW/NHF National Cardiac Surgery Register.

Figure 4: Valve surgery, type of procedure, 1989–95 and 1998

Surgery for coronary artery disease

From the National Hospital Morbidity Database it is estimated that 17,448 coronary artery bypass graft operations were performed in 1998. As noted previously, five out of 50 units did not provide information for 1998 so the National Cardiac Surgery Register contains details of only 14,907 bypass graft operations; they are presented in this section.

The Register covers 14,935 operations for coronary artery disease in 1998: 14,907 with bypass grafts and 28 without. Mortality associated with bypass graft surgery was 2.1%. The average number of grafts per patient was 3.0. The results over the last decade indicate that this average number of grafts has stabilised at around three per patient.

Information on the number of procedures for transmyocardial laser revascularisation (TMLR) was collected for the first time in 1998. This is a new technique where small holes or channels are drilled through the heart muscle (myocardium) using laser energy to improve blood supply to the heart in cases unsuitable for CABG or percutaneous transluminal coronary angioplasty (PTCA). There were 60 TMLR procedures in 1998.

In 1998, 5.9% of coronary artery bypass operations were reoperations. The mortality rate for these reoperations was 5.3%, more than double the mortality rate of CABG surgery overall.

Tables 9 and 10 show numbers of operations with and without concomitant procedures, according to the number of distal anastomoses.

Nearly 3% of CABG procedures involved newer modalities in 1998. These CABG modalities include procedures without cardiopulmonary bypass, CABG via thoracotomy and minimally invasive techniques.

Table 9: Coronary artery bypass graft operations (including operations with concomitant procedures), 1995–98

	1995			1996			1997			1998			
	Number of distal anastomoses	Number of operations	% of total	Deaths	Number of operations	% of total ^(a)	Deaths	Number of operations	% of total ^(a)	Deaths	Number of operations	% of total ^(a)	Deaths
1		1,191	7.9	40	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1,111	7.5	25
2		3,352	22.2	79	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2,908	19.5	81
3		5,180	34.2	110	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	5,003	33.6	102
4		3,825	25.3	82	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	3,720	25.0	62
5		1,279	8.5	26	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1,249	8.4	22
6		256	1.7	4	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	207	1.4	5
7		39	0.3	3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	17	0.1	2
8		2	0.0	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2	0.0	0
9		1	0.0	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0	0.0	0
19 Not specified		n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	690	4.6	21
<i>Subtotal</i>		<i>15,125</i>	<i>100.0</i>	<i>344</i>	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	<i>14,907</i>	<i>100.0</i>	<i>320</i>
Estimate from NHMD ^(b)		2,025	..	n.a.	17,759	..	n.a.	17,377	..	n.a.	2,541	..	n.a.
Total		17,150	..	..	17,759	..	..	17,377	..	..	17,448	..	..
Average number of grafts per patient		3.1			n.a.			n.a.			3.0		
Overall mortality		2.3%			n.a.			n.a.			2.1%		
Reoperations		7.2%			n.a.			n.a.			5.9%		
Newer CABG modalities ^(c)		0.0%			n.a.			n.a.			2.7%		

.. not applicable.

n.a. not available.

(a) Calculated as a proportion of those procedures for which details are available.

(b) Estimates were made (for non-responding units) from the National Hospital Morbidity Database.

(c) Newer CABG modalities include procedures without cardiopulmonary bypass, CABG via thoracotomy and minimally invasive techniques.

Sources: AIHW/NHF National Cardiac Surgery Register and AIHW National Hospital Morbidity Database.

Table 10: Operations for coronary artery disease, 1998

Number of distal anastomoses	Concomitant procedures						Total
	None	Valve surgery	Excision of infarct or aneurysm	Ventricular septal defect	Other	Unspecified	
	Number (deaths)						
1	574 (9)	488 (12)	7 (0)	4 (2)	38 (2)	..	1,111 (25)
2	2,438 (54)	406 (19)	17 (0)	5 (4)	42 (4)	..	2,908 (81)
3	4,606 (82)	327 (15)	22 (1)	1 (0)	47 (4)	..	5,003 (102)
4	3,527 (51)	151 (9)	10 (0)	0	32 (2)	..	3,720 (62)
5	1,204 (19)	29 (1)	3 (1)	0	13 (1)	..	1,249 (22)
6	204 (5)	3 (0)	0	0	0	..	207 (5)
7	17 (2)	0	0	0	0	..	17 (2)
8	2 (0)	0	0	0	0	..	2 (0)
9	0	0	0	0	0	..	0
Unspecified	25 (0)	1 (0)	0	0	2 (0)	662 (21)	690 (21)
<i>Total with grafts</i>	<i>12,597 (222)</i>	<i>1,405 (56)</i>	<i>59 (2)</i>	<i>10 (6)</i>	<i>174 (13)</i>	<i>662 (21)</i>	<i>14,907 (320)</i>
Without grafts	0	0	10 (0)	10 (4)	8 (1)	..	28 (5)
TMLR	..	..	..	..	..	..	60 (9)
Overall total	12,597 (222)	1,405 (56)	69 (2)	20 (10)	182 (14)	662 (21)	14,995 (325)
Reoperations	778 (37)	83 (7)	1 (0)	1 (0)	18 (3)	..	881 (47)
Newer CABG modalities ^(a)	..	..	..	..	..	..	397

20

CABG = coronary artery bypass grafting; TMLR = transmyocardial laser revascularisation.

.. not applicable.

(a) Newer CABG modalities include procedures without cardiopulmonary bypass, CABG via thoracotomy and minimally invasive techniques.

Note: This table shows details only of those procedures for which there is information available. It is estimated that there are an additional 2,541 coronary artery bypass graft operations not included in this table, making the estimated total of coronary artery operations with grafts 17,448.

Source: AIHW/NHF National Cardiac Surgery Register.

Table 11 presents information on the types of graft used in these operations in 1998. Not all units could supply the information, so results have been calculated as percentages of bypass graft operations that involved the use of at least one of the types of graft. The table shows that nearly all bypass graft operations used at least one internal mammary artery graft (81.8%), with saphenous vein graft the next major type at 68.2% and radial artery graft 32.3%.

Between 1994 and 1998, the number of patients having a cephalic vein graft fell by more than a half and those having a saphenous vein graft has declined by almost a third. In comparison there has been an enormous increase (two hundredfold) in the number of patients having a radial artery graft. The number of patients having an internal mammary artery graft has remained steady over this period.

Table 11: Types of grafts used, 1994–95 and 1998

Type of graft	1994		1995		1998	
	Number of patients	Per cent of patients	Number of patients	Per cent of patients	Number of patients	Per cent of patients
Saphenous vein	12,893	91.5	13,034	88.0	9,127	68.2
Internal mammary artery	10,962	77.8	11,971	80.8	10,934	81.8
Cephalic vein	108	0.8	82	0.6	50	0.4
Radial artery	22	0.2	554	3.7	4,320	32.3
Gastro-epiploic artery	9	0.0	1	0.0	4	0.0
Prosthetic or bioprosthetic	3	0.0	4	0.0	4	0.0

Notes

1. Not all units could supply this information, so results have been calculated as percentages of bypass graft operations which involved the use of at least one of the types of graft.
2. Each patient can have more than one type of graft.

Source: AIHW/NHF National Cardiac Surgery Register.

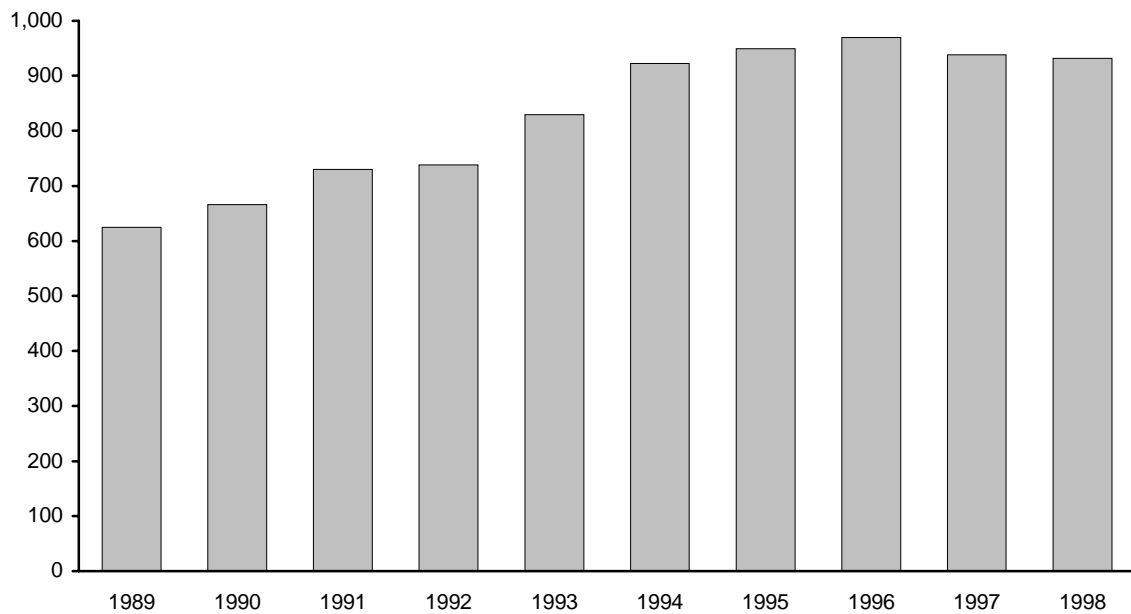
There was a steady increase in the rate of bypass graft surgery in Australia to 1996, with the rate remaining stable since then (Table 12 and Figure 5). The rise is only partly explained by changes in the size and age structure of the population over that period.

Table 12: Rates for coronary artery bypass graft operations (including operations with concomitant procedures), Australia, 1989–98^(a)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Number of operations per million population										
Crude rate	625	666	730	738	829	922	949	970	938	932

(a) Data for 1995 to 1998 are based on estimates from the National Hospital Morbidity Database to provide complete coverage of units nationally.
Source: AIHW National Hospital Morbidity Database.

Rate per million population



Note: Data for 1995 to 1998 are based on estimates from the AIHW National Hospital Morbidity Database to provide complete coverage of units nationally.

Source: AIHW National Hospital Morbidity Database.

Figure 5: Rates for coronary artery bypass graft operations (including operations with concomitant procedures), Australia, 1989–98

Bypass graft surgery by age and sex

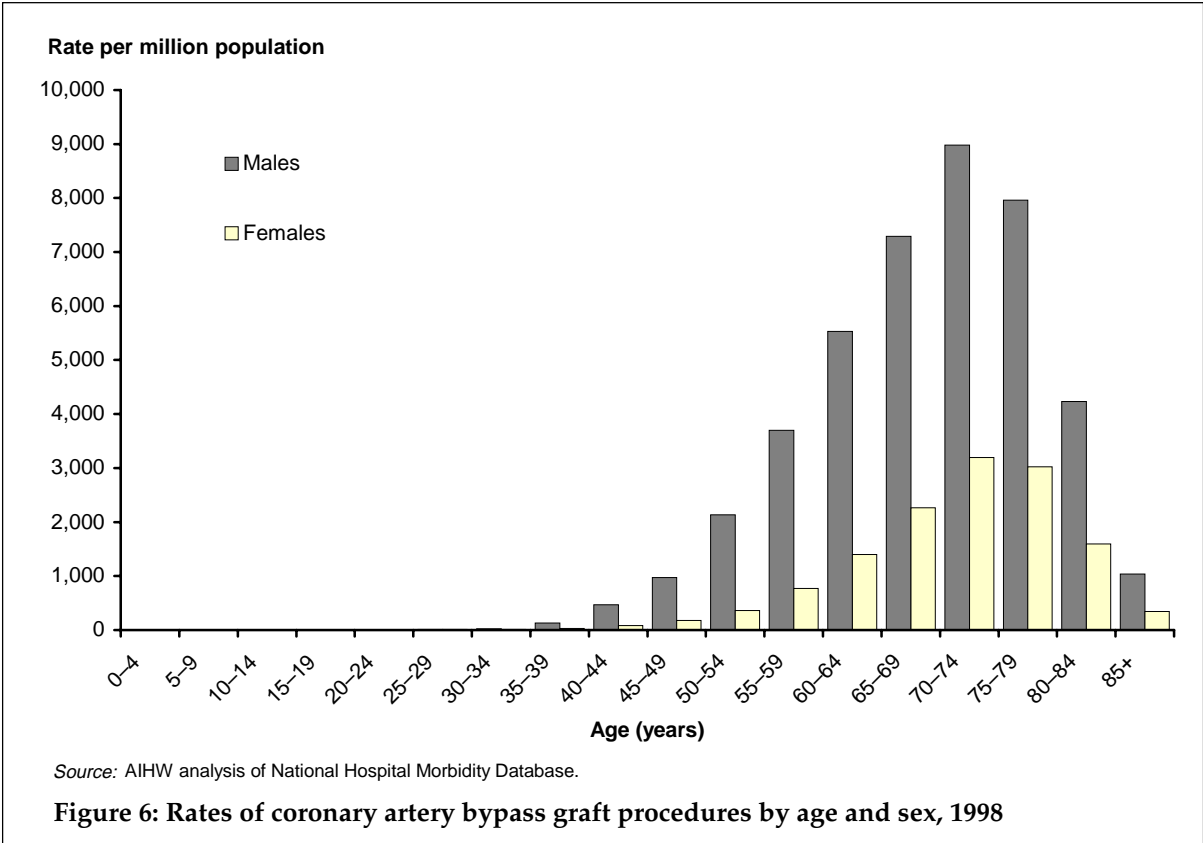
Coronary artery bypass graft surgery in Australia is done more frequently in males than females, at a ratio of about 3:1. The difference in procedure rates between men and women is most marked in the age range 35–54 but is evident across all adult ages (Table 13 and Figure 6). Procedure rates peak at ages 70–74 among both males and females.

Table 13: Coronary artery bypass graft procedures by age and sex, 1998

Age group (years)	Males			Females			Ratio male:female
	Number	Per cent	Age-specific rate per million	Number	Per cent	Age-specific rate per million	
0–4	1	0.0	1.5	1	0.0	1.6	0.9
5–9	0	0.0	0.0	2	0.0	3.1	0.0
10–14	1	0.0	1.5	0	0.0	0.0	..
15–19	0	0.0	0.0	0	0.0	0.0	..
20–24	0	0.0	0.0	0	0.0	0.0	..
25–29	8	0.1	10.9	7	0.2	9.5	1.1
30–34	18	0.1	25.6	10	0.2	14.1	1.8
35–39	99	0.8	132.8	20	0.5	26.7	5.0
40–44	328	2.5	469.7	59	1.4	84.0	5.6
45–49	636	4.8	971.2	117	2.7	180.1	5.4
50–54	1,261	9.6	2,132.9	206	4.8	361.2	5.9
55–59	1,651	12.5	3,701.0	331	7.8	767.7	4.8
60–64	2,041	15.5	5,532.1	518	12.1	1,399.5	4.0
65–69	2,437	18.5	7,290.2	790	18.5	2,265.5	3.2
70–74	2,568	19.5	8,979.3	1,054	24.7	3,194.8	2.8
75–79	1,596	12.1	7,959.2	810	19.0	3,023.3	2.6
80–84	466	3.5	4,233.3	287	6.7	1,594.4	2.7
85+	71	0.5	1,039.6	54	1.3	346.1	3.0
All ages	13,182	100.0	1,414.4	4,266	100.0	453.3	3.1

.. not applicable.

Source: AIHW analysis of the National Hospital Morbidity Database.



Regional rates for bypass graft surgery

The (age-standardised) national rate for coronary artery bypass graft surgery is 879 per million population. This rate varies across States, from 650 per million population in Western Australia to 951 per million population in New South Wales (including the Australian Capital Territory) (Table 14 and Figure 7).

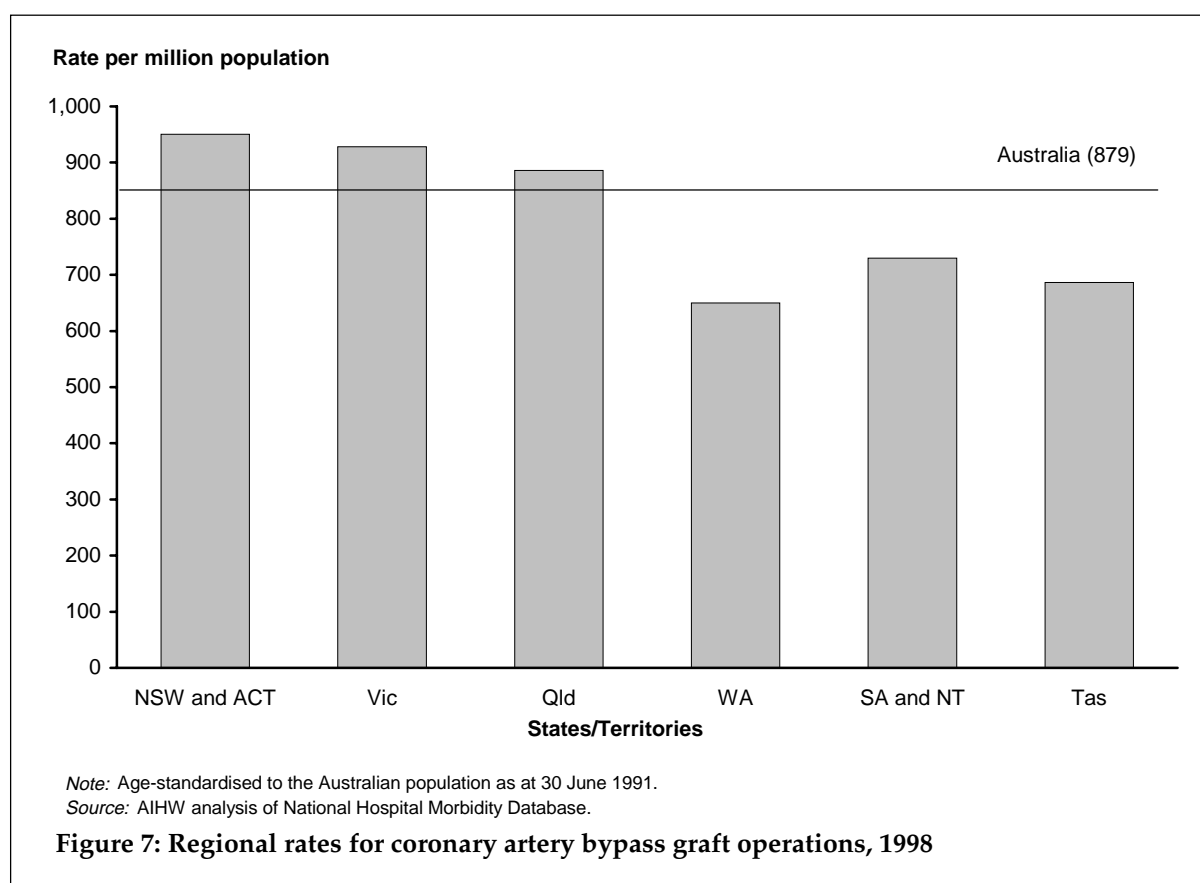
Table 14: Rates for coronary artery bypass graft operations by State, 1998

	NSW and ACT	Vic	Qld	WA	SA and NT	Tas	Australia
Per million population							
Crude rate	1,026	1,008	896	628	796	763	932
Age-standardised rate	951	928	886	650	730	686	879

Notes

1. Age-standardised to the Australian population as at 30 June 1991.
2. Rates have been calculated to include the Australian Capital Territory population with New South Wales and the Northern Territory population with South Australia since those States are where the vast majority of Australian Capital Territory and Northern Territory residents are treated.

Source: AIHW analysis of the National Hospital Morbidity Database.



Transplants

The National Cardiac Surgery Register has full coverage of data on transplants up to 1998. Table 15 shows information on heart, lung and heart–lung transplants performed from 1993 to 1998.

Between 1993 and 1998, the number of heart transplants and heart–lung transplants has decreased while the number of lung transplants has more than doubled.

In 1998, the main reason for a heart transplant was cardiomyopathy (58% of cases). Lung transplants were predominantly whole lung (80% of cases).

Table 15: Transplantation—operations and deaths, 1993–98

	1993	1994	1995	1996	1997	1998
	Number (deaths)					
Heart transplants						
Cardiomyopathy	38 (4)	51 (0)	52 (4)	51 (10)	40 (3)	42 (7)
Ischaemia	37 (1)	33 (4)	41 (4)	24 (1)	31 (3)	23 (2)
Other/unstated	28 (0)	9 (4)	7 (1)	16 (2)	19 (2)	7 (1)
Total	103 (5)	93 (8)	100 (9)	91 (13)	90 (8)	72 (10)
Heart–lung transplants						
Congenital	7 (0)	9 (0)	11 (1)	6 (1)	2 (0)	3 (0)
Other	4 (0)	5 (0)	2 (0)	1 (0)	2 (0)	1 (0)
Total	11 (0)	14 (0)	13 (1)	7 (1)	4 (0)	4 (0)
Lung transplants						
Whole	29 (2)	41 (4)	69 (7)	66 (10)	79 (7)	66 (13)
Lobe	10 (2)	0	0	0	3 (0)	17 (5)
Total	39 (4)	41 (4)	69 (7)	66 (10)	82 (7)	83 (18)

Source: AIHW/NHF National Cardiac Surgery Register.

Operations on the aorta

Operations on the aorta during 1998 are presented in Table 16.

Table 16: Operations on the aorta, 1998

	Acute (dissection)	Chronic (for aneurysm or dissection)	Total
Number (deaths)			
Repair or replacement of ascending aorta			
Aortic repair			
without valve resuspension	25 (4)	16 (2)	
with valve resuspension	8 (0)	13 (1)	
Composite graft replacing aortic valve and ascending aorta	22 (5)	109 (8)	
Allograft replacement of aortic valve and ascending aorta	1 (0)	9 (0)	
Separate aorta and valve replacement	5 (1)	39 (4)	
Total	61 (10)	186 (15)	247 (25)
	For aneurysm	For dissection	Total
Replacement of descending thoracic aorta	37 (5)	8 (2)	45 (7)
Replacement of aortic arch	25 (5)	8 (3)	33 (8)
Total aortic operations			325 (40)

Source: AIHW/NHF National Cardiac Surgery Register.

Other acquired heart conditions

Information on operations and deaths for other acquired heart conditions such as electrophysiological surgery, pulmonary embolectomies, pericardiectomies, cardiac tumours and cardiac trauma is presented in Table 17.

Table 17: Operations for other acquired heart conditions, 1998

Procedures		Number (deaths)
Electrophysiological surgery for:		
Supraventricular tachycardias	Wolff–Parkinson–White Syndrome	2 (0)
	AV junction	1 (0)
	Atrial fibrillation or flutter	1 (0)
	AV node ablation	1 (0)
Ventricular tachycardias	Recurrent ventricular tachycardia	0
	Aneurysmectomy	0
	Myocardial incision	0
	Automatic defibrillator	128 (0)
Total electrophysiological surgery		133 (0)
Cardiac tumour/cardiomyopathy	Myxoma	23 (2)
	Other cardiac tumour	4 (0)
	IHSS	7 (0)
Total cardiac tumour/cardiomyopathy		34 (2)
Cardiac trauma	Atrium	1 (1)
	Ventricle	5 (0)
	Valves	0
	Ascending aorta	1 (0)
	Descending aorta	8 (1)
	Other	0
Total cardiac trauma		15 (2)
Pulmonary embolectomy		8 (2)
Pericardectomy for:	Tuberculosis	1 (0)
	Non-specific infections	10 (0)
	Uraemia	1 (0)
	Other	12 (2)
Total pericardectomy		24 (2)
Other conditions		35 (10)

Source: AIHW/NHF National Cardiac Surgery Register.

Glossary

Allograft valve (homograft): a human valve used for transplantation.

Acquired valve disease: valve disease which is neither genetic nor present at birth.

Anastomosis: connection between blood vessels.

Aortic valve: valve between the left ventricle and the aorta.

Arrhythmia: any abnormality in the heartbeat, making it beat too fast, too slow or irregularly.

Atresia: absence or closure of a normal orifice.

Atrial septal defect: a hole in the wall (septum) between the upper two chambers of the heart (the atria).

Bioprosthetic valves: specially treated pig heart valves and their function approximates closely to that of a normal human valve.

Cardiomyopathy: a disease of the heart muscle.

Cardiopulmonary bypass: diversion of the blood circulation from the heart and lungs and the pumping of blood through a heart–lung machine to provide oxygen while the heart is stopped during surgery.

Coarctation of aorta: congenital narrowing of a short section of the aorta.

Congenital heart defect: heart disorder present at birth.

Coronary artery bypass grafting (CABG): grafting of blood vessel(s) to bypass obstructions in coronary arteries and improve the supply of blood to the heart.

Coronary artery disease: any disease of the coronary arteries, particularly atherosclerosis, that reduces the flow of blood and hence the oxygen supply to the heart muscle.

Ductus arteriosus: special blood vessel in the foetus which allows blood to bypass the lungs.

Ebstein's anomaly: congenital malformation of the tricuspid valve of the heart.

Fibrillation: rapid, uncoordinated quivering of the muscle fibres of the heart instead of beating, so it cannot pump.

Heterograft valve (xenograft): an animal valve used for transplantation.

Homograft valve (allograft): a human valve used for transplantation.

Internal mammary artery: an artery in the chest commonly used as a conduit in coronary artery bypass grafting, that is, used as a graft.

Ischaemic heart disease: heart disease caused by inadequate flow of blood to the heart. Manifestations include angina and heart attack. Also known as coronary heart disease.

Mechanical valves: made of high technology materials such as titanium and pyrolytic carbon. They require lifelong use of anticoagulants (blood thinners) to prevent the adherence of blood clots to the valve mechanism.

Mitral valve: valve between the left atrium and the left ventricle.

Myocardial infarction: death of part of the heart muscle deprived of an adequate blood supply by coronary artery blockage (heart attack).

Myocardium: the muscular wall of the heart.

Newer CABG modalities: alternative procedures to the standard techniques for coronary artery bypass grafting. They include operations done while the heart is beating (that is, without cardiopulmonary bypass) and minimally invasive techniques such as port-access coronary artery surgery. The latter involves making small cuts (ports) in the patient's chest through which surgical instruments are passed to do the coronary bypasses, rather than opening the chest.

Percutaneous transluminal coronary angioplasty (PTCA): a method of treating localised coronary artery narrowing, using a special catheter with a balloon that can be inflated to dilate the narrowed vessel.

Persistent ductus arteriosus (patent ductus arteriosus): a congenital heart defect in which the ductus arteriosus, which during foetal life allows the blood to bypass the lungs, fails to close at or soon after birth.

Pulmonary valve: valve between the right ventricle and the pulmonary artery.

Saphenous vein: a blood vessel in the leg; the most common vessel used as a supply of conduits for coronary artery bypass grafting.

Separation: refers to the episode of care in hospital. It also means the process by which an admitted patient completes an episode of care by being discharged, dying, transferring to another hospital or changing the type of care.

Stenosis: narrowing, such as occurs inside a blood vessel or to the opening of a valve.

Supraventricular tachycardia: episodes of abnormally fast heart rate. This is caused by fast spontaneous impulses, arising in the upper chambers of the heart, that override the natural pacemaker.

Tachycardia: a rapid heart rate.

Tetralogy of Fallot: one of the most common congenital heart diseases. It comprises four defects: narrowing of the main artery to the lungs (pulmonary artery); a hole in the wall between the two lower chambers of the heart; defective positioning of the aorta; and thickening of the right ventricle of the heart.

Transmyocardial laser revascularisation (TMLR): a new technique where small holes or channels are drilled through the myocardium using laser energy to improve blood supply to the heart in cases unsuitable for coronary artery bypass grafting or percutaneous transluminal coronary angioplasty.

Tricuspid valve: valve between the right atrium and the right ventricle.

Truncus arteriosus: a congenital defect where one artery replaces the aortic and pulmonary arteries.

Valvotomy: an operation that opens up a stenosed (unnaturally narrow) heart valve and allows it to function properly.

Ventricular septal defect: a hole in the wall (septum) between the lower two chambers of the heart (the ventricles).

Xenograft valve (heterograft): an animal valve used for transplantation.

Appendix A: Cardiac surgery units

Table A1: Cardiac surgery units operating in 1998

State	Unit
New South Wales	The Hills Private Hospital
	John Hunter Hospital
	Lake Macquarie Private Hospital
	Liverpool Hospital
	The New Children's Hospital
	NSW Private Hospital
	Prince of Wales Hospital
	Prince of Wales Private Hospital
	Royal North Shore Hospital
	Royal Prince Alfred Hospital
	St George Hospital
	St Vincent's Hospital
	St Vincent's Private Hospital
	Strathfield Private Hospital
	Sydney Adventist Hospital
	Sydney Children's Hospital
	Sydney South West Private Hospital
Westmead Hospital	
Victoria	The Alfred Hospital
	Austin Repatriation Medical Centre
	Cabrini Hospital
	Epworth Hospital
	Geelong Private Hospital
	Knox Private Hospital
	Melbourne Private Hospital
	Monash Medical Centre
	Royal Children's Hospital
	Royal Melbourne Hospital
	St Vincent's Private Hospital
	St Vincent's Public Hospital
	Warrigal Private Hospital

(continued)

Table A1 (continued): Cardiac surgery units operating in 1998

State	Unit
Queensland	John Flynn Hospital and Medical Centre
	Mater Misericordiae Hospital
	Prince Charles Hospital
	Princess Alexandra Hospital
	St Andrews War Memorial Hospital
	Townsville General Hospital
	The Wesley Hospital
Western Australia	Fremantle Hospital
	Mount Hospital
	Princess Margaret Hospital for Children
	Royal Perth Hospital
	Sir Charles Gairdner Hospital
South Australia	Ashford Community Hospital
	Flinders Medical Centre
	Royal Adelaide Hospital
	Wakefield Hospital
	Women's and Children's Hospital
Tasmania	Royal Hobart Hospital
Australian Capital Territory	The Canberra Hospital

Appendix B: Data collection form

AUSTRALIAN INSTITUTE OF HEALTH AND WELFARE

CARDIAC SURGERY REGISTER

Annual report form for year ending December 1998

To be completed by

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**CARDIAC SURGERY REGISTER REPORT FORM
FOR OPERATIONS PERFORMED IN 1998**

NAME OF UNIT:

UNIT NUMBER:

CARDIAC SURGEONS IN YOUR UNIT

	1998	
SURGEONS	Names of surgeons	Head of department
		Surgeon responsible for this report
SURGEONS IN TRAINING IN AUSTRALIA*	Names of trainees	Status (i.e. R.A.C.S. approved trainee, service registrar, overseas registrar)
AUSTRALIANS TRAINING OVERSEAS		

* *Please indicate if a foreign national visiting Australia for training.*

MISCELLANEOUS PROCEDURES

List here all procedures not readily fitting into any other section

Only enter here cases that do not fit into the specific categories used on subsequent pages. Please provide as much information as possible on these miscellaneous cases, such as the age of the patients, if the case involves a congenital defect, the number of grafts involved, if it includes coronary artery surgery, and the type of valve used if it is a valve case. If it is not obvious, please indicate whether cardiopulmonary bypass was used or not.

for ACQUIRED DISEASE

PROCEDURE	CLOSED		OPEN	
	No.	D.	No.	D.

for CONGENITAL DEFECTS

PROCEDURE	CLOSED		OPEN	
	No.	D.	No.	D.

Please note: Throughout the form, the column heading 'No.' refers to the total number of operations in the particular category, not only the survivors of the operation. The column heading 'D.' refers to the number of deaths resulting from this total number of operations.

ACQUIRED DISEASE: VALVE SURGERY—SINGLE

	CLOSED	
	No.	D.
MITRAL—Valvotomy		

SINGLE VALVE PROCEDURE	OPEN			
	Without coronary artery graft		With coronary artery graft	
	No.	D.	No.	D.
MITRAL Open mitral valvotomy Reconstruction <i>with support ring</i> <i>without ring</i> Replacement <i>mitral homograft</i> <i>heterograft</i> <i>prosthesis</i>				
AORTIC Valvotomy Reconstruction <i>decalcification</i> <i>for regurgitation</i> <i>other/unstated</i> Replacement <i>pulmonary autograft</i> <i>classical homograft</i> <i>'mini root' homograft</i> <i>stent-mounted heterograft</i> <i>'mini root' heterograft</i> <i>prosthesis</i>				
TRICUSPID Reconstruction <i>with support ring</i> <i>without ring</i> Replacement <i>heterograft</i> <i>prosthesis</i>				
PULMONARY Reconstruction Replacement* <i>homograft</i> <i>heterograft</i> <i>prosthesis</i>				
TOTAL NUMBER OF PATIENTS				

* *In case of valve replacement using pulmonary autograft, please indicate the pulmonary replacement as an attached note. This will not be included as a double valve.*

ACQUIRED DISEASE: VALVE SURGERY—DOUBLE

DOUBLE VALVE PROCEDURE			OPEN			
			Without coronary artery graft		With coronary artery graft	
			No.	D.	No.	D.
MITRAL	Valvotomy					
	Reconstruction	<i>with support ring</i>				
		<i>without ring</i>				
	Replacement	<i>mitral homograft</i>				
		<i>heterograft prosthesis</i>				
AORTIC	Valvotomy					
	Reconstruction	<i>decalcification for regurgitation</i>				
		<i>other/unstated</i>				
	Replacement	<i>pulmonary autograft</i>				
		<i>classical homograft</i>				
		<i>'mini root' homograft</i>				
		<i>stent-mounted heterograft</i>				
		<i>'mini root' heterograft prosthesis</i>				
	TRICUSPID	Reconstruction	<i>with support ring</i>			
<i>without ring</i>						
Replacement		<i>heterograft</i>				
		<i>prosthesis</i>				
TOTAL NUMBER OF VALVES*						
TOTAL NUMBER OF PATIENTS						

* *By individual valves. As each patient has operations on two valves, the total number and total deaths must each add up to twice the number shown for total patients.*

ACQUIRED DISEASE: VALVE SURGERY—TRIPLE

TRIPLE VALVE PROCEDURE			OPEN			
			Without coronary artery graft		With coronary artery graft	
			No.	D.	No.	D.
MITRAL	Valvotomy					
	Reconstruction	<i>with support ring</i>				
		<i>without ring</i>				
	Replacement	<i>mitral homograft</i>				
		<i>heterograft prosthesis</i>				
AORTIC	Valvotomy					
	Reconstruction	<i>decalcification</i>				
		<i>for regurgitation</i>				
		<i>other/unstated</i>				
	Replacement	<i>pulmonary autograft</i>				
		<i>classical homograft</i>				
		<i>'mini root' homograft</i>				
		<i>'mini root' valve replacement</i>				
		<i>stent-mounted heterograft</i>				
		<i>'mini root' heterograft prosthesis</i>				
	TRICUSPID	Reconstruction	<i>with support ring</i>			
<i>without ring</i>						
Replacement		<i>heterograft</i>				
		<i>prosthesis</i>				
TOTAL NUMBER OF VALVES*						
TOTAL NUMBER OF PATIENTS						

* *By individual valves. As each patient has operations on three valves, the total number and total deaths must each add up to three times the number shown for total patients.*

ACQUIRED DISEASE: VALVE SURGERY RE-OPERATIONS

Some of the valve patients reported on pages 36, 37 and 38 will be having their second valve replacement. Please indicate the number of <i>valves</i> (not patients) replaced for:		
	No.	D.
MECHANICAL VALVES	Mechanical failure	
	Endocarditis	
	Paravalvular leak	
BIOPROSTHETIC VALVES	Degeneration	
	Endocarditis	
	Paravalvular leak	
ALLOGRAFT VALVES	Degeneration	
	Endocarditis	
	Paravalvular leak	

SURGERY FOR ACQUIRED CORONARY HEART DISEASE

OPEN AND CLOSED—WITH GRAFTS												
Number of distal anastomoses	No other procedure		With valve surgery		With myocardial resection or plication		With repair of VSD		With other procedures		Total	
	No.	D.	No.	D.	No.	D.	No.	D.	No.	D.	No.	D.
1.												
2.												
3.												
4.												
5.												
6.												
7.												
8.												
9.												
TOTAL			**									
Reoperations for coronary artery disease*												

* Please make sure that the re-operations are also included in the main part of the table.

** Please check that this total is the same as the total number of patients reported on pages 36, 37 & 38 as having coronary artery grafts as well as valve surgery.

SURGERY FOR ACQUIRED CORONARY HEART DISEASE (cont.)

TYPE OF GRAFT

Please enter here how many of your patients had one of the following used as at least one of their grafts, so that we can calculate the use of each. Please report the number of *patients*, not grafts.

	No. of patients
Saphenous vein	
Internal mammary artery	
Inferior epigastric artery	
Gastroepiploic artery	
Cephalic vein	
Radial artery	
Prosthetic or bioprosthetic	

SURGERY FOR ACQUIRED CORONARY HEART DISEASE WITHOUT GRAFTS

Open	Myocardial resection or plication		Closure of VSD		Other		Total	
	No.	D.	No.	D.	No.	D.	No.	D.
Without grafts								

NON-CONVENTIONAL CABG

Some of the procedures already reported on pages 40 and 41 may have been done without CPB or using other non-conventional techniques. Please indicate here their number.

	No. procedures
Without CPB	
Minimally invasive techniques	
CABG via thoracotomy	

ACQUIRED DISEASE: GREAT VESSEL SURGERY

REPAIR OR REPLACEMENT OF ASCENDING AORTA			OPEN			
			Without Coronary artery graft		With coronary artery graft	
			No.	D.	No.	D.
Acute (dissection)	aortic repair	without valve resuspension				
	aortic repair	with valve resuspension				
	*composite graft replacing aortic valve and ascending aorta					
	*homograft replacement of aortic valve and ascending aorta					
	*separate aorta and valve replacement					
Chronic (for aneurysm or dissection)	aortic repair	without valve resuspension				
	aortic repair	with valve resuspension				
	*composite graft replacing aortic valve and ascending aorta					
	*homograft replacement of aortic valve and ascending aorta					
	*separate aorta and valve replacement					
TOTAL						

* *These cases should **not** be included under valve surgery.*

REPLACEMENT OF AORTIC ARCH		OPEN			
		Without coronary artery graft		With coronary artery graft	
		No.	D.	No.	D.
for aneurysm					
for dissection					
TOTAL					

REPLACEMENT OF DESCENDING THORACIC AORTA		CLOSED		OPEN	
		No.	D.	No.	D.
for aneurysm					
for dissection					
TOTAL					

If hemi-arch replacement is part of any of the above procedures, please indicate this in a footnote or attachment.

ACQUIRED DISEASE: OTHER CONDITIONS

TRANSPLANTATION		NO.	DEATHS
Cardiac	cardiomyopathy		
	ischaemia		
	other/unstated		
Heart–lung	congenital		
	other/unstated		
Lung	whole		
	lobe		

		OPEN			
		Without coronary artery graft		With coronary artery graft	
		No.	D.	No.	D.
ELECTROPHYSIOLOGICAL SURGERY					
SUPRAVENTRICULAR TACHYCARDIAS	Wolff–Parkinson–White Syndrome				
	AV junction				
	Atrial fibrillation or flutter				
	AV node ablation				
VENTRICULAR TACHYCARDIAS	Recurrent ventricular tachycardia				
	—aneurysmectomy				
	—myocardial incision				
CARDIAC TUMOUR/ CARDIOMYOPATHY	myxoma				
	other cardiac tumour				
	IHSS				
TOTAL					

		CLOSED		OPEN	
		No.	D.	No.	D.
AUTOMATIC DEFIBRILLATOR	Patches				
	Transvenous				

ACQUIRED DISEASE: OTHER CONDITIONS (cont.)

		CLOSED		OPEN without grafts	
		No.	D.	No.	D.
CARDIAC TRAUMA	atrium				
	ventricle				
	valves				
	ascending aorta				
	descending aorta				
	other				
PULMONARY EMBOLCTOMY					
PERICARDIECTOMY FOR	tuberculosis				
	non-specific infection				
	uraemia				
	other				
OTHER CONDITIONS	please list				
TOTAL					

* *These cases **should not be** included under valve surgery.*

TOTAL PATIENTS : ACQUIRED DISEASE	OPEN				CLOSED	
	WITHOUT GRAFTS		WITH GRAFTS			
	No.	D.	No.	D.	No.	D.

CONGENITAL DEFECTS: VALVE SURGERY

	CLOSED		
	No.	D.	Age
MITRAL—valvotomy			
PULMONARY—valvotomy			

SINGLE VALVE PROCEDURE		Under 1 Month		1–6 Months		Over 6 Months	
		No.	D.	No.	D.	No.	D.
OPEN							
MITRAL	Valvotomy						
	Reconstruction						
	Replacement <i>heterograft</i>						
	<i>prosthesis</i>						
AORTIC	Valvotomy						
	Reconstruction						
	Replacement <i>homograft</i>						
	<i>heterograft</i>						
<i>prosthesis</i>							
TRICUSPID	Valvotomy						
	Reconstruction						
	Replacement <i>heterograft</i>						
	<i>prosthesis</i>						
PULMONARY	Valvotomy						
	Reconstruction						
	Replacement <i>homograft</i>						
	<i>heterograft</i>						
<i>prosthesis</i>							
TOTAL NUMBER OF PATIENTS							

CONGENITAL DEFECTS: OTHER COMMON CONDITIONS

	Under 1 Month				1-6 Months				Over 6 Months			
	Closed		Open		Closed		Open		Closed		Open	
	No.	D.	No.	D.	No.	D.	No.	D.	No.	D.	No.	D.
Persistent ductus arteriosus												
Coarctation of aorta												
Simple												
Complicated												
Atrial septal defect												
Ventricular septal defect												
Uncomplicated <i>palliative</i>												
<i>corrective</i>												
With PS <i>palliative</i>												
<i>corrective</i>												
With pulmonary atresia <i>palliative</i>												
<i>corrective</i>												
Tetralogy of Fallot												
Simple <i>palliative</i>												
<i>corrective</i>												
Complicated <i>palliative</i>												
<i>corrective</i>												
Acquired pulmonary atresia <i>palliative</i>												
<i>corrective</i>												
TOTALS (this page)												

Please note: Please be careful to put the cases in the correct columns, indicating whether they were done using the open or closed technique.

CONGENITAL DEFECTS: OTHER COMMON CONDITIONS (cont.)

	Under 1 Month				1-6 Months				Over 6 Months			
	Closed		Open		Closed		Open		Closed		Open	
	No.	D.	No.	D.	No.	D.	No.	D.	No.	D.	No.	D.
Transposition of great vessels												
With intact ventricular septum												
<i>palliative</i>												
<i>corrective</i>												
With VSD												
<i>palliative</i>												
<i>corrective</i>												
With other significant anomaly												
<i>palliative</i>												
<i>corrective</i>												
With inversion of ventricles*												
<i>palliative</i>												
<i>corrective</i>												
Corrected transposition & other significant anomaly												
<i>palliative</i>												
<i>corrective</i>												
TOTALS (this page)												

* Formerly 'corrected transposition with VSD'.

Please note: Please be careful to put the cases in the correct columns, indicating whether they were done using the open or closed technique.

CONGENITAL DEFECTS: LESS COMMON CONDITIONS

	Under 1 Month				1-6 Months				Over 6 Months			
	Closed		Open		Closed		Open		Closed		Open	
	No.	D.	No.	D.	No.	D.	No.	D.	No.	D.	No.	D.
EXTRA-CARDIAC LESIONS A-P window Interrupted aortic arch Vascular ring												
CORONARY ARTERY DEFECTS												
MISCELLANEOUS Total anomalous pulmonary venous return <i>palliative</i> <i>corrective</i>												
Asplenia syndrome <i>palliative</i> <i>corrective</i>												
Exploration only Surgical procedures for other conditions (please specify)												
TOTALS (this page)												

Please note: Please be careful to put the cases in the correct columns, indicating whether they were done using the open or closed technique.

CONGENITAL DEFECTS: LESS COMMON CONDITIONS (cont.)

	Under 1 Month				1-6 Months				Over 6 Months			
	Closed		Open		Closed		Open		Closed		Open	
	No.	D.	No.	D.	No.	D.	No.	D.	No.	D.	No.	D.
RIGHT SIDED LESIONS												
Ebstein's anomaly <i>palliative</i>												
<i>corrective</i>												
Tricuspid atresia <i>palliative</i>												
<i>corrective</i>												
Pulmonary atresia (with intact septum) <i>palliative</i>												
<i>corrective</i>												
LEFT SIDED LESIONS												
Cor triatrium <i>palliative</i>												
<i>corrective</i>												
Mitral atresia												
Hypoplastic left heart syndrome												
Subaortic stenosis												
Supravalvular stenosis												
TOTALS (this page)												

Please note: Please be careful to put the cases in the correct columns, indicating whether they were done using the open or closed technique.

CONGENITAL DEFECTS: LESS COMMON CONDITIONS (cont.)

	Under 1 Month				1-6 Months				Over 6 Months			
	Closed		Open		Closed		Open		Closed		Open	
	No.	D.	No.	D.	No.	D.	No.	D.	No.	D.	No.	D.
DEFECTS OF PARTITIONING												
AV Canal—partial <i>palliative</i>												
<i>corrective</i>												
AV Canal—total <i>palliative</i>												
<i>corrective</i>												
Double outlet RV <i>palliative</i>												
<i>corrective</i>												
Truncus arteriosus <i>palliative</i>												
<i>corrective</i>												
Other (please specify)												
TOTALS (this page)												
TOTAL PATIENTS : CONGENITAL DEFECTS (pages 45 to 50)												

Please note: *Please be careful to put the cases in the correct columns, indicating whether they were done using the open or closed technique.*

Related publications

Australian Institute of Health and Welfare (AIHW) 2000. Australia's health 2000: the seventh biennial health report of the Australian Institute of Health and Welfare. AIHW Cat. No. 19. Canberra: AIHW.

Australian Institute of Health and Welfare (AIHW) 2000. Australian hospital statistics 1998–1999. Health Services Series No. 15. AIHW Cat. No. HSE 11. Canberra: AIHW.

Australian Institute of Health and Welfare (AIHW) 1999. Australian hospital statistics 1997–1998. Health Services Series No. 12. AIHW Cat. No. HSE 6. Canberra: AIHW.

Australian Institute of Health and Welfare (AIHW) 2001. Heart, stroke and vascular diseases: Australian facts 2001. Canberra: AIHW, National Heart Foundation of Australia, National Stroke Foundation.

Davies J & Senes S 2001. Coronary angioplasty in Australia 1998. Cardiovascular Disease Series No. 15. AIHW Cat. No. CVD 14. Canberra: AIHW.

Senes-Ferrari S 1999. Cardiac surgery in Australia 1994. Cardiovascular Disease Series No. 9. AIHW Cat. No. CVD 6. Canberra: AIHW.

Senes-Ferrari S 1999. Coronary angioplasty in Australia 1995. Cardiovascular Disease Series No. 8. AIHW Cat. No. CVD 5. Canberra: AIHW.

Senes S & Davies J 1999. Cardiac surgery in Australia 1995. Cardiovascular Disease Series No. 11. AIHW Cat. No. CVD 8. Canberra: AIHW.

Senes S & Davies J 1999. Coronary angioplasty in Australia 1996. Cardiovascular Disease Series No. 12. AIHW Cat. No. CVD 9. Canberra: AIHW.

Waters A-M, Armstrong T & Senes-Ferrari S 1998. Medical care of cardiovascular disease in Australia. Cardiovascular Disease Series No. 7. AIHW Cat. No. CVD 4. Canberra: AIHW.

AIHW web site

Information relating to cardiovascular disease, its treatment and risk factors can be found on the Cardiovascular Health portal and the National Cardiovascular Disease Database, both located on the Institute's web site <http://www.aihw.gov.au>