

Thoracic and cardiovascular surgery in Japan during 2011

Annual report by The Japanese Association for Thoracic Surgery

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The Japanese Association for Thoracic Surgery has conducted annual surveys of thoracic surgery throughout Japan since 1986 to determine the statistics regarding the number of procedures according to the operative category. Here, we have summarized the results from our annual survey of thoracic surgery performed during 2011.

The incidence of hospital mortality was added to the survey to determine the nationwide status, which can be useful not only for surgeons, who can better compare their work with that of others, but also for the Association, which can gain a better understanding of present problems as well as future prospects. Thirty-day mortality (some-

times termed “operative mortality”) is death within 30 days of an operation regardless of the patient’s geographic location and even though the patient had been discharged from the hospital within those 30 days.

Hospital mortality is death within any time interval after an operation if the patient had not been discharged from the hospital. Hospital-to-hospital transfer is not considered discharge; transfer to a nursing home or a rehabilitation unit is considered hospital discharge unless the patient subsequently dies of complications of the operation. (The definitions of terms are based on the published guidelines of the Ad Hoc Liaison Committee for Standardizing Definitions of Prosthetic Heart Valve Morbidity of the Society of Thoracic Surgeons and the American Association for Thoracic Surgery (Edmunds et al. *Ann Thorac Surg* 1996;62:932–5; *J Thorac Cardiovasc Surg* 1996;112:708–11).

Thoracic surgery was classified into three categories—cardiovascular, general thoracic, and esophageal surgery—and the pertinent data were examined and analyzed for each group. Access to the computerized data is offered to all members of this Association. We honor and value your continued kind support and contributions (Tables 1, 2).

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Abstract of the survey

We sent out survey questionnaire forms to the departments of each category in all 1,952 institutions nationwide in early April 2012. The response rates in each category by the end of December 2012 were 96.4, 95.6, and 93.3 % for cardiovascular, general thoracic, and esophageal surgery, respectively.

Table 1 Questionnaires sent out and received back by the end of December 2010

	Sent out	Returned	Response rate (%)
(A) Cardiovascular surgery	591	570	96.4
(B) General thoracic surgery	790	755	95.6
(C) Esophageal surgery	571	533	93.3

Table 2 Categories subclassified according to the number of operations performed

Number of operations performed	Category	
	Cardiovascular surgery	General thoracic surgery
0	41	22
1–24	45	96
25–49	102	97
50–99	157	191
100–149	98	153
150–199	47	90
≥200	80	106
Total	570	755

Number of operations performed	Esophageal surgery
0	77
1–4	150
5–9	104
10–19	80
20–29	45
30–39	27
40–49	10
≥50	40
Total	533

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(A) Cardiovascular surgery

First, we are very pleased with the high response rate to our survey of cardiovascular surgery (96.4 %), which definitely enhances the quality of this annual report. We very much appreciate the enormous effort put into completing the survey at each participating institution.

Figure 1 shows the development of cardiovascular surgery in Japan over the last 26 years. Aneurysm surgery includes only operations for thoracic or thoracoabdominal aortic aneurysms. The number of pacemaker and assist device implantation operations is not included in the total number of surgical operations. A total of 60,284 cardiovascular operations were performed at 570 institutions during 2011 alone and included 31 cardiac transplantations, which were started in 1999. The number of operations for thoracic aortic aneurysm consistently increased, by 11.1 %, and that for valvular heart disease also increased, by 2.4 %, compared with 2010. Surgery for congenital heart disease slightly increased, by 3.1 %. By contrast, the number of operations for ischemic heart disease decreased by 8.0 % in 2011 compared with 2010.

Data for individual categories are summarized in Tables 1, 2, 3, 4, 5, 6, 7. In 7,435 open-heart operations performed for congenital heart disease, the overall hospital mortality was 2.4 %, which has varied little since 2005. Mitral valve repair constituted 29.2 % of all valvular heart disease operations (19,164), which is similar to that of the last 3 years. Aortic valve replacement with a bioprosthesis was performed in 7,531 cases, with the number consistently increasing. The hospital mortality rates associated with primary single valve replacement were 2.9 and 5.8 % for aortic and mitral valve replacement, respectively, while that for primary mitral valve repair was 1.5 %. However, hospital mortality rates for redo valve surgery were 8.4 and 7.6 % for aortic and mitral procedures, respectively.

Isolated coronary artery bypass grafting (CABG) was performed in 14,256 cases which is a decrease of 8.2 % compared with 15,521 in 2010.

The operative and hospital mortality rates associated with primary elective CABG procedures in 11,977 cases were 0.7 and 1.1 %, respectively. However, hospital mortality of primary emergency CABG in 2,236 cases was 7.6 %, which was still high. Off-pump coronary bypass grafting (OPCAB) was performed in 8,680 cases, constituting 60.9 % of the total isolated CABG procedures. The percentage of OPCAB cases among the total isolated CABG procedures has been at the same level since 2005.

A total of 1,321 patients underwent surgery for complications of myocardial infarction, including 362 operations for a left ventricular aneurysm or infarction and 316

operations for ischemic mitral regurgitation. Operations for thoracic aortic dissection were performed in 6,013 cases. For 3,839 type A acute aortic dissections, hospital mortality was 11.1 %, which was similar to that in 2010 (11.1 %). Operations for a nondissected thoracic aneurysm were carried out in 8,203 cases, with an overall hospital mortality of 6.7 %, which was same level as 6.3 % in 2010. The hospital mortality associated with unruptured aneurysms was 3.9 %, and that for ruptured aneurysms was 22.2 %, which remains markedly high.

The number of stent graft procedures remarkably increased. A total of 758 patients with aortic dissection underwent stent graft placement: transluminal stent

grafting (TEVAR) in 590 cases, open stent grafting in 137 cases. The hospital mortality rates associated with TEVAR for type B aortic dissection were 7.7 and 1.1 %, for acute and chronic cases, respectively. A total of 3,972 patients with a nondissected aortic aneurysm underwent stent graft placement. The hospital mortality rates for TEVAR were 2.6 and 16.3 % for nonruptured and ruptured aneurysms, respectively.

In summary, the total cardiovascular operations increased during 2011 by 814 cases, with steadily improving results in almost all categories compared with those in 2010.

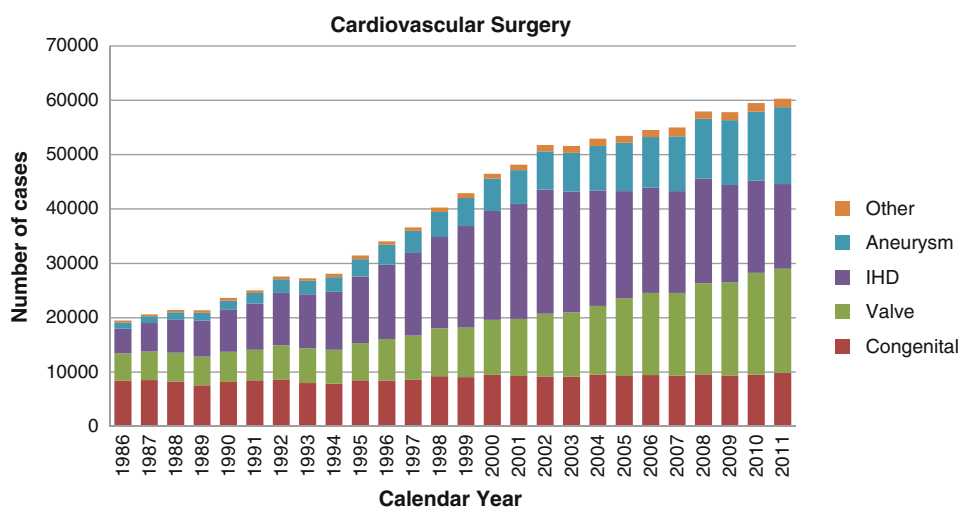


Fig. 1 General thoracic surgery, IHD, ischemic heart disease

Table 1 Congenital (total; 9,858)
(1) CPB (+) (total; 7,435)

	Neonate				Infant				1–17 years				≥18 years				Total					
	Cases		Hospital mortality		Cases		Hospital mortality		Cases		Hospital mortality		Cases		Hospital mortality		Cases		Hospital mortality			
	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge		
1 PDA	8	7 (87.5)	0	0	2	0	0	0	3	0	0	0	21	1 (4.8)	0	0	34	8 (23.5)	0	0	8 (23.5)	0
2 Coarctation (simple)	8	0	0	0	4	0	0	0	5	0	0	0	9	0	0	0	26	0	0	0	0	0
3 +VSD	43	1 (2.3)	1 (2.3)	1 (2.2)	46	1 (2.2)	1 (2.2)	1 (2.2)	9	0	0	0	3	0	0	0	101	2 (2.0)	0	0	2 (2.0)	0
4 +DORV	5	0	1 (20.0)	0	3	0	0	0	3	0	0	0	0	0	0	0	11	0	0	0	0	1 (9.1)
5 +AVSD	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
6 +TGA	4	0	0	2 (50.0)	2	1 (50.0)	1 (50.0)	0	0	0	0	0	0	0	0	0	6	1 (16.7)	0	0	1 (16.7)	0
7 +SV	12	0	1 (8.3)	0	12	0	0	0	2	0	0	0	0	0	0	0	26	0	0	0	0	1 (3.8)
8 +Others	7	1 (14.3)	1 (14.3)	0	12	0	0	0	3	0	0	0	0	0	0	0	22	1 (4.5)	0	0	1 (4.5)	0
9 Interrupt. of Ao (simple)	1	1 (100.0)	1 (100.0)	0	2	0	0	0	1	0	0	0	0	0	0	0	4	1 (25.0)	0	0	1 (25.0)	0
10 +VSD	21	0	0	1 (5.0)	20	1 (5.0)	1 (5.0)	0	6	0	0	0	0	0	0	0	47	1 (2.1)	0	0	1 (2.1)	0
11 +DORV	5	1 (20)	2 (40.0)	0	4	0	0	0	1	0	0	0	0	0	0	0	10	1 (10.0)	0	0	2 (20.0)	0
12 +Truncus	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
13 +TGA	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
14 +Others	7	1 (14.3)	1 (14.3)	1 (20.0)	5	1 (20.0)	1 (20.0)	0	3	0	0	0	0	0	0	0	15	2 (13.3)	0	0	2 (13.3)	0
15 Vascular ring	0	0	0	0	3	0	0	0	6	0	0	0	0	0	0	0	9	0	0	0	0	0
16 PS	0	0	0	0	13	0	0	0	23	0	0	0	9	0	0	0	45	0	0	0	0	0
17 PA IVS or critical PS	16	1 (6.3)	1 (6.3)	1 (2.2)	46	1 (2.2)	2 (4.3)	0	75	1 (1.3)	1 (1.3)	1 (1.3)	6	0	0	0	143	3 (2.1)	0	0	4 (2.8)	0
18 TAPVR	102	9 (8.8)	12 (11.8)	0	82	0	1 (1.2)	0	7	0	0	0	1	0	0	0	192	9 (5)	0	0	13 (7)	0
19 PAPVR ± ASD	3	0	0	0	7	0	0	0	53	0	0	0	22	0	0	0	85	0	0	0	0	1 (1.2)
20 ASD	27	0	0	0	81	0	0	1 (0.2)	616	1 (0.2)	1 (0.2)	1 (0.2)	639	1 (0.2)	0	0	1,363	2 (0.1)	1 (0.07)	1 (0.07)	2 (0.1)	0
21 Cor triatriatum	1	0	0	0	9	0	0	0	10	0	0	0	2	0	0	0	22	0	0	0	0	1 (4.5)
22 AVSD (partial)	1	0	0	0	8	0	0	0	57	0	0	0	11	0	0	0	77	0	0	0	0	0
23 AVSD (complete)	4	0	0	3 (75.0)	115	3 (2.6)	4 (3.5)	0	74	1 (1.4)	1 (1.4)	1 (1.4)	2	0	0	0	195	4 (2.1)	0	0	5 (2.6)	0
24 +TOF or DORV	1	0	1 (100.0)	2 (22.2)	9	2 (22.2)	2 (22.2)	0	18	0	0	1 (5.6)	0	0	0	0	28	2 (7.1)	0	0	4 (14.3)	0
25 +Others	2	1 (50.0)	1 (50.0)	0	12	0	0	0	18	2 (11.1)	2 (11.1)	2 (11.1)	1	0	0	0	33	3 (9.1)	0	0	3 (9.1)	0
26 VSD (subbacterial)	3	0	0	0	92	0	0	0	239	0	0	0	37	0	0	0	371	0	0	0	0	0
27 VSD (perimemb./muscular)	14	0	0	3 (0.3)	868	3 (0.3)	5 (0.6)	0	426	0	0	5 (0.6)	82	0	0	0	1,390	3 (0.2)	0	0	5 (0.4)	0
28 VSD + PS	0	0	0	0	10	0	0	0	18	0	0	0	3	0	0	0	31	0	0	0	0	0
29 DCRV ± VSD	0	0	0	0	16	0	0	0	48	0	0	0	15	0	0	0	79	0	0	0	0	0
30 Aneurysm of sinus valsalva	2	0	0	0	7	0	0	0	4	0	0	0	24	0	0	0	37	0	0	0	0	0
31 TOF	9	0	0	0	185	0	0	0	189	0	0	2 (1.1)	20	1 (5.0)	0	0	403	1 (0.2)	0	0	3 (0.7)	0
32 PA + VSD	6	0	0	1 (1.8)	57	2 (3.5)	4 (7.0)	0	123	1 (0.8)	1 (0.8)	1 (0.8)	3	0	0	0	189	3 (1.6)	1 (0.5)	5 (2.6)	5 (2.6)	0
33 DORV	12	2 (16.7)	2 (16.7)	4 (3.9)	102	4 (3.9)	4 (3.9)	0	147	1 (0.7)	1 (0.7)	1 (0.7)	11	0	0	0	272	7 (2.6)	0	0	8 (2.9)	0

Table 1 continued

	Neonate			Infant			1–17 years			≥18 years			Total			
	Cases	30-day mortality		Cases	30-day mortality		Cases	30-day mortality		Cases	30-day mortality		Cases	30-day mortality		
		Hospital	After discharge		Hospital	After discharge		Hospital	After discharge		Hospital	After discharge		Hospital	After discharge	Hospital
34 TGA (simple)	108	2 (1.9)	1 (9.1)	11	1 (9.1)	1 (9.1)	3	0	0	0	0	0	122	3 (2.5)	0	3 (2.5)
35 +VSD	33	2 (6.1)	0	17	0	0	5	0	0	1	0	0	56	2 (3.6)	0	2 (3.6)
36 VSD + PS	2	0	0	16	0	0	20	0	0	3	0	0	41	0	0	0
37 Corrected TGA	2	0	0	8	0	0	50	0	0	9	0	0	69	0	0	0
38 Truncus arteriosus	1	0	0	19	0	0	15	0	0	2	0	0	37	0	0	0
39 SV	32	5 (15.6)	6 (18.8)	228	3 (1.3)	8 (3.5)	271	2 (0.7)	1 (0.4)	8 (3.0)	2 (10.0)	2 (10.0)	551	12 (2.2)	1 (0.2)	24 (4.4)
40 TA	6	0	0	48	0	1 (2.1)	75	1 (1.3)	2 (2.7)	19	0	0	148	1 (0.7)	0	3 (2.0)
41 HLHS	56	7 (12.5)	14 (25.0)	117	14 (12.0)	16 (13.7)	64	4 (6.3)	4 (6.3)	0	0	0	237	25 (10.5)	0	34 (14.3)
42 Aortic valve lesion	5	0	1 (20.0)	18	3 (16.7)	3 (16.7)	85	1 (1.2)	1 (1.2)	1 (1.2)	23	0	131	4 (3.1)	0	5 (3.8)
43 Mitral valve lesion	0	0	0	35	2 (5.7)	3 (8.6)	87	0	1 (1.1)	9	0	0	131	2 (1.5)	0	4 (3.1)
44 Ebstein	17	7 (41.2)	8 (47.1)	14	1 (7.1)	3 (21.4)	24	0	0	18	1 (5.6)	1 (5.6)	73	9 (12.3)	1 (8.1)	12 (16.4)
45 Coronary disease	3	0	0	9	2 (22.2)	2 (22.2)	23	0	0	16	0	0	51	2 (3.9)	0	2 (3.9)
46 Others	13	1 (7.7)	2 (15.4)	41	3 (7.3)	4 (9.8)	52	0	1 (1.9)	22	0	0	128	4 (3.1)	0	8 (6.3)
47 Redo VSD	0	0	0	1	0	0	10	1 (10.0)	1 (10.0)	9	0	0	20	1 (5.0)	0	1 (5.0)
48 PS release	1	0	0	8	0	0	55	0	0	4	0	0	68	0	0	0
49 RV-PA conduit replace	0	0	0	2	0	0	70	0	0	24	0	0	96	0	0	2 (2.1)
50 Others	5	0	0	37	1 (2.7)	2 (5.4)	95	0	1 (1.1)	66	3 (4.5)	3 (4.5)	203	4 (2.0)	0	6 (3.0)
Total	612	49 (8.0)	67 (10.9)	2,466	49 (2.0)	1 (0.04)	3,191	16 (0.5)	2 (0.1)	29 (0.9)	1,166	9 (0.8)	7,435	123 (1.7)	4 (0.1)	180 (2.4)

Values in parenthesis represent mortality %

CPB cardiopulmonary bypass, *PDA* patent ductus arteriosus, *VSD* ventricular septal defect, *DORV* double outlet right ventricle, *AVSD* atrioventricular septal defect, *TGA* transposition of great arteries, *Interrupt. of A.o.* interruption of aorta, *PS* pulmonary stenosis, *PA-IVS* pulmonary atresia with intact ventricular septum, *TAPVR* total anomalous pulmonary venous return, *PAPVR* partial anomalous pulmonary venous return, *ASD* atrial septal defect, *TOF* tetralogy of Fallot, *DCRV* double-chambered right ventricle, *TA* tricuspid atresia, *HLHS* hypoplastic left heart syndrome, *RV-PA* right ventricle-pulmonary artery

Table 1 continued
(2) CPB (–) (total; 2,424)

	Neonate				Infant				1–17 years				≥ 18 years				Total			
	Cases		Hospital mortality		Cases		Hospital mortality		Cases		Hospital mortality		Cases		Hospital mortality		Cases		Hospital mortality	
	30-day	After discharge	30-day	After discharge	30-day	After discharge	30-day	After discharge	30-day	After discharge	30-day	After discharge	30-day	After discharge	30-day	After discharge	30-day	After discharge	30-day	After discharge
1 PDA	321	7 (2.2)	9 (2.8)		171	0	1 (0.6)		27	0	0		5	0	0		524	7 (1.3)	10 (1.9)	
2 Coarctation (simple)	20	0	0		30	0	0		9	0	0		0	0	0		59	0	0	
3 +VSD	48	0	1 (2.1)		17	0	0		2	0	0		0	0	0		67	0	1 (1.5)	
4 +DORV	15	0	1 (6.7)		2	0	0		0	0	0		0	0	0		17	0	1 (5.9)	
5 +AVSD	9	0	0		4	0	0		0	0	0		0	0	0		13	0	0	
6 +TGA	2	0	0		0	0	0		0	0	0		0	0	0		2	0	0	
7 +SV	17	0	0		3	0	0		0	0	0		0	0	0		20	0	0	
8 +Others	3	0	0		2	0	0		1	0	0		0	0	0		6	0	0	
9 Interrupt. of Ao (simple)	1	0	0		1	0	0		0	0	0		0	0	0		2	0	0	
10 +VSD	20	1 (5.0)	3 (15.0)		5	0	0		0	0	0		0	0	0		25	1 (4.0)	3 (12.0)	
11 +DORV	2	0	0		1	0	0		0	0	0		0	0	0		3	0	0	
12 +Truncus	2	0	0		0	0	0		0	0	0		0	0	0		2	0	0	
13 +TGA	2	0	1 (50.0)		0	0	0		0	0	0		0	0	0		2	0	0	
14 +Others	5	1 (20.0)	1 (20.0)		0	0	0		0	0	0		0	0	0		5	1 (20.0)	1 (20.0)	
15 Vascular ring	0	0	0		12	0	0		9	0	0		0	0	0		21	0	0	
16 PS	3	0	0		2	0	0		1	0	0		0	0	0		6	0	0	
17 PA IVS or critical PS	26	3 (11.5)	3 (11.5)		38	0	1 (2.6)		4	0	0		1	0	0		69	3 (4.3)	4 (5.8)	
18 TAPVR	0	0	0		2	0	0		0	0	0		0	0	0		2	0	0	
19 PAPVR ± ASD	0	0	0		0	0	0		2	0	0		0	0	0		2	0	0	
20 ASD	0	0	0		0	0	0		0	0	0		7	0	0		7	0	0	
21 Cor triatriatum	0	0	0		0	0	0		0	0	0		0	0	0		0	0	0	
22 AVSD (partial)	0	0	0		1	1 (100.0)	1 (100.0)		1	0	0		0	0	0		2	1 (50.0)	1 (50.0)	
23 AVSD (complete)	22	2 (9.1)	2 (9.1)		72	1 (1.4)	2 (2.8)		2	0	0		0	0	0		96	3 (3.1)	4 (4.2)	
24 +TOF or DORV	2	0	0		6	0	0		3	0	0		0	0	0		11	0	0	
25 +Others	5	0	0		4	1 (25.0)	1 (25.0)		2	0	0		0	0	0		11	1 (9.1)	1 (9.1)	
26 VSD (subarterial)	0	0	0		4	0	0		0	0	0		0	0	0		4	0	0	
27 VSD (perimemb./muscular)	46	1 (2.2)	1 (2.2)		100	0	1 (1.0)		4	0	0		4	0	0		154	1 (0.6)	2 (1.3)	
28 VSD + PS	0	0	0		5	0	0		0	0	0		0	0	0		5	0	0	
29 DCRV ± VSD	2	0	0		1	0	0		2	0	0		0	0	0		5	0	0	

Table 1 continued

	Neonate				Infant				1–17 years				≥18 years				Total			
	Cases		Hospital mortality		Cases		Hospital mortality		Cases		Hospital mortality		Cases		Hospital mortality		Cases		Hospital mortality	
	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge
30 Aneurysm of sinus valsalva	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
31 TOF	25	0	2 (11.8)	0	116	1 (0.9)	1 (0.9)	19	0	0	0	0	0	0	0	0	161	1 (0.6)	1 (0.6)	1 (0.6)
32 PA + VSD	17	2 (11.8)	2 (11.8)	2 (2.5)	81	2 (2.5)	2 (2.5)	35	0	0	0	0	0	0	0	0	133	4 (3.0)	4 (3.0)	4 (3.0)
33 DORV	32	1 (3.1)	1 (3.1)	0	50	0	0	15	0	0	0	0	0	0	0	0	97	1 (1.0)	1 (1.0)	1 (1.0)
34 TGA (simple)	5	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0
35 +VSD	4	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0
36 VSD + PS	5	0	0	0	8	0	0	1	0	0	0	0	0	0	0	0	14	0	0	0
37 Corrected TGA	8	0	0	0	5	0	0	14	0	0	0	0	0	0	0	0	30	0	0	0
38 Truncus arteriosus	20	0	1 (5.0)	1 (14.3)	7	1 (14.3)	1 (14.3)	2	0	0	0	0	0	0	0	0	29	1 (3.4)	1 (3.4)	2 (6.9)
39 SV	85	3 (3.5)	6 (7.1)	1 (1.2)	83	0	1 (1.2)	20	1 (5.0)	1 (5.0)	1 (5.0)	6	0	0	0	0	194	4 (2.1)	4 (2.1)	8 (4.1)
40 TA	18	0	0	0	21	0	0	3	0	0	0	1	0	0	0	0	43	0	0	0
41 HLHS	78	4 (5.1)	8 (10.3)	0	21	0	0	8	0	0	0	1	0	0	0	0	108	4 (3.7)	4 (3.7)	8 (7.4)
42 Aortic valve lesion	2	0	0	0	4	0	0	1	0	0	0	1	0	0	0	0	8	0	0	0
43 Mitral valve lesion	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0
44 Ebstein	8	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0
45 Coronary disease	2	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	4	0	0	0
46 Others	41	1 (2.4)	3 (7.3)	1 (0.9)	107	1 (0.9)	1 (0.9)	124	0	0	0	61	0	0	0	0	333	2 (0.6)	2 (0.6)	5 (1.5)
47 Redo VSD	0	0	0	0	5	0	0	1	0	0	0	0	0	0	0	0	6	0	0	0
48 PS release	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	3	0	0	0
49 RV-PA conduit replace	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
50 Others	11	0	0	2 (6.5)	31	2 (6.5)	2 (6.5)	42	0	0	0	5	0	0	0	0	89	2 (2.2)	2 (2.2)	2 (2.2)
Total	936	26 (2.8)	43 (4.6)	10 (1.0)	1,034	10 (1.0)	15 (1.5)	357	1 (0.3)	1 (0.3)	2 (0.6)	97	0	0	0	0	2,424	37 (1.5)	37 (1.5)	60 (2.5)

Values in parenthesis represent mortality %

CPB cardiopulmonary bypass, PDA patent ductus arteriosus, VSD ventricular septal defect, DORV double outlet right ventricle, AVSD atrioventricular septal defect, TGA transposition of great arteries, SV single ventricle, Interrupt. of Ao. interruption of aorta, PS pulmonary stenosis, PA-IVS pulmonary atresia with intact ventricular septum, PAPVR partial anomalous pulmonary venous return, PAPVR partial anomalous pulmonary venous return, ASD atrial septal defect, TOF tetralogy of Fallot, DCRV double-chambered right ventricle, TA tricuspid atresia, HLHS hypoplastic left heart syndrome, RV-PA right ventricle-pulmonary artery

Table 1 continued
(3) Main procedure

	Neonate			Infant			1–17 years			≥18 years			Total			
	Cases	30-day mortality		Hospital mortality	Cases	30-day mortality		Hospital mortality	Cases	30-day mortality		Hospital mortality	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge			Hospital	After discharge			Hospital	After discharge			Hospital	After discharge	
1 SP shunt	172	13 (7.6)	17 (9.9)	463	5 (1.1)	9 (1.9)	84	1 (1.2)	2 (2.4)	4	0	0	723	19 (2.6)	0	28 (3.9)
2 PAB	356	6 (1.7)	19 (5.3)	273	1 (0.4)	3 (1.1)	12	0	0	0	0	0	641	7 (1.1)	0	22 (3.4)
3 Bidirectional Glenn or hemi-Fontan ± α	0	0	0	306	1 (0.3)	1 (0.3)	122	1 (0.8)	2 (1.6)	5	0	0	433	2 (0.5)	0	3 (0.7)
4 Damus-Kaye-Stansel operation	5	1 (20.0)	1 (20.0)	52	3 (5.8)	3 (5.8)	10	0	0	1	0	0	68	4 (5.9)	0	4 (5.9)
5 PA reconstruction/repair (including redo)	17	2 (11.8)	3 (17.6)	110	3 (2.7)	3 (2.7)	143	0	0	7	0	0	277	5 (1.8)	0	6 (2.2)
6 RVOT reconstruction/repair	6	1 (16.7)	1 (16.7)	111	0	0	218	2 (0.9)	2 (0.9)	36	0	0	371	3 (0.8)	0	3 (0.8)
7 Rastelli procedure	3	0	0	37	2 (5.4)	2 (5.4)	112	1 (0.9)	1 (0.9)	11	1 (9.1)	1 (9.1)	163	4 (2.5)	0	4 (2.5)
8 Arterial switch procedure	128	4 (3.1)	5 (3.9)	32	5 (15.6)	5 (15.6)	8	0	0	1	0	0	169	9 (5.3)	0	10 (5.9)
9 Atrial switch procedure	1	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0
10 Double switch procedure	1	0	0	1	0	0	16	0	0	0	0	0	18	0	0	0
11 Repair of anomalous origin of CA	1	0	0	6	1 (16.7)	1 (16.7)	10	0	0	3	0	0	20	1 (5.0)	0	1 (5.0)
12 Closure of coronary AV fistula	2	0	0	2	0	0	7	0	0	18	0	0	29	0	0	0
13 Fontan/TCP	0	0	0	13	0	0	405	5 (1.2)	10 (2.5)	23	0	0	441	5 (1.1)	0	10 (2.3)
14 Norwood procedure	43	6 (14.0)	11 (25.6)	77	11 (14.3)	15 (19.5)	6	0	0	1	0	0	127	17 (13.4)	0	26 (20.5)
15 Ventricular septation	1	0	0	1	0	0	3	0	0	1	0	0	6	0	0	0
16 Left side AV valve repair (including redo)	3	1 (33.3)	1 (33.3)	65	0	4 (6.2)	85	1 (1.2)	2 (2.4)	17	0	1 (5.9)	170	2 (1.2)	0	8 (4.7)
17 Left side AV valve replace (including Redo)	0	0	0	10	1 (10.0)	1 (10.0)	39	1 (2.6)	1 (2.6)	12	0	0	61	2 (3.3)	0	2 (3.3)
18 Right side AV valve repair (including redo)	7	2 (28.6)	3 (42.9)	9	0	0	34	0	1 (2.9)	24	0	0	74	2 (2.7)	0	4 (5.4)
19 Right side AV valve replace (including redo)	0	0	0	1	1 (100.0)	1 (100.0)	4	0	0	13	1 (7.7)	1 (7.7)	18	2 (11.1)	1 (5.6)	2 (11.1)
20 Common AV valve repair (including redo)	4	0	0	30	1 (3.3)	2 (6.7)	22	1 (4.5)	2 (9.1)	0	0	0	56	2 (3.6)	0	4 (7.1)
21 Common AV valve replace (including redo)	1	1 (100.0)	1 (100.0)	2	0	1 (50.0)	5	0	1 (20.0)	3	0	0	11	1 (9.1)	0	3 (27.3)

Table 1 continued

	Neonate				Infant				1–17 years				≥18 years				Total				
	Cases		Hospital mortality		Cases		Hospital mortality		Cases		Hospital mortality		Cases		Hospital mortality		Cases		Hospital mortality		
	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	30-day mortality	After discharge	
22	0	0	0	0	8	0	0	0	13	0	0	0	0	1	0	0	0	22	0	0	0
23	0	0	0	0	4	1 (25)	1 (25)	0	36	0	0	0	0	5	0	0	0	45	1 (2.2)	0	1 (2.2)
24	2	0	0	0	10	0	0	0	18	0	0	0	0	8	0	0	0	38	0	0	0
25	2	0	0	0	0	0	0	0	23	1 (4.3)	1 (4.3)	0	0	37	1 (2.7)	1 (2.7)	0	62	2 (3.2)	0	2 (3.2)
26	0	0	0	0	0	0	0	0	13	0	0	0	0	3	0	0	0	16	0	0	0
27	1	0	0	0	0	0	0	0	1	0	0	0	0	6	0	0	0	8	0	0	0
28	0	0	0	0	3	0	0	0	19	0	0	0	0	6	0	0	0	28	0	0	0
Total	756	37 (4.9)	62 (8.2)	62 (8.2)	1,626	36 (2.2)	52 (3.2)	52 (3.2)	1,469	14 (1.0)	25 (1.7)	25 (1.7)	246	3 (1.2)	1 (0.4)	4 (1.6)	4,097	90 (2.2)	1 (0.0)	143 (3.5)	

Values in parenthesis represent mortality %

SP systemic-pulmonary, PAB pulmonary artery banding, RVOT right ventricular outflow tract, CA coronary artery, AV fistula arteriovenous fistula, TCPC total cavopulmonary connection, AV valve atrioventricular valve, VSD ventricular septal defect, AVR aortic valve replacement

Table 2 Acquired (total (1) + (2) + (4) + (5) + (6) + (7) + isolated ope. for arrhythmia in (3); 36,148 (1) Valvular heart disease (total; 19,164)

Valve	Cases	Operation				30-day mortality				Hospital mortality				Redo		
		Mechanical		Bioprosthesis	Ross procedure	Repair	With CABG	Hospital		After discharge		Replace	Repair	30-day mortality		Hospital mortality
		Cases	Operation					Replace	Repair	Replace	Repair			Cases	Hospital	
Isolated	A	8,589	2,346	5,930	4	309	1,944	166 (2.0)	7 (2.3)	243 (2.9)	7 (2.3)	296	19 (6.4)	25 (8.4)		
	M	4,376	783	733	0	2,860	704	55 (3.6)	25 (0.9)	88 (5.8)	44 (1.5)	304	13 (4.3)	23 (7.6)		
	T	268	18	68	0	182	30	5 (5.8)	3 (1.6)	8 (9.3)	6 (3.3)	41	2 (4.9)	3 (7.3)		
	P	9	0	6	0	3	1	0	0	1	0	1	0	0		
A+M	A	1,303	499	751	0	53	183	48 (3.7)		86 (6.6)		73	7 (9.6)	10 (13.7)		
	M	340		301	2	660										
A+T	A	374		246	0	23	50	6 (1.6)		12 (3.2)		44	1 (2.3)	3 (6.8)		
	T	3		7	1	363										
M+T	M	690		800	0	1,698	323	53 (1.7)		90 (2.8)		259	7 (2.7)	17 (6.6)		
	T	3,188		32		3,142										
A+M+T	A	357		605	0	24										
	M	986		322	0	379	106	36 (3.7)	1 (0.1)	53 (5.4)		72	4 (5.6)	5 (6.9)		
	T	1		5	0	980										
Others		71	11	26	0	34	6	2 (2.8)		6 (8.5)		6	0	1 (16.7)		
Total		19,164	5,452	9,832	7	10,710	3,347	406 (2.1)		644 (3.4)		1,096	53 (4.8)	87 (7.9)		

Number of redo cases is included in total case number of 18,713

Values in parenthesis represent mortality %

CABG coronary artery bypass grafting, A aortic valve, M mitral valve, T tricuspid valve, P pulmonary valve

Table 2 continued

(2) Ischemic heart disease (total; (A) + (B) + (C); 15,581)

(A) Isolated CABG (total; (a) + (b); 14,256)

(a-1) On-pump arrest CABG (total; 3,397)

	Primary, elective			Primary, emergency			Redo, elective			Redo, emergency			Arterial graft only	Artery graft + SVG	SVG only	Others	Uncertain					
	Cases	30-day mortality	After discharge	Hospital mortality	Cases	30-day mortality	After discharge	Hospital mortality	Cases	30-day mortality	After discharge	Hospital mortality						Cases	30-day mortality	After discharge	Hospital mortality	
IVD	69	0	0	1 (4.0)	25	1 (4.0)	0	1 (4.0)	5	1 (20.0)	0	1 (20.0)	1	0	0	0	51	13	35	1	0	
2VD	382	3 (0.8)	4 (1.0)	3 (5.7)	53	1 (1.9)	0	3 (5.7)	7	0	0	0	1	0	0	0	70	334	31	0	8	
3VD	1,489	8 (0.5)	15 (1.0)	15 (7.8)	192	13 (6.8)	0	15 (7.8)	14	0	0	0	1	0	0	0	86	1,560	49	1	0	
LMT	874	6 (0.7)	7 (0.8)	26 (9.8)	266	17 (6.4)	0	26 (9.8)	13	0	0	0	5	0	0	0	117	982	54	3	2	
Uncertain				0			0	0				0										
Total	2,814	17 (0.6)	26 (0.9)	45 (8.4)	536	32 (6.0)	0	45 (8.4)	39	1 (2.6)	0	1 (2.6)	8	0	0	0	324	2,889	169	5	10	
Kawasaki	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	3	0	0	0	
Hemodialysis	186	2 (1.1)	4 (2.2)	4 (4.3)	28	4 (14.3)	0	4 (4.3)	2	0	0	0	0	0	0	0	13	180	15	0	8	

Values in parenthesis represent mortality %

LMT includes LMT alone or LMT with other branch diseases. CABG coronary artery bypass grafting, 1VD one-vessel disease, 2VD two-vessel disease, 3VD three-vessel disease, LMT left main trunk, SVG saphenous vein graft

(a-2) On-pump beating CABG (total; 2,052)

	Primary, elective			Primary, emergency			Redo, elective			Redo, emergency			Arterial graft only	Artery graft+SVG	SVG only	Others	Uncertain				
	Cases	30-day mortality	After discharge	Hospital mortality	Cases	30-day mortality	After discharge	Hospital mortality	Cases	30-day mortality	After discharge	Hospital mortality						Cases	30-day mortality	After discharge	Hospital mortality
IVD	40	1 (2.5)	2 (5.0)	6 (31.6)	19	5 (26.3)	0	6 (31.6)	6	0	0	0	3	1 (33.3)	0	1 (33.3)	35	10	23	0	0
2VD	183	0	1 (0.5)	13 (18.8)	69	11 (15.9)	0	13 (18.8)	9	0	0	0	2	1 (50.0)	0	1 (50.0)	58	166	39	0	0
3VD	769	6 (0.8)	13 (1.7)	23 (12.6)	182	12 (6.6)	0	23 (12.6)	13	2 (15.4)	0	3 (23.1)	3	0	0	0	78	833	55	1	0
LMT	499	7 (1.4)	14 (2.8)	27 (11.2)	242	20 (8.3)	0	27 (11.2)	11	1 (9.1)	0	1 (9.1)	2	0	0	0	112	587	55	0	0
Total	1,491	14 (0.9)	30 (2.0)	69 (13.5)	512	48 (9.4)	0	69 (13.5)	39	3 (7.7)	0	4 (10.3)	10	2 (20.0)	0	2 (20.0)	283	1,596	172	1	0
Kawasaki	5	0	1 (20.0)	0	0	0	0	0	1	0	0	0	0	0	0	0	5	1	0	0	0
Hemodialysis	140	6 (4.3)	13 (9.3)	7 (12.7)	55	4 (7.3)	0	7 (12.7)	3	1 (33.3)	0	2 (66.7)	0	0	0	0	18	155	21	1	3

Values in parenthesis represent mortality %

LMT includes LMT alone or LMT with other branch diseases. CABG coronary artery bypass grafting, 1VD one-vessel disease, 2VD two-vessel disease, 3VD three-vessel disease, LMT left main trunk, SVG saphenous vein graft

(b) Off-pump CABG (total; 8,807)

(The present section also includes cases of planned off-pump CABG in which, during surgery, the change is made to an on-pump CABG or on-pump beating-heart procedure)

	Primary, elective			Primary, emergency			Redo, elective			Redo, emergency			Arterial graft only	Artery graft+SVG	SVG only	Others	Uncertain				
	Cases	30-day mortality	After discharge	Hospital mortality	Cases	30-day mortality	After discharge	Hospital mortality	Cases	30-day mortality	After discharge	Hospital mortality						Cases	30-day mortality	After discharge	Hospital mortality
IVD	558	2 (0.4)	2 (0.4)	4 (0.7)	64	0	0	2 (3.1)	33	0	0	1 (3.0)	4	1 (25.0)	0	1 (25.0)	536	65	56	0	2
2VD	1,400	7 (0.5)	16 (1.1)	16 (1.1)	145	4 (2.8)	0	6 (4.1)	31	0	0	0	0	0	0	0	552	955	50	0	19
3VD	3,276	24 (0.7)	35 (1.1)	35 (1.1)	378	10 (2.6)	0	13 (3.4)	29	1 (3.4)	0	1 (3.4)	1	0	0	0	742	2,848	85	1	8
LMT	2,276	16 (0.7)	21 (0.9)	21 (0.9)	567	19 (3.4)	0	29 (5.1)	21	1 (4.8)	0	1 (4.8)	8	0	0	0	739	2,041	79	2	11
Uncertain	15	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	15	0	0	0
Total	7,525	49 (0.7)	2 (0.03)	76 (1.0)	1,155	33 (2.9)	0	50 (4.3)	114	2 (1.8)	0	3 (2.6)	13	1 (7.7)	0	1 (7.7)	2,570	5,924	270	3	40
Kawasaki	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	5	0	0	0
Hemodialysis	529	7 (1.3)	1 (0.19)	12 (2.3)	79	7 (8.9)	0	9 (11.4)	7	1 (14.3)	0	1 (14.3)	1	0	0	0	135	436	34	0	11

Values in parenthesis represent mortality %

LMT includes LMT alone or LMT with other branch diseases. CABG coronary artery bypass grafting, 1VD one-vessel disease, 2VD two-vessel disease, 3VD three-vessel disease, LMT left main trunk, SVG saphenous vein graft

(c) Includes cases of conversion, during surgery, from off-pump CABG to on-pump CABG or on-pump beating-heart CABG (total; 186)

	Primary, elective		Primary, emergency		Redo, elective		Redo, emergency		
	30-day mortality		30-day mortality		30-day mortality		30-day mortality		
	Hospital	After discharge	Hospital	After discharge	Hospital	After discharge	Hospital	After discharge	
A conversion to on-pump CABG arrest heart	22	0	5	1 (20.0)	1	0	0	0	0
A conversion to on-pump beating-heart CABG	110	4 (3.6)	27	5 (18.5)	6	22.2	4	0	1
Uncertain	15		1						
Total	147	4 (2.7)	33	6 (18.2)	7	21.2	5	0	1
Hemodialysis	13	2 (15.4)	5	0	0	0	1	0	0

Values in parenthesis represent mortality %
CABG coronary artery bypass grafting

(B) Operation for complications of MI (total; 1,321)

	Chronic		Acute		Concomitant operation					
	30-day mortality		Hospital mortality		Hospital mortality					
	Cases	30-day mortality	Hospital	After discharge	Cases	30-day mortality				
Infarctectomy or aneurysmectomy	362	18 (5.0)	1 (0.3)	29 (8.0)	34	12 (35.3)	13 (38.2)	274	125	16
VSP closure	51	12 (23.5)		12 (23.5)	245	72 (29.4)	89 (36.3)	83	4	9
Cardiac rupture	27	4 (14.8)		4 (14.8)	204	68 (33.3)	69 (33.8)	25	3	1
Mitral regurgitation										
1) Papillary muscle rupture	10	1 (10.0)		1 (10.0)	38	7 (18.4)	7 (18.4)	19	6	25
2) Ischemic	306	16 (5.2)		22 (7.2)	32	8 (25.0)	9 (28.1)	293	248	56
Others	9	1 (11.1)		1 (11.1)	3	0	0	7	2	0
Total	765	52 (6.8)	1 (0.1)	69 (9.0)	556	167 (30.0)	187 (33.6)	701	388	107

Values in parenthesis represent mortality %
Acute, within 2 weeks from the onset of myocardial infarction

MI myocardial infarction, CABG coronary artery bypass grafting, MVP mitral valve repair, MVR mitral valve replacement, VSP ventricular septal perforation

(C) TMLR (total 4)

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
Isolated	0	0		0
With CABG	4	0		0
Total	4	0		0

TMLR transmyocardial laser revascularization

(3) Operation for arrhythmia (total; 3,992)

	Cases	30-day mortality		Hospital mortality	Concomitant operation						
		Hospital	After discharge		Isolated	Congenital	Valve	IHD	Others	Multiple combination	
										2 categories	3 categories
Maze	3,771	51 (1.4)	1 (0.03)	79 (2.1)	36	176	3,374	468	200	425	31
For WPW	2	0		0	0	0	0	2	1	1	0
For ventricular tachyarrhythmia	53	3 (5.7)		4 (7.5)	4	1	12	30	15	7	1
Others	166	4 (2.4)		4 (2.4)	2	14	127	38	12	23	3
Total	3,992	58 (1.5)	1 (0.03)	87 (2.2)	42	191	3,513	538	228	456	35

Values in parenthesis represent mortality %. Except for 20 isolated cases, all remaining 3,950 cases are doubly allocated, one for this subgroup and the other for the subgroup corresponding to the concomitant operations

WPW Wolff–Parkinson–White syndrome, IHD ischemic heart disease

(4) Operation for constrictive pericarditis (total; 148)

	CPB (+)			CPB (–)				
	Cases	30-day mortality		Hospital mortality	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge			Hospital	After discharge	
Total	68	5 (7.4)	1 (1.5)	12 (17.6)	80	2 (2.5)	4 (5.0)	

Values in parenthesis represent mortality %

CPB cardiopulmonary bypass

(5) Cardiac tumor (total; 556)

	Cases	30-day mortality		Hospital mortality	Concomitant operation			
		Hospital	After discharge		AVR	MVR	CABG	Others
Benign tumor	479	4 (0.8)		5 (1.0)	10	5	30	56
Cardiac myxoma	387	3 (0.8)		3 (0.8)	7	1	22	45
Papillary fibroelastoma	34	0		0	3	2	3	3
Rhabdomyoma	0	0		0	0	0	0	0
Others	58	1 (1.7)		2 (3.4)	0	2	5	8
Malignant tumor	77	6 (7.8)	1 (1.3)	7 (9.1)	0	0	1	5
Primary	45	1 (2.2)	1 (2.2)	2 (4.4)	0	0	1	2
Metastatic	32	5 (15.6)		5 (15.6)	0	0	0	3

Values in parenthesis represent mortality %

AVR aortic valve replacement, MVR mitral valve replacement, CABG coronary artery bypass grafting

(6) HOCM and DCM (total; 176)

	Cases	30-day mortality		Hospital mortality	Concomitant operation			
		Hospital	After discharge		AVR	MVR	MVP	CABG
Myotomy	2	0		0	0	1	0	0
No-resection	24	0		1 (4.2)	4	7	15	4
Volume reduction surgery of the left ventricle	49	6 (12.2)		9 (18.4)	3	3	36	13
Total	176	9 (5.1)		13 (7.4)	66	39	64	30

Values in parenthesis represent mortality %

HOCM hypertrophic obstructive cardiomyopathy, DCM dilated cardiomyopathy, AVR aortic valve replacement, MVR mitral valve replacement, MVP mitral valve repair, CABG coronary artery bypass grafting

(7) Other open-heart operation (total; 481)

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
Total	481	32 (6.7)	(2.0) (0.4)	40 (8.3)

Values in parenthesis represent mortality %

Table 3 Thoracic aortic aneurysm (total; 14,126)
(1) Dissection (total; 6,013)

Stanford type	Replaced site																										
	Acute						Chronic						Concomitant operation						Redo								
	A			B			A			B			AVP			MVP			CABG			Cases		Hospital mortality			
	30-day mortality		Hospital mortality	30-day mortality		Hospital mortality	30-day mortality		Hospital mortality	30-day mortality		Hospital mortality	30-day mortality		Hospital mortality	30-day mortality		Hospital mortality	30-day mortality		Hospital mortality	30-day mortality		Hospital mortality	30-day mortality		Hospital mortality
	Hospital	After discharge		Hospital	After discharge		Hospital	After discharge		Hospital	After discharge		Hospital	After discharge		Hospital	After discharge		Hospital	After discharge		Hospital	After discharge		Hospital	After discharge	
1. Ascending Ao.	2,387	199 (8.3)	243 (10.2)	2	0	0	214	8 (3.7)	9 (4.2)	11	0	0	219	95	16	13	135	43	7 (16.3)	7 (16.3)	43	7 (16.3)	7 (16.3)	7 (16.3)	7 (16.3)		
2. Aortic root	174	22 (12.6)	26 (14.9)	0	0	0	51	2 (3.9)	5 (9.8)	2	0	0	16	120	3	1	45	26	5 (19.2)	5 (19.2)	26	5 (19.2)	5 (19.2)	6 (23.1)	6 (23.1)		
3. Ascending Ao.+Arch	1,205	110 (9.1)	145 (12.0)	22	3 (13.6)	4 (18.2)	319	14 (4.4)	20 (6.3)	104	4 (3.8)	6 (5.8)	95	59	9	2	89	81	6 (7.4)	6 (7.4)	81	6 (7.4)	7 (8.6)	7 (8.6)	7 (8.6)		
4. Arch+Descending Ao.	18	5 (27.8)	5 (27.8)	16	4 (25.0)	4 (25.0)	29	1 (3.4)	3 (10.3)	82	2 (2.4)	3 (3.7)	1	1	0	0	2	18	3 (16.7)	3 (16.7)	18	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)		
5. Aortic root+ Asc.Ao.+Arch	73	6 (8.2)	8 (11.0)	0	0	0	18	1 (5.6)	1 (5.6)	6	0	0	7	44	2	0	18	7	0	0	7	0	0	0	0	0	
6. Descending Ao.	10	1 (10.0)	2 (20.0)	38	7 (18.4)	8 (21.1)	75	2 (2.7)	4 (5.3)	258	15 (5.8)	18 (7.0)	1	4	2	0	1	61	3 (4.9)	3 (4.9)	61	3 (4.9)	4 (6.6)	4 (6.6)	4 (6.6)		
7. Thoracoabdominal Ao.	6	0	0	4	0	2 (50.0)	38	7 (18.4)	8 (21.1)	112	8 (7.1)	10 (8.9)	0	1	0	0	0	37	4 (10.8)	4 (10.8)	37	4 (10.8)	6 (16.2)	6 (16.2)	6 (16.2)		
8. Extra-anatomical bypass	17	5 (29.4)	5 (29.4)	21	5 (23.8)	5 (23.8)	2	0	0	2	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	
9. Stent graft ^a	82	5 (6.1)	5 (6.1)	90	7 (7.8)	7 (7.8)	119	1 (0.8)	2 (1.7)	406	5 (1.2)	5 (1.2)	0	2	0	0	4	61	1 (1.6)	1 (1.6)	61	1 (1.6)	2 (3.3)	2 (3.3)	2 (3.3)		
1) TEVAR ^b	14	2 (14.3)	2 (14.3)	78	6 (7.7)	6 (7.7)	82	1 (1.2)	2 (2.4)	359	3 (0.8)	4 (1.1)	0	0	0	0	1	57	1 (1.8)	1 (1.8)	57	1 (1.8)	2 (3.5)	2 (3.5)	2 (3.5)		
2) Open stent	68	3 (4.4)	3 (4.4)	9	0	0	14	0	0	42	2 (4.8)	0	0	2	0	0	3	4	0	0	4	0	0	0	0	0	
a) With total arch ^c	7	1 (14.3)	1 (14)	1	0	0	1	0	0	7	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	
b) Without total arch ^d	61	2 (3.3)	2 (3.3)	8	0	0	13	0	0	35	2 (5.7)	1 (2.9)	0	1	0	0	2	4	0	0	4	0	0	0	0	0	
3) Unspecified	0	0	0	3	1 (33.3)	1 (33.3)	23	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	3,972	353 (8.9)	439 (11.1)	193	26 (13.5)	30 (15.5)	865	36 (4.2)	52 (6.0)	983	34 (3.5)	42 (4.3)	339	326	32	16	294	335	29 (8.7)	29 (8.7)	335	29 (8.7)	35 (10.4)	35 (10.4)	35 (10.4)		

Values in parenthesis represent mortality %
 Ao aorta, AVP aortic valve repair, AVR aortic valve replacement, MVP mitral valve repair, MVR mitral valve replacement, CABG coronary artery bypass grafting, TEVAR thoracic endovascular aortic (aneurysm) repair
 *a = *b + *c + *d + unspecified

Table 3 continued
(2) Non-dissection (total; 8,203)

Replaced site	Unruptured				Ruptured				Concomitant operation				Redo				CPB(-)							
	30-day mortality		Hospital mortality		30-day mortality		Hospital mortality		AVP	AVR	MVP	MVR	CABG	Cases	30-day mortality		Hospital mortality		Cases	30-day mortality		Hospital mortality		
	Hospital	After discharge	Hospital	After discharge	Hospital	After discharge	Hospital	After discharge							Hospital	After discharge	Hospital	After discharge		Hospital	After discharge	Hospital	After discharge	
1. Ascending Ao.	1,139	19 (1.7)	28 (2.5)	31	4 (12.9)	6 (19.4)	92	698	52	43	113	113	79	5 (6.3)	1 (1.3)	9 (11.4)	3	0	3	0	0	0	0	
2. Aortic root	797	15 (1.9)	20 (2.5)	13	4 (30.8)	5 (38.5)	135	489	56	21	94	94	93	3 (3.2)		6 (6.5)	3	0	3	0	0	0	0	
3. Ascending Ao.+Arch	2,077	85 (4.1)	121 (5.8)	196	29 (14.8)	43 (21.9)	25	174	13	6	381	381	98	11 (11.2)		14 (14.3)	24	0	24	0	1	1	1 (4.2)	
4. Arch+Descending Ao.	190	9 (4.7)	16 (8.4)	35	12 (34.3)	14 (40.0)	2	4	1	0	15	15	5	1 (20.0)		1 (20.0)	56	3 (5.4)	56	3 (5.4)	3	3	3 (5.4)	
5. Aortic root+Asc.Ao.+Arch	85	1 (1.2)	1 (1.2)	2	1 (50.0)	1 (50.0)	12	42	4	2	14	14	6	1 (16.7)		1 (16.7)	0	0	0	0	0	0	0	
6. Descending Ao.	416	13 (3.1)	18 (4.3)	117	23 (19.7)	30 (25.6)	0	1	0	0	9	9	36	4 (11.1)		10 (27.8)	80	2 (2.5)	80	2 (2.5)	4	4	4 (5.0)	
7. Thoracoabdominal Ao.	308	20 (6.5)	27 (8.8)	37	9 (24.3)	12 (32.4)	0	2	0	1	1	1	25	4 (16.0)		6 (24.0)	14	1 (7.1)	14	1 (7.1)	1	1	1 (7.1)	
8. Extra-anatomical bypass	35	1 (2.9)	1 (2.9)	0	0	0	0	4	0	1	2	2	2	1 (50.0)		1 (50.0)	5	0	5	0	0	0	0	
9. Stent graft ^a	2,461	52 (2.1)	63 (2.6)	264	34 (12.9)	43 (16.3)	0	10	1	0	19	19	145	7 (4.8)		7 (4.8)	1,102	33 (3.0)	1,102	33 (3.0)	1	1	1 (0.1)	
1) TEVAR ^b	2,184	41 (1.9)	53 (2.4)	249	34 (13.7)	41 (16.5)	0	2	1	0	3	3	128	6 (4.7)		6 (4.7)	1,078	33 (3.1)	1,078	33 (3.1)	1	1	1 (0.1)	
2) Open stent	270	11 (4.1)	10 (3.7)	15	0	2 (13.3)	0	8	0	0	16	16	17	1 (5.9)		0	24	0	24	0	0	0	0	
a) With total arch ^c	162	3 (1.9)	3 (1.9)	6	0	0	0	5	0	0	11	11	8	0		0	20	0	20	0	0	0	0	
b) Without total arch ^d	108	8 (7.4)	7 (6.5)	9	0	2 (22.2)	0	3	0	0	5	5	9	1 (11.1)		1 (11.1)	4	0	4	0	0	0	0	
3) Unspecified	7	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	
Total	7,508	215 (2.9)	295 (3.9)	695	116 (16.7)	154 (22.2)	266	1,424	127	74	648	648	489	37 (7.6)	1 (0.2)	55 (11.2)	1,287	39 (3.0)	1,287	39 (3.0)	1	1	1 (0.1)	45 (3.5)

Values in parenthesis represent mortality %

Ao aorta, AVP aortic valve repair, AVR aortic valve replacement, MVP mitral valve repair, MVR mitral valve replacement, CABG coronary artery bypass grafting, TEVAR thoracic endovascular aortic (aneurysm) repair

*a = *b + *c + *d + unspecified

Table 4 Pulmonary thromboembolism (total; 130)

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
Acute	78	16 (20.5)		16 (20.5)
Chronic	52	5 (9.6)		5 (9.6)
Total	130	21 (16.2)		21 (16.2)

Values in parenthesis represent mortality %

Table 5 Assisted circulation (total; 1,759)

Sites	VAD									Heart–Lung assist						Unspec-ified	
	Device			Results						Method			Results				
	Centrif-ugal	VAS	Others	Not weaned			Weaned			PCPS	Others	Unspecified	Not weaned		Weaned		
				On going	Death	Trans-plant	Alive	Deaths	Trans-plant				Deaths	Trans-plant	Deaths		Alive
Post cardiotomy																	
Left	14	17	3	7	19 (55.9)	0	6	2 (6.5)	0								
Right	3	0	1	0	2 (50.0)	0	2	0	0								
Biventricle																	
Right	9	3	0	1	9 (75.0)	0	1	1 (20.0)	0	465	48	16	266 (51.9)	0	79 (15.4)	184	0
Left	5	7	0														
Congestive heart failure																	
Left	9	39	45	65	20 (21.5)	1	6	1 (1.1)	1								
Right	1	0	0	0	0 (0.0)	0	1	0	0								
Biventricle																	
Right	19	2	0	15	8 (72.7)	0	6	1 (9.1)	0	846	36	22	439 (49.8)	1	130 (14.7)	311	23
Left	16	10	4														
Respiratory failure																	
Total	76	78	53	88	58 (28.0)	1	22	5 (2.4)	1	1,381	108	44	743 (49.9)	1	226 (15.2)	538	25

Values in parenthesis represent mortality %

VAD ventricular assist devise, VAS ventricular assist system, PCPS percutaneous cardiopulmonary support

Table 6 Heart transplantation (total; 21)

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
Heart transplantation	31	0		1 (3.2)
Heart and lung transplantation	0	0		0
Total	31	0		1 (3.2)

Values in parenthesis represent mortality %

Table 7 Pacemaker + ICD (total; 7,752)

	Pacemaker			ICD	
	Univent	Bivent	CRTD	CRTD	ICD
Initial	830	3,018	127	402	490
Exchange	894	1,694	34	72	191
Total	1,724	4,712	161	474	681

ICD implantable cardioverter-defibrillator, CRTD cardiac resynchronization therapy devise with incorporated ICD devise

(B) General thoracic surgery

The total number of operations reported in 2011 in general thoracic surgery has reached 69,223. This is due to the steady increase in lung cancer surgery as last year (31,301, 2009; 32,801, 2010; 33,878, 2011).

Surgery for lung cancer consists more than 49 % of all the general thoracic surgery. Among lung cancer subtypes, adenocarcinoma consists of an overwhelming percentage of 68.8 % of the total lung cancer surgery. More and more lung cancer surgeries are being done using video-assisted thoracic surgery (VATS) and 62.9 % of the total lung cancer surgeries were done by VATS in 2011 (59.6 %, 2010). The 30 day mortality of lung cancer patients undergoing lobectomy is as low as 0.3 % (0.4, 2010). Pneumonectomy was done in 596 patients with a hospital death of 1.8 (1.8, 2010) %. The number of sleeve lobectomy (403) has plummeted (441, 2009; 400, 2010).

Interstitial pneumonia was the most frequent cause of death after lung cancer surgery and the top five causes of death after lung cancer surgery (interstitial pneumonia, pneumonia, respiratory failure, cardiovascular, bronchopleural fistula) have not been changed in these 3 years.

7,210 patients with metastatic pulmonary tumor were operated in 2011 and steady increase was observed (6,248,

2009; 6,748, 2010). 77 % of these were operated using VATS.

90 tracheal tumors were operated in 2011. Adenoid cystic carcinoma and squamous cell carcinoma were frequent primary tracheal tumor.

434 tumors of pleural origin were operated in 2011. Diffuse malignant pleural mesothelioma was the most frequent histology. Extrapleural pneumonectomy was the most frequently chosen operative method (146 cases) with a hospital death of 5.5 %. These results were same as last year. 682 chest wall tumors were resected in 2011. Mediastinal tumors are resected in 4,463 cases, including 1,798 thymomas, 261 thymic cancers, 229 germ cell tumors, 492 neurogenic tumors, and 908 congenital cysts. The number of operated thymoma increased in 2011. A half of mediastinal tumors are now operated using VATS.

2,063 operations for empyema were reported in 2011. 75.6 % are acute empyema and 22.2 % of these had fistula.

13,479 operations for pneumothorax were reported in 2011. More than 90 % (93.8 %) of operations for this disease have been done by VATS.

48 lung transplantations were reported in 2011 (35 cases, 2010; 22 cases, 2009). The number of lung transplantation operation has increased after the change in the regulation of selection of the brain-dead donors in 2010.

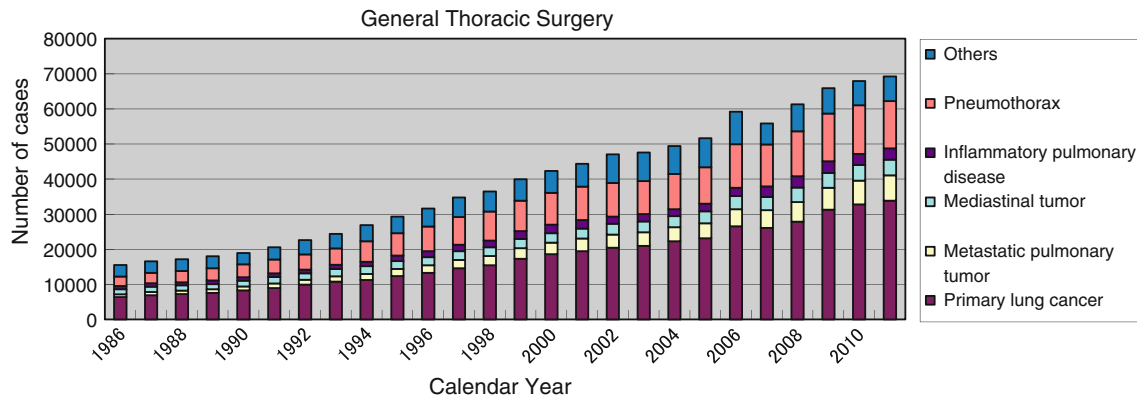


Fig. 1 General thoracic surgery

Table 1 Total entry cases of general thoracic surgery during 2011

	Cases	%
Benign pulmonary tumor	900	1.3
Primary lung cancer	33,878	48.9
Other primary malignant pulmonary tumor	350	0.5
Metastatic pulmonary tumor	7,210	10.4
Tracheal tumor	90	0.1
Mesothelioma	434	0.6
Chest wall tumor	682	1.0
Mediastinal tumor	4,463	6.4
Thymectomy for MG without thymoma	284	0.4
Inflammatory pulmonary disease	3,209	4.6
Epyema	2,063	3.0
Bullous disease excluding pneumothorax	620	0.9
Pneumothorax	13,479	19.5
Chest wall deformity	255	0.4
Diaphragmatic hernia including traumatic	129	0.2
Chest trauma excluding diaphragmatic hernia	354	0.5
Lung transplantation	48	0.1
Others	775	1.1
Total	69,223	100.0

Table 2

1. Benign pulmonary tumor

	Cases	30-day mortality		Hospital mortality	By VATS
		Hospital	After discharge		
Hamartoma	447	0	0	0	388
Sclerosing hemangioma	107	0	0	0	90
Papilloma	11	0	0	0	8
Mucous gland adenoma bronchial	1	0	0	0	1
Fibroma	40	0	0	0	37
Lipoma	3	0	0	0	3
Neurogenic tumor	13	0	0	0	10
Clear cell tumor	3	0	0	0	3
Leiomyoma	10	0	0	0	8
Chondroma	5	0	0	0	3
Inflammatory myofibroblastic tumor	4	0	0	0	3
Pseudolymphoma	33	0	0	0	30
Histiocytosis	3	0	0	0	3
Teratoma	4	0	0	0	3
Others	216	0	0	0	185
Total	900	0	0	0	775

Values in parenthesis represent mortality %

Table 3

2. Primary malignant pulmonary tumor

	Cases	30-day mortality		Hospital mortality	By VATS
		Hospital	After discharge		
2. Primary malignant pulmonary tumor	34,228	103 (0.3)	15 (0.04)	243 (0.7)	
Lung cancer	33,878	103 (0.3)	15 (0.04)	238 (0.7)	21,293
Adenocarcinoma	23,296	46 (0.2)	7 (0.03)	98 (0.4)	
Squamous cell carcinoma	6,834	41 (0.6)	7 (0.10)	93 (1.4)	
Large cell carcinoma	935	6 (0.6)	0	20 (2.1)	
(LCNEC)	492	2 (0.4)	0	10 (2.0)	
Small cell carcinoma	581	1 (0.2)	0	5 (0.9)	
Adenosquamous carcinoma	562	0	0	3 (0.5)	
Carcinoma with pleomorphic, sarcomatoid or sarcomatous elements	444	5 (1.1)	0	13 (2.9)	
Carcinoid	198	0	1 (0.5)	0	
Carcinomas of salivary-gland type	36	0	0	0	
Unclassified	52	1 (1.9)	0	1 (1.9)	
Multiple lung cancer	801	2 (0.2)	0	4 (0.5)	
Others	139	1 (0.7)	0	1 (0.7)	
Wedge resection	4,564	6 (0.1)	3 (0.07)	10 (0.2)	3,770
Segmental excision	3,538	4 (0.1)	0	11 (0.3)	2,414
(Sleeve segmental excision)	9	0	0	0	2
Lobectomy	24,929	78 (0.3)	11 (0.04)	189 (0.8)	14,951
(Sleeve lobectomy)	403	5 (1.2)	1 (0.2)	6 (1.5)	42
Pneumonectomy	596	11 (1.8)	1 (0.2)	23 (3.9)	54
(Sleeve pneumonectomy)	14	0	0	1 (7.1)	1
Other bronchoplasty	19	1 (5.3)	0	2 (10.5)	0
Pleuropneumonectomy	4	0	0	0	0
Others	258	3 (1.2)	0	3 (1.2)	101
Sarcoma	36	0	0	2 (5.6)	
AAH	157	0	0	1 (0.6)	
Others	157	0	0	2 (1.3)	

Values in parenthesis represent mortality %

Table 4 Details of lung cancer operation
TNM

	Cases
c-Stage	
Ia	19,454
Ib	6,642
IIa	2,684
IIb	1,779
IIIa	2,489
IIIb	248
IV	386
NA	196
Total	33,878
Sex	
Male	21,225
Female	12,651
NA	2
Total	33,878
Cause of death	
Cardiovascular	30
Pneumonia	46
Pyothorax	4
Bronchopleural fistula	25
Respiratory failure	30
Pulmonary embolism	7
Interstitial pneumonia	67
Brain infarction or bleeding	11
Others	25
Unknown	8
Unclassifiable	0
Total	253
p-Stage	
0 (pCR)	140
Ia	16,639
Ib	6,904
IIa	2,859
IIb	2,082
IIIa	3,711
IIIb	316
IV	969
NA	258
Total	33,878

Table 4 continued

	Cases
Age	
<20	5
20–29	35
30–39	197
40–49	947
50–59	3,782
60–69	11,874
70–79	13,144
80–89	3,851
≥90	39
NA	4
Total	33,878

Table 5
3. Metastatic pulmonary tumor

	Cases	30-day mortality		Hospital mortality	By VATS
		Hospital	After discharge		
3. Metastatic pulmonary tumor	7,210	2 (0.03)	0	5 (0.1)	5,554
Colo-rectal	3,503	0	0	0	2,745
Hepatobiliary/pancreatic	341	0	0	0	262
Uterine	344	0	0	0	274
Mammary	432	0	0	0	362
Ovarian	51	0	0	0	36
Testicular	96	0	0	0	69
Renal	551	0	0	0	446
Skeletal	133	0	0	0	90
Soft tissue	294	0	0	0	194
Otorhinolaryngological	415	0	0	1 (0.2)	308
Pulmonary	383	1 (0.3)	0	1 (0.3)	245
Others	667	1	0	1 (0.1)	523
Unknown	0	0	0	0	0

Values in parenthesis represent mortality %

Table 6
4. Tracheal tumor

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
4. Tracheal tumor	90	1 (1.1)	1 (1.1)	4 (4.4)
(A) Primary malignant tumor (histological classification)				
Squamous cell carcinoma	10	1 (10.0)	0	3 (30.0)
Adenoid cystic carcinoma	10	0	0	0
Mucoepidermoid carcinoma	2	0	0	0
Others	5	0	0	0
Total	27	1 (3.7)	0	3 (11.1)
(B) Metastatic/invasive malignant tumor, e.g., invasion of thyroid cancer	29	0	1 (3.4)	1 (3.4)
(C) Benign tracheal tumor (histological classification)				
Papilloma	2	0	0	0
Adenoma	4	0	0	0
Neurofibroma	3	0	0	0
Chondroma	3	0	0	0
Leiomyoma	2	0	0	0
Others	20	0	0	0
Histology unknown	0	0	0	0
Total	34	0	0	0
Operation				
Sleeve resection with reconstruction	25	1 (4.0)	0	3 (12.0)
Wedge with simple closure	17	0	0	0
Wedge with patch closure	1	0	0	0
Total laryngectomy with tracheostomy	4	0	0	0
Others	43	0	1 (2.3)	1 (2.3)
Unknown	0	0	0	0
Total	90	1 (1.1)	1 (1.1)	4 (4.4)

Values in parenthesis represent mortality %

Table 7
5. Tumor of pleural origin

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
Histological classification				
Solitary fibrous tumor	154	0	0	1 (0.6)
Diffuse malignant pleural mesothelioma	213	3 (1.4)	0	9 (4.2)
Localized malignant pleural mesothelioma	30	0	0	0
Others	37	0	0	1 (2.7)
Total	434	3 (0.7)	0	11 (2.5)
Operative procedure				
Extrapleural pneumonectomy	146	2 (1.4)	0	8 (5.5)
Total pleurectomy	11	0	0	0
Total parietal pleurectomy	0	0	0	0
Partial pleurectomy	0	0	0	0
Exploratory thoracotomy	0	0	0	0
Others	56	1 (1.8)	0	1 (1.8)
Total	213	3 (1.4)	0	9 (4.2)

Values in parenthesis represent mortality %

Table 8
6. Chest wall tumor

	Cases	30-day mortality		Hospital mortality	By VATS
		Hospital	After discharge		
Primary malignant tumor	138	0	0	0	13
Metastatic malignant tumor	240	2 (0.8)	0	2 (0.8)	32
Benign tumor	304	0	0	0	159
Total	682	2 (0.3)	0	2 (0.3)	204

Values in parenthesis represent mortality %

Table 9
7. Mediastinal tumor

	Cases	30-day mortality		Hospital mortality	By VATS
		Hospital	After discharge		
7. Mediastinal tumor	4,463	2 (0.04)	0	8 (0.2)	2,230
Thymoma*	1,798	1 (0.1)	0	1 (0.1)	604
Thymic cancer	261	0	0	2 (0.8)	64
Thymus carcinoid	41	0	0	0	12
Germ cell tumor	229	0	0	0	80
<i>Benign</i>	174	0	0	0	70
<i>Malignant</i>	55	0	0	0	10
Neurogenic tumor	492	0	0	1 (0.2)	394
Congenital cyst	908	1 (0.1)	0	3 (0.3)	734
Goiter	99	0	0	0	13
Lymphatic tumor	185	0	0	1 (0.5)	106
Excision of pleural recurrence of thymoma	94	0	0	0	40
Others	356	0	0	0	183

* Includes those with myasthenia gravis

Values in parenthesis represent mortality %

Table 10
8. Thymectomy for myasthenia gravis with thymoma

	Cases	30-day mortality		Hospital mortality	By VATS
		Hospital	After discharge		
8. Thymectomy for myasthenia gravis	499	1 (0.2)	0	1 (0.2)	163
With thymoma	284	1 (0.4)	0	1 (0.4)	67

Values in parenthesis represent mortality %

Table 11

9. Operation for non-neoplastic disease
(A) Inflammatory pulmonary disease

	Cases	30-day mortality		Hospital mortality	By VATS
		Hospital	After discharge		
9. Operation for non-neoplastic disease	20,880	120 (0.6)	10 (0.05)	213 (1.0)	
(A) Inflammatory pulmonary disease	3,209	6 (0.2)	1 (0.03)	14 (0.4)	2,328
Tuberculous infection	113	0	0	0	68
Mycobacterial infection	440	0	0	1 (0.2)	305
Fungal infection	410	2 (0.5)	0	6 (1.5)	230
Bronchiectasis	97	0	0	0	49
Tuberculous nodule	390	0	0	0	323
Inflammatory pseudo tumor	912	1 (0.1)	0	2 (0.2)	707
Interpulmonary lymph node	187	0	0	0	161
Others	660	3 (0.5)	1 (0.2)	5 (0.8)	485

Values in parenthesis represent mortality %

Table 12

9. Operation for non-neoplastic disease
(B) Empyema

	Cases	30-day mortality		Hospital mortality	By VATS
		Hospital	After discharge		
Acute empyema	1,559	11 (0.7)	0	33 (2.1)	1,021
With fistula	346	6 (1.7)	0	25 (7.2)	88
Without fistula	1,208	5 (0.4)	0	8 (0.7)	931
Unknown	5	0	0	0	2
Chronic empyema	504	7 (1.4)	0	23 (4.6)	120
With fistula	256	5 (2.0)	0	18 (7.0)	34
Without fistula	244	1 (0.4)	0	4 (1.6)	82
Unknown	4	1 (25.0)	0	1 (25.0)	4
Total	2,063	18 (0.9)	0	56 (2.7)	1,141

Values in parenthesis represent mortality %

Table 13

9. Operation for non-neoplastic disease
(C) Descending necrotizing mediastinitis

	Cases	30-day mortality		Hospital mortality	By VATS
		Hospital	After discharge		
(C) Descending necrotizing mediastinitis	88	6 (6.8)	0	8 (9.1)	47

Values in parenthesis represent mortality %

Table 14

9. Operation for non-neoplastic disease
(D) Bullous disease

	Cases	30-day mortality		Hospital mortality	By VATS
		Hospital	After discharge		
(D) Bullous disease	620	0	0	2 (0.3)	490
Empysematous bulla	468	0	0	2 (0.4)	368
Bronchogenic cyst	87	0	0	0	66
Empysema with volume reduction surgery	25	0	0	0	18
Others	40	0	0	0	20

Values in parenthesis represent mortality %

LVRS lung volume reduction surgery

Table 15
9. Operation for
non-neoplastic disease
(E) Pneumothorax

	Cases	30-day mortality		Hospital mortality	By VATS
		Hospital	After discharge		
(E) Pneumothorax	13,479	37 (0.3)	10 (0.07)	68 (0.5)	12,638
<i>Spontaneous pneumothorax</i>					
Operative procedure					
Bullectomy	3,722	0	0	3 (0.08)	3,557
Bullectomy with additional procedure	7,141	4 (0.1)	9 (0.13)	8 (0.1)	6,861
Coverage with artificial material	6,686	4 (0.1)	9 (0.13)	8 (0.1)	6,421
Parietal pleurectomy	49	0	0	0	45
Coverage and parietal pleurectomy	115	0	0	0	115
Others	291	0	0	0	280
Others	318	3 (0.9)	0	3 (0.9)	281
Total	11,181	7 (0.1)	9 (0.08)	14 (0.1)	10,699
<i>Secondary pneumothorax</i>					
Associated disease					
COPD	1,760	18 (1.0)	1 (0.1)	34 (1.9)	1,517
Tumorous disease	84	5 (6.0)	0	6 (7.1)	64
Catamenial	122	0	0	0	117
LAM	35	0	0	0	30
Others (excluding pneumothorax by trauma)	290	7 (2.4)	0	14 (4.8)	212
Operative procedure					
Bullectomy	398	4 (1.0)	1	8 (2.0)	354
Bullectomy with additional procedure	1,613	18 (1.1)	0	34 (2.1)	1,370
Coverage with artificial material	1,499	10 (0.7)	0	25 (1.7)	1,275
Parietal pleurectomy	13	1 (7.7)	0	1 (7.7)	10
Coverage and parietal pleurectomy	19	1 (5.3)	0	2 (10.5)	16
Others	82	6 (7.3)	0	6 (7.3)	69
Others	294	8 (2.7)	0	12 (4.1)	223
Unknown	2	0	0	0	1
Total	2,307	30 (1.3)	1 (0.04)	54 (2.3)	1,948

Values in parenthesis represent mortality %

Table 16
9. Operation for non-neoplastic disease
(F) Chest wall deformity

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
(F) Chest wall deformity	255	0	0	0
Funnel chest	236	0	0	0
Others	19	0	0	0

Values in parenthesis represent mortality %

Table 17
9. Operation for non-neoplastic disease
(G) Diaphragmatic hernia

	Cases	30-day mortality		Hospital mortality	By VATS
		Hospital	After discharge		
(G) Diaphragmatic hernia	129	2 (1.6)	0	4 (3.1)	32
Congenital	78	2 (2.6)	0	3 (3.8)	15
Traumatic	23	0	0	0	6
Others	28	0	0	1 (3.6)	11

Values in parenthesis represent mortality %

Table 18

9. Operation for non-neoplastic disease
(H) Chest trauma

Values in parenthesis represent mortality %

	Cases	30-day mortality		Hospital mortality	By VATS
		Hospital	After discharge		
(H) Chest trauma	354	39 (11.0)	0	42 (11.9)	106

Table 19

9. Operation for non-neoplastic disease
(I) Other respiratory surgery

* Includes those with myasthenia gravis

Values in parenthesis represent mortality %

	Cases	30-day mortality		Hospital mortality	By VATS
		Hospital	After discharge		
(I) Other respiratory surgery	687	12 (1.7)	0	19 (2.8)	350
Arteriovenous malformation*	84	1 (1.2)	0	1 (1.2)	68
Pulmonary sequestration	123	0	0	0	74
Others	480	11 (2.3)	0	18 (3.8)	208

Table 20

10. Lung transplantation

Values in parenthesis represent mortality %

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
Single lung transplantation from brain dead donor	20	0	0	1 (5.0)
Bilateral lung transplantation from brain dead donor	15	0	0	1 (6.7)
Lung transplantation from living donor	13	1 (7.7)	0	1 (7.7)
Total of lung transplantation	48	1 (2.1)	0	3 (6.3)
Donor of living donor lung transplantation	22	0	0	0

Table 21

11. Video-assisted thoracic surgery

Values in parenthesis represent mortality %
(Including thoracic sympathectomy 146)

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
11. Video-assisted thoracic surgery	50,823	57 (0.1)	18 (0.04)	121 (0.2)

Table 22

12. Tracheobronchoplasty

Values in parenthesis represent mortality %

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
12. Tracheobronchoplasty	533	8 (1.5)	1 (0.2)	14 (2.6)
Trachea	101	1 (1.0)	0	3 (3.0)
Sleeve resection with reconstruction	49	1 (2.0)	0	2 (4.1)
Wedge with simple closure	28	0	0	0
Wedge with patch closure	2	0	0	0
Total laryngectomy with tracheostomy	2	0	0	0
Others	20	0	0	1 (5.0)
Crainal reconstruction	13	0	0	0
Sleeve pneumonectomy	13	0	0	1 (7.7)
Sleeve lobectomy	356	5 (1.4)	1 (0.3)	8 (2.2)
Sleeve segmental excision	11	0	0	0
Bronchoplasty without lung resection	18	1 (5.6)	0	1 (5.6)
Others	21	1 (4.8)	0	1 (4.8)

Table 23

13. Pediatric surgery

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
13. Pediatric surgery	426	5 (1.2)	0	8 (1.9)

Values in parenthesis represent mortality %

Table 24

14. Combined resection of neighboring organ(s)

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
14. Combined resection of neighboring organ(s)	1,002	5 (0.5)	3 (0.3)	15 (1.5)
(A) Primary lung cancer (organ resected)				
Aorta	13	0	0	1 (7.7)
Superior vena cava	33	2 (6.1)	0	2 (6.1)
Brachiocephalic vein	16	0	0	1 (6.3)
Pericardium	150	2 (1.3)	1 (0.7)	4 (2.7)
Pulmonary artery	186	0	0	1 (0.5)
Left atrium	41	1 (2.4)	2 (4.9)	2 (4.9)
Diaphragm	85	0	0	0
Chest wall (including ribs)	500	0	0	4 (0.8)
Vertebra	20	0	0	0
Esophagus	10	0	0	0
Total	1,054	5 (0.5)	3 (0.3)	15 (1.4)
(B) Mediastinal tumor (organ resected)				
Aorta	7	0	0	1 (14.3)
Superior vena cava	58	0	0	0
Brachiocephalic vein	83	0	0	1 (1.2)
Pericardium	237	1 (0.4)	0	3 (1.3)
Pulmonary artery	2	0	0	0
Left atrium	1	0	0	0
Diaphragm	15	0	0	0
Chest wall (including ribs)	30	0	0	0
Vertebra	3	0	0	0
Esophagus	10	0	0	1 (10.0)
Lung	291	0	0	2 (0.7)
Total	737	1 (0.1)	0	8 (1.1)

Values in parenthesis represent mortality %

Table 25

15. Operation of lung cancer invading the chest wall of the apex

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
15. Operation of lung cancer invading the chest wall of the apex	117	1 (0.9)	0	3 (0.03)

Values in parenthesis represent mortality %

Includes tumors invading the anterior apical chest wall and posterior apical chest wall (superior sulcus tumor, so-called Pancoast type)

(C) Esophageal surgery

During 2011 alone, a total of 11,376 patients with esophageal diseases were registered from 533 institutions (response rate 93.3 %) which affiliated to the Japanese Association for Thoracic Surgery and/or to the Japan Esophageal Society. Among these institutions, those where 20 or more patients underwent esophageal surgeries within the year of 2011 were 122 institutions (22.9 %), which shows a slight shift of esophageal operations to low volume institutions as compared to the data of 2010 (27.5 %) (Table 1). Of 1,763 patients with a benign esophageal disease, 911 (51.7 %) patients underwent surgery, and 38 (2.2 %) patients underwent endoscopic resection, while 814 (46.2 %) patients did not undergo any surgical treatment (Table 2). Of 9,613 patients with a malignant esophageal tumor, 7,201 (74.9 %) patients underwent resection, esophagectomy for 5,430 (56.5 %) and endoscopic mucosal resection (EMR) including endoscopic submucosal dissection (ESD) for 1,771 (18.4 %), while 2,412 (25.1 %) patients did not undergo any resection (Tables 3, 4). The decrease of registered patients with nonsurgically treated benign esophageal diseases is obvious during 2011. The patients registered, particularly those undergoing nonsurgical therapy for a malignant esophageal disease, have been increasing since 1990 (Fig. 1).

Among benign esophageal diseases (Table 2), hiatal hernia, esophageal varices, achalasia and esophagitis (including reflux esophagitis) were the most common conditions in Japan. On the other hand, spontaneous rupture of the esophagus, benign esophageal tumors and congenital esophageal atresia were common diseases which were surgically treated as well as the above-mentioned diseases. The thoracoscopic and/or laparoscopic procedures have been widely adopted for benign esophageal diseases, in particular achalasia, hiatal hernia and benign tumors. Open surgery was performed in 460 patients with a benign esophageal disease, with 30-day mortality in 7 (1.5 %), while thoracoscopic and/or laparoscopic surgery was performed for 451 patients, with 1 (0.2 %) of the 30-day mortality. The difference in these death rates between open and scopic surgeries seems to be related to the conditions requiring open surgery.

The majority of malignant diseases were carcinomas (Table 3). Among esophageal carcinomas, the incidence of squamous cell carcinoma was 92.4 %, while that of adenocarcinomas including Barrett cancer was 5.4 %. The resection rate for patients with a squamous cell carcinoma was 74.3 %, while that for patients with an adenocarcinoma was 88.9 %.

According to location, cancer in the thoracic esophagus was the most common (Table 4). Of the 3,582 patients

(37.3 % of total esophageal malignancies) having superficial esophageal cancers within mucosal and submucosal layers, 1,621 (45.3 %) patients underwent esophagectomy, while 1,766 (49.3 %) patients underwent EMR or ESD. The 30-day mortality rate and hospital mortality rate after esophagectomy for patients with a superficial cancer were 0.5 and 1.9 % respectively. There was no EMR or ESD-related death. Advanced esophageal cancer invading deeper than the submucosal layer was observed in 5,979 (62.2 %) patients. Of the 5,979 patients with advanced esophageal cancer, 3,809 (63.7 %) underwent esophagectomy, with 0.8 % of the 30-day mortality rate and with 3.3 % of the hospital mortality rate.

Multiple primary cancers were observed in 1,504 (15.6 %) of all the 9,613 patients with esophageal cancer. Synchronous cancer was found in 974 (64.8 %) patients, while metachronous cancer (found before esophageal cancer) was observed in 907 (60.3 %) patients. The stomach is the commonest site for both synchronous and metachronous malignancy followed by head and neck cancer (Table 4).

Among esophagectomy procedures, transthoracic esophagectomy through right thoracotomy was the most commonly adopted for patients with a superficial cancer as well as for those with an advanced cancer (Table 5). Transhiatal esophagectomy commonly performed in Western countries was adopted in only 4.9 % of patients having a superficial cancer who underwent esophagectomy and in 1.9 % of those having an advanced cancer in Japan. The thoracoscopic and/or laparoscopic esophagectomy were adopted for 698 patients (43.1 %) with a superficial cancer, and for 844 patients (22.2 %) with an advanced cancer. The number of cases of thoracoscopic and/or laparoscopic surgery for superficial or advanced cancer has been increasing for these several years (Fig. 2).

Combined resection of the neighboring organs during resection of an esophageal cancer was performed in 250 patients (Tables 5, 6). Resection of the aorta together with the esophagectomy was performed in 4 cases. Tracheal and/or bronchial resection combined with esophagectomy was performed in 26 patients, with the 30-day mortality rate at 0 % and the hospital mortality rate at 3.8 %. Lung resection combined with esophagectomy was performed in 41 patients, with the 30-day mortality rate at 0 % and the hospital mortality rate at 0 %.

Salvage surgery after definitive (chemo-) radiotherapy was performed in 187 patients, with the 30-day mortality rate at 0.5 % and with the hospital mortality rate at 4.3 % (Table 5).

Last, in spite of the efforts of the Committee to cover wider patient populations to this annual survey, the majority of the institutions which responded to the questionnaire were the departments of thoracic or esophageal

surgery. It should be noted that larger number of patients with esophageal diseases should have been treated medically and endoscopically. We should continue our effort

for complete survey through more active collaboration with the Japan Esophageal Society and other related societies.

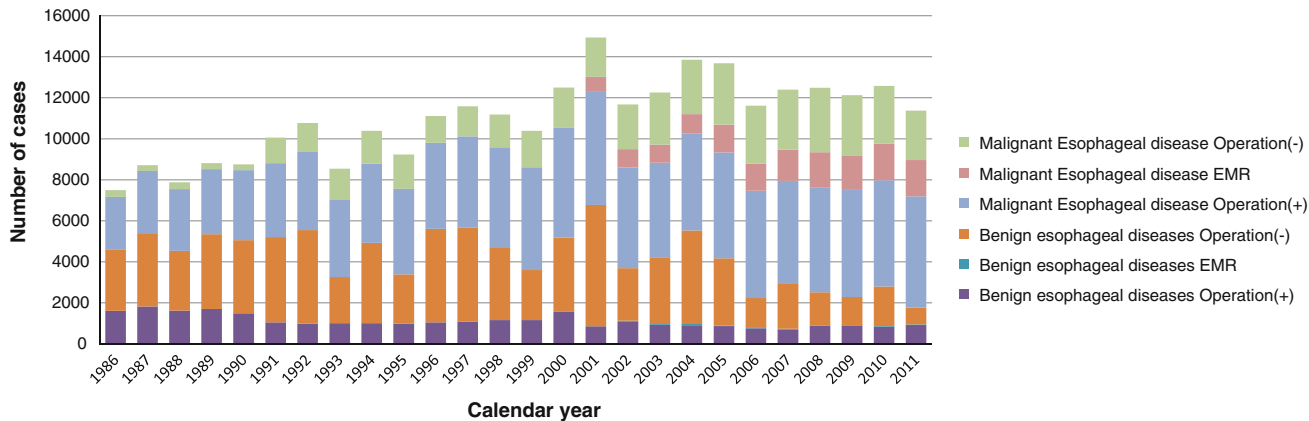


Fig. 1 Annual trend of in-patients with esophageal diseases, *EMR* endoscopic mucosal resection (including endoscopic submucosal)

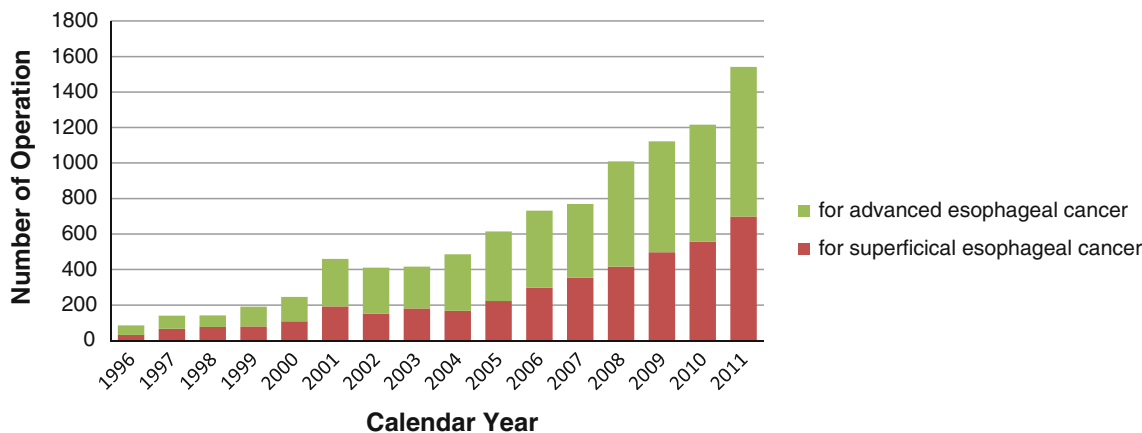


Fig. 2 Annual trend of video-assisted esophagectomy for esophageal malignancy

Table 1 Distribution of number of esophageal operations in 2011 in each institution

Esophageal surgery			
Number of operations in 2009	Benign esophageal diseases	Malignant esophageal disease	Benign + malignant
0	290	99	77
1–4	190	165	150
5–9	36	88	104
10–19	13	72	80
20–29	0	43	45
30–39	1	23	27
40–49	1	11	10
≥50	2	32	40
Total	533	533	533

Table 2 Benign esophageal diseases

	Operation (+)										Endoscopic resection	Operation (–)	Total		
	Number of patients			30-day mortality						Hospital mortality					
	Total	Open	T/L*3	Open surgery			T/L*3			Total				Open surgery	T/L*3
				Total	Hospital	After discharge	Total	Hospital	After discharge						
1. Achalasia	171	9	162	0	0	0	0	0	0	0	0	0	0	43	214
2. Benign tumor	66	37	29	0	0	0	0	0	0	0	0	0	38	12	116
(1) Leiomyoma	41	25	16	0	0	0	0	0	0	0	0	0	9	9	59
(2) Cyst	4	1	3	0	0	0	0	0	0	0	0	0	3	2	9
(3) Others	20	11	9	0	0	0	0	0	0	0	0	0	26	1	47
(4) Not specified	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1
3. Diverticulum	23	10	13	0	0	0	0	0	0	0	0	0	0	9	32
4. Hiatal hernia	337	128	209	0	0	0	0	0	0	0	1 (0.8)	0	0	153	490
5. Spontaneous rupture of the esophagus	79	74	5	1 (1.4)	1 (1.4)	0	0	0	0	0	4 (5.4)	0	0	13	92
6. Esophago-tracheal fistula	12	12	0	1 (8.3)	0	1 (8.3)	0	0	0	0	0	0	0	13	25
7. Congenital esophageal atresia	55	54	1	0	0	0	0	0	0	1 (1.8)	1 (1.9)	0	0	1	56
8. Congenital esophageal stenosis	2	2	0	0	0	0	0	0	0	0	0	0	0	3	5
9. Corrosive stricture of the esophagus	11	11	0	0	0	0	0	0	0	0	0	0	0	7	18
10. Esophagitis, Esophageal ulcer	28	11	17	0	0	0	1 (5.9)	1 (5.9)	0	1 (3.6)	0	1 (5.9)	0	155	183
11. Esophageal varices	77	68	9	1 (1.5)	1 (1.5)	0	0	0	0	1 (1.3)	1 (1.5)	0	0	370	447
(1) Laparotomy	26	21	5	1 (4.8)	1 (4.8)	0	0	0	0	1 (3.8)	1 (4.8)	0	0	0	26
(2) Others				0	0	0	0	0	0	0	0	0	0	0	0
(3) Sclerotherapy				0	0	0	0	0	0	0	0	0	0	179	179
12. Others	50	44	6	4 (9.1)	4 (9.1)	0	0	0	0	5 (10.0)	5 (11.4)	0	0	35	85
Total	911	460	451	7 (1.5)	6 (1.3)	1 (0.2)	1 (0.2)	1 (0.2)	0	8 (0.9)	12 (2.6)	1 (0.2)	38	814	1,763

Values in parenthesis represent mortality %
 T/L thoracoscopic and/or laparoscopic

Table 3 Malignant esophageal diseases (histologic classification)

	Resection (+)	Resection (–)	Total
Carcinomas	7,133	2,344	9,477
1. Squamous cell carcinoma	6,502	2,254	8,756
2. Basaloid(-squamous) carcinoma	78	7	85
3. Carcinosarcoma	29	2	31
4. Adenocarcinoma in the Barrett’s esophagus	247	12	259
5. Other adenocarcinoma	209	45	254
6. Adenosquamous carcinoma	28	6	34
7. Mucoepidermoid carcinoma	3	0	3
8. Adenoid cystic carcinoma	1	0	1
9. Endocrine cell carcinoma	22	4	26
10. Undifferentiated carcinoma	5	7	12
11. Others	9	7	16
Other malignancies	35	6	41
1. Malignant non-epithelial tumors	9	1	10
2. Malignant melanoma	18	3	21
3. Other malignant tumors	8	2	10
Not specified	33	62	95
Total	7,201	2,412	9,613

Resection: including endoscopic resection

Table 4 Malignant esophageal disease (clinical characteristics)

	Operation (+)				Hospital mortality	EMR or ESD	Operation (–)	Total
	Cases	30-day mortality						
		Total	Hospital	After discharge				
1. Esophageal cancer	5,430	38 (0.7)	38 (0.7)	0	155 (2.9)	1,771	2,412	9,613
Location								0
(1) Cervical esophagus	204	0	0	0	5 (2.5)	86	195	485
(2) Thoracic esophagus	4,438	32 (0.7)	32 (0.7)	0	128 (2.9)	1,481	2,046	7,965
(3) Abdominal esophagus	491	5 (1.0)	5 (1.0)	0	11 (2.2)	58	61	610
(4) Multiple cancers	284	0	0	0	7 (2.5)	139	53	476
(5) Others/not described	13	1 (7.7)	1 (7.7)	0	4 (30.8)	7	57	77
Tumor depth								
(A) Superficial cancer	1,621	8 (0.5)	8 (0.5)	0	30 (1.9)	1,766	195	3,582
(B) Advanced cancer	3,809	30 (0.8)	30 (0.8)	0	125 (3.3)	1	2,169	5,979
(C) Not specified							48	48
2. Multiple primary cancers	805	4 (0.5)	4 (0.5)	0	20 (2.5)	297	402	1,504
1) Synchronous	563	5 (0.9)	5 (0.9)	0	20 (3.6)	224	187	974
(1) Head and neck	144	0 (0.0)	0	0	6 (4.2)	84	55	283
(2) Stomach	253	3 (1.2)	3 (0.7)	0	9 (3.6)	81	73	407
(3) Others	141	1 (0.7)	1 (0.7)	0	4 (2.8)	34	41	216
(4) Triple cancers	25	0	0	0	1 (4.0)	18	16	59
(5) Not specified	0	1	1	0	0	7	2	9
2) Metachronous	426	5 (1.2)	5 (1.2)	0	8 (1.9)	317	164	907
(1) Head and neck	93	1 (1.1)	1 (1.1)	0	2 (2.2)	104	35	232
(2) Stomach	117	1 (0.9)	1 (0.9)	0	2 (1.7)	94	48	259
(3) Others	183	3 (1.6)	3 (1.6)	0	2 (1.1)	74	63	320
(4) Triple cancers	33	0	0	0	2 (6.1)	43	17	93
(5) Not specified	0	0	0	0	0	2	1	3

Values in parenthesis represent mortality %

EMR endoscopic mucosal resection (including endoscopic submucosal dissection)

Table 5 Malignant esophageal disease (surgical procedures)

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
Superficial cancer				
1. Endoscopic mucosal resection	1,766			
2. Esophagectomy	1,621	8 (0.5)	0	30 (1.9)
(1) Transhiatal esophagectomy	79	1 (1.3)	0	3 (3.8)
(2) Thoracoscopic and/or laparoscopic procedure	698	1 (0.1)	0	8 (1.1)
(3) Transthoracic (rt.) esophagectomy and reconstruction	708	4 (0.6)	0	15 (2.1)
(4) Transthoracic (lt.) esophagectomy and reconstruction	34	0	0	1 (2.9)
(5) Cervical esophageal resection and reconstruction	10	0	0	0
(6) Two stage operation	37	1 (2.7)	0	1 (2.7)
(7) Others/not specified	55	1		2 (3.6)
Advanced cancer				
1. Endoscopic mucosal resection	1			
2. Esophagectomy	3,809	30 (0.8)	0	125 (3.3)
(1) Transhiatal esophagectomy	74	1 (1.4)	0	3 (4.1)
(2) Thoracoscopic and/or laparoscopic procedure	844	5 (0.6)	0	25 (3.0)
(3) Transthoracic (rt.) esophagectomy and reconstruction	2,393	21 (0.9)	0	86 (3.6)

Table 5 continued

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
(4) Transthoracic (lt.) esophagectomy and reconstruction	169	1 (0.6)	0	3 (1.8)
(5) Cervical esophageal resection and reconstruction	105	1 (1.0)	0	2 (1.9)
(6) Two stage operation	79	0	0	2 (2.5)
(7) Others/not specified	145	1 (0.7)	0	4 (2.8)
(Depth not specified)				
2. Combined resection of other organs	250	5 (2.0)	0	8 (3.2)
(1) Aorta	4	0	0	0
(2) Trachea, Bronchus	26	0	0	1 (3.8)
(3) Lung	41	0	0	0
(4) Others	179	5 (2.8)	0	7 (3.9)
3. Salvage surgery	187	1 (0.5)	0	8 (4.3)

Values in parenthesis represent mortality %

Table 6 Mortality after combined resection of the neighboring organs

Years	Esophagectomy			Combined resection											
				Aorta			Tracheobronchus			Lung			Others		
	a	b	c (%)	a	b	c (%)	a	b	c (%)	a	b	c (%)	a	b	c (%)
1996	4,194	120	2.86	7	3	42.86	24	0	0.00	50	2	4.00	78	4	5.13
1997	4,441	127	2.86	1	0	0.00	34	5	14.71	56	1	1.79	94	3	3.19
1998	4,878	136	2.79	4	0	0.00	29	0	0.00	74	1	1.35	128	2	1.56
1999	5,015	116	2.31	5	0	0.00	23	2	8.70	68	0	0.00	122	1	0.82
2000	5,350	81	1.51	2	0	0.00	23	2	8.70	69	0	0.00	96	1	1.04
2001	5,521	110	1.99	1	0	0.00	26	1	3.85	83	3	3.61	99	2	2.02
2002	4,904	66	1.35	3	1	33.33	20	2	10.00	63	0	0.00	63	1	1.59
2003	4,639	45	0.97	0	0	0.00	24	2	8.33	58	0	0.00	88	1	1.14
2004	4,739	64	1.35	2	0	0.00	17	0	0.00	59	5	8.47	119	2	1.68
2005	5,163	52	1.01	1	0	0.00	11	1	9.09	67	1	1.49	73	1	1.37
2006	5,236	63	1.20	0	0	0.00	17	0	0.00	62	2	3.23	122	3	2.46
2007	4,990	60	1.20	0	0	0.00	25	1	4.00	44	1	2.27	138	2	1.45
2008	5,124	63	1.23	0	0	0.00	17	1	5.88	48	1	2.08	185	0	0.00
2009	5,260	63	1.20	0	0	0.00	19	2	10.53	58	2	3.45	211	3	1.42
2010	5,180	45	0.87	2	0	0.00	33	0	0.00	58	0	0.00	245	5	2.04
2011	5,430	38	0.70	4	0	0.00	26	0	0.00	41	0	0.00	179	5	2.79
Total	80,064	1,040	1.30	26	4	15.38	273	16	5.86	753	16	2.12	1,220	23	1.89

a number of patients who underwent the operation, *b* number of patients died within 30 days after operation, *c* % ratio of *b/a*, i.e., direct operative mortality

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