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ANNUAL REPORT

Thoracic and cardiovascular surgery in Japan during 2015

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 operative category. Here, we have summarized the results from our annual survey of thoracic surgery performed during 2015.

As has been done so far, thoracic surgery was classified into three categories—cardiovascular, general thoracic, and esophageal surgery—and the patient 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 all member's continued professional support and contributions (Tables 1, 2).

The incidence of hospital mortality was added to the survey to determine the nationwide status, which has contributed to the Japanese surgeons to understand the present status of thoracic surgery in Japan and to make progress to improve operative results by comparing their work with those of others. The Association was able to gain a better understanding of present problems as well as future prospects, which has been reflected to its activity including education of its members.

Thirty-day mortality (so-called "operative mortality") is defined as death within 30 days of operation regardless of the patient's geographic location and even after the patient had been discharged from the hospital. Hospital mortality is defined as death within any time interval after an operation if the patient had not been discharged from the hospital.

Hospital-to-hospital transfer in the categories of esophageal surgery 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. On the contrary, hospital-to-hospital transfer after 30 days of operation in the categories of cardiovascular surgery and general thoracic surgery is considered discharge because data of national clinical database (NCD) 2015 were used in this category and hospital-to-hospital transfer after 30 days of operation is considered discharge in NCD.

Abstract of the survey

All data regarding cardiovascular surgery and thoracic surgery were obtained from NCD, whereas data regarding esophageal surgery were collected from survey questionnaire by The Japanese Association for Thoracic Surgery forms because NCD of esophageal surgery does not include non-surgical cases (i.e., patients with adjuvant chemotherapy or radiation alone). Based on the change in data aggregation, there are several differences between this 2015 annual report and previous annual reports: the number of institutions decreased in each category from 578 (2014) to 568 (2015) in cardiovascular, from 762 to 714 in general thoracic and from 626 to 571 in esophageal surgery. Because more than two departments in the same institute registered their data to NCD individually, we cannot calculate correct number of institutes in this survey. Then, the response rate is not indicated in the category of cardiovascular surgery (Table 1), and the number of institutions classified by the operation number is also not

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Table 1 Questionnaires sent out and received back by the end of December 2015

	Sent out	Returned	Response rate
(A) Cardiovascular surgery	–	568	–
(B) General thoracic surgery	736	714	97.0%
(C) Esophageal surgery	610	571	93.6%

Table 2 Categories subclassified according to the number of operations performed

Number of operations performed	Category General thoracic surgery
0	12
1–24	66
25–49	120
50–99	190
100–149	138
150–199	80
≧ 200	108
Total	714
Number of operations performed	**Esophageal surgery**
0	81
1–4	151
5–9	101
10–19	102
20–29	46
30–39	29
40–49	13
≧ 50	48
Total	571

calculated in the category of cardiovascular surgery (Table 2).

2015 Final report

(A) Cardiovascular surgery

First, we are very pleased with our colleague's (member's) cooperation to our survey of cardiovascular surgery, which definitely enhances the quality of this annual report. We are truly grateful again for the enormous effort put into completing the NCD at each participating institution.

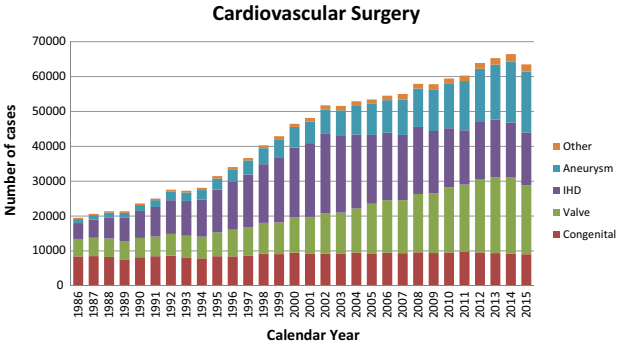

Fig. 1 Cardiovascular surgery, *IHD* ischemic heart disease

Figure 1 shows the development of cardiovascular surgery in Japan over the last 29 years. Aneurysm surgery includes only operations for thoracic and thoracoabdominal aortic aneurysm. Extra-anatomic bypass surgery for thoracic aneurysm and pacemaker implantation were totally excluded from the survey since 2015. The number of assist device implantation operations is not included in the total number of surgical operations, while it remained in the survey. A total of 69,512 cardiovascular operations were performed at 561 institutions during 2015 alone and included 44 heart transplantations, which were re-started in 1999.

The number of operations for congenital heart disease (9054 cases) decreased in 2.3% compared with that of 2014 (9269 cases) [1], and 2.5% decrease when compared with the data of 10 years ago (9287 cases in 2005) [2]. The number of operations for adult heart disease (19,820 cases in valvular heart disease, 15,103 ischemic heart disease, 17,444 cases in thoracic aortic aneurysm and 1897 cases for other procedures) decreased compared with those of 2014 (9.7, 3.4, 0.3 and 10.4%, respectively).

During the last 10 years, the numbers of operations for adult heart disease increased constantly except for that for ischemic heart disease (39.1% increase in valvular heart disease, 23.5% decrease in ischemic heart disease, 101.1% increase in thoracic aortic aneurysm, and 56.5% increase in other procedures compared those of 2005 [2]). The concomitant coronary artery bypass grafting procedure (CABG) is not included in ischemic heart disease but included in other categories such as valvular heart disease

Table 3 Congenital (total 9269)
(1) CPB (+) (total 6710)

	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	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge			Hospital	After discharge			Hospital	After discharge			Hospital	After discharge			Hospital	After discharge	
PDA	3	0	0	0	8	0	0	0	4	0	0	0	10	0	0	0	25	0	0	0
Coarctation (simple)	13	0	0	0	14	0	0	0	14	0	0	0	12	0	0	0	53	0	0	0
+ VSD	54	0	0	0	42	0	0	1 (2.4)	14	0	0	0	0	0	0	0	110	0	0	1 (0.9)
+ DORV	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
+ AVSD	4	0	0	1 (25.0)	3	0	0	1 (33.3)	0	0	0	0	0	0	0	0	7	0	0	2 (28.6)
+ TGA	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
+ SV	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	3	0	0	0
+ Others	7	0	0	0	9	1 (11.1)	0	1 (11.1)	9	1 (11.1)	0	1 (11.1)	3	0	0	0	28	2 (7.1)	0	2 (7.1)
Interrupt. of Ao (simple)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
+ VSD	27	0	0	0	34	0	0	1 (2.9)	11	0	0	0	1	0	0	0	73	0	0	1 (1.4)
+ DORV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+ Truncus	3	0	0	0	5	0	0	1 (20.0)	2	0	0	0	0	0	0	0	10	0	0	1 (10.0)
+ TGA	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
+ Others	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
Vascular ring	0	0	0	0	6	0	0	0	2	0	0	0	0	0	0	0	8	0	0	0
PS	2	0	0	0	26	0	0	0	79	0	0	0	14	0	0	0	121	0	0	0
PA • IVS or critical PS	14	0	0	1 (7.1)	52	0	0	0	66	0	0	0	4	0	0	0	136	0	0	1 (0.7)
TAPVR	123	12 (9.8)	0	23 (18.7)	75	1 (1.3)	0	5 (6.7)	7	0	0	0	4	0	0	0	209	13 (6.2)	0	28 (13.4)
PAPVR ± ASD	1	0	0	0	4	0	0	0	58	0	0	0	17	1 (5.9)	0	1 (5.9)	80	1 (1.3)	0	1 (1.3)
ASD	8	0	0	0	77	0	0	0	655	0	0	1 (0.2)	291	0	0	0	1031	0	0	1 (0.1)
Cor triatriatum	1	0	0	0	7	0	0	0	2	0	0	0	0	0	0	0	10	0	0	0
AVSD (partial)	0	0	0	0	14	0	0	1 (7.1)	36	0	0	0	6	0	0	0	56	0	0	1 (1.8)
AVSD (complete)	6	0	0	0	94	1 (1.1)	0	4 (4.3)	97	5 (5.2)	0	7 (7.2)	6	0	0	0	203	6 (3.0)	0	11 (5.4)
+ TOF or DORV	2	0	0	0	6	0	0	0	24	1 (4.2)	0	2 (8.3)	5	0	0	1 (20.0)	37	1 (2.7)	0	3 (8.1)
+ Others	1	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	5	0	0	0
VSD (subarterial)	4	0	0	0	113	0	0	0	189	0	0	0	18	0	0	0	324	0	0	0
VSD (perimemb./muscular)	14	0	0	0	849	2 (0.2)	0	4 (0.5)	340	0	0	0	50	1 (2.0)	0	1 (2.0)	1253	3 (0.2)	0	5 (0.4)
VSD (type unknown)	0	0	0	0		0	0			0	0	0	21		0		21	0	0	0
VSD + PS	0	0	0	0	40	0	0	0	19	0	0	0	0	0	0	0	59	0	0	0
DCRV ± VSD	0	0	0	0	9	0	0	0	30	0	0	0	7	0	0	0	46	0	0	0
Aneurysm of sinus Valsalva	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	4	0	0	0

Table 3 (continued)

	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	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge			Hospital	After discharge			Hospital	After discharge			Hospital	After discharge			Hospital	After discharge	
TOF	12	1 (8.3)	0	2 (16.7)	144	2 (1.4)	0	2 (1.4)	194	2 (1.0)	0	2 (1.0)	33	2 (6.1)	0	2 (6.1)	383	7 (1.8)	0	8 (2.1)
PA + VSD	10	0	0	2 (20.0)	69	3 (4.3)	0	5 (7.2)	132	4 (3.0)	0	6 (4.5)	17	0	0	0	228	7 (3.1)	0	13 (5.7)
DORV	30	2 (6.7)	0	2 (6.7)	121	3 (2.5)	0	5 (4.1)	146	4 (2.7)	0	5 (3.4)	13	0	0	0	310	9 (2.9)	0	12 (3.9)
TGA (simple)	100	3 (3.0)	0	7 (7.0)	7	0	0	0	5	1 (20.0)	0	1 (20.0)	1	0	0	0	113	4 (3.5)	0	8 (7.1)
+ VSD	42	2 (4.8)	0	4 (9.5)	29	1 (3.4)	0	1 (3.4)	24	0	0	1 (4.2)	3	1 (33.3)	0	1 (33.3)	98	4 (4.1)	0	7 (7.1)
VSD + PS	0	0	0	0	3	0	0	0	4	0	0	0	0	0	0	0	7	0	0	0
Corrected TGA	0	0	0	0	9	1 (11.1)	0	1 (11.1)	37	1 (2.7)	0	2 (5.4)	17	0	0	0	63	2 (3.2)	0	3 (4.8)
Truncus arteriosus	9	3 (33.3)	0	3 (33.3)	15	1 (6.7)	0	1 (6.7)	14	0	0	4 (28.6)	0	0	0	0	38	4 (10.5)	0	8 (21.1)
SV	21	2 (9.5)	0	3 (14.3)	184	3 (1.6)	0	7 (3.8)	194	3 (1.5)	0	6 (3.1)	15	0	0	0	414	8 (1.9)	0	16 (3.9)
TA	8	0	0	0	34	0	0	1 (2.9)	48	0	0	0	6	0	0	0	96	0	0	1 (1.0)
HLHS	34	2 (5.9)	0	5 (14.7)	132	6 (4.5)	0	10 (7.6)	57	2 (3.5)	0	3 (5.3)	1	0	0	0	224	10 (4.5)	0	18 (8.0)
Aortic valve lesion	5	0	0	0	24	1 (4.2)	0	1 (4.2)	107	0	0	2 (1.9)	28	0	0	0	164	1 (0.6)	0	3 (1.8)
Mitral valve lesion	3	1 (33.3)	0	1 (33.3)	45	2 (4.4)	0	3 (6.7)	67	0	0	0	19	0	0	1 (5.3)	134	3 (2.2)	0	5 (3.7)
Ebstein	8	2 (25.0)	0	3 (37.5)	25	0	0	0	27	0	0	0	14	0	0	0	74	2 (2.7)	0	3 (4.1)
Coronary disease	1	0	0	0	8	0	0	0	25	0	0	0	7	0	0	0	41	0	0	0
Others	11	3 (27.3)	0	4 (36.4)	37	2 (5.4)	0	3 (8.1)	45	1 (2.2)	0	1 (2.2)	56	0	0	0	149	6 (4.0)	0	8 (5.4)
Conduit failure	0	0	0	0	5	0	0	0	20	0	0	0	8	0	0	0	33	0	0	0
Redo (excluding conduit failure)	3	0	0	1 (33.3)	69	0	0	3 (4.3)	98	1 (1. 0)	0	3 (3.1)	48	0	1 (2.1)	0	218	1 (0.5)	1 (0.5)	7 (3.2)
Total	588	33 (5.6)	0	62 (10.5)	2457	30 (1.2)	0	62 (2.5)	2905	26 (0.9)	0	47 (1.6)	760	5 (0.7)	1 (0.1)	7 (0.9)	6710	94 (1.4)	1 (0.0)	178 (2.7)

(), % mortality

CPB cardiopulmonary bypass, *PDA* patient 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, *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 3 (continued)
(2) CPB (−) (total 2344)

	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	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge			Hospital	After discharge			Hospital	After discharge			Hospital	After discharge			Hospital	After discharge	
PDA	347	5 (1.4)	0	17 (4.9)	182	1 (0.5)	0	4 (2.2)	45	0	0	0	6	0	0	0	580	6 (1.0)	0	21 (3.6)
Coarctation (simple)	21	0	0	0	21	0	0	0	2	0	0	0	2	0	0	0	46	0	0	0
+ VSD	41	1 (2.4)	0	2 (4.9)	20	0	0	0	1	0	0	0	0	0	0	0	62	1 (1.6)	0	2 (3.2)
+ DORV	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	3	0	0	0
+ AVSD	6	0	0	1 (16.7)	0	0	0	0	1	0	0	0	0	0	0	0	7	0	0	1 (14.3)
+ TGA	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
+ SV	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0
+ Others	12	1 (8.3)	0	1 (8.3)	5	0	0	0	1	0	0	0	0	0	0	0	18	1 (5.6)	0	1 (5.6)
Interrupt. of Ao (simple)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+ VSD	26	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0
+ DORV	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
+ Truncus	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0
+ TGA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+ Others	2	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	4	0	0	0
Vascular ring	4	0	0	0	14	0	0	0	4	0	0	0	0	0	0	0	22	0	0	0
PS	8	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0
PA • IVS or critical PS	33	1 (3.0)	0	2 (6.1)	35	0	0	0	8	0	0	0	0	0	0	0	76	1 (1.3)	0	2 (2.6)
TAPVR	5	0	0	0	5	0	0	1 (20.0)	2	0	0	0	1	0	0	0	13	0	0	1 (7.7)
PAPVR ± ASD	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
ASD	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0
Cor triatriatum	0	0	0		0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
AVSD (partial)	2	0	0	1 0	3	0	0	0	0	0	0	0	0	0	0	0	5	0	0	1 (20.0)
AVSD (complete)	39	0	0	2 (5.1)	66	2 (3.0)	0	2 (3.0)	6	0	0	0	2	0	0	0	113	2 (1.8)	0	4 (3.5)
+ TOF or DORV	1	0	0	0	4	0	0	0	1	0	0	0	0	0	0	0	6	0	0	0
+ Others	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
VSD (subarterial)	3	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0
VSD (perimemb./muscular)	66	0	0	0	156	0	0	1 (0.6)	4	0	0	0	0	0	0	0	226	0	0	1 (0.4)
VSD + PS	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
DCRV ± VSD	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0
Aneurysm of sinus valsalva	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOF	17	0	0	0	71	0	0	0	8	0	0	0	1	0	0	0	97	0	0	0

Table 3 (continued)

	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	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge			Hospital	After discharge			Hospital	After discharge			Hospital	After discharge			Hospital	After discharge	
PA + VSD	16	0	0	1 (6.3)	61	2 (3.3)	0	3 (4.9)	35	0	0	0	0	0	0	0	112	2 (1.8)	0	4 (3.6)
DORV	50	2 (4.0)	0	2 (4.0)	76	0	0	1 (1.3)	8	0	0	0	2	0	0	0	136	2 (1.5)	0	3 (2.2)
TGA (simple)	6	0	0	0	3	0	0	0	0	0	0	0	3	0	0	0	12	0	0	0
+ VSD	10	0	0	0	9	0	0	0	2	0	0	0	0	0	0	0	21	0	0	0
VSD + PS	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
Corrected TGA	2	0	0	0	9	0	0	0	20	0	0	0	6	0	0	0	37	0	0	0
Truncus arteriosus	20	0	0	0	6	0	0	0	2	0	0	1 (50.0)	0	0	0	0	28	0	0	1 (3.6)
SV	76	2 (2.6)	0	6 (7.9)	66	1 (1.5)	0	3 (4.5)	17	0	0	0	4	0	0	0	163	3 (1.8)	0	9 (5.5)
TA	10	0	0	0	16	0	0	0	5	0	0	0	3	0	0	0	34	0	0	0
HLHS	109	2 (1.8)	0	9 (8.3)	34	0	0	0	14	0	0	0	0	0	0	0	157	2 (1.3)	0	9 (5.7)
Aortic valve lesion	8	1 (12.5)	0	2 (25.0)	3	0	0	0	2	0	0	0	1	0	0	0	14	1 (7.1)	0	2 (14.3)
Mitral valve lesion	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Ebstein	2	0	0	0	8	0	0	0	1	0	0	0	1	0	0	0	12	0	0	0
Coronary disease	0	0	0	0	0	0	0	0	4	1 (25.0)	0	1 (25.0)	0	0	0	0	4	1 (25.0)	0	1 (25.0)
Others	10	2 (20.0)	0	4 (40.0)	14	2 (14.3)	0	2 (14.3)	16	0	0	0	1	0	0	0	41	4 (9.8)	0	6 (14.6)
Conduit failure	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Redo (excluding conduit failure)	21	1 (4.8)	0	1 (4.8)	71	0	0	1 (1.4)	104	1 (1.0)	0	2 (1.9)	14	0	0	0	210	2 (1.0)	0	4 (1.9)
Total	991	18 (1.8)	0	51 (5.1)	986	8 (0.8)	0	18 (1.8)	319	2 (0.6)	0	4 (1.3)	48	0	0	0	2344	28 (1.2)	0	73 (3.1)

(), % mortality *CPB* cardiopulmonary bypass, *PDA* patient 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, *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 3 (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	Cases	30-day mortality		Hospital mortality
			Hospital	After discharge			Hospital	After discharge			Hospital	After discharge			Hospital	After discharge			Hospital	After discharge	
1	SP Shunt	135	3 (2.2)	0	7 (5.2)	364	5 (1.4)	0	8 (2.2)	63	1 (1.6)	0	1 (1.6)	4	0	0	0	566	9 (1.6)	0	16 (2.8)
2	PAB	415	7 (1.7)	0	22 (5.3)	324	1 (0.3)	0	3 (0.9)	17	0	0	0	2	0	0	0	758	8 (1.1)	0	25 (3.3)
3	Bidirectional Glenn or hemi-Fontan ± α	0	0	0	0	263	2 (0.8)	0	5 (1.9)	99	0	0	1 (1.0)	2	0	0	0	364	2 (0.5)	0	6 (1.6)
4	Damus–Kaye–Stansel operation	4	1 (25.0)	0	1 (25.0)	31	1 (3.2)	0	2 (6.5)	11	1 (9.1)	0	1 (9.1)	2	1 (50.0)	0	1 (50.0)	48	4 (8.3)	0	5 (10.4)
5	PA reconstruction/ repair(including redo)	15	1 (6.7)	0	3 (20.0)	92	3 (3.3)	0	6 (6.5)	104	0	0	1 (1.0)	5	0	0	0	216	4 (1.9)	0	10 (4.6)
6	RVOT reconstruction/ repair	5	1 (20.0)	0	1 (20.0)	161	2 (1.2)	0	3 (1.9)	308	5 (1.6)	0	6 (1.9)	33	0	0	0	507	8 (1.6)	0	10 (2.0)
7	Rastelli procedure	1	0	0	0	30	2 (6.7)	0	2 (6.7)	100	4 (4.0)	0	5 (5.0)	5	0	0	0	136	6 (4.4)	0	7 (5.1)
8	Arterial switch procedure	155	5 (3.2)	0	11 (7.1)	28	2 (7.1)	0	2 (7.1)	6	1 (16.7)	0	1 (16.7)	0	0	0	0	189	8 (4.2)	0	14 (7.4)
9	Atrial switch procedure	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	3	0	0	0
10	Double switch procedure	0	0	0	0	2	1 (50.0)	0	1 (50.0)	8	0	0	1 (12.5)	0	0	0	0	10	1 (10.0)	0	2 (20.0)
11	Repair of anomalous origin of CA	0	0	0	0	5	0	0	0	10	0	0	0	0	0	0	0	15	0	0	0
12	Closure of coronary AV fistula	0	0	0	0	2	0	0	0	7	1 (14.3)	0	1 (14.3)	8	0	0	0	17	1 (5.9)	0	1 (5.9)
13	Fontan/TCPC	0	0	0	0	0	0	0	0	347	3 (0.9)	0	9 (2.6)	23	0	0	0	370	3 (0.8)	0	9 (2.4)
14	Norwood procedure	29	2 (6.9)	0	4 (13.8)	110	7 (6.4)	0	16 (14.5)	6	1 (16.7)	0	1 (16.7)	0	0	0	0	145	10 (6.9)	0	21 (14.5)
15	Ventricular septation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Left side AV valve repair (including Redo)	3	0	0	0	48	1 (2.1)	0	1 (2.1)	53	0	0	0	14	0	0	0	118	1 (0.8)	0	1 (0.8)
17	Left side AV valve replace (including Redo)	0	0	0	0	8	1 (12.5)	0	2 (25.0)	33	0	0	1 (3.0)	14	0	0	1 (7.1)	55	1 (1.8)	0	4 (7.3)
18	Right side AV valve repair (including Redo)	7	2 (28.6)	0	3 (42.9)	22	0	0	0	41	0	0	2 (4.9)	29	0	0	0	99	2 (2.0)	0	5 (5.1)

Table 3 (continued)

		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	Cases	30-day mortality		Hospital mortality
			Hospital	After discharge			Hospital	After discharge			Hospital	After discharge			Hospital	After discharge			Hospital	After discharge	
19	Right side AV valve replace (including Redo)	0	0	0	0	1	0	0	0	7	0	0	0	16	0	0	0	24	0	0	0
20	Common AV valve repair(including Redo)	3	0	0	0	14	0	0	2 (14.3)	19	2 (10.5)	0	2 (10.5)	2	0	0	0	38	2 (5.3)	0	4 (10.5)
21	Common AV valve replace(including Redo)	0	0	0	0	7	1 (14.3)	0	1 (14.3)	8	0	0	1 (12.5)	1	0	0	0	16	1 (6.3)	0	2 (12.5)
22	Repair of supra-aortic stenosis	1	0	0	0	10	1 (10.0)	0	1 (10.0)	17	0	0	0	1	0	0	0	29	1 (3.4)	0	1 (3.4)
23	Repair of subaortic stenosis (including Redo)	0	0	0	0	4	0	0	0	34	0	0	0	5	0	0	0	43	0	0	0
24	Aortic valve plasty ± VSD closure	2	0	0	0	12	0	0	0	24	0	0	1 (4.2)	2	0	0	0	40	0	0	1 (2.5)
25	Aortic valve replacement	0	0	0	0	1	0	0	0	26	0	0	0	23	0	0	0	50	0	0	0
26	AVR with annular enlargement	0	0	0	0	0	0	0	0	13	1 (7.7)	0	1 (7.7)	1	0	0	0	14	1 (7.1)	0	1 (7.1)
27	Aortic root replacement (except Ross)	0	0	0	0	0	0	0	0	12	0	0	1 (8.3)	6	0	0	0	18	0	0	1 (5.6)
28	Ross procedure	0	0	0	0	2	1 (50.0)	0	1 (50.0)	12	0	0	0	0	0	0	0	14	1 (7.1)	0	1 (7.1)
Total		775	22 (2.8)	0	52 (6.7)	1543	31 (2.0)	0	56 (3.6)	1386	20 (1.4)	0	37 (2.7)	198	1 (0.5)	0	2 (1.0)	3902	74 (1.9)	0	147 (3.8)

(), % mortality *SP* systemic pulmonary, *PAB* pulmonary artery banding, *PA* pulmonary artery, *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 4 Acquired [total, (1) + (2) + (4) + (5) + (6) + (7) + isolated ope. for arrhythmia in (3)] 39,485(1) Valvular heart disease (total 21,939)

	Valve	Cases	Operation					30-day mortality				Hospital mortality		Redo			
			Mechanical	Bioprosthesis	Ross procedure	Repair	With CABG	Hospital		After discharge					30-day mortality		Hospital mortality
								Replace	Repair	Replace	Repair	Replace	Repair	Cases	Hospital	After discharge	
Isolated	A	8651	1653	6704	1	293	2492	165 (2.0)	6 (2.0)	1 (0.01)	0	249 (3.0)	12 (4.1)	513	21 (4.1)	0	29 (5.7)
	M	4524	583	789		3152	794	72 (5.2)	36 (1.1)	1 (0.1)	1 (0.03)	111 (8.1)	55 (1.7)	521	23 (4.4)	0	37 (7.1)
	T	261	5	54		202	30	5 (8.5)	8 (4.0)	0	0	12 (20.3)	13 (6.4)	81	6 (7.4)	0	12 (14.8)
	P	11	2	7		2	0	0	0	0	0	0	0	7	0	0	0
A + M	A	1192	305	840	0	55	237	58 (4.9)		0		98 (8.2)		136			
															13 (9.6)	0	21 (15.4)
	M		194	353		801											
A + T	A	390	78	307	0	6	82	12 (3.1)		0		22 (5.6)		61			
															4 (6.6)	0	7 (11.5)
	T		0	10		380											
M + T	M	3337	440	881		2022	343	57 (1.7)		1 (0.0)		119 (3.6)		372			
															15 (4.0)	0	31 (8.3)
	T		2	35		3300											
A + M + T	A	819	219	589	0	23	117	55 (6.7)		1 (0.1)		88 (10.7)		110			
	M		163	322		442									13 (11.8)	0	18 (16.4)
	T		0	7		812											
Others		635	3	20	0	27	22	13 (2.0)		0		19 (2.3)		78	1 (1.3)	0	1
Total		19,820					4117	487 (2.5)		5 (0.03)		798 (4.0)		1879	96 (5.1)	0	156 (8.3)

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
TAVR	1132	16 (1.4)	1 (0.1)	24 (2.1)

(), % mortality

CABG coronary artery bypass grafting, *A* aortic valve, *M* mitral valve, *T* tricuspid valve, *P* pulmonary valve; number of redo cases is included in total case number of 21,939

Table 4 (continued)

(2) Ischemic heart disease (total, (A) + (B) + (C), 15,103)

(A) Isolated CABG (total, (a) + (b), 13,830)

(a−1) On-pump arrest CABG (total 3121)

	Primary, elective				Primary, emergency				Redo, elective				Redo, emergency				Arterial graft only	Artery graft + SVG	SVG only	Others	Unclear
	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						
1VD	78	4 (5.1)	0	4 (5.1)	11	3 (27.3)	0	5 (45.5)	2	0	0	0	3	0	0	0	45	24	25	0	0
2VD	345	3 (0.9)	0	5 (1.4)	47	5 (10.6)	0	6 (12.8)	6	0	0	0	0	0	0	0	68	302	25	3	0
3VD	1186	14 (1.2)	0	28 (2.4)	174	9 (5.2)	0	11 (6.3)	10	2 (20.0)	0	2 (20.0)	2	0	0	0	92	1234	31	6	9
LMT	945	10 (1.1)	0	14 (1.5)	297	20 (6.7)	1 (0.3)	25 (8.4)	10	1 (10.0)	0	1 (10.0)	5	1 (20.0)	0	1 (20.0)	130	1078	43	5	1
Total	2554	31 (1.2)	0	51 (2.0)	529	37 (7.0)	1 (0.2)	47 (8.9)	28	3 (10.7)	0	3 (10.7)	10	1 (10.0)	0	1 (10.0)	335	2638	124	14	10
Kawasaki	15	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	7	7	1	0	1
Hemodialysis	220	7 (3.2)	0	11 (5.0)	57	9 (15.8)	0	13 (22.8)	4	1 (25.0)	0	1 (25.0)	0	0	0	0	19	245	16	1	3

(), % mortality

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

LMT includes LMT alone or LMT with other branch diseases

(a−2) On-pump beating CABG (total 2024)

	Primary, elective				Primary, emergency				Redo, elective				Redo, emergency				Arterial graft only	Artery graft + SVG	SVG only	Others	Unclear
	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						
1VD	25	0	0	1 (4.0)	10	1 (10.0)	0	1 (10.0)	7	0	0	0	2	2 (100.0)	0	2 (100.0)	16	16	12	0	0
2VD	184	1 (0.5)	0	2 (1.1)	48	5 (10.4)	0	7 (14.6)	6	0	0	0	2	0	0	0	47	173	13	1	6
3VD	643	13 (2.0)	1 (0.2)	24 (3.7)	174	19 (10.9)	0	24 (13.8)	10	1 (10.0)	0	1 (10.0)	2	1 (50.0)	0	1 (50.0)	95	691	30	2	11
LMT	591	8 (1.4)	0	10 (1.7)	305	32 (10.5)	0	41 (13.4)	9	0	0	0	6	2 (33.3)	0	2 (33.3)	143	706	44	5	13
Total	1443	22 (1.5)	1 (0.1)	37 (2.6)	537	57 (10.6)	0	73 (13.6)	32	1 (3.1)	0	1 (3.1)	12	5 (41.7)	0	5 (41.7)	301	1586	99	8	30
Kawasaki	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0
Hemodialysis	182	7 (3.8)	0	13 (7.1)	76	18 (23.7)	0	23 (30.3)	2	0	0	0	3	1 (33.3)	0	1 (33.3)	25	214	19	2	3

() % mortality

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

LMT includes LMT alone or LMT with other branch diseases

Table 4 (continued)

(b) Off-pump CABG (total 8685)(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	Unclear
	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						
1VD	464	0	0	1 (0.2)	58	2 (3.4)	0	3 (5.2)	10	0	0	0	5	1 (20.0)	0	1	(20.0)	386	111	32	1	7
2VD	1172	6 (0.5)	0	10 (0.9)	143	4 (2.8)	0	7 (4.9)	17	0	0	0	5	2 (40.0)	0	2	(40.0)	477	785	44	9	22
3VD	2939	20 (0.7)	1 (0.0)	44 (1.5)	417	13 (3.1)	0	21 (5.0)	22	0	0	0	7	0	0	1	(14.3)	706	2595	49	11	24
LMT	2694	12 (0.4)	0	31 (1.2)	683	18 (2.6)	0	24 (3.5)	36	4 (11.1)	0	5 (13.9)	13	2 (15.4)	0	2	(15.4)	956	2367	94	13	0
Total	7269	38 (0.5)	1 (0.0)	86 (1.2)	1301	37 (2.8)	0	55 (4.2)	85	4 (4.7)	0	5 (5.9)	30	5 (16.7)	0	6	(20.0)	2525	5858	219	34	53
Kawasaki	12	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0		11	2	0	0	1
Hemodialysis	706	18 (2.5)	0	32 (4.5)	135	7 (5.2)	0	11 (8.1)	14	4 (28.6)	0	4 (28.6)	8	1 (12.5)	0	1	(12.5)	212	610	33	4	4

() % mortality

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

LMT includes LMT alone or LMT with other branch diseases

(c) Includes cases of conversion, during surgery, from off-pump CABG to on-pump CABG or on-pump beating-heart CABG (total 240)

	Primary, elective				Primary, emergency				Redo, elective				Redo, emergency			
	Cases	30-day mortality			Cases	30-day mortality			Cases	30-day mortality			Cases	30-day mortality		
		Hospital	After discharge	Hospital mortality		Hospital	After discharge	Hospital mortality		Hospital	After discharge	Hospital mortality		Hospital	After discharge	Hospital mortality
A conversion to on-pump CABG arrest heart	36	3 (8.3)	0	3 (8.3)	9	2 (22.2)	0	2 (22.2)	4	2 (50.0)	0	2 (50.0)	0	0	0	0
A conversion to on-pump beating-heart CABG	132	4 (3.0)	0	9 (6.8)	56	8 (14.3)	0	11 (19.6)	2	0	0	0	1	0	0	0
Total	168	7 (4.2)	0	12 (7.1)	65	10 (15.4)	0	13 (20.0)	6	2 (33.3)	0	2 (33.3)	1	0	0	0
Hemodialysis	30	4 (13.3)	0	5 (16.7)	11	3 (27.3)	0	4 (36.4)	3	2 (66.7)	0	2 (66.7)	0	0	0	0

(), % mortality

CABG coronary artery bypass grafting

Table 4 (continued)
(B) Operation for complications of MI (total 1273)

	Chronic				Acute				Concomitant operation		
	Cases	30-day mortality		Hospital mortality	Cases	30-day mortality		Hospital mortality			
		Hospital	After discharge			Hospital	After discharge		CABG	MVP	MVR
Infarctectomy or aneurysmectomy	202	13	0	19	19	2	0	2	143	68	10
		(6.4)		(9.4)		(10.5)		(10.5)			
VSP closure	56	4	0	10	219	64	1	87	89	4	6
		(7.1)		(17.9)		(29.2)	(0.5)	(39.7)			
Cardiac rupture	14	4	0	4	199	71	1	80	33	1	3
		(28.6)		(28.6)		(35.7)	(0.5)	(40.2)			
Mitral regurgitation											
1)Papillary muscle rupture	14	1	0	3	50	15	0	17	30	10	52
		(7.1)		(21.4)		(30.0)		(34.0)			
2) Ischemic	326	22	0	33	44	10	0	13	279	260	108
		(6.7)		(10.1)		(22.7)		(29.5)			
Others	54	5	0	7	76	14	0	23	55	10	2
		(9.3)		(13.0)		(18.4)		(30.3)			
Total	666	49	0	76	607	176	2	222	629	353	181
		(7.4)		(11.4)		(29.0)	(0.3)	(36.6)			

(), % mortality

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

Acute, within 2 weeks from the onset of myocardial infarction

Table 4 (continued)
(C) TMLR (total 0)

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

TMLR transmyocardial laser revascularization

(3) Operation for arrhythmia (total 5765)

	Cases	30-day mortality		Hospital mortality	Concomitant operation						
					Isolated	Congenital	Valve	IHD	Others	Multiple combination	
		Hospital	After discharge							2 categories	3 categories
Maze	3795	73 (1.9)	1 (0.03)	108 (2.8)	80	180	3338	607	290	636	49
For WPW	2	0	0	0	0	0	2	0	0	0	0
For ventricular tachyarrhythmia	40	1 (2.5)	0	2 (5.0)	2	0	15	24	8	8	1
Others	1928	35 (1.8)	0	68 (3.5)	122	82	1531	400	214	384	30
Total	5765	109 (1.9)	1 (0.02)	178 (3.1)	204	262	4886	1031	512	1028	80

() % mortality

Except for 106 isolated cases, all remaining 3749 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 184)

	CPB (+)				CPB (−)			
	Cases	30-day mortality		Hospital mortality	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge			Hospital	After discharge	
Total	96	10 (10.4)	0	17 (17.7)	88	5 (5.7)	0	7 (8.0)

() % mortality

CPB cardiopulmonary bypass

(5) Cardiac tumor (total 560)

	Cases	30-day mortality		Hospital mortality	Concomitant operation			
		Hospital	After discharge		AVR	MVR	CABG	others
Benign tumor (cardiac myxoma)	465	2 (0.4)	0	6 (1.3)	10	7	32	82
	347	1 (0.3)	0	4 (1.2)	8	4	22	53
Malignant tumor (primary)	95	9 (9.5)	1 (1.1)	12 (12.6)	0	3	3	15
	29	3 (10.3)	1 (3.4)	3 (10.3)	0	1	2	7

(), % mortality

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

Table 4 (continued)
(6) HOCM and DCM (total 304)

	Cases	30-day mortality		Hospital mortality	Concomitant operation			
		Hospital	After discharge		AVR	MVR	MVP	CABG
Myectomy	139	6 (4.3)	0	10 (7.2)	73	33	16	20
Myotomy	4	0	0	0	1	0	1	1
No resection	144	7 (4.9)	0	15 (10.4)	27	63	81	16
Volume reduction surgery of the left ventricle	17	0	0	2 (11.8)	0	1	13	4
Total	304	13 (4.3)	0	27 (8.9)	101	97	111	41

(), % 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 669)

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
Open-heart operation	390	32 (8.2)	0	41 (10.5)
Non-open-heart operation	279	33 (11.8)	1 (0.4)	38 (13.6)
Total	669	65 (9.7)	1 (0.1)	79 (11.8)

(), % mortality

and thoracic aneurysm in our study, then, the number of CABG still remained over 20,000 cases per year (20,785 cases) in 2015. Data for individual categories are summarized in Tables 3, 4, 5, 6, 7, 8 and 9.

In 2015, 6894 open-heart operations for congenital heart disease were performed with overall hospital mortality of 2.7%. The number of operations for congenital heart disease decreased gradually throughout these 10 years (maximum 7386 cases in 2006), and overall hospital mortality showed plateau around 3.0%. In detail, the most common disease was ventricular septal defect (1253 cases), for the first time since the inauguration of this survey. Atrial septal defect (ASD), which had been the most common disease, was the "second" common one (1031 cases) in 2015. It was mainly due to the development of catheter device for ASD closure commercially available in Japan since 2005. In the last 10 years, hospital mortality for complex congenital heart disease was as follows (2005 [2], 2010 [3], and 2015): complete atrio-septal defect (4.7, 4.2 and 1.7%), tetralogy of Fallot (1.6, 0.8 and 1.3%), transposition of the great arteries with intact septum (6.2, 4.1 and 6.6%) and with ventricular septal defect (15.9, 7.3 and 3.9%), single ventricle (5.3, 7.5 and 4.3%), and hypoplastic left heart syndrome (24.4, 13.1 and 9.8%). Right heart bypass surgery is now commonly performed (364 bidirectional Glenn procedures excluding 48 Damus–Kaye–Stansel procedures and 370 Fontan type procedures including total cavopulmonary connection) with acceptable hospital mortality (1.6 and 2.4%). Norwood type I procedure was performed in 145 cases with relatively low hospital mortality rate of 14.5%.

The number of operations for valvular heart disease has constantly increased until 2014 (21,939 cases) [1], and that was 19,820 cases in 2015. The hospital mortality of primary single valve placement was 2.8 and 8.7% for the aortic and the mitral position, while that for primary mitral valve repair was 1.7%. Hospital mortality rate for redo valve surgery was 5.7% in aortic and 7.1% in mitral positions, respectively. Finally, overall hospital mortality did not show dramatic improvement during the last 10 years (3.6% in 2005 [2], 3.1% in 2010 [3], and 4.0% in 2015), which might be partially due to the recent progression of age of the patients. Repair of the valve became a popular procedure (377 cases in the aortic, 6417 cases in the mitral, and 4942 cases in the tricuspid), and mitral valve repair constituted 32.4% of all valvular operations and 65.0% of all mitral valve procedures, which are similar to those of the last 5 years. Aortic and mitral valve

Table 5 Thoracic aortic aneurysm (total 17,444)

(1) Dissection (total 8547)

Stanford type	Acute								Chronic								Concomitant operation						Redo			
	A				B				A				B													
Replaced site	Cases	30-day mortality		Hospital mortality	Cases	30-day mortality		Hospital mortality	Cases	30-day mortality		Hospital mortality	Cases	30-day mortality		Hospital mortality	AVP	AVR	MVP	MVR	CABG	Others	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge			Hospital	After discharge			Hospital	After discharge			Hospital	After discharge									Hospital	After discharge	
1. Ascending Ao.	2458	209 (8.5)	0	259 (10.5)	15	0	0	0	318	9 (2.8)	0	17 (5.3)	11	0	0	1 (9.1)	117	154	14	16	148	61	102	7 (6.9)	0	9 (8.8)
2. Aortic Root	165	29 (17.6)	1 (0.61)	35 (21.2)	0	0	0	0	75	2 (2.7)	0	4 (5.3)	3	1 (33.3)	0	1 (33.3)	28	122	3	2	50	9	39	6 (15.4)	0	6 (15.4)
3. Arch	1357	134 (9.9)	0	172 (12.7)	30	4 (13.3)	0	5 (16.7)	318	8 (2.5)	0	15 (4.7)	220	9 (4.1)	0	12 (5.5)	63	89	11	6	106	45	151	9 (6.0)	0	14 (9.3)
4. Aortic root + Asc.Ao. + arch	229	41 (17.9)	1 (0.44)	41 (17.9)	1	0	0	0	61	6 (9.8)	0	7 (11.5)	12	0	0	1 (8.3)	29	138	5	0	60	6	31	4 (12.9)	0	5 (16.1)
5. Descending Ao.	58	7 (12.1)	0	7 (12.1)	37	8 (21.6)	1 (2.7)	9 (24.3)	85	4 (4.7)	0	6 (7.1)	314	18 (5.7)	0	24 (7.6)	1	6	0	0	7	1	28	10 (35.7)	0	16 (57.1)
6. Thoracoabdominal Ao.	11	1 (9.1)	0	2 (18.2)	12	2 (16.7)	0	2 (16.7)	41	1 (2.4)	0	2 (4.9)	199	11 (5.5)	0	14 (7.0)	0	1	0	0	2	0	135	6 (4.4)	0	7 (5.2)
7. Stent graft *a	595	47 (7.9)	0	61 (10.3)	362	32 (8.8)	2 (0.6)	40 (11.0)	313	8 (2.6)	0	16 (5.1)	1245	23 (1.8)	2 (0.2)	36 (2.9)	15	53	4	0	59	27	577	23 (4.0)	1 (0.2)	35 (6.1)
1) TEVARI*b	90	11 (12.2)	0	13 (14.4)	303	23 (7.6)	2	31 (10.2)	161	5 (3.1)	0	9 (5.6)	1013	20 (2.0)	1 (0.1)	28 (2.8)	2	4	0	0	4	3	449	14 (3.1)	0	20 (4.5)
2) Open stent	505	36 (7.1)	0	48 (9.5)	59	9 (15.3)	0	9 (15.3)	152	3 (2.0)	0	7 (4.6)	232	3 (1.3)	1 (0.4)	8 (3.4)	13	49	4	0	55	24	128	9 (7.0)	1 (0.8)	15 (11.7)
a) With total arch *c	472	32 (6.8)	0	44 (9.3)	34	6 (17.6)	0	6 (17.6)	137	3 (2.2)	0	6 (4.4)	145	1 (0.7)	1 (0.7)	4 (2.8)	13	48	4	0	52	20	83	5 (6.0)	1 (1.2)	10 (12.0)
b) Without total arch *d	33	4 (12.1)	0	4 (12.1)	25	3 (12.0)	0	3 (12.0)	15	0	0	1 (6.7)	87	2 (2.3)	0	4 (4.6)	0	1	0	0	3	4	45	4 (8.9)	0	5 (11.1)
() % mortality	4875	468 (9.6)	2 (0.04)	577 (11.8)	457	46 (10.1)	3 (0.7)	56 (12.3)	1211	38 (3.1)	0	67 (5.5)	2004	62 (3.1)	2 (0.1)	89 (4.4)	253	563	37	24	432	149	1134	65 (5.7)	1 (0.1)	92 (8.1)

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 5 (continued)
(2) Non-dissection (total 8897)

Replaced site	Unruptured				Ruptured				Concomitant operation						Redo			
	Cases	30-day mortality		Hospital mortality	Cases	30-day mortality		Hospital	AVp	AVR	MVP	MVR	CABG	Others	Case	30-day mortality		Hospital mortality
		Hospital	After discharge			Hospital	After discharge	Mortality								Hospital	After discharge	
1. Ascending Ao.	1375	25	0	41	46	6	0	10	65	991	85	36	184	215	148	10	0	15
		(1.8)		(3.0)		(13.0)		(21.7)								(6.8)		(10.1)
2. Aortic root	735	24	0	30	29	7	0	8	168	485	50	10	100	91	160	14		16
		(3.3)		(4.1)		(24.1)		(27.6)								(8.8)		(10.0)
3. Arch	1714	57	0	107	123	19	0	30	25	278	22	15	301	106	183	9	0	21
		(3.3)		(6.2)		(15.4)		(24.4)								(4.9)		(11.5)
4. Aortic root + Asc.Ao. + Arch	257	8	0	11	16	2	0	2	49	167	21	1	34	46	41	4	0	5
		(3.1)		(4.3)		(12.5)		(12.5)								(9.8)		(12.2)
5. Descending Ao.	365	13	0	20	52	12	0	17	2	10	2	0	28	3	86	7	0	11
		(3.6)		(5.5)		(23.1)		(32.7)								(8.1)		(12.8)
6. Thoracoabdominal Ao.	356	18	0	34	35	10	0	11	0	2	0	0	2	0	116	12	0	20
		(5.1)		(9.6)		(28.6)		(31.4)								(10.3)		(17.2)
7. Stent graft *a	3489	96	3	161	389	65	1	83	19	65	10	2	184	52	770	38	1	55
		(2.8)	(0.1)	(4.6)		(16.7)	(0.3)	(21.3)								(4.9)	(0.1)	(7.1)
1) TEVARl*b	2334	51	1	80	298	51	1	63	1	3	1	0	14	10	626	28	1	39
		(2.2)	(0.0)	(3.4)		(17.1)	(0.3)	(21.1)								(4.5)	(0.2)	(6.2)
2) Open stent	1075	45	2	81	91	14	0	20	18	62	9	2	170	42	144	10	0	16
		(4.2)	(0.2)	(7.5)		(15.4)		(22.0)								(6.9)		(11.1)
a) With total arch *c	296	14	1	17	38	6	0	7	2	3	1	1	22	4	52	3	0	3
		(4.7)	(0.3)	(5.7)		(15.8)		(18.4)								(5.8)		(5.8)
b) Without total arch *d	779	31	1	64	53	8	0	13	16	59	8	1	148	38	92	7	0	13
		(4.0)	(0.1)	(8.2)		(15.1)		(24.5)								(7.6)		(14.1)
Total	8209	249	3	404	688	121	1	161	328	1998	190	64	833	513	1504	94	1	143
		(3.0)	(0.04)	(4.9)		(17.6)	(0.1)	(23.4)								(6.3)	(0.1)	(9.5)

(), % 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 6 Pulmonary thromboembolism (total 134)

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
Acute	75	18 (24.0)	0	19 (25.3)
Chronic	59	0	0	0
Total	134	18 (13.4)	0	19 (14.2)

( ), % mortality

replacements with bioprosthesis were performed in 6704 cases and 789 cases, respectively. The ratio of bioprosthesis was 76.4% at the aortic and 23.8% at the mitral position. This ratio of the aortic bioprosthesis increased dramatically from 30 to 40% in the early 2000s [4, 5] to more than 70% recent 5 years. CABG as a concomitant procedure was performed in 20.8% of operations for all valvular heart disease (14.4% in 2005 [2] and 17.3% in 2010 [3]).

Isolated CABG was performed in 13,830 cases which were only 75.4% of that of 10 years ago (2005 [2]). Among these, off-pump CABG was intended in 8685 cases (63.0%) with a success rate of 97.2%, so final success rate of off-pump CABG was 61.1%. The percentage of intended off-pump CABG reached 60.3% in 2004 [4] and then was kept over 60% until now. In 13,830 isolated CABG patients, 96.8% of them received at least one arterial graft, while all arterial graft CABGs were performed only in 22.9% of them. The operative and hospital mortality rates associated with primary elective CABG procedures in 11,266 cases were 0.8 and 1.5%, respectively. Similar data analysis of CABG including primary/redo and elective/emergency data was begun in 2003 [5], and the operative and hospital mortality rates associated with primary elective CABG procedures in 2003 were 1.0 and 1.5%, respectively, so operative results of primary CABG have been stable. Hospital mortality of primary emergency CABG in 2367 cases was still high and was 7.4%. The result of conversion from off-pump CABG rate was 2.8% and hospital mortality in that was 11.3%. A total of 1273 patients underwent surgery for complications of myocardial infarction, including 272 operations for left ventricular aneurysm, ventricular septal perforation or cardiac rupture and 340 operations for ischemic mitral regurgitation.

Operations for arrhythmia were performed mainly as a concomitant procedure in 5765 cases associated with 49.5% increase comparing with that of 2014. The hospital mortality of arrhythmia surgery including 3795 MAZE procedures was 3.1%. MAZE procedure has become quite popular procedure (2497 cases in 2005 [2] and 3591 cases in 2010 [3]).

Operations for thoracic aortic dissection were performed in 8691 cases and this increased by 12.4% this year compared with those of last year. For 6575 Stanford type A acute aortic dissections, hospital mortality remained high and was 9.9%. Operations for a non-dissected thoracic

Table 7 Assisted circulation (total 1637)

Sites	VAD									Heart–lung assist					
	Device			Results						Method		Results			
	Centrifugal	VAS (extra)	VAS (implant)	Not weaned			Weaned			PCPS	Others	Not weaned		Weaned	
				On going	Death	Transplant	Alive	Deaths	Transplant			Deaths	Transplant	Deaths	Alive
Post-cardiotomy															
Left	13	4	2	3	9 (47.4)	0	12	4 (21.1)	0						
Right	8	0	0	0	2 (25.0)	0	5	1	0						
Biventricle															
Right	4	0	0	0	3 (75.0)	0	1	0 (0.0)	0	485	99	269 (46.1)	0	87 (14.9)	228
Left	2	2	0												
Congestive heart failure															
Left	61	37	135	131	57 (24.5)	1	41	15 (6.4)	2						
Right	4	0	0	1	0 (0.0)	0	2	0 (0.0)	1						
Biventricle															
Right	24	10	2	8	18 (50.0)	0	7	2 (5.6)	1	624	30	326 (49.8)	2	90 (13.8)	236
Left	17	19	0												
Respiratory failure										80	40	35 (29.2)	0	16 (13.3)	44
Total	133	72	139	143	89 (25.9)	1	68	22 (6.4)	4	1189	169	630 (46.4)	2	193 (14.2)	508

( ), % mortality

Table 8 Heart transplantation (total 44)

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
Heart transplantation	44	0	0	0
Heart and lung transplantation	0	0	0	0
Total	44	0	0	0

( ), % mortality

Table 9 Pacemaker + ICD (total 4078)

	Pacemaker			ICD	
	V	A–V	CRT	CRTD	ICD
Initial	442	1700	66	158	251
Exchange	350	862	45	93	111
Unclear	0	0	0	0	0
Total	792	2562	111	251	362

aneurysm were carried out in 9226 cases (decreased by 5.6%), with overall hospital mortality of 6.0%. The hospital mortality associated with unruptured aneurysm was 4.5%, and that of ruptured aneurysm was 24.2%, which remains markedly high.

The number of stent graft procedures remarkably increased recently. A total of 2521 patients with aortic dissection underwent stent graft placement: thoracic endovascular aortic repair (TEVAR) in 1650 cases and open stent grafting in 871 cases. The number of TEVAR for type B chronic aortic dissections increased from 835 cases in 2014 to 1065 cases in 2015. The hospital mortality rates associated with TEVAR for type B aortic dissection were 8.9% in acute cases and 2.6% for chronic cases, respectively.

A total of 3935 patients with non-dissected aortic aneurysm underwent stent graft placement: TEVAR in 2912 cases (17.3% decrease compared with that in 2014) and open stent grafting in 937 cases (155% increase compared with that in 2014). The reason of striking increase of open stent grafting might be due to commercial availability since 2014. The hospital mortality rates for TEVAR and open stenting were as follows: TEVAR (3.2% for unruptured, 21.7% for ruptured aneurysm,) and open stenting (7.2% for unruptured and 25.6% for ruptured.)

In summary, the total cardiovascular operations decreased during 2015 by 2933 cases with steadily constant

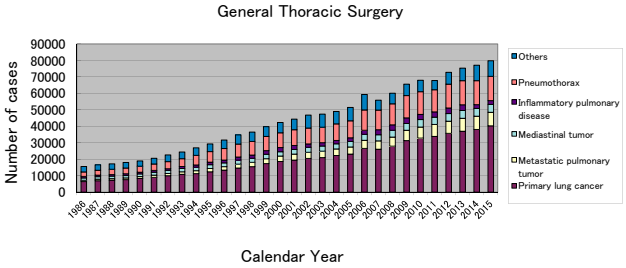

Fig. 2 General thoracic surgery

results in almost all categories. The main reason why the number of operations decreased in 2015 was the number of extra-anatomical bypass operations in thoracic aortic aneurysm and the number of trans-venous pacemaker implantations was excluded from the total number of cardiovascular operations in association with the change of data aggregation as was referred to earlier.

(B) General thoracic surgery

The 2015 survey of general thoracic surgery comprised 736 surgical units, and most data were submitted using the web-based collection system of the national clinical database

Table 10 Total entry cases of General Thoracic Surgery during 2015

	Cases	%
Benign pulmonary tumor	2161	2.7
Primary lung cancer	40,302	50.5
Other primary malignant pulmonary tumor	385	0.5
Metastatic pulmonary tumor	8226	10.3
Tracheal tumor	166	0.2
Mesothelioma	635	0.8
Chest wall tumor	677	0.8
Mediastinal tumor	4813	6.0
Thymectomy for MG without thymoma	164	0.2
Inflammatory pulmonary disease	2265	2.8
Empyema	2739	3.4
Bullous disease excluding pneumothorax	416	0.5
Pneumothorax	14,728	18.5
Chest wall deformity	174	0.2
Diaphragmatic hernia including traumatic	36	0.0
Chest trauma excluding diaphragmatic hernia	388	0.5
Lung transplantation	63	0.1
Others	1437	1.8
Total	79,775	100.0

Table 11
1. Benign pulmonary tumor

	Cases	30-day mortality		Hospital mortality	By VATS	
		Hospital	After discharge		2015	2014*
Hamartoma	478	0	0	0	469	454
Sclerosing hemangioma	125	0	0	0	118	96
Papilloma	20	0	0	0	19	16
Mucous gland adenoma bronchial	5	0	0	0	5	7
Fibroma	166	0	0	0	162	128
Lipoma	10	0	0	0	8	6
Neurogenic tumor	15	0	0	0	13	16
Clear cell tumor	4	0	0	0	4	2
Leiomyoma	10	0	0	0	10	16
Chondroma	6	0	0	0	6	4
Inflammatory myofibroblastic tumor	3	0	0	0	3	1
Pseudolymphoma	23	0	0	0	22	31
Histiocytosis	20	0	0	0	19	22
Teratoma	8	0	0	0	5	0
Others	1268	1 (0.1)	0	3 (0.2)	1200	1266
Total	2161	1 (0.0)	0	3 (0.1)	2063	2065

( ) Mortality %

*Unpublished reference data

(NCD) [1]. In total, 79,775 operations were reported by general thoracic surgery departments in 2015—1.8 times the number of operations in 2001 and 2705 more operations than in 2014 (Fig. 2).

In 2015, 40,302 operations for primary lung cancer were performed (Table 10), and the number has increased every year. The 2015 value is 2.1 times that of 2001. Operations for lung cancer were 50.5% of all procedures in general thoracic surgery.

The number of video-assisted thoracic surgery (VATS) procedures in the NCD unexpectedly increased in 2014; however, the exact number of such procedures was not published. The increase was attributed to the use of a non-standard definition of VATS for the NCD registry until 2013. The NCD registry previously included VATS procedures utilizing a skin incision longer than 8 cm and/or a minithoracotomy (hybrid) approach, which are traditionally not regarded as VATS procedures. In this report, the traditional VATS definition is used to describe the number of VATS procedures in the NCD. The number of VATS operations for benign pulmonary tumor, primary lung cancer, and the total number of VATS operation in 2014 and 2015 are shown in Tables 11, 12, 14, 17, 18, 19, 20, 21, 22, 23, 24, 26, 27, 28, and 30, respectively.

There were 2161 operations for benign pulmonary tumors in 2015, which was similar to the number in 2014 (Table 11). Hamartoma was the most frequent diagnosis in operations for benign pulmonary tumors. VATS was performed in 2063 patients (95.5%). Additional information on primary malignant pulmonary tumors is shown in Tables 12 and 13. With regard to lung cancer subtype, adenocarcinoma was by far the most frequent diagnosis (70.0% of all lung cancer operations), followed by squamous cell carcinoma (19.0%). Sublobar resection was performed in 10,040 lung cancer cases (24.9% of all cases) and lobectomy was performed in 29,323 cases (72.8% of all cases). Sleeve lobectomy was performed in 541 cases, and pneumonectomy was required in 533 cases (1.3% of all cases). VATS lobectomy for lung cancer was performed in 18,078 cases (61.7%). The number of VATS procedures for primary lung cancer was slightly higher than in 2014.

In total, 129 patients died before hospital discharge within 30 days after lung cancer surgery, and 45 patients died after discharge within 30 days after lung cancer surgery. Therefore, 174 patients died within 30 days after lung cancer surgery (30-day mortality rate, 0.43%). In total, 277 patients died before discharge (hospital mortality rate, 0.69%), and the 30-day mortality rate, by procedure, was 0.26% for segmentectomy, 0.44% for lobectomy, and 2.44% for pneumonectomy. Interstitial pneumonia was the leading cause of death after lung cancer surgery, followed

Table 12
2. Primary malignant pulmonary tumor

	Cases	Hospital	After discharge	Hospital mortality	By VATS	
					2015	2014*
2. Primary malignant pulmonary tumor						
Lung cancer	40,687	129 (0.3)	45 (0.1)	275 (0.7)	26,188	24,306
Adenocarcinoma	28,206	47 (0.2)	21 (0.1)	87 (0.3)		
Squamous cell carcinoma	7651	60 (0.8)	15 (0.2)	132 (1.7)		
Large cell carcinoma	744	5 (0.7)	1 (0.1)	14 (1.9)		
(LCNEC)	*465*	*2* (0.4)	0	*10* (2.2)		
Small cell carcinoma	707	6 (0.8)	0	11 (1.6)		
Adenosquamous carcinoma	583	3 (0.5)	1 (0.2)	6 (1.0)		
Carcinoma with pleomorphic, sarcomatoid or sarcomatous elements	473	3 (0.6)	5 (1.1)	7 (1.5)		
Carcinoid	237	1 (0.4)	0	1 (0.4)		
Carcinomas of salivary gland type	35	0	0	0		
Unclassified	54	1 (1.9)	0	2 (3.7)		
Multiple lung cancer	1245	3 (0.2)	0	11 (0.9)		
Others	367	0	2 (0.5)	2 (0.5)		
Wedge resection	5810	10 (0.2)	4 (0.1)	25 (0.4)	4917	4359
Segmental excision	4230	10 (0.24)	1 (0.0)	17 (0.4)	2950	2836
(*Sleeve segmental excision*)	*11*	*0*	*0*	*0*	*7*	*7*
Lobectomy	29,323	96 (0.3)	33 (0.1)	206 (0.7)	18,078	16,676
(*Sleeve lobectomy*)	*541*	*4* (0.7)	*2* (0.4)	*12* (2.2)	*75*	*69*
Pneumonectomy	533	7 (1.3)	6 (1.1)	13 (2.4)	55	48
(*Sleeve pneumonectomy*)	*10*	0	0	*1* (10.0)	*0*	*0*
Other bronchoplasty	43	2 (4.7)	1 (2.3)	4 (9.3)	5	5
Pleuropneumonectomy	3	0	0	0	0	0
Others	351	4 (1.1)	0	8 (2.3)	183	202
Unknown	9	0	0	0		
Sarcoma	47	0	0	2 (4.3)		
AAH	109	0	0	0		
Others	229	0	0	0		

( ) Mortality %

*Unpublished reference data

by pneumonia, respiratory failure, and cardiovascular events, as was the case in 2014.

Operations for metastatic pulmonary tumors are shown in Table 14; 8226 such operations were performed in 2015, an increase from the previous year. Colorectal cancer was the most frequent diagnosis (47.2% of all cases).

There were 127 operations for malignant tracheal tumor in 2015, but only 16 patients were treated with curative intent (Table 15).

There were 635 pleural tumors in 2015 (Table 16). Diffuse malignant pleural mesothelioma was the most frequent histologic diagnosis. Total pleurectomy was performed in 89 cases and extrapleural pneumonectomy in 80 cases. The hospital mortality rate was 4.5% after total pleurectomy and 5.0% after extrapleural pneumonectomy.

In total, 677 chest wall tumors were resected in 2015 (Table 17); 352 (52.0%) were benign. Among the 325 malignant chest wall tumors, 195 (60.0%) were metastatic tumors.

Mediastinal tumors were resected in 4813 patients, a slight increase from the previous year (Table 18). Thymic epithelial tumor—including 1912 thymomas, 336 thymic carcinomas, and 30 thymic neuroendocrine carcinomas—was the most frequent mediastinal tumor type in 2015.

Thymectomy for myasthenia gravis was performed in 474 cases (Table 19); 310 cases were associated with

Table 13 Details of lung cancer operation

	Cases
c-Stage (TNM)	
Ia	24,563
Ib	7631
IIa	3012
IIb	1777
IIIa	2504
IIIb	160
IV	480
NA	175
Total	40,302
Sex	
Male	24,882
Female	15,420
NA	0
Total	40,302
Cause of death	
Cardiovascular	21
Pneumonia	40
Pyothorax	5
Bronchopleural fistula	17
Respiratory failure	31
Pulmonary embolism	5
Interstitial pneumonia	99
Brain infarction or bleeding	19
Others	75
Unknown	6
Total	318
p-Stage	
0 (pCR)	418
Ia	21,131
Ib	7928
IIa	3280
IIb	2088
IIIa	4020
IIIb	194
IV	1027
NA	216
Total	40,302
Age	
< 20	49
20–29	32
30–39	234
40–49	1066
50–59	3716
60–69	13,276
70–79	16,954
80–89	4912
≥ 90	62
NA	1
Total	40,302

thymoma and the remaining cases were not associated with thymoma.

There were 2265 cases of lung resection for inflammatory lung diseases (Table 20); 34.2% of the cases were inflammatory tumors of unknown origin, 22.2% were atypical mycobacterium infections, and 13.6% were fungal infections.

The 2739 operations for empyema (Table 21) comprised 1999 cases (73.0%) of acute empyema and 740 cases of chronic empyema. Bronchopleural fistula was reported in 466 patients (23.3%) with acute empyema and 325 patients (43.9%) with chronic empyema. The hospital mortality rate was 16.5% in patients with acute empyema with fistula.

There were 98 operations for descending necrotizing mediastinitis (Table 22). The hospital mortality rate was 8.2%.

There were 416 operations for bullous diseases (Table 23). Lung volume reduction surgery was performed in only 21 patients.

The NCD showed 14,728 operations for spontaneous pneumothorax (Table 24). The 11,816 operations for primary pneumothorax comprised 3118 patients (26.4%) who underwent bullectomy only and 7805 patients (66.1%) who underwent an additional procedure. There were 2851 operations for secondary pneumothorax. COPD was by far the most prevalent associated disease (69.5%). The hospital mortality rate for secondary pneumothorax associated with COPD was 3.1%.

The 2015 survey reported 174 operations for chest wall deformity (Table 25). However, this might be an underestimate, because the Nuss procedure was more likely to have been performed in centers not associated with JATS.

Diaphragmatic hernia was treated surgically in 36 patients (Table 26). This figure might be an underestimate, as some procedures might have been classified as gastrointestinal surgery.

The survey reported 388 procedures for chest trauma excluding iatrogenic injuries (Table 27). The hospital mortality rate was 6.7%.

Table 28 shows operations for other diseases, including 82 cases of arteriovenous malformation and 90 cases of pulmonary sequestration.

A total of 63 lung transplantations were performed in 2015 (Table 29): 47 patients received lung transplants from brain-dead donors and 16 received transplants from living-related donors. The number of lung transplantation procedures has remained constant for several years.

The number of VATS procedures has increased annually, reaching 60,735 in 2015 (Table 30).

The details of tracheobronchoplasty, pediatric surgery, and combined resection of neighboring organs are shown in Tables 31, 32, 33 and 34.

Table 14
3. Metastatic pulmonary tumor

	Cases	30-day mortality		Hospital mortality	By VATS	
		Hospital	After discharge		2015	2014*
3. Metastatic pulmonary tumor	8226	13 (0.2)	5 (0.1)	25 (0.3)	7593	7424
Colorectal	3886	2 (0.1)	3 (0.1)	6 (0.2)	3589	3618
Hepatobiliary/pancreatic	352	0	1 (0.3)	1 (0.3)	327	332
Uterine	475	0	0	0	446	363
Mammary	474	1 (0.2)	0	1 (0.2)	448	420
Ovarian	74	0	0	0	71	56
Testicular	65	0	0	1 (1.5)	58	77
Renal	653	0	0	0	627	589
Skeletal	118	0	0	0	107	135
Soft tissue	249	1 (0.4)	0	2 (0.8)	219	212
Otorhinolaryngological	460	0	0	2 (0.4)	425	385
Pulmonary	480	3 (0.6)	0	5 (1.0)	394	407
Others	940	6 (0.6)	1 (0.1)	7 (0.7)	882	830

( ) Mortality %

*Unpublished reference data

Table 15
4. Tracheal tumor

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
4. Tracheal tumor	166	4 (2.4)	3 (1.8)	6 (3.6)
A. Primary malignant tumor				
Histological classification				
Squamous cell carcinoma	17	1 (5.9)	1 (5.9)	1 (5.9)
Adenoid cystic carcinoma	21	0	0	0
Mucoepidermoid carcinoma	4	0	0	0
Others	17	0	0	0
Total	59	1 (1.7)	1 (1.7)	1 (1.7)
B. Metastatic/invasive malignant tumor				
E.g., invasion of thyroid cancer	68	3 (4.4)	2 (2.9)	5 (7.4)
C. Benign tracheal tumor				
Histological classification				
Papilloma	1	0	0	0
Adenoma	3	0	0	0
Neurofibroma	0	0	0	0
Chondroma	0	0	0	0
Leiomyoma	4	0	0	0
Others	31	0	0	0
Histology unknown	0	0	0	0
Total	39	0	0	0
Operation				
Sleeve resection with reconstruction	13	0	0	1 (7.7)
Wedge with simple closure	2	0	0	0
Wedge with patch closure	0		0	0
Total laryngectomy with tracheostomy	0	0	0	0
Others	1	0	0	0
Unknown	0	0	0	0
Total	16	0	0	1 (6.3)

( ) Mortality %

Table 16
5. Tumor of pleural origin

5. Tumor of pleural origin	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
Histological classification				
Solitary fibrous tumor	116	0	0	0
Diffuse malignant pleural mesothelioma	280	4 (1.4)	3 (1.1)	9 (3.2)
Localized malignant pleural mesothelioma	36	0	0	0
Others	203	1 (0.5)	0	3 (1.5)
Total	635	5 (0.8)	3 (0.5)	12 (1.9)
Operative procedure				
Extrapleural pneumonectomy	80	1 (1.3)	0	4 (5.0)
Total pleurectomy	89	2 (2.2)	0	4 (4.5)
Others	111	1 (0.9)	3 (2.7)	1 (0.9)
Total	280	4 (1.4)	3 (1.1)	9 (3.2)

( ) Mortality %

Table 17
6. Chest wall tumor

6. Chest wall tumor	Cases	30-day mortality		Hospital mortality	By VATS	
		Hospital	After discharge		2015	2014*
Primary malignant tumor	130	0	0	0	54	57
Metastatic malignant tumor	195	0	1 (0.5)	1 (0.5)	62	81
Benign tumor	352	0	0	1 (0.3)	264	274
Total	677	0	1 (0.1)	2 (0.3)	380	412

( ) Mortality %

*Unpublished reference data

Table 18
7. Mediastinal tumor

	Cases	30-day mortality		Hospital mortality	By VATS	
		Hospital	After discharge		2015	2014*
7. Mediastinal tumor	4813	3 (0.1)	3 (0.06)	9 (0.2)	3369	3208
Thymoma*	1912	2 (0.1)	0	3 (0.2)	1127	1016
Thymic cancer	336	0	0	1 (0.3)	167	143
Thymus carcinoid	30	0	0	0	20	15
Germ cell tumor	107	0	0	0	58	56
Benign	*82*	*0*	*0*	*0*	*47*	47
Malignant	*25*	*0*	*0*	*0*	*11*	9
Neurogenic tumor	424	0	1 (0.2)	0	397	440
Congenital cyst	1026	0	0	0	924	811
Goiter	84	1 (1.2)	1 (1.2)	1 (1.2)	24	19
Lymphatic tumor	186	0	0	2 (1.1)	141	155
Excision of pleural recurrence of thymoma	27	0	0	0	23	31
Thymolipoma	15	0	0	0	10	9
Others	666	0	1 (0.2)	2 (0.3)	478	513

( ) Mortality %

*Unpublished reference data

Table 19
8. Thymectomy for myasthenia gravis

	Cases	30-day mortality		Hospital mortality	By VATS	
		Hospital	After discharge		2015	2014*
8. Thymectomy for myasthenia gravis	474	3 (0.6)	0	4 (0.8)	248	269
With thymoma	310	2 (0.6)	0	3 (1.0)	152	161

( ) Mortality %

*Unpublished reference data

Table 20
9. Operations for non-neoplastic disease(A) Inflammatory pulmonary disease

Cases	30-day mortality		Hospital mortality
	Hospital	After discharge	
22,183	175 (0.8)	33 (0.1)	428 (1.9)

	Cases	30-day mortality		Hospital mortality	By VATS	
		Hospital	After discharge		2015	2014*
(A) Inflammatory pulmonary disease	2265	8 (0.4)	3 (0.1)	24 (1.1)	2004	1958
Tuberculous infection	68	0	0	0	57	60
Mycobacterial infection	503	0	0	0	449	435
Fungal infection	309	5 (1.6)	0	7 (2.3)	236	249
Bronchiectasis	67	0	0	3 (4.5)	49	54
Tuberculous nodule	106	0	1 (0.9)	0	103	120
Inflammatory pseudo tumor	776	0	1 (0.1)	1 (0.1)	734	508
Interpulmonary lymph node	56	0	0	0	56	59
Others	380	3 (0.8)	1 (0.3)	13 (3.4)	320	473

( ) Mortality %

*Unpublished reference data

(C) Esophageal surgery

During 2015 alone, a total of 12,732 patients with esophageal diseases were registered from 571 institutions (response rate: 93.6%) 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 2015 were 136 institutions (23.8%), which shows no definite shift of esophageal operations to high-volume institutions when compared to the data of 2014 (22.1%) (Table 35). Of 2991 patients with a benign esophageal disease, 1619 (54.1%) patients underwent surgery, and 77 (2.6%) patients underwent endoscopic resection, while 1295 (43.3%) patients did not undergo any surgical treatment (Table 36). Of 10,288 patients with a malignant esophageal tumor, 8106 (78.8%) patients underwent resection, esophagectomy for 6151 (59.8%) and endoscopic mucosal resection (EMR) or endoscopic submucosal dissection (ESD) for 1955 (19.0%), while 2182 (21.2%) patients did not undergo any resection (Tables 37, 38). The patients registered, particularly those undergoing non-surgical therapy for a malignant esophageal disease, have been increasing since 1990 (Fig. 3).

Among benign esophageal diseases (Table 36), hiatal hernia, esophageal varices, esophagitis (including reflux esophagitis) and achalasia 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

Table 21
9. Operations for non-neoplastic disease
(B) Empyema

	Cases	30-day mortality		Hospital mortality	By VATS	
		Hospital	After discharge		2015	2014*
Acute empyema	1999	45 (2.3)	8 (0.4)	131 (6.6)	1657	1574
With fistula	466	27 (5.8)	3 (0.6)	77 (16.5)	275	274
Without fistula	1516	18 (1.2)	5 (0.3)	52 (3.4)	1369	1279
Unknown	17	0	0	2 (11.8)	13	21
Chronic empyema	740	10 (1.4)	2 (0.3)	53 (7.2)	404	368
With fistula	325	5 (1.5)	1 (0.3)	33 (10.2)	126	132
Without fistula	367	5 (1.4)	1 (0.3)	18 (4.9)	248	214
Unknown	48	0	0	2 (4.2)	30	22
Total, %	2739	55 (2.0)	10 (0.4)	184 (6.7)	2061	1942

( ) Mortality %

*Unpublished reference data

Table 22
9. Operations for non-neoplastic disease
(C) Descending necrotizing mediastinitis

Cases	30-day mortality		Hospital mortality	By VATS	
	Hospital	After discharge		2015	2014*
(C) Descending necrotizing mediastinitis					
98	2 (2.0)	0	8 (8.2)	70	80

( ) Mortality %

*Unpublished reference data

Table 23
9. Operations for non-neoplastic disease
(D) Bullous disease

	Cases	30-day mortality		Hospital mortality	By VATS	
		Hospital	After discharge		2015	2014*
(D) Bullous disease	416	1 (0.2)	0	2 (0.5)	393	366
Emphysematous bulla	330	1 (0.3)	0	2 (0.6)	314	288
Bronchogenic cyst	16	0	0	0	14	15
Emphysema with volume reduction surgery	21	0	0	0	20	23
Others	49	0	0	0	45	40

LVRS lung volume reduction surgery

( ) Mortality %

surgery was performed in 1072 (66.2%) patients with a benign esophageal disease, with 30-day mortality in 7 (0.7%), while thoracoscopic and/or laparoscopic surgery was performed for 547 (33.8%) patients, with none of the 30-day mortality. The difference in these death rates between open and scopic surgery seems to be related to the conditions requiring open surgery.

The majority of malignant diseases were carcinomas (Table 37). Among esophageal carcinomas, the incidence of squamous cell carcinoma was 90.1%, while that of adenocarcinomas including Barrett cancer was 7.2%. The resection rate for patients with a squamous cell carcinoma was 77.9%, while that for patients with an adenocarcinoma was 88.9%.

According to location, cancer in the thoracic esophagus was the most common (Table 38). Of the 4137 patients (40.2% of total esophageal malignancies) having superficial esophageal cancers within mucosal and submucosal

Table 24
9. Operations for non-neoplastic disease
(E) Pneumothorax

Cases	30-day mortality		Hospital mortality
	Hospital	After discharge	
14,728	95 (0.6)	17 (0.1)	120 (0.8)

	Cases	30-day mortality		Hospital mortality	By VATS	
		Hospital	After discharge		2015	2014*
Spontaneous pneumothorax						
Operative procedure						
Bullectomy	3118	6 (0.2)	1 (0.0)	9 (0.3)	3122	3380
Bullectomy with additional procedure	7805	4 (0.05)	3 (0.04)	8 (0.1)	7713	7453
Coverage with artificial material	7409	3 (0.04)	3 (0.0)	7 (0.1)	7327	7059
Parietal pleurectomy	35	0	0	0	33	52
Coverage and parietal pleurectomy	109	1 (0.9)	0	1 (0.9)	105	94
Others	252	0	0	0	248	248
Others	888	4 (0.5)	2 (0.2)	8 (0.9)	799	836
Unknown	5	0	0	0	5	8
Total	11,816	14 (0.1)	6 (0.05)	25 (0.2)	11,639	11,679
Secondary pneumothorax						
Associated disease						
COPD	1981	33 (1.7)	6 (0.3)	61 (3.1)	1912	1696
Tumorous disease	123	2 (1.6)	3 (2.4)	5 (4.1)	114	79
Catamenial	137	0	0	0	132	146
LAM	50	0	0	0	50	42
Others (excluding pneumothorax by trauma)	560	16 (2.9)	2 (0.4)	29 (5.2)	509	544
Unknown	0	0	0	0	0	0
Operative procedure						
Bullectomy	436	11 (2.5)	2 (0.5)	17 (3.9)	422	383
Bullectomy with additional procedure	1665	21 (1.3)	4 (0.2)	42 (2.5)	1616	1416
Coverage with artificial material	1560	21 (1.3)	4 (0.3)	41 (2.6)	1516	1335
Parietal pleurectomy	10	0	0	0	9	7
Coverage and parietal pleurectomy	37	0	0	0	34	16
Others	58	0	0	1 (1.7)	57	58
Others	748	19 (2.5)	5 (0.7)	36 (4.8)	678	690
Unknown	2	0	0	0	1	5
Total	2851	51 (1.8)	11 (0.4)	95 (3.3)	2717	2507

( ) Mortality %

*Unpublished reference data

Table 25
9. Operations for non-neoplastic disease
(F) Chest wall deformity

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
(F) Chest wall deformity	174	0	0	0
Funnel chest	167	0	0	0
Others	7	0	0	0

( ) Mortality %

layers, 6151 (59.8%) patients underwent esophagectomy, while 1955 (19.0%) 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 1.7% (141/6151), respectively.

Multiple primary cancers were observed in 1816 (17.7%) of all the 10,288 patients with esophageal cancer. Synchronous cancer was found in 960 (9.3%) patients, while metachronous cancer was observed in 856 (8.3%) patients. The stomach is the commonest site for both

Table 26
9. Operations for non-neoplastic disease
(G) Diaphragmatic hernia

	Cases	30-day mortality		Hospital mortality	By VATS	
		Hospital	After discharge		2015	2014*
(G) Diaphragmatic hernia	36	0	0	0	22	24
Congenital	3	0	0	0	3	8
Traumatic	12	0	0	0	7	3
Others	21	0	0	0	12	13

( ) Mortality %

*Unpublished reference data

Table 27
9. Operations for non-neoplastic disease
(H) Chest trauma

	Cases	30-day mortality		Hospital mortality	By VATS	
		Hospital	After discharge		2015	2014*
(H) Chest trauma	388	17 (4.4)	0	26 (6.7)	243	239

( ) Mortality %

*Unpublished reference data

Table 28
9. Operations for non-neoplastic disease
(I) Other respiratory surgery

	Cases	30-day mortality		Hospital mortality	By VATS	
		Hospital	After discharge		2015	2014*
(I) Other respiratory surgery	1339	27 (2.0)	3 (0.2)	64 (4.8)	953	957
Arteriovenous malformation*	82	0	0	0	77	70
Pulmonary sequestration	90	0	0	0	73	89
Postoperative bleeding > air leakage	385	11 (2.9)	0	27 (7.0)	273	255
Chylothorax	64	2 (3.1)	0	2 (3.1)	55	52
Others	718	14 (1.9)	3 (0.4)	35 (4.9)	475	491

( ) Mortality %

*Unpublished reference data

Table 29
10. Lung transplantation

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
Single lung transplantation from brain-dead donor	23	1 (4.3)	0	2 (8.7)
Bilateral lung transplantation from brain-dead donor	24	0	0	1 (4.2)
Lung transplantation from living donor	16	0	0	1 (6.3)
Total of lung transplantation	63	1 (1.6)	0	4 (6.3)
Donor of living donor lung transplantation	31	0	0	0

( ) Mortality %

Table 30
11. Video-assisted thoracic surgery

		Cases	30-day mortality		Hospital mortality
			Hospital	After discharge	
11. Video-assisted thoracic surgery	2015	60,735	186 (0.3)	59 (0.10)	396 (0.7)
	2014*	58,259	194 (0.3)	43 (0.07)	437 (0.8)

*Unpublished reference data

( ) Mortality % (including thoracic sympathectomy 160)

Table 31
12. Tracheobronchoplasty

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
12. Tracheobronchoplasty	703	9 (1.3)	5 (0.7)	21 (3.0)
Trachea	29	2 (6.9)	0	2 (6.9)
Sleeve resection with reconstruction	16	0	0	0
Wedge with simple closure	5	0	0	0
Wedge with patch closure	0	0	0	0
Total laryngectomy with tracheostomy	0	0	0	0
Others	8	2 (25.0)	0	2 (25.0)
Carinal reconstruction	33	0	1 (3.0)	0
Sleeve pneumonectomy	11	0	0	1 (9.1)
Sleeve lobectomy	536	5 (0.9)	2 (0.4)	13 (2.4)
Sleeve segmental excision	17	0	0	0
Bronchoplasty without lung resection	14	0	0	0
Others	63	2 (3.2)	2 (3.2)	5 (7.9)

( ) Mortality %

Table 32
13. Pediatric surgery

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
13. Pediatric surgery	359	4 (1.1)	0	6 (1.7)

( ) Mortality %

synchronous and metachronous malignancy followed by head and neck cancer (Table 38).

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 39). Transhiatal esophagectomy commonly performed in Western countries was adopted in only 2.8% of patients having

Table 33
14. Combined resection of neighboring organ(s)

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
14.Combined resection of neighboring organ(s)	1451	7 (0.5)	3 (0.2)	22 (1.5)

Organ resected	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
A. Primary lung cancer				
Aorta	8	0	0	0
Superior vena cava	24	0	0	0
Brachiocephalic vein	17	1 (5.9)	0	1 (5.9)
Pericardium	127	1 (0.8)	2 (1.6)	8 (6.3)
Pulmonary artery	129	1 (0.8)	0	2 (1.6)
Left atrium	27	0	0	1 (3.7)
Diaphragm	71	0	0	1 (1.4)
Chest wall (including ribs)	360	3 (0.8)	1 (0.3)	8 (2.2)
Vertebra	11	0	0	1 (9.1)
Esophagus	6	0	0	0
Total	780	6 (0.8)	3 (0.4)	22 (2.8)
B. Mediastinal tumor				
Aorta	3	0	0	0
Superior vena cava	72	0	0	1 (1.4)
Brachiocephalic vein	92	0	0	0
Pericardium	355	1 (0.3)	0	2 (0.6)
Pulmonary artery	2	0	0	0
Left atrium	0	0	0	0
Diaphragm	34	0	0	0
Chest wall (including ribs)	7	0	0	0
Vertebra	3	0	0	0
Esophagus	5	0	0	0
Lung	530	1 (0.2)	0	2 (0.4)
Total	1103	2 (0.2)	0	5 (0.5)

( ) Mortality %

Table 34
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	741	2 (0.3)	4 (0.5)	7 (0.9)

( ) Mortality %

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

a superficial cancer who underwent esophagectomy and in 1.4% of those having an advanced cancer in Japan. The thoracoscopic and/or laparoscopic esophagectomy were adopted for 1036 patients (51.3%) with a superficial

Table 35 Distribution of number of esophageal operations in 2015 in each institution

Esophageal surgery			
Number of operations in 2015	Benign esophageal diseases	Malignant esophageal disease	Benign + malignant
0	267	117	81
1–4	241	145	151
5–9	43	108	101
10–19	14	80	102
20–29	3	42	46
30–39	1	26	29
40–49	1	12	13
≧ 50	1	41	48
Total	571	571	571

Table 36 Benign esophageal diseases

	Operation (+)										Endoscopic resection	Operation (−)	Total
	Number of patients			Hospital mortality									
	Total	Open	T/L*3	Open surgery			T/L*3			Total			
				~ 30 days	31–90 days	Total (including after 91-day mortality)	~ 30 days	31–90 days	Total (including after 91-day mortality)				
1. Achalasia	343	200	143	0	0	0	0	0	0	0		21	364
2. Benign tumor	106	70	36	0	0	0	0	0	0	0	60	9	175
(1) Leiomyoma	68	43	25	0	0	0	0	0	0	0	32	6	106
(2) Cyst	9	7	2	0	0	0	0	0	0	0	5	0	14
(3) Others	29	20	9	0	0	0	0	0	0	0	23	3	55
(4) Not specified	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Diverticulum	47	32	15	0	0	0	0	0	0	0		9	56
4. Hiatal hernia	686	392	294	0	0	1 (0.3)	0	0	0	1 (0.1)		171	857
5. Spontaneous rupture of the esophagus	100	88	12	4 (4.5)	1 (1.1)	6 (6.8)	0	0	0	6 (6.0)		7	107
6. Esophago-tracheal fistula	20	18	2	0	1 (5.6)	2 (11.1)	0	1 (50.0)	1 (50.0)	3 (15.0)		1	21
7. Congenital esophageal atresia	34	31	3	0	2 (6.5)	2 (6.5)	0	0	0	2 (5.9)		1	35
8. Congenital esophageal stenosis	3	2	1	0	0	0	0	0	0	0		12	15
9. Corrosive stricture of the esophagus	10	8	2	0	0	0	0	0	0	0		19	29
10. Esophagitis, Esophageal ulcer	39	31	8	0	0	0	0	0	0	0		287	326
11. Esophageal varices	114	110	4	1 (0.9)	0	1 (0.9)	0	0	0	1 (0.9)		685	799
(1) Laparotomy	22	22	0	0	0	0	0	0	0	0			22
(2) Sclerotherapy												196	196
(3) EVL												354	354
12. Others	117	90	27	2 (2.2)	0	5 (5.6)	0	0	0	5 (4.3)	17	73	207
Total	1619	1072	547	7 (0.7)	4 (0.4)	17 (1.6)	0	1 (0.2)	1 (0.2)	18 (1.1)	77	1295	2991

( ) Mortality %

T/L thoracoscopic and/or laparoscopic

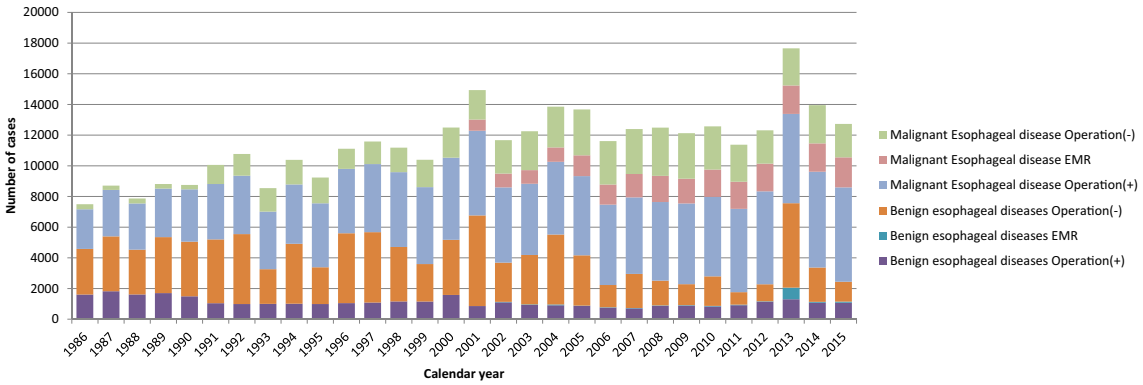

Fig. 3 Annual trend of in-patients with esophageal diseases. *EMR* endoscopic mucosal resection (including endoscopic submucosal)

Table 37 Malignant esophageal diseases (histologic classification)

	Resection (+)	Resection (−)	Total
Carcinomas	7979	2158	10,137
1. Squamous cell carcinoma	7116	2021	9137
2. Basaloid(-squamous) carcinoma	82	9	91
3. Carcinosarcoma	26	4	30
4. Adenocarcinoma in the Barrett's esophagus	346	32	378
5. Other adenocarcinoma	302	49	351
6. Adenosquamous carcinoma	20	3	23
7. Mucoepidermoid carcinoma	5	0	5
8. Adenoid cystic carcinoma	2	0	2
9. Endocrine cell carcinoma	46	18	64
10. Undifferentiated carcinoma	5	7	12
11. Others	29	15	44
Other malignancies	42	6	48
1. Malignant non-epithelial tumors	10	1	11
2. Malignant melanoma	25	3	28
3. Other malignant tumors	7	2	9
Not specified	127	24	151
Total	8148	2188	10,336

Resection: including endoscopic resection

Table 38 Malignant esophageal disease (clinical characteristics)

	Operation (+)				EMR or ESD	Operation (−)	Total
	Cases	Hospital mortality					
		~ 30 days	31–90 days	Total (including after 91-day mortality)			
1. *Esophageal cancer*	6151	39 (0.6)	72 (1.2)	141 (2.3)	1955	2182	10,288
Location							
(1) Cervical esophagus	203	1 (0.5)	6 (3.0)	13 (6.4)	68	182	453
(2) Thoracic esophagus	5030	31 (0.6)	61 (1.2)	115 (2.3)	1580	1737	8347
(3) Abdominal esophagus	651	4 (0.6)	3 (0.5)	7 (1.1)	136	100	887
(4) Multiple cancers	260	3 (1.2)	2 (0.8)	6 (2.3)	136	60	456
(5) Others/not described	7	0	0	0	35	103	145
Tumor depth							
(A) Superficial cancer (T1)	2019	10 (0.5)	15 (0.7)	34 (1.7)	1952	166	4137
Mucosal cancer (T1a)	*434*	*4 (0.9)*	*1 (0.2)*	*6 (1.4)*	*1544*	*37*	*2015*
(B) Advanced cancer (T2–T4)	4130	29 (0.7)	56 (1.4)	106 (2.6)	3	2012	6145
(C) Not specified	2	0	1	1	0	4	6
2. *Multiple primary cancers*	1022	8 (0.8)	11 (1.1)	28 (2.7)	490	304	1816
1) Synchronous	583	5 (0.9)	4 (0.7)	15 (2.6)	202	175	960
(1) Head and neck	164	0	1 (0.6)	3 (1.8)	78	58	300
(2) Stomach	217	2 (0.9)	1 (0.5)	5 (2.3)	71	55	343
(3) Colorectum	71	1 (1.4)	1 (1.4)	3 (4.2)	14	11	96
(4) Lung	26	0	0	0	3	13	42
(5) Pancreas	5	0	0	0	0	3	8
(6) Liver	12	1 (8.3)	0	1 (8.3)	4	1	17
(7) Others	45	1 (2.2)	0	1 (2.2)	8	17	70
(8) Triple cancers	43	0	1 (2.3)	2 (4.7)	22	16	81
(9) Unknown	0	0	0	0	2	1	3
2) Metachronous	439	3 (0.7)	7 (1.6)	13 (3.0)	288	129	856
(1) Head and neck	81	0	0	0	81	15	177
(2) Stomach	99	2 (2.0)	2 (2.0)	5 (5.1)	69	36	204
(3) Colorectum	53	0	1 (1.9)	1 (1.9)	24	16	93
(4) Lung	23	0	0	0	14	8	45
(5) Pancreas	2	0	0	0	0	0	2
(6) Liver	5	0	0	0	4	3	12
(7) Others	145	1 (0.7)	3 (2.1)	6 (4.1)	49	31	225
(8) Triple cancers	31	0	1 (3.2)	1 (3.2)	47	17	95
(9) Unknown	0	0	0	0	0	3	3
Unknown	0	0	0	0	0	0	0

( ), Mortality %

EMR endoscopic mucosal resection (including endoscopic submucosal dissection

Table 39 Malignant esophageal disease (surgical procedures)

	Operation (+)				Thoracoscopic and/or laparoscopic procedure				EMR or ESD
	Cases	Hospital mortality			Cases	Hospital mortality			
		~ 30 days	31–90 days	Total (including after 91-day mortality)		~ 30 days	31–90 days	Total (including after 91-day mortality)	
Superficial cancer (T1)	*2019*	*10* (0.5)	*15* (0.7)	*34* (1.7)	*1306*	*4* (0.3)	*9* (0.7)	*16* (1.2)	1952
Mucosal cancer (T1a)	*434*	*4* (0.9)	*1* (0.2)	*6* (1.4)	*260*	*2* (0.8)	*1* (0.4)	*3* (1.2)	*1544*
Esophagectomy	*2019*	*10* (0.5)	*15* (0.7)	*34* (1.7)	*1306*	*4* (0.3)	*9* (0.7)	*16* (1.2)	1952
(1) Transhiatal esophagectomy	57	1 (1.8)	1 (1.8)	2 (3.5)	15	0	0	0	
(2) Transthoracic (rt.) esophagectomy and reconstruction	1709	7 (0.4)	12 (0.7)	27 (1.6)	1194	3 (0.3)	8 (0.7)	14 (1.2)	
(3) Transthoracic (lt.) esophagectomy and reconstruction	27	0	0	0	3	0	0	0	
(4) Cervical esophageal resection and reconstruction	31	1 (3.2)	1 (3.2)	2 (6.5)	15	0	1 (6.7)	1 (6.7)	
(5) Two-stage operation	41	1 (2.4)	0	2 (4.9)	23	1 (4.3)	0	1 (4.3)	
(6) Others	135	0	1 (0.7)	1 (0.7)	49	0	0	0	
(7) Not specified	19	0	0	0	7	0	0	0	
Advanced cancer (T2–T4)									
Esophagectomy	*4130*	*29* (0.7)	*56* (1.4)	*106* (2.6)	*1734*	*12* (0.7)	*25* (1.4)	*42* (2.4)	3
(1) Transhiatal esophagectomy	57	1 (1.8)	1 (1.8)	3 (5.3)	12	0	0	0	
(2) Transthoracic (rt.) esophagectomy and reconstruction	3500	26 (0.7)	46 (1.3)	85 (2.4)	1607	11 (0.7)	22 (1.4)	38 (2.4)	
(3) Transthoracic (lt.) esophagectomy and reconstruction	105	0	0	1 (1.0)	12	0	0	0	
(4) Cervical esophageal resection and reconstruction	137	0	3 (2.2)	8 (5.8)	23	0	2 (8.7)	2 (8.7)	
(5) Two-stage operation	71	1 (1.4)	4 (5.6)	6 (8.5)	16	0	0	0	
(6) Others/not specified	206	1 (0.5)	2 (1.0)	3 (1.5)	58	1 (1.7)	1 (1.7)	2 (3.4)	
(7) Not specified	54	0	0	0	6	0	0	0	
(Depth not specified)	*2*	*0*	*1*	*1*	*0*	*0*	*0*	*0*	0
Combined resection of other organs	*351*	*7* (2.0)	*4* (1.1)	*15* (4.3)					
(1) Aorta	3	0	0	0					
(2) Trachea, bronchus	15	0	0	0					
(3) Lung	67	3 (4.5)	0	4 (6.0)					
(4) Others	266	4 (1.5)	4 (1.5)	11 (4.1)					
Unknown	0	0	0	0					
Salvage surgery	*264*	*4* (1.5)	*11* (4.2)	*21* (8.0)	*58*	*1* (1.7)	*1* (1.7)	*3* (5.2)	29

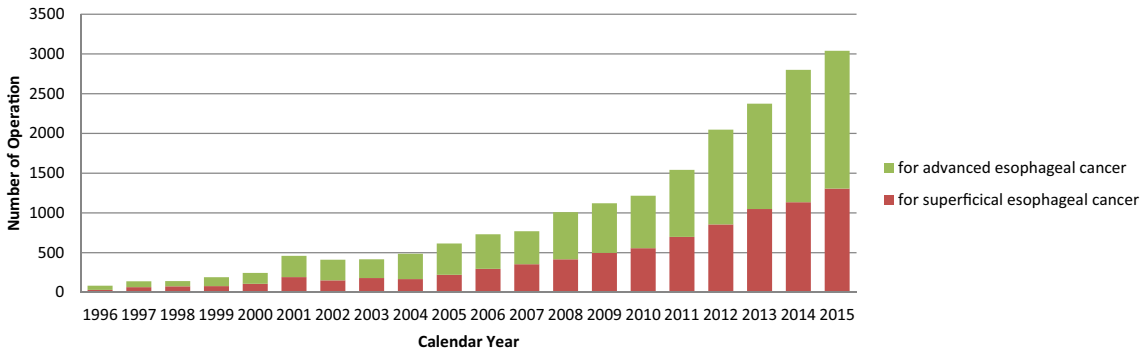

Fig. 4 Annual trend of video-assisted esophagectomy for esophageal malignancy

Table 40 Mortality after combined resection of the neighboring organs

Year	Esophagectomy			Combined resection											
				Aorta			Tracheobronchus			Lung			Others		
	a	b	c (%)	a	b	c (%)	a	b	c (%)	a	b	c (%)	a	b	c (%)
1996	4194	120	2.86	7	3	42.86	24	0	0.00	50	2	4.00	78	4	5.13
1997	4441	127	2.86	1	0	0.00	34	5	14.71	56	1	1.79	94	3	3.19
1998	4878	136	2.79	4	0	0.00	29	0	0.00	74	1	1.35	128	2	1.56
1999	5015	116	2.31	5	0	0.00	23	2	8.70	68	0	0.00	122	1	0.82
2000	5350	81	1.51	2	0	0.00	23	2	8.70	69	0	0.00	96	1	1.04
2001	5521	110	1.99	1	0	0.00	26	1	3.85	83	3	3.61	99	2	2.02
2002	4904	66	1.35	3	1	33.33	20	2	10.00	63	0	0.00	63	1	1.59
2003	4639	45	0.97	0	0	0.00	24	2	8.33	58	0	0.00	88	1	1.14
2004	4739	64	1.35	2	0	0.00	17	0	0.00	59	5	8.47	119	2	1.68
2005	5163	52	1.01	1	0	0.00	11	1	9.09	67	1	1.49	73	1	1.37
2006	5236	63	1.20	0	0	0.00	17	0	0.00	62	2	3.23	122	3	2.46
2007	4990	60	1.20	0	0	0.00	25	1	4.00	44	1	2.27	138	2	1.45
2008	5124	63	1.23	0	0	0.00	17	1	5.88	48	1	2.08	185	0	0.00
2009	5260	63	1.20	0	0	0.00	19	2	10.53	58	2	3.45	211	3	1.42
2010	5180	45	0.87	2	0	0.00	33	0	0.00	58	0	0.00	245	5	2.04
2011	5430	38	0.70	4	0	0.00	26	0	0.00	41	0	0.00	179	5	2.79
2012	6055	47	0.78	2	0	0.00	23	1	4.35	69	0	0.00	240	1	0.42
2013	5824	41	0.70	2	0	0.00	44	0	0.00	77	1	1.30	156	3	1.92
2014	6244	47	0.75	2	0	0.00	24	0	0.00	77	3	3.90	227	3	1.32
2015	6151	39	0.63	3	0	0.00	15	0	0.00	67	3	4.48	266	4	1.50
Total	1,04,338	1423	1.36	41	4	9.76	273	20	7.33	1248	26	2.08	2929	47	1.60

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

cancer, and for 1734 patients (42.0%) 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. 4).

Combined resection of the neighboring organs during resection of an esophageal cancer was performed in 351 patients (Tables 39, 40). Resection of the aorta together with esophagectomy was performed in three cases. Tracheal and/or bronchial resection combined with esophagectomy was performed in 15 patients, with the both of 30-day mortality rate and the hospital mortality rate at 0%. Lung resection combined with esophagectomy was performed in 67 patients, with the 30-day mortality rate at 4.5% and the hospital mortality rate at 6.0%.

Salvage surgery after definitive (chemo-)radiotherapy was performed in 264 patients, with the 30-day mortality

rate at 1.5% and with the hospital mortality rate at 8.0% (Table 39).

Lastly, 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.

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