General Thoracic and Cardiovascular Surgery
https://doi.org/10.1007/s11748-020-01298-2

ANNUAL REPORT

Thoracic and cardiovascular surgeries in Japan during 2017

Annual report by the Japanese Association for Thoracic Surgery

Committee for Scientific Affairs, The Japanese Association for Thoracic Surgery[1] · Hideyuki Shimizu[2] · Morihito Okada[3] · Akira Tangoku[4] · Yuichiro Doki[5] · Shunsuke Endo[6] · Hirotsugu Fukuda[7] · Yasutaka Hirata[8] · Hisashi Iwata[9] · Junjiro Kobayashi[10] · Hiraku Kumamaru[11] · Hiroaki Miyata[12] · Noboru Motomura[13] · Shoji Natsugoe[14] · Soji Ozawa[15] · Yoshikatsu Saiki[16] · Aya Saito[13] · Hisashi Saji[17] · Yukio Sato[18] · Tsuyoshi Taketani[19] · Kazuo Tanemoto[20] · Wataru Tatsuishi[21] · Yasushi Toh[22] · Hiroyuki Tsukihara[8] · Masayuki Watanabe[23] · Hiroyuki Yamamoto[12] · Kohei Yokoi[24] · Yutaka Okita[25]

The Japanese Association for Thoracic Surgery has conducted annual surveys of thoracic surgery throughout Japan since 1986 to determine statistics pertaining to the number of procedures performed, based on surgical category. Herein, we summarize the results of the association's annual survey of thoracic surgery performed in 2017.

Adhering to the norm to date, thoracic surgery was classified into three categories: cardiovascular, general thoracic, and esophageal surgeries. Patient data were examined and analyzed for each group. Access to computerized data is available to all members of the association. We honor and value all members' continued professional support and contributions (Tables 1, 2).

Incidence of hospital mortality was included in the survey to determine nationwide status, which has contributed to Japanese surgeons' understanding of the present status of thoracic surgery in Japan, while helping to effect progress for improving operative results by enabling them to compare their work with that of others. In this way, the association has been able to gain a better understanding of present problems and future prospects, which is reflected in its activities and the education of its members.

Thirty-day mortality (so-called *operative mortality*) is defined as death within 30 days of surgery, regardless of the patient's geographic location, including after the patient is discharged from hospital. *Hospital mortality* is defined as death within any time interval following surgery if the patient has not been discharged from hospital.

Hospital-to-hospital transfer in the category of esophageal surgery is not considered a form of discharge; transfer to a nursing home or a rehabilitation unit is considered hospital discharge, unless the patient subsequently dies because of complications from surgery. Contrastingly, hospital-to-hospital transfer 30 days following surgery in the categories of cardiovascular and general thoracic surgery is considered discharge, as data related to the National Clinical Database (NCD 2017) were employed in this category, and hospital-to-hospital transfer 30 days following surgery is considered discharge according to the NCD.

Survey abstract

All data pertaining to cardiovascular and thoracic surgeries were obtained from the NCD, whereas data regarding esophageal surgery were collected from a survey questionnaire derived from the Japanese Association for Thoracic Surgery documentation. The reason for this was that NCD information regarding esophageal surgery does not include non-surgical cases (i.e., patients with adjuvant chemotherapy or radiation only).

Because of changes in data collection related to cardiovascular surgery (initially self-reported using questionnaire sheets in each participating institution up to 2014, then by downloading an automatic package from the Japanese Cardiovascular Surgery Database (JCVSD), a cardiovascular sub-section of the NCD), the response rate is not available and is, therefore, not indicated in the cardiovascular surgery category (Table 1). Additionally, the number of institutions (based on surgery count) was not calculated in the cardiovascular surgery category (Table 2).

Morihito Okada and Akira Tangoku have equally contributed to this work.

✉ Hideyuki Shimizu
survey-adm@umin.net

Extended author information available on the last page of the article

Published online: 05 March 2020

Table 1 Number of institutions involved in the survey

	Questionnaires		
	Sent out	Responded	Response rate (%)
(A) Cardiovascular surgery	–	–	–
(B) General thoracic surgery	740	678	91.6
(C) Esophageal surgery	568	523	92.1

Table 2 Categories subclassified according to the number of operations performed

Number of operations performed	Category General thoracic surgery
0	6
1–24	28
25–49	72
50–99	167
100–149	129
150–199	100
≥200	176
Total	678
Number of operations performed	**Esophageal surgery**
0	76
1–4	114
5–9	96
10–19	98
20–29	47
30–39	26
40–49	21
≥50	45
Total	523

Final report: 2017

(A) Cardiovascular surgery

We are extremely pleased with the cooperation of our colleagues (members) in terms of completing the cardiovascular surgery survey, thereby undoubtedly improving the quality of this annual report. We are truly grateful for the significant efforts made by all within each participating institution in completing the JCVSD/NCD.

Figure 1 illustrates the development of cardiovascular surgery in Japan over the past 30 years. Aneurysm surgery includes only surgeries for thoracic and thoracoabdominal aortic aneurysms. Extra-anatomic bypass surgery for thoracic aneurysm and pacemaker implantation has been excluded from the survey since 2015. The number of assist device implantation surgeries is not included in the total number of surgical procedures but was nonetheless included in the survey.

A total of 70,078 cardiovascular surgeries including 56 heart transplants were performed in 2017, an increase of 3.3% compared with that in the 2016 survey results (n= 67,867). The number of cardiovascular surgeries is continuously increasing, despite an apparent decrease in 2015, likely due to major changes in data collection and aggregation approaches.

When compared with data for 2016 [1] and 2007 [2], the number of surgeries in 2017 for congenital heart disease increased by 7.1% (9368 vs. 8744) and 0.2%, respectively; procedures for valvular heart disease increased by 0.2% (23,312 vs. 23,254) and 53.2%, respectively; surgery for thoracic aortic aneurysm increased by 8.7% (20,746 vs. 19,078) and 114.6%, respectively; ischemic heart procedures decreased by 6.6% (13,898 vs. 14,874) and 23.6%,

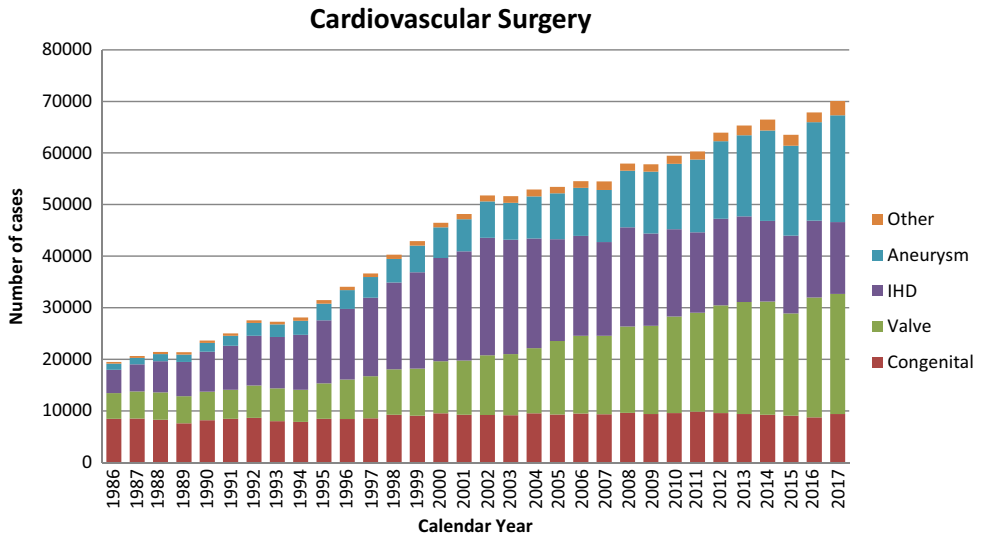

Fig. 1 Cardiovascular surgery. *IHD* ischemic heart disease

Table 3 Congenital (total; 9368)
(1) CPB (+) (total; 7072)

	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	1	0	0	0	4	0	0	0	0	0	0	0	14	0	0	0	19	0	0	0
Coarctation (simple)	7	0	0	0	11	0	0	0	13	0	0	0	4	0	0	0	35	0	0	0
+VSD	49	0	0	1 (2.0)	51	2 (3.9)	0	3 (5.9)	13	0	0	0	0	0	0	0	113	2 (1.8)	0	4 (3.5)
+DORV	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
+AVSD	2	0	0	1 (50.0)	3	0	0	0	1	0	0	0	0	0	0	0	6	0	0	1 (16.7)
+TGA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+SV	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	3	0	0	0
+Others	5	0	0	0	7	0	0	0	8	0	0	0	2	0	0	0	22	0	0	0
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	27	0	0	1 (3.7)	23	0	0	1 (4.3)	12	0	0	0	0	0	0	0	62	0	0	2 (3.2)
+DORV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+Truncus	4	0	0	0	2	0	0	0	5	0	0	0	0	0	0	0	11	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	1	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	5	0	0	0
Vascular ring	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
PS	5	0	0	0	25	0	0	0	77	1 (1.3)	0	1 (1.3)	26	0	0	0	133	1 (0.8)	0	1 (0.8)
PA･IVS or critical PS	15	1 (6.7)	0	1 (6.7)	66	0	0	2 (3.0)	48	0	0	1 (2.1)	2	0	0	0	131	1 (0.8)	0	4 (3.1)
TAPVR	112	6 (5.4)	0	9 (8.0)	59	1 (1.7)	0	3 (5.1)	17	0	0	1 (5.9)	1	0	0	0	189	7 (3.7)	0	13 (6.9)
PAPVR ± ASD	0	0	0	0	5	0	0	0	38	0	0	0	22	0	0	0	65	0	0	0
ASD	1	0	0	0	73	0	0	0	583	0	0	0	761	7 (0.9)	0	7 (0.9)	1418	7 (3.7)	0	7 (0.5)
Cor triatriatum	1	0	0	0	8	0	0	0	6	0	0	0	4	0	0	0	19	0	0	0
AVSD (partial)	1	0	0	0	7	0	0	1 (14.3)	42	0	0	0	6	0	0	0	56	0	0	1 (1.8)
AVSD (complete)	8	0	0	0	117	3 (2.6)	0	4 (3.4)	94	2 (2.1)	0	2 (2.1)	3	0	0	0	222	5 (2.3)	0	6 (2.7)
+TOF or DORV	2	1 (50.0)	0	1 (50.0)	9	0	0	0	14	1 (7.1)	0	1 z(7.1)	0	0	0	0	25	2 (8.0)	0	2 (8.0)
+Others	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VSD (subarterial)	3	0	0	0	106	0	0	0	142	0	0	0	14	0	0	0	265	0	0	0
VSD (perimemb./ muscular)	17	0	0	0	729	1 (0.1)	0	1 (0.1)	325	0	0	1 (0.3)	21	0	0	0	1092	1 (0.1)	0	2 (0.2)
VSD (type unknown)	0	0	0	0	5				3		0		123	2 (1.6)	0	2 (1.6)	131	2 (1.5)	0	2 (1.5)
VSD + PS	0	0	0	0	32	0	1 (3.1)	0	21	0	0	0	1	0	0	0	54	0	1 (1.9)	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	
DCRV ± VSD	1	0	0	0	5	0	0	0	20	0	0	0	11	0	0	0	37	0	0	0
Aneurysm of sinus of Valsalva	0	0	0	0	0	0	0	0	2	0	0	0	3	0	0	0	5	0	0	0
TOF	13	0	0	0	174	2 (1.1)	0	3 (1.7)	212	1 (0.5)	0	1 (0.5)	37	0	0	0	436	3 (0.7)	0	4 (0.9)
PA + VSD	9	1 (11.1)	0	1 (11.1)	76	0	0	2 (2.6)	108	1 (0.9)	0	3 (2.8)	15	0	0	0	208	2 (1.0)	0	6 (2.9)
DORV	24	1 (4.2)	0	2 (8.3)	142	0	0	3 (2.1)	160	0	0	0	11	0	0	0	337	1 (0.3)	0	5 (1.5)
TGA (simple)	97	1 (1.0)	0	4 (4.1)	9	1 (11.1)	0	1 (11.1)	3	0	0	0	2	0	0	0	111	2 (1.8)	0	5 (4.5)
+VSD	40	1 (2.5)	0	1 (2.5)	16	0	0	0	9	0	0	0	2	0	0	0	67	1 (1.5)	0	1 (1.5)
VSD + PS	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	3	0	0	0
Corrected TGA	2	0	0	0	17	0	0	0	33	1 (3.0)	0	1 (3.0)	16	0	0	0	68	1 (1.5)	0	1 (1.5)
Truncus arteriosus	13	0	0	1 (7.7)	17	1 (5.9)	0	1 (5.9)	16	0	0	0	0	0	0	0	46	1 (2.2)	0	2 (4.3)
SV	27	0	0	2 (7.4)	151	2 (1.3)	1 (0.7)	7 (4.6)	213	0	0	0	12	0	0	0	403	2 (0.5)	1 (0.2)	9 (2.2)
TA	5	0	0	0	39	0	0	1 (2.6)	47	0	0	1 (2.1)	6	1 (16.7)	0	1 (16.7)	97	1 (1.0)	0	3 (3.1)
HLHS	33	6 (18.2)	0	11 (33.3)	80	0	0	3 (3.8)	104	3 (2.9)	0	5 (4.8)	0	0	0	0	217	9 (4.1)	0	19 (8.8)
Aortic valve lesion	11	1 (9.1)	0	2 (18.2)	18	1 (5.6)	0	2 (11.1)	104	0	0	1 (1.0)	30	2 (6.7)	0	2 (6.7)	163	4 (2.5)	0	7 (4.3)
Mitral valve lesion	0	0	0	0	43	0	0	1 (2.3)	70	0	0	1 (1.4)	19	2 (10.5)	0	2 (10.5)	132	2 (1.5)	0	4 (3.0)
Ebstein	12	4 (33.3)	0	4 (33.3)	9	0	0	0	23	0	0	0	7	0	0	0	51	4 (7.8)	0	4 (7.8)
Coronary disease	2	0	0	0	10	0	0	0	18	0	0	0	1	0	0	0	31	0	0	0
Others	13	2 (15.4)	0	2 (15.4)	27	1 (3.7)	0	3 (11.1)	49	0	0	1 (2.0)	232	1 (0.4)	0	1 (0.4)	321	4 (1.2)	0	7 (2.2)
Conduit failure	0	0	0	0	2	0	0	0	19	1 (5.3)	0	1 (5.3)	7	0	0	0	28	1 (3.6)	0	1 (3.6)
Redo (excluding conduit failure)	0	0	0	0	41	0	0	2 (4.9)	106	2 (1.9)	0	5 (4.7)	83	2 (2.4)	0	3 (3.6)	230	4 (1.7)	0	10 (4.3)
Total	568	25 (4.4)	0	44 (7.7)	2222	15 (0.7)	2 (0.09)	44 (2.0)	2783	13 (0.5)	0	27 (1.0)	1499	17 (1.1)	0	18 (1.2)	7072	70 (1.0)	2 (0.0)	133 (1.9)

( ), % 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, *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; 2296)

	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	325	11 (3.4)	0	14 (4.3)	164	0	0	4 (2.4)	24	0	0	0	1	0	0	0	514	11 (2.1)	0	18 (3.5)
Coarctation (simple)	23	0	0	0	15	0	0	0	9	0	0	0	0	0	0	0	47	0	0	0
+VSD	39	2 (5.1)	0	3 (7.7)	18	1 (5.6)	0	2 (11.1)	1	0	0	0	0	0	0	0	58	3 (5.2)	0	5 (8.6)
+DORV	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
+AVSD	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
+TGA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+SV	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
+Others	8	0	0	0	9	0	0	1 (11.1)	2	0	0	0	0	0	0	0	19	0	0	1 (5.3)
Interrupt. of Ao (simple)	2	0	0	1 (50.0)	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1 (50.0)
+VSD	31	1 (3.2)	0	2 (6.5)	11	0	0	0	2	0	0	0	0	0	0	0	44	1 (2.3)	0	2 (4.5)
+DORV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+Truncus	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	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	0	0	0	0	1	0	0	0	1	0	0	0	4	0	0	0
Vascular ring	1	0	0	0	10	0	0	0	6	0	0	0	1	0	0	0	18	0	0	0
PS	3	0	0	0	9	0	0	0	4	0	0	0	0	0	0	0	16	0	0	0
PA･IVS or critical PS	33	1 (3.0)	0	1 (3.0)	26	0	0	0	3	0	0	0	3	0	0	0	65	1 (1.5)	0	1 (1.5)
TAPVR	22	2 (9.1)	0	4 (18.2)	12	0	0	1 (8.3)	1	0	0	0	0	0	0	0	35	2 (5.7)	0	5 (14.3)
PAPVR±ASD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASD	0	0	0	0	2	0	0	0	1	0	0	0	1	0	0	0	4	0	0	0
Cor triatriatum	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
AVSD (partial)	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2	0	0	0
AVSD (complete)	51	0	0	2 (3.9)	84	3 (3.6)	0	4 (4.8)	16	0	0	0	1	0	0	0	152	3 (2.0)	0	6 (3.9)
+TOF or DORV	1	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0
+Others	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VSD (subarterial)	2	0	0	0	6	0	0	0	1	0	0	0	0	0	0	0	9	0	0	0
VSD (perimemb./muscular)	67	2 (3.0)	0	2 (3.0)	129	2 (1.6)	0	3 (2.3)	7	0	0	0	1	0	0	0	204	4 (2.0)	0	5 (2.5)
VSD (Type Unknown)	0	0	0	0	0		0	0	0		0		1		0	0	1	0	0	0
VSD+PS	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
DCRV±VSD	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Aneurysm of sinus of Valsalva	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOF	19	0	0	0	79	1 (1.3)	0	2 (2.5)	9	1 (11.1)	0	1 (11.1)	1	0	0	0	108	2 (1.9)	0	3 (2.8)
PA+VSD	20	2 (10.0)	0	3 (15.0)	52	0	0	1 (1.9)	23	0	0	1 (4.3)	0	0	0	0	95	2 (2.1)	0	5 (5.3)

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	
DORV	46	0	0	3 (6.5)	85	1 (1.2)	0	1 (1.2)	19	1 (5.3)	0	1 (5.3)	1	0	0	0	151	2 (1.3)	0	5 (3.3)
TGA (simple)	6	0	0	0	4	0	0	0	1	0	0	0	0	0	0	0	11	0	0	0
+VSD	12	0	0	0	8	0	0	0	1	0	0	0	1	0	0	0	22	0	0	0
VSD+PS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corrected TGA	7	0	0	0	10	0	0	0	15	1 (6.7)	0	1 (6.7)	3	1 (33.3)	0	1 (33.3)	35	2 (5.7)	0	2 (5.7)
Truncus arteriosus	18	1 (5.6)	0	2 (11.1)	9	0	0	0	1	0	0	0	0	0	0	0	28	1 (3.6)	0	2 (7.1)
SV	50	2 (4.0)	0	4 (8.0)	53	3 (5.7)	0	3 (5.7)	20	0	0	0	5	0	0	1 (20.0)	128	5 (3.9)	0	8 (6.3)
TA	23	0	0	2 (8.7)	15	0	0	0	3	0	0	0	3	0	0	0	44	0	0	2 (4.5)
HLHS	66	4 (6.1)	0	17 (25.8)	22	0	0	0	21	1 (4.8)	0	4 (19.0)	0	0	0	0	109	5 (4.6)	0	21 (19.3)
Aortic valve lesion	8	1 (12.5)	0	2 (25.0)	1	0	0	0	0	0	0	0	0	0	0	0	9	1 (11.1)	0	2 (22.2)
Mitral valve lesion	3	1 (33.3)	0	1 (33.3)	1	0	0	0	2	0	0	0	7	0	0	0	13	1 (7.7)	0	1 (7.7)
Ebstein	8	0	0	4 (50.0)	2	0	0	0	4	0	0	0	0	0	0	0	14	0	0	4 (28.6)
Coronary disease	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Others	13	1 (7.7)	0	1 (7.7)	14	0	0	3 (21.4)	15	2 (13.3)	0	3 (20.0)	10	0	0	0	52	3 (5.8)	0	7 (13.5)
Conduit failure	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
Redo (excluding conduit failure)	16	1 (6.3)	0	2 (12.5)	91	2 (2.2)	0	6 (6.6)	117	1 (0.9)	0	2 (1.7)	35	1 (2.9)	0	2 (5.7)	259	5 (1.9)	0	12 (4.6)
Total	932	32 (3.4)	0	70 (7.5)	957	13 (1.4)	0	31 (3.2)	330	7 (2.1)	0	13 (3.9)	77	2 (2.6)	0	4 (5.2)	2296	54 (2.4)	0	118 (5.1)

( ), % mortality

CPB cardiopulmonary bypass, *PDA* patent ductus arteriosus, *VSD* ventricular septal defect, *DORV* double-outlet right ventricle, *AVSD* atrioventricular septal defect, *TGA* transposition of the 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	169	5 (3.0)	0	12 (7.1)	356	1 (0.3)	0	6 (1.7)	55	0	0	1 (1.8)	1	0	0	0	581	6 (1.0)	0	19 (3.3)
2	PAB	308	3 (1.0)	0	14 (4.5)	311	4 (1.3)	0	9 (2.9)	15	1 (6.7)	0	1 (6.7)	1	0	0	0	635	8 (1.3)	0	24 (3.8)
3	Bidirectional Glenn or hemi-Fontan ±α	1	0	0	0	240	0	0	3 (1.3)	103	1 (1.0)	0	1 (1.0)	6	0	0	0	350	1 (0.3)	0	4 (1.1)
4	Damus–Kaye–Stansel operation	3	1 (33.3)	0	1 (33.3)	21	1 (4.8)	0	1 (4.8)	4	0	0	0	0	0	0	0	28	2 (7.1)	0	2 (7.1)
5	PA reconstruction/repair (including redo)	19	1 (5.3)	0	2 (10.5)	190	4 (2.1)	0	7 (3.7)	180	1 (0.6)	0	3 (1.7)	17	0	0	0	406	6 (1.5)	0	12 (3.0)
6	RVOT reconstruction/repair	6	0	0	0	200	1 (0.5)	1 (0.5)	2 (1.0)	338	1 (0.3)	0	1 (0.3)	39	0	0	0	583	2 (0.3)	1 (0.2)	3 (0.5)
7	Rastelli procedure	3	0	0	0	31	0	0	0	96	1 (1.0)	0	2 (2.1)	5	0	0	0	135	1 (0.7)	0	2 (1.5)
8	Arterial switch procedure	143	3 (2.1)	0	7 (4.9)	22	0	0	0	5	0	0	0	0	0	0	0	170	3 (1.8)	0	7 (4.1)
9	Atrial switch procedure	0	0	0	0	1	0	0	0	7	1 (14.3)	0	1 (14.3)	0	0	0	0	8	1 (12.5)	0	1 (12.5)
10	Double-switch procedure	0	0	0	0	1	0	0	0	12	0	0	0	0	0	0	0	13	0	0	0
11	Repair of anomalous origin of CA	0	0	0	0	4	0	0	0	3	0	0	0	0	0	0	0	7	0	0	0
12	Closure of coronary AV fistula	3	0	0	0	1	0	0	0	6	0	0	0	2	0	0	0	12	0	0	0
13	Fontan/TCPC	0	0	0	0	1	0	0	0	401	2 (0.5)	0	4 (1.0)	27	2 (7.4)	0	2 (7.4)	429	4 (0.9)	0	6 (1.4)
14	Norwood procedure	34	5 (14.7)	0	8 (23.5)	70	1 (1.4)	0	5 (7.1)	4	0	0	0	0	0	0	0	108	6 (5.6)	0	13 (12.0)
15	Ventricular septation	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
16	Left-side AV valve repair (including redo)	0	0	0	0	46	0	0	1 (2.2)	77	1 (1.3)	0	2 (2.6)	15	0	0	0	138	1 (0.7)	0	3 (2.2)
17	Left-side AV valve replace (including redo)	0	0	0	0	8	0	0	1 (12.5)	33	1 (3.0)	0	1 (3.0)	13	1 (7.7)	0	1 (7.7)	54	2 (3.7)	0	3 (5.6)
18	Right-side AV valve repair (including redo)	19	6 (31.6)	0	6 (31.6)	82	1 (1.2)	0	2 (2.4)	85	1 (1.2)	0	2 (2.4)	72	0	0	0	258	8 (3.1)	0	10 (3.9)
19	Right-side AV valve replace (including redo)	0	0	0	0	2	0	0	0	12	0	0	0	36	1 (2.8)	0	1 (2.8)	50	1 (2.0)	0	1 (2.0)
20	Common AV valve repair (including redo)	4	1 (25.0)	0	1 (25.0)	20	2 (10.0)	1 (5.0)	3 (15.0)	5	0	0	0	3	0	0	0	32	3 (9.4)	1 (3.1)	4 (12.5)
21	Common AV valve replace (including redo)	0	0	0	0	4	0	0	0	8	0	0	1 (12.5)	1	0	0	0	13	0	0	1 (7.7)
22	Repair of supra-aortic stenosis	0	0	0	0	10	0	0	1 (10.0)	19	0	0	1 (5.3)	2	0	0	0	31	0	0	2 (6.5)
23	Repair of subaortic stenosis (including redo)	1	0	0	0	6	0	0	0	32	0	0	0	1	0	0	0	40	0	0	0
24	Aortic valve plasty ± VSD closure	5	0	0	0	10	0	0	0	37	1 (2.7)	0	1 (2.7)	2	0	0	0	54	1 (1.9)	0	1 (1.9)
25	Aortic valve replacement	1	0	0	0	0	0	0	0	27	1 (3.7)	0	2 (7.4)	30	0	0	0	58	1 (1.7)	0	2 (3.4)
26	AVR with annular enlargement	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	9	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	
27	Aortic root replace (except Ross)	0	0	0	0	0	0	0	0	9	0	0	0	7	1 (14.3)	0	1 (14.3)	16	1 (6.3)	0	1 (6.3)
28	Ross procedure	1	0	0	0	2	0	0	0	17	0	0	0					20	0	0	0
29	Bilateral pulmonary artery banding	143	9 (6.3)	0	28 (19.6)	9	0	0	1 (11.1)	0	0	0	0			0		152	9 (5.9)	0	29 (19.1)
Total		863	34 (3.9)	0	79 (9.2)	1,649	15 (0.9)	2 (0.1)	42 (2.5)	1,599	13 (0.8)	0	24 (1.5)	280	5 (1.8)	0	5 (1.8)	4,391	67 (1.5)	2 (0.05)	150 (3.4)

( ), % 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 operations for arrhythmia in (3): 39,734.
(1) Valvular heart disease (total; 23,312)

	Valve	Cases	Operation					30-Day mortality				Hospital mortality		Redo			
			Mechanical	Bioprosthesis	Repair	Unknown	WITH CABG	Hospital		After discharge				Cases	30-Day mortality		Hospital mortality
								Replace	Repair	Replace	Repair	Replace	Repair		Hospital	After discharge	
Isolated	A	10,690	1511	8505	293	381	2641	187 (1.9)	4 (1.4)	1 (0.01)	0	308 (3.1)	12 (4.1)	627	21 (3.4)	0	35 (5.6)
	M	4687	498	832	3264	93	593	52 (3.9)	29 (0.9)	2 (0.2)	0	70 (5.3)	39 (1.2)	542	31 (5.7)	2 (0.4)	38 (7.0)
	T	615	11	94	503	7	57	2 (1.9)	15 (3.0)	0	0	7 (6.7)	32 (6.4)	110	6 (5.5)	0	12 (10.9)
	P	32	2	21	7	2	2	0	0	0	0	1 (4.4)	0	20	0	0	1 (5.0)
A+M		1415					247	68 (4.8)		1 (0.1)		112 (7.9)		161	15 (9.3)	0	18 (11.2)
	A		276	1030	57	52											
	M		188	434	756	37											
A+T		569					94	18(3.2)		0		29 (5.1)		73	5 (6.9)	0	5 (6.9)
	A		85	446	13	25											
	T		0	6	550	13											
M+T		3924					346	63(1.6)		1 (0.03)		107 (2.7)		421	12 (2.9)	0	20 (4.8)
	M		403	1033	2402	86											
	T		3	55	3833	33											
A+M+T		1196					155	52(4.4)		0		84 (7.0)		123	7 (5.7)	0	15 (12.2)
	A		217	890	42	47											
	M		165	448	554	29											
	T		0	8	1175	13											
Others		184	9	34	4	137	21	7(3.8)		0		10 (5.4)		39	3 (7.7)	0	4 (10.3)
Total		23,312					4156	517(2.2)		5 (0.02)		837 (3.6)		2116	100 (4.7)	2 (0.1)	148 (7.0)

TAVR	Cases	30-Day mortality	
	4632	55	(1.2)

Table 4 (continued)

(2) Ischemic heart disease (total, (A)+(B); 13,898)

(A) Isolated CABG (total; (a)+(b); 12,629)

(a-1) On-pump arrest CABG (total; 2875)

	Primary, elective				Primary, emergent				Redo, elective				Redo, emergent				Artery only	Artery +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	45	0	0	0	8	1 (12.5)	0 (0.0)	1 (12.5)	0	0	0	0	0	0	0	0	17	29	6	0	1
2VD	303	2 (0.7)	0	4 (1.3)	31	0 (0.0)	1 (3.2)	0 (0.0)	1	0 (0.0)	0	0	1	0	0	0	40	272	18	3	3
3VD	1015	8 (0.8)	1 (0.1)	14 (1.4)	124	8 (6.5)	0 (0.0)	12 (9.7)	6	0 (0.0)	0	0	0	0	0	0	80	1019	34	2	10
LMT	924	10 (1.1)	0	13 (1.4)	277	12 (4.3)	0 (0.0)	13 (4.7)	10	1 (10.0)	0	1 (10.0)	4	1 (25.0)	0	1 (25.0)	107	1025	71	5	7
No info	97	2 (2.1)	0	2 (2.1)	28	4 (14.3)	0 (0.0)	6 (21.4)	1	0 (0.0)	0	0	0	0	0	0	25	80	13	1	7
Total	2384	22 (0.9)	1 (0.0)	33 (1.4)	468	25 (5.3)	1 (0.2)	32 (6.8)	18	1 (5.6)	0	1 (5.6)	5	1 (20.0)	0	1 (20.0)	269	2425	142	11	28
Kawasaki	13	0	0	0	1	0 (0.0)	0 (0.0)	0 (0.0)	0	0	0	0	0	0	0	0	8	5	0	0	1
On dialysis	246	9 (3.7)	0 (0.0)	14 (5.7)	57	7 (12.3)	1 (1.8)	7 (12.3)	4	1 (25.0)	0	1 (25.0)	3	1 (33.3)	0	1 (33.3)	22	258	24	1	5

( ), % 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; 2323)

	Primary, elective				Primary, emergent				Redo, elective				Redo, emergent				Artery only	Artery +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	45	0	0	1 (2.2)	12	5 (41.7)	0	5 (41.7)	1	0	0	0	1	0	0	0	20	24	14	0	1
2VD	207	3 (1.4)	0	4 (1.9)	40	6 (15.0)	0	6 (15.0)	3	0	0	0	2	1 (50.0)	0	1 (50.0)	55	168	24	2	3
3VD	718	11 (1.5)	0	19 (2.6)	197	19 (9.6)	0	24 (12.2)	5	0	0	0	3	1 (33.3)	0	2 (66.7)	101	765	47	4	6
LMT	661	12 (1.8)	0	18 (2.7)	342	30 (8.8)	0	39 (11.4)	9	1 (11.1)	0	1 (11.1)	4	1 (25.0)	0	1 (25.0)	129	814	62	4	7
no info	53	4 (7.5)	0	4 (7.5)	18	5 (27.8)	0	6 (33.3)	0	0	0	0	2	0	0	0	19	40	13	0	1
Total	1684	30 (1.8)	0	46 (2.7)	609	65 (10.7)	0	80 (13.1)	18	1 (5.6)	0	1 (5.6)	12	3 (25.0)	0	4 (33.3)	324	1811	160	10	18
Kawasaki	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
On dialysis	223	10 (4.5)	0	18 (8.1)	83	16 (19.3)	0	22 (26.5)	3	0	0	0	2	1 (50.0)	0	1 (50.0)	40	234	29	2	6

(), % 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

Table 4 (continued)

(b) Off-pump CABG (total;7,431)

(Including 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, emergent				Redo, elective				Redo, emergent				Artery only	Artery +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	347	1 (0.3)	0	4 (1.2)	45	1 (2.2)	0	1 (2.2)	7	0	0	0	1	0	0	0	284	79	33	0	4
2VD	948	1 (0.1)	1 (0.1)	4 (0.4)	117	4 (3.4)	0	5 (4.3)	11	0	0	0	1	0	0	0	364	666	38	2	7
3VD	2341	19 (0.8)	1 (0.0)	35 (1.5)	301	7 (2.3)	0	10 (3.3)	14	0	0	1 (7.1)	2	0	0	0	598	1978	60	12	10
LMT	2394	26 (1.1)	0	38 (1.6)	622	21 (3.4)	0	27 (4.3)	27	0	0	0	8	0	0	0	913	2031	91	6	10
no info	185	1 (0.5)	0	2 (1.1)	49	2 (4.1)	0	2 (4.1)	7	0	0	0	4	1 (25.0)	0	1 (25.0)	84	142	13	2	4
Total	6215	48 (0.8)	2 (0.0)	83 (1.3)	1134	35 (3.1)	0	45 (4.0)	66	0	0	1 (1.5)	16	1 (6.3)	0	1 (6.3)	2243	4896	235	22	35
Kawasaki	16	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	12	5	0	0	0
On dialysis	725	15 (2.1)	1 (0.1)	34 (4.7)	123	9 (7.3)	0	11 (8.9)	9	0	0	0	4	1 (25.0)	0	1 (25.0)	202	618	33	3	5

( ), % 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) Cases of conversion, during surgery, from off-pump CABG to on-pump CABG or on- pump beating-heart CABG (these cases are also included in category (b))

	Primary, elective				Primary, emergent				Redo, elective				Redo, emergent			
	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	
Converted to arrest	34	0	0	0	6	0	0	0 (0.0)	0	0	0	0	0	0	0	0
Converted to beating	131	5 (3.8)	0	9 (6.9)	45	6 (13.3)	0	6 (13.3)	1	0	0	0	1	0	0	0
Total	165	5 (3.0)	0	9 (5.5)	51	6 (11.8)	0	6 (11.8)	1	0	0	0	1	0	0	0
On dialysis	31	1 (3.2)	0	3 (9.7)	9	4 (44.4)	0	4 (44.4)	0	0	0	0	0	0	0	0

( ), % mortality

CABG coronary artery bypass grafting

Table 4 (continued)

(B) Operation for complications of MI (total; 1269)

	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	122	7 (5.7)	0	8 (6.6)	24	5 (20.8)	0	7 (29.2)	87	22	10
VSP closure	66	10 (15.2)	0	13 (19.7)	242	60 (24.8)	0	81 (33.5)	86	2	3
Cardiac rupture	28	7 (25.0)	1 (3.6)	10 (35.7)	221	64 (29.0)	0	86 (38.9)	35	2	5
Mitral regurgitation											
1) Papillary muscle rupture	21	1 (4.8)	0	1 (4.8)	47	14 (29.8)	0	17 (36.2)	28	15	53
2) Ischemic	295	15 (5.1)	0	29 (9.8)	36	10 (27.8)	1 (2.8)	14 (38.9)	235	193	138
Others	80	3 (3.8)	0	4 (5.0)	87	20 (23.0)	0	30 (34.5)	58	10	6
Total	612	43 (7.0)	1 (0.2)	65 (10.6)	657	173 (26.3)	1 (0.2)	235 (35.8)	529	244	215

( ), % 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

(3) Operation for arrhythmia (total; 5066)

	Cases	30-Day mortality		Hospital mortality	Concomitant operation						
					Isolated	Congenital	Valve	IHD	Others	Multiple combination	
		Hospital	After discharge							2 categories	3 categories
Maze	3286	52 (1.6)	1 (0.03)	89 (2.7)	120	185	2844	561	257	627	46
For WPW	4	0	0	0	0	1	3	0	0	1	0
For ventricular tachyarrhythmia	35	2 (5.7)	0	3 (8.6)	2	1	10	18	5	7	1
Others	1741	34 (2.0)	3 (0.17)	52 (3.0)	31	124	1512	324	145	370	24
Total	5066	88 (1.7)	4 (0.08)	144 (2.8)	153	311	4369	903	407	1005	71

( ), % mortality

Except for 153 isolated cases, all remaining 4913 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

Table 4 (continued)

(4) Operation for constrictive pericarditis (total; 216)

	CPB (+)				CPB (–)			
	Cases	30-Day mortality		Hospital mortality	Cases	30-Day mortality		Hospital mortality
		Hospital	After discharge			Hospital	After discharge	
Total	116	9 (7.8)	0	17 (14.7)	100	2 (2.0)	0	9 (9.0)

( ), % mortality

CPB cardiopulmonary bypass

(5) Cardiac tumor (total; 622)

	Cases	30-Day mortality		Hospital mortality	Concomitant operation			
		Hospital	After discharge		AVR	MVR	CABG	others
Benign tumor	548	6 (1.1)	0	11 (2.0)	19	15	47	112
(Cardiac myxoma)	385	6 (1.6)	0	9 (2.3)	6	6	26	61
Malignant tumor	74	2 (2.7)	0	5 (6.8)	1	3	2	18
(Primary)	9	0	0	0	1	1	1	4

( ), % mortality

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

(6) HOCM and DCM (total; 302)

	Cases	30-Day mortality		Hospital mortality	Concomitant operation			
		Hospital	After discharge		AVR	MVR	MVP	CABG
Myectomy	138	2 (1.4)	0	4 (2.9)	63	20	17	12
Myotomy	11	0	0	0	2	0	3	1
No resection	144	8 (5.6)	0	12 (8.3)	30	70	74	13
Volume reduction surgery of the left ventricle	9	1 (11.1)	0	2 (22.2)	0	2	4	1
Total	302	11 (3.6)	0	18 (6.0)	95	92	98	27

( ), % 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

Table 4 (continued)

(7) Other open-heart operation (total: 1231)	Cases	30-Day mortality		Hospital mortality
		Hospital	After discharge	
Open-heart operation	516	63 (12.2)	1 (0.2)	88 (17.1)
Non-open-heart operation	715	66 (9.2)	1 (0.1)	108 (15.1)
Total	1231	129 (10.5)	2 (0.2)	196 (15.9)

(), % mortality

respectively. Data for individual categories are summarized in Tables 3, 4, 5, 6, 7, and 8.

In 2017, among 9368 procedures for congenital heart disease, 7072 open-heart surgeries were performed with an overall hospital mortality of 1.9%. Compared with data for 2007, the number of surgeries for neonates and infants has not changed significantly; however, hospital mortality decreased significantly from 13.7 to 7.7% for neonates and from 3.9 to 2.0% for infants. In 2017, atrial septal defect was once again the most common disease (1418 cases) for the first time in 3 years. This was primarily due to a doubling in the number of surgeries for patients above the age of 18 years (from 372 to 761 cases). Ventricular septal defect (perimemb/muscular) was the second most common health issue (1092 cases) and had previously been the most common disease in 2015 and 2016. In the past 10 years, hospital mortality for complex congenital heart disease was as follows (2007 [2], 2012 [3], and 2017): complete atrioventricular septal defect (4.3%, 3.2%, and 2.7%, respectively), tetralogy of Fallot (1.4%, 1.1%, and 0.9%, respectively), transposition of the great arteries with intact septum (2.7%, 2.6%, and 4.5%, respectively) and with ventricular septal defect (5.6%, 3.2%, and 1.5%, respectively), and single ventricle (5.4%, 5.5%, and 2.2%, respectively) and hypoplastic left heart syndrome (20.1%, 10.2%, and 8.8%, respectively). Right heart bypass surgery is now commonly performed (350 bidirectional Glenn procedures excluding 28 Damus–Kaye–Stansel procedures and 429 Fontan type procedures including total cavopulmonary connection) at an acceptable hospital mortality rate (1.1% and 1.4%). The Norwood type I procedure was performed in 108 cases, with a relatively low hospital mortality rate of 12.0% (Table 9).

The total number of procedures for valvular heart disease is increasing. The number of isolated aortic valve replacement/repair with/without coronary artery bypass grafting (CABG) (n=10,690) increased by 12.9% from the previous year (n=9472) and by 10.3% from 5 years ago (n=9688), despite the rapid spread of transcatheter aortic valve replacement (n=4632 in 2017). On the other hand, the number of isolated mitral valve replacement/repair with/without CABG (n=4687) remained stable, with a 2.4% increase from the previous year (n=4576) and a 1.5% increase from 5 years ago (n=4617). Aortic and mitral valve replacements with bioprosthesis procedures were performed in 10,871 cases and 2747 cases, respectively. The ratio for employing bioprosthesis increased dramatically from the 30% level in the early 2000s [4, 5] and was 83.9% and 68.7% in the aortic and mitral positions, respectively, in 2017. Additionally, CABG was performed as a concomitant procedure in 17.8% for all valvular procedures (15.7% in 2007 [2] and 18.2% in 2012 [3]). Repair of the valve was a popular procedure in mitral and tricuspid

Table 5 Thoracic aortic aneurysm (total; 20, 746) (1) Dissection (total; 10, 086)

	Acute								Chronic													
	Stanford A				Stanford B				Stanford A				Stanford B				AVP	AVR	MVP	MVR	CABG	Other
	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							
Ascending Ao.	2328	206 (8.8)	2 (0.1)	255 (11.0)	3	1 (33.3)	0	1 (33.3)	225	5 (2.2)	0	12 (5.3)	8	0	0	0	98	145	15	11	133	99
Aortic Root	229	39 (17.0)	0	47 (20.5)	2	0 (0.0)	0	0	86	6 (7.0)0		7 (8.1)	7	0	0	0	32	217	7	0	69	19
Arch	2038	156 (7.7)	3 (0.1)	192 (9.4)	35	1 (2.9)	0	1 (2.9)	371	14 (3.8)	0	17 (4.6)	173	8 (4.6)	0	12 (6.9)	114	144	14	13	141	94
Aortic root + asc. Ao. + Arch	199	22 (11.1)	0	25 (12.6)	3	0 (0.0)	0	0 (0.0)	50	2 (4.0)	0	4 (8.0)	10	0	0	0	33	121	3	3	49	19
Descending Ao.	56	6 (10.7)	0	9 (16.1)	37	5 (13.5)	0	6 (16.2)	75	4 (5.3)	0	4 (5.3)	267	5 (1.9)	1 (0.4)	10 (3.7)	3	6	0	0	4	10
Thoracoabdominal	10	0	0	1 (10.0)	11	1 (9.1)	0	1 (9.1)	49	3 (6.1)	0	3 (6.1)	222	8 (3.6)	0	15 (6.8)	0	0	0	0	1	7
TEVAR without BR	75	12 (16.0)	0	15 (20.0)	318	26 (8.2)	2 (0.6)	32 (10.1)	175	3 (1.7)	0	3 (1.7)	919	10 (1.1)	1 (0.1)	14 (1.5)	0	0	0	0	0	13
Open stent graft with/ without BR	1035	98 (9.5)	0	118 (11.4)	71	12 (16.9)	0	12 (16.9)	222	12 (5.4)	0	14 (6.3)	258	6 (2.3)	0	10 (3.9)	48	113	2	4	85	34
Arch TEVAR with BR	15	4 (26.7)	0	5 (33.3)	77	7 (9.1)	0	7 (9.1)	66	1 (1.5)	0	3 (4.5)	324	4 (1.2)	2 (0.6)	6 (1.9)	0	0	0	0	0	23
Thoracoabdominal TEVAR with BR	2	1 (50.0)	0	1 (50.0)	1	0 (0.0)	0	0	1	0	0	0	4	0	0	1 (25.0)	0	1	0	0	0	2
Other	8	1 (12.5)	0	2 (25.0)	5	2 (40.0)	0	2 (40.0)	3	0	0	0	13	1 (7.7)	0	1 (7.7)	0	1	0	0	2	3
	5995	545 (9.1)	5 (0.1)	670 (11.2)	563	55 (9.8)	2 (0.4)	62 (11.0)	1323	50 (3.8)	0	67 (5.1)	2205	42 (1.9)	4 (0.2)	69 (3.1)	328	748	41	31	484	323

( ), % 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, BR, branch reconstruction

Table 5 (continued)
(2) Non-dissection (total; 10,660)

		Unruptured				Ruptured				AVP	AVR	MVP	MVR	CABG	Other
		Cases	30-Day mortality		Hospital mortality	Cases	30-Day mortality		Hospital mortality						
			Hospital	After discharge			Hospital	After discharge							
1	Ascending Ao.	1406	35 (2.5)	0	54 (3.8)	52	6 (11.5)	0	11 (21.2)	81	1024	87	50	180	233
2	Aortic root	1066	35 (3.3)	0	50 (4.7)	36	4 (11.1)	0	7 (19.4)	294	710	73	17	168	134
3	Arch	2193	65 (3.0)	2 (0.1)	104 (4.7)	97	16 (16.5)	1 (1.0)	18 (18.6)	48	485	52	17	358	178
4	Aortic root + asc. Ao. + Arch	261	6 (2.3)	0	9 (3.4)	8	1 (12.5)	0	3 (37.5)	32	197	13	13	36	24
5	Descending Ao.	264	7 (2.7)	1 (0.4)	14 (5.3)	40	6 (15.0)	1 (2.5)	8 (20.0)	0	6	1	1	16	7
6	Thoracoabdominal	365	22 (6.0)	0	33 (9.0)	36	8 (22.2)	0	9 (25.0)	0	0	0	0	2	1
7d	TEVAR without BR	1970	28 (1.4)	1 (0.1)	48 (2.4)	281	49 (17.4)	2 (0.7)	59 (21.0)	0	3	1	1	6	22
	Open stent graft with/without BR	1267	46 (3.6)	0	65 (5.1)	97	23 (23.7)	1 (1.0)	28 (28.9)	22	117	17	5	196	67
7c	Arch TEVAR with BR	940	20 (2.1)	2 (0.2)	35 (3.7)	78	12 (15.4)	0	19 (24.4)	0	1	0	0	4	47
7a1	Thoracoabdominal TEVAR with BR	19	1 (5.3)	0	1 (5.3)	4	1 (25.0)	0	1 (25.0)	0	2	0	0	0	0
9	Other	158	8 (5.1)	0	9 (5.7)	22	5 (22.7)	0	6 (27.3)	2	35	6	1	16	28
		9909	273 (2.8)	6 (0.1)	422 (4.3)	751	131 (17.4)	5 (0.7)	169 (22.5)	479	2580	250	105	982	741

(), % 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, *TABR* thoracoabdominal branch reconstruction, *SABR* supra-aortic branch reconstruction

Table 6 Pulmonary thromboembolism (total; 174)

	Cases	30-Day mortality		Hospital mortality
		Hospital	After discharge	
Acute	101	11 (10.9)	0	12 (11.9)
Chronic	73	3 (4.1)	0	7 (9.6)
Total	174	14 (8.0)	0	19 (10.9)

(), % mortality

Table 7 Implantation of VAD (total; 172)

	Cases	30-Day mortality		Hospital mortality
		Hospital	After discharge	
Implantation of VAD	172	5 (2.9)		7 (4.1)

(), mortality %

VAD ventricular assist device

Table 8 Heart transplantation (total; 56)

	Cases	30-Day mortality		Hospital mortality
		Hospital	After discharge	
Heart transplantation	56	1 (1.8)	0	1 (1.8)
Heart and lung transplantation	0	0	0	0
Total	56	1 (1.8)	0	1 (1.8)

(), mortality %

valve positions (6976 cases in the mitral and 6061 cases in the tricuspid) but is less frequently observed in aortic valve positions (405 patients, only 2.7% of all aortic valve procedures). Mitral valve repair constituted 29.9% of all valvular operations and 62.2% of all mitral valve procedures. Hospital mortality for single valve replacement was 3.1% and 5.3% for the aortic and mitral positions, respectively, whereas for mitral valve repair, this was only 1.2%. The hospital mortality for redo valve surgery was 3.4% and 5.7% in the aortic and mitral positions, respectively. Finally, overall hospital mortality did not show dramatic improvement during the past 10 years (3.8% in 2007 [2], 3.2% in 2012 [3], and 3.6% in 2017).

Isolated CABG was performed in 12,629 cases, representing only 73.0% of the number performed 10 years ago (n=17,295) [2]. Among these, off-pump CABG was intended in 7431 cases (58.8%) at a success rate of 97.1%. The percentage of intended off-pump CABG in 2017 was less than 60% for the first time in 13 years, since 2004 [4]. Hospital mortality associated with primary elective CABG procedures in 10,283 cases was 1.6%, unchanged from 2003 (1.5%) [5]. Hospital mortality for primary emergency CABG in 2211 cases was still as high as 7.1%. The result of conversion from off-pump CABG was 2.9%, and hospital mortality in this context was 6.9%. Hospital mortality was higher in patients with end-stage renal failure on dialysis, regardless of surgical procedures (on-pump arrest, on-pump beating, and off-pump). In this report, the number of concomitant CABGs alongside other major procedures was not included in the category of ischemic heart disease but in other categories such as valvular heart disease and thoracic aortic aneurysm. Accordingly, the overall number of CABGs, including concomitant CABG with other major procedures, remained more than 18,000 cases per year (18,327 cases) in 2017.

Measures for arrhythmia were performed primarily as concomitant procedures in 5066 cases, with hospital mortality of 2.8%. Implantation of pacemaker and implantable cardioverter–defibrillator was not included in this category.

In 2017, 20,746 procedures were performed for thoracic and thoracoabdominal aortic diseases; 10,086 and 10,660 were for aortic dissection and non-dissection, respectively. The number of surgeries for aortic dissection increased by 6.9% this year, compared with that in the preceding year (n =9441). The hospital mortality of procedures for 5995 Stanford type A acute aortic dissections remained as high as 11.2%. The number of procedures for non-dissected aneurysm increased by 10.6%, with overall hospital mortality of 5.5%, and 4.3% and 22.5% for unruptured and ruptured aneurysms, respectively. The rate of thoracic endovascular aortic repair (TEVAR) among all operative

procedures for aortic diseases is increasing. A total of 3563 patients with aortic dissection underwent stent graft placement: 1969 TEVARs and 1594 open stent graftings, respectively. The number of TEVARs for type B chronic aortic dissections was 1505 cases and accounted for 68.3% of total cases. The hospital mortality rates associated with TEVAR for type B aortic dissection were 11.0% and 3.1% in acute and chronic cases, respectively. A total of 4656 patients with non-dissected aortic aneurysm underwent stent graft placement, comprising 3269 TEVARs (a 6.7% increase compared with that in 2016, n=3063) and 1387 open stent graftings (a 16.2% increase compared with that in 2016, n=1194). The hospital mortality rates for TEVARs and open stenting were as follows: TEVAR, 2.8% and 21.7% for unruptured and ruptured aneurysms, respectively, and open stent grafting, 5.1% and 28.7% for unruptured and ruptured aneurysms, respectively.

(B) General thoracic surgery

The 2017 survey of general thoracic surgery comprised 678 surgical units, with the bulk of data submitted via a web-based collection system of the NCD [1]. In total, 85,307 procedures were reported by general thoracic surgery departments in 2017, twice the number of operations in 2000 and 12,560 more than in 2012 (Fig. 2).

In 2017, 44,140 procedures for primary lung cancer were performed, a number that has increased annually. The 2017 value was 2.4 times that of 2000. Procedures for lung cancer represented 52% of all general thoracic surgery instances.

The number of video-assisted thoracoscopic surgery (VATS) instances, defined by a surgical procedure utilizing a skin incision longer than 8 cm and/or a minithoracotomy (hybrid) approach, has been noted since the 2015 annual report. The number of VATS procedures for benign pulmonary tumors and primary lung cancer, and the total number of VATS procedures in 2016 are shown in Tables 10, 11, 13, 16, 17, 18, 19, 20, 21, 22, 23, 25, 26, and 27, respectively.

Table 9 Total cases of general thoracic surgery during 2017

	Cases	%
Benign pulmonary tumor	2197	2.6
Primary lung cancer	44,140	51.7
Other primary malignant pulmonary tumor	423	0.5
Metastatic pulmonary tumor	8950	10.5
Tracheal tumor	120	0.1
Mesothelioma	698	0.8
Chest wall tumor	691	0.8
Mediastinal tumor	5197	6.1
Thymectomy for MG without thymoma	189	0.2
Inflammatory pulmonary disease	2423	2.8
Empyema	2962	3.5
Bullous disease excluding pneumothorax	400	0.5
Pneumothorax	14,499	17.0
Chest wall deformity	193	0.2
Diaphragmatic hernia including traumatic	28	0.0
Chest trauma excluding diaphragmatic hernia	443	0.5
Lung transplantation	68	0.1
Others	1686	2.0
Total	85,307	100.0

In 2017, 2197 procedures were conducted for benign pulmonary tumors (Table 10), a similar number to that recorded in 2016. Hamartoma was the most frequent diagnosis in procedures for benign pulmonary tumors. VATS was performed for 2071 patients (94%).

Additional information on primary malignant pulmonary tumors is shown in Tables 11 and 12. With regard to lung cancer sub-type, adenocarcinoma was by far the most frequent diagnosis (71% of all lung cancer procedures), followed by squamous cell carcinoma (18%). Sublobar resection was performed in 11,784 lung cancer cases (27% of all cases) and lobectomy in 31,584 cases (72% of

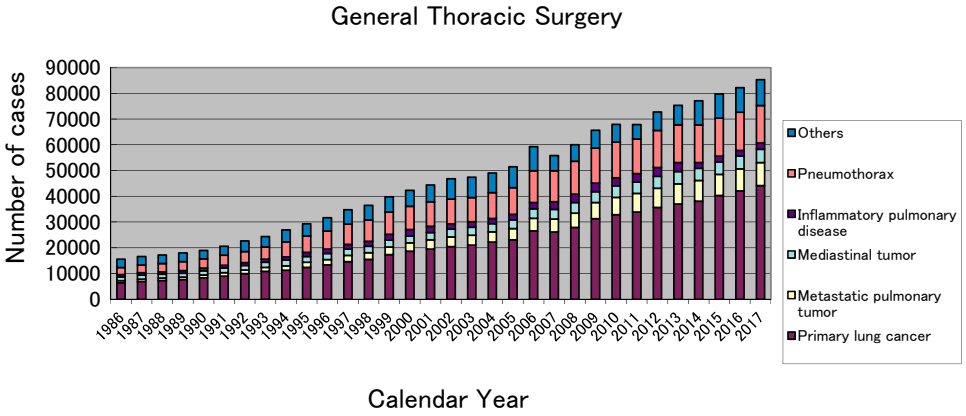

Fig. 2 General thoracic surgery

Table 10 Benign pulmonary tumor

	Cases	30-Day mortality		Hospital mortality	By VATS
		Hospital	After discharge		
Benign pulmonary tumor					
Hamartoma	518	0	0	0	498
Sclerosing hemangioma	76	0	0	0	73
Papilloma	23	0	0	0	21
Mucous gland adenoma bronchial	2	0	0	0	2
Fibroma	132	0	0	0	129
Lipoma	4	0	0	0	4
Neurogenic tumor	21	0	0	0	17
Clear cell tumor	3	0	0	0	3
Leiomyoma	18	0	0	0	17
Chondroma	7	0	0	0	7
Inflammatory myofibroblastic tumor	5	0	0	0	5
Pseudolymphoma	19	0	0	0	17
Histiocytosis	13	0	0	0	12
Teratoma	6	0	0	0	2
Others	1350	2 (0.1)	2 (0.1)	5 (0.4)	1264
Total	2197	2 (0.1)	2 (0.09)	5 (0.2)	2071

(), mortality %

all cases). Sleeve lobectomy was performed in 496 cases, and pneumonectomy was required in 403 cases (0.9% of all cases). VATS lobectomy for lung cancer was performed in 21,992 cases (70% of all lobectomy cases). The number of VATS procedures for primary lung cancer was slightly higher in 2017 than that in 2016. The number of the patients aged 80 years or older who underwent lung cancer surgery was 5779 (13%). In total, 121 patients died prior to hospital discharge within 30 days following surgery, and 32 patients died following discharge within 30 days after surgery. Therefore, 153 patients died within 30 days after surgery (30-day mortality rate 0.3%). In total, 247 patients died prior to discharge (hospital mortality rate 0.6%), and the 30-day mortality rate, according to procedure, was 0.2% for segmentectomy, 0.3% for lobectomy, and 2% for pneumonectomy. Interstitial pneumonia was the leading cause of death following lung cancer surgery, followed by pneumonia, respiratory failure, and cardiovascular events.

Procedures for metastatic pulmonary tumors, 8950 of which were performed in 2017, are shown in Table 13. In this instance, colorectal cancer was the most frequent diagnosis (47% of all cases).

Table 11 Primary malignant pulmonary tumor

	Cases	30-Day mortality		Hospital mortality	VATS
		Hospital	After discharge		
Primary malignant pulmonary tumor	44,563	122 (0.3)	32 (0.1)	247 (0.6)	32,206
Lung cancer	44,140	121 (0.3)	31 (0.1)	244 (0.6)	32,206
Adenocarcinoma	31,119	52 (0.2)	13 (0.0)	91 (0.3)	
Squamous cell carcinoma	8132	56 (0.7)	14 (0.2)	121 (1.5)	
Large cell carcinoma	301	1 (0.3)	1 (0.3)	4 (1.3)	
LCNEC	601	3 (0.5)	0	4 (0.7)	
Small cell carcinoma	823	2 (0.2)	0	4 (0.5)	
Adenosquamous carcinoma	571	1 (0.2)	2 (0.4)	2 (0.4)	
Carcinoma with pleomorphic, sarcomatoid or sarcomatous elements	493	2 (0.4)	0	9 (1.8)	
Carcinoid	233	0	0	0	
Carcinomas of salivary-gland type	38	0	0	1 (2.6)	
Unclassified	43	0	0	0	
Multiple lung cancer	1464	3 (0.2)	1 (0.1)	6 (0.4)	
Others	322	1 (0.3)	0	2 (0.6)	
Wedge resection	7099	14 (0.2)	8 (0.1)	28 (0.4)	6299
Segmental excision	4685	9 (0.19)	2 (0.0)	16 (0.3)	3698
(Sleeve segmental excision)	14	0	0	0	3
Lobectomy	31,584	85 (0.3)	18 (0.1)	179 (0.6)	21,992
(Sleeve lobectomy)	496	1 (0.2)	2 (0.4)	2 (0.4)	71
Pneumonectomy	403	8 (2.0)	1 (0.2)	15 (3.7)	33
(Sleeve pneumonectomy)	10	2 (20.0)	0	2 (20.0)	2
Other bronchoplasty	33	0	0	0	4
Pleuropneumonectomy	1	0	0	0	0
Others	335	5 (1.5)	2 (0.6)	6 (1.8)	180
Unknown	0	0	0	0	
Sarcoma	56	1 (1.8)	1 (1.8)	1 (1.8)	
AAH	117	0	0	0	
Others	250	0	0	2 (0.8)	

(), mortality %

There were 46 procedures for malignant tracheal tumor in 2017; however, 21 patients were treated with sleeve resection and reconstruction (Table 14).

Pleural tumors numbered 698 in 2017 (Table 15). Diffuse malignant pleural mesothelioma was the most frequent histologic diagnosis. Total pleurectomy was performed in 104 cases and extrapleural pneumonectomy in 65 cases. The 30-day mortality rate was 0% following total pleurectomy and 2% after extrapleural pneumonectomy, both representing better outcomes than before.

In total, 691 chest wall tumors were resected in 2017 (Table 16), 362 (52%) of which were benign. Among the 329 malignant chest wall tumors, 189 (57%) were metastatic tumors.

Table 12 Details of lung cancer operations

TNM	
c-Stage	Cases
IA1	7464
IA2	12,312
IA3	7771
IB	5228
IIA	1661
IIB	3846
IIIA	2802
IIIB	524
IIIC	25
IVA	449
IVB	70
NA	1988
Total	44,140
Sex	Cases
Male	27,089
Female	14,051
NA	0
Total	41,140
Cause of death	Case
Cardiovascular	23
Pneumonia	43
Pyothorax	2
Bronchopleural fistula	11
Respiratory failure	25
Pulmonary embolism	5
Interstitial pneumonia	78
Brain infarction or bleeding	11
Others	62
Unknown	15
Total	275
p-Stage	Cases
0(pCR)	2940
IA1	8908
IA2	9422
IA3	4873
IB	5999
IIA	1242
IIB	4579
IIIA	4026
IIIB	818
IIIC	17
IVA	982
IVB	69
NA	265
Total	44,140
Age (years)	Cases
<20	20
20–29	38
30–39	209
40–49	1226
50–59	3768
60–69	14,080
70–79	19,020
80–89	5681
≥90	98
NA	0
Total	44,140

Mediastinal tumors were resected in 5197 patients in 2017, a slight increase from the previous year (Table 17). Thymic epithelial tumor—including 1939 thymomas, 368 thymic carcinomas, and 39 thymic carcinoids—was the most frequent mediastinal tumor type in 2017.

Thymectomy for myasthenia gravis was performed in 508 patients (Table 18); 319 procedures were associated with thymoma, and the remaining was not associated with thymoma.

Procedures for non-neoplastic disease were performed for 22,634 patients. There were 2423 cases of lung resection for inflammatory lung diseases (Table 19), 20% of which were associated with atypical mycobacterium infections and 15% with fungal infections. Procedures for inflammatory nodules were performed in cases where lung cancer was suspected prior to surgery (in 918 cases, 38%).

The 2962 procedures for empyema (Table 20) comprised 2226 cases (75%) of acute empyema and 736 cases of chronic empyema. Bronchopleural fistula was reported in 453 patients with acute empyema and in 355 patients with chronic empyema. The hospital mortality rate was 15% among patients with acute empyema with fistula.

In 2017, 101 operations were performed for descending necrotizing mediastinitis (Table 21). The hospital mortality rate was 7%. Furthermore, 400 procedures were conducted for bullous diseases (Table 22); lung volume reduction surgery was performed in only 28 patients.

A total of 14,499 procedures were performed for spontaneous pneumothorax (Table 23). The 11,113 procedures for primary pneumothorax comprised 2838 patients (26%) who underwent bullectomy only and 7488 patients (67%) who underwent an additional procedure. There were 3386

Table 13 Metastatic pulmonary tumor

	Cases	30-Day mortality		Hospital mortality	VATS
		Hospital	After discharge		
Metastatic pulmonary tumor	8950	12 (0.1)	4 (0.0)	18 (0.2)	8298
Colorectal	4240	5 (0.1)	0	7 (0.2)	3965
Hepatobiliary/pancreatic	422	0	0	1 (0.2)	400
Uterine	448	0	0	0	425
Mammary	545	0	1 (0.2)	0	517
Ovarian	71	0	0	0	65
Testicular	72	1 (1.4)	1 (1.4)	1 (1.4)	66
Renal	746	0	0	0	706
Skeletal	144	0	0	1 (0.7)	124
Soft tissue	274	0	1 (0.4)	0	248
Otorhinolaryngological	435	0	0	0	397
Pulmonary	573	3 (0.5)	0	4 (0.7)	483
Others	980	3 (0.3)	1 (0.1)	4 (0.4)	902

(), mortality %

Table 14 Tracheal tumor

	Cases	30-Day mortality		Hospital mortality
		Hospital	After discharge	
Tracheal tumor	120	2 (1.7)	2 (1.7)	4 (3.3)
A. Primary malignant tumor				
Histological classification				
Squamous cell carcinoma	10	0	0	0
Adenoid cystic carcinoma	20	0	0	0
Mucoepidermoid carcinoma	4	0	0	0
Others	12	0	1 (8.3)	0
Total	46	0	1 (2.2)	0
B. Metastatic/invasive malignant tumor				
(e.g., invasion of thyroid cancer)	36	0	1 (2.8)	2 (5.6)
C. Benign tracheal tumor				
Histological classification				
Papilloma	5	0	0	0
Adenoma	1	0	0	0
Neurofibroma	0	0	0	0
Chondroma	0	0	0	0
Leiomyoma	2	0	0	0
Others	30	2 (6.7)	0	2 (6.7)
Histology unknown	0	0	0	0
Total	38	2 (5.3)	0	2 (5.3)
Operation				
Sleeve resection with reconstruction	21	0	0	0
Wedge with simple closure	2	0	0	0
Wedge with patch closure	1	0	0	0
Total laryngectomy with tracheostomy	0	0	0	0
Others	3	0	0	0
Unknown	0	0	0	0
Total	27	0	0	0

(), mortality %

Table 15 Tumor of pleural origin

Histological classification	Cases	30-Day mortality		Hospital mortality
		Hospital	After discharge	
Tumor of pleural origin				
Solitary fibrous tumor	131	0	0	0
Diffuse malignant pleural mesothelioma	264	2 (0.8)	0	8 (3.0)
Localized malignant pleural mesothelioma	35	1 (2.9)	0	1 (2.9)
Others	268	1 (0.4)	1 (0.4)	5 (1.9)
Total	698	4 (0.6)	1 (0.1)	14 (2.0)

Operative procedure	Cases	30-Day mortality		Hospital mortality
		Hospital	After discharge	
Extrapleural pneumonectomy	65	1 (1.5)	0	1 (1.5)
Total pleurectomy	104	0	0	3 (2.9)
Others	95	1 (1.1)	0	4 (4.2)
Total	264	2 (0.8)	0	8 (3.0)

(), mortality %

procedures for secondary pneumothorax, where COPD was by far the most prevalent associated disease (69%). The hospital mortality rate for secondary pneumothorax associated with COPD was 2.6%.

The 2017 survey reported 193 procedures for chest wall deformity (Table 24). However, this may have been underestimated, because the Nuss procedure for pectus excavatum was more likely to have been performed in pediatric surgery centers not associated with the Japanese Association for Thoracic Surgery.

Diaphragmatic hernia was treated surgically in 28 patients (Table 25). This figure may also have been underestimated, as procedures may have been classified as gastrointestinal surgery.

The survey reported 443 procedures for chest trauma excluding iatrogenic injuries (Table 26). In this context, hospital mortality rate was 5%.

Table 27 shows procedures for other diseases, including 89 cases of arteriovenous malformation and 92 cases of pulmonary sequestration.

A total of 68 lung transplantations were performed in 2017 (Table 28): 57 patients received lung transplants from brain-dead donors, and 11 patients received transplants from living, related donors.

The number of VATS procedures has increased annually to reach 68,458 (80% of all general thoracic surgeries) in 2017 (Table 29).

The details of tracheobronchoplasty, pediatric surgery, and combined resection of neighboring organs are shown in Tables 30, 31, 32, and 33.

Table 16 Chest wall tumor

	Cases	30-Day mortality		Hospital mortality	VATS
		Hospital	After discharge		
Chest wall tumor					
Primary malignant tumor	140	1 (0.7)	1 (0.7)	6 (4.3)	65
Metastatic malignant tumor	189	0	1 (0.5)	0	77
Benign tumor	362	1 (0.3)	0	1 (0.3)	281
Total	691	2 (0.3)	2 (0.3)	7 (1.0)	423

(), mortality %

Table 17 Mediastinal tumor

	Cases	30-Day mortality		Hospital mortality	By VATS
		Hospital	After discharge		
Mediastinal tumor	5197	3 (0.1)	3 (0.06)	9 (0.2)	3808
Thymoma*	1939	1 (0.1)	2 (0.1)	3 (0.2)	1222
Thymic cancer	368	0	1 (0.3)	1 (0.3)	189
Thymus carcinoid	39	0	0	0	19
Germ cell tumor	85	0	0	0	59
Benign	66	0	0	0	51
Malignant	19	0	0	0	8
Neurogenic tumor	489	0	0	0	447
Congenital cyst	1185	1 (0.1)	0	1 (0.1)	1071
Goiter	68	0	0	0	29
Lymphatic tumor	185	0	0	1 (0.5)	134
Excision of pleural recurrence of thymoma	27	0	0	0	20
Thymolipoma	19	0	0	0	14
Others	793	1 (0.1)	0	3 (0.4)	604

(), mortality %

Table 18 Thymectomy for myasthenia gravis with thymoma

	Cases	30-Day mortality		Hospital mortality	By VATS
		Hospital	After discharge		
Thymectomy for myasthenia gravis with thymoma	508	0	0	1 (0.2)	298
	319	0	0	1 (0.3)	175

(), mortality %

Table 19 Operations for non-neoplastic diseases

	Cases	30-Day mortality		Hospital mortality
		Hospital	After discharge	
Operations for non-neoplastic diseases	22,634	214 (0.9)	31 (0.1)	467 (2.1)

	Cases	30-Day mortality		Hospital mortality	VATS
		Hospital	After discharge		
A. Inflammatory pulmonary disease	2423	3 (0.1)	2 (0.1)	9 (0.4)	2165
Tuberculous infection	46	0	0	0	41
Mycobacterial infection	496	0	1 (0.2)	1 (0.2)	447
Fungal infection	361	1 (0.3)	0	3 (0.8)	284
Bronchiectasis	58	0	0	0	43
Tuberculous nodule	79	0	0	0	70
Inflammatory pseudotumor	918	0	1 (0.1)	0	858
Interpulmonary lymph node	76	0	0	0	74
Others	389	2 (0.5)	0	5 (1.3)	348

(), mortality %

Table 20 B. Empyema

	Cases	30-Day mortality		Hospital mortality	By VATS
		Hospital	After discharge		
Acute empyema	2226	54 (2.4)	5 (0.2)	128 (5.8)	1858
With fistula	453	26 (5.7)	1 (0.2)	69 (15.2)	251
Without fistula	1756	27 (1.5)	4 (0.2)	57 (3.2)	1592
Unknown	17	1 (5.9)	0	2 (11.8)	15
Chronic empyema	736	20 (2.7)	3 (0.4)	58 (7.9)	406
With fistula	355	9 (2.5)	2 (0.6)	23 (6.5)	148
Without fistula	357	11 (3.1)	1 (0.3)	33 (9.2)	236
Unknown	24	0	0	2 (8.3)	22
Total	2962	74 (2.5)	8 (0.3)	186 (6.3)	2264

(), mortality %

Table 21 C. Descending necrotizing mediastinitis

	Cases	30-Day mortality		Hospital mortality	VATS
		Hospital	After discharge		
C. Descending necrotizing mediastinitis	101	5 (5.0)	0	7 (6.9)	75

(), mortality %

Table 22 D. Bullous diseases

	Cases	30-Day mortality		Hospital mortality	VATS
		Hospital	After discharge		
D. Bullous diseases	400	2 (0.5)	0	5 (1.3)	371
Emphysematous bulla	308	2 (0.6)	0	5 (1.6)	289
Bronchogenic cyst	13	0	0	0	12
Emphysema with LVRS	28	0	0	0	28
Others	51	0	0	0	42

(), mortality %

LVRS lung volume reduction surgery

Table 23 E. Pneumothorax

Cases	30-Day mortality		Hospital mortality	VATS
	Hospital	After discharge		
14,499	70 (0.5)	16 (0.1)	156 (1.1)	14,783

Spontaneous pneumothorax

Operative procedure	Cases	30-Day mortality		Hospital mortality	VATS
		Hospital	After discharge		
Bullectomy	2838	2 (0.1)	1 (0.04)	8 (0.3)	2791
Bullectomy with additional procedure	7488	7 (0.1)	1 (0.01)	17 (0.2)	7382
Coverage with artificial material	7233	7 (0.1)	1 (0.01)	17 (0.2)	7130
Parietal pleurectomy	28	0	0	0	28
Coverage and parietal pleurectomy	79	0	0	0	78
Others	148	0	0	0	146
Others	783	6 (0.8)	3 (0.4)	12 (1.5)	745
Unknown	4	0	0	0	4
Total	11,113	15 (0.1)	5 (0.04)	37 (0.3)	10,922

Secondary pneumothorax

Associated disease	Cases	30-Day mortality		Hospital mortality	VATS
		Hospital	After discharge		
COPD	2350	28 (1.2)	6 (0.3)	62 (2.6)	2289
Tumorous disease	130	5 (3.8)	2 (1.5)	14 (10.8)	124
Catamenial	157	0	0	0	154
LAM	41	0	0	0	39
Others (excluding pneumothorax by trauma)	708	22 (3.1)	3 (0.4)	43 (6.1)	655
Unknown	0	0	0	0	0

Operative procedure	Cases	30-Day mortality		Hospital mortality	VATS
		Hospital	After discharge		
Bullectomy	571	6 (1.1)	3 (0.5)	18 (3.2)	551
Bullectomy with additional procedure	2016	25 (1.2)	6 (0.3)	44 (2.2)	1979
Coverage with artificial material	1914	24 (1.3)	5 (0.3)	43 (2.2)	1881
Parietal pleurectomy	8	0	0	0	8
Coverage and parietal pleurectomy	29	1 (3.4)	0	1 (3.4)	29
Others	65	0	1 (1.5)	0	61
Others	793	24 (3.0)	2 (0.3)	57 (7.2)	726
Unknown	6	0	0	0	5
Total	3386	55 (1.6)	11 (0.3)	119 (3.5)	3261

(), mortality %

Table 24 F. Chest wall deformity

	Cases	30-Day mortality		Hospital mortality
		Hospital	After discharge	
F. Chest wall deformity	193	1 (0.5)	0	1 (0.5)
Funnel chest	182	0	0	0
Others	11	1 (9.1)	0	1 (9.1)

(), mortality %

Table 25 G. Diaphragmatic hernia

	Cases	30-Day mortality		Hospital mortality	VATS
		Hospital	After discharge		
G. Diaphragmatic hernia	28	1 (3.6)	0	1 (3.6)	19
Congenital	4	0	0	0	3
Traumatic	10	0	0	0	6
Others	14	1 (7.1)	0	1 (7.1)	10

(), mortality %

Table 26 H. Chest trauma

	Cases	30-Day mortality		Hospital mortality	VATS
		Hospital	After discharge		
H. Chest trauma	443	20 (4.5)	0	23 (5.2)	289

(), mortality %

Table 27 I. Other respiratory surgery

	Cases	30-Day mortality		Hospital mortality	VATS
		Hospital	After discharge		
I. Other respiratory surgery	1585	38 (2.4)	5 (0.3)	79 (5.0)	1161
Arteriovenous malformation*	89	0	0	0	84
Pulmonary sequestration	92	0	0	0	84
Postoperative bleeding · air leakage	492	17 (3.5)	1 (0.2)	30 (6.1)	339
Chylothorax	62	2 (3.2)	0	4 (6.5)	52
Others	850	19 (2.2)	4 (0.5)	45 (5.3)	602

(), mortality %

Table 28 Lung transplantation

	Cases	30-Day mortality		Hospital mortality
		Hospital	After discharge	
Single-lung transplantation from brain-dead donor	29	0	0	3 (10.3)
Bilateral lung transplantation from brain-dead donor	28	0	0	0
Lung transplantation from living donor	11	0	0	0
Total lung transplantation	68	0	0	3 (4.4)
Donor of living donor lung transplantation	19	0	0	0

(), mortality %

Table 29 Video-assisted thoracic surgery

	Cases	30-Day mortality		Hospital mortality
		Hospital	After discharge	
Video-assisted thoracic surgery	68,458	218 (0.3)	51 (0.07)	470 (0.7)

(), mortality %

(including thoracic sympathectomy 160)%

Table 30 Tracheobronchoplasty

	Cases	30-Day mortality		Hospital mortality
		Hospital	After discharge	
Tracheobronchoplasty	774	7 (0.9)	4 (0.5)	16 (2.1)
Trachea	40	0	0	1 (2.5)
Sleeve resection with reconstruction	28	0	0	1 (3.6)
Wedge with simple closure	4	0	0	0
Wedge with patch closure	1	0	0	0
Total laryngectomy with tracheostomy	0	0	0	0
Others	7	0	0	0
Carinal reconstruction	31	1 (3.2)	0	2 (6.5)
Sleeve pneumonectomy	12	2 (16.7)	0	2 (16.7)
Sleeve lobectomy	492	1 (0.2)	2 (0.4)	2 (0.4)
Sleeve segmental excision	14	0	0	0
Bronchoplasty without lung resection	29	1 (3.4)	0	1 (3.4)
Others	156	2 (1.3)	2 (1.3)	8 (5.1)

(), mortality %

Table 31 Pediatric surgery

	Cases	30-Day mortality		Hospital mortality
		Hospital	After discharge	
Pediatric surgery	292	3 (1.0)	0	3 (1.0)

(), mortality %

Table 32 Combined resection of neighboring organ(s)

	Cases	30-Day mortality		Hospital mortality
		Hospital	After discharge	
Combined resection of neighboring organ (s)	1371	7 (0.5)	0	21 (1.5)
Organ resected	Cases	30-Day mortality		Hospital mortality
		Hospital	After discharge	
A. Primary lung cancer				
Aorta	11	0	0	0
Superior vena cava	14	1 (7.1)	0	1 (7.1)
Brachiocephalic vein	8	0	0	1 (12.5)
Pericardium	108	1 (0.9)	0	2 (1.9)
Pulmonary artery	127	1 (0.8)	0	1 (0.8)
Left atrium	19	1 (5.3)	0	2 (10.5)
Diaphragm	55	1 (1.8)	0	1 (1.8)
Chest wall (including ribs)	352	4 (1.1)	0	12 (3.4)
Vertebra	19	0	0	0
Esophagus	3	0	0	0
Total	716	9 (1.3)	0	20 (2.8)
B. Mediastinal tumor				
Aorta	7	0	0	0
Superior vena cava	54	0	0	0
Brachiocephalic vein	107	0	0	2 (1.9)
Pericardium	351	0	0	3 (0.9)
Pulmonary artery	3	0	0	1 (33.3)
Left atrium	0	0	0	0
Diaphragm	21	0	0	0
Chest wall (including ribs)	10	0	0	0
Vertebra	5	0	0	0
Esophagus	3	0	0	0
Lung	476	0	0	2 (0.4)
Total	1037	0	0	8 (0.8)

(), mortality %

Table 33 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	743	7 (0.9)	2 (0.3)	15 (2.0)

(), mortality %

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

Table 34 Distribution of number of esophageal operations in 2017 in each institution

Esophageal surgery			
Number of operations in 2017	Benign esophageal diseases	Malignant esophageal disease	Benign+malignant
0	235	95	76
1–4	218	126	114
5–9	52	89	96
10–19	14	88	98
20–29	1	45	47
30–39	2	27	26
40–49	0	13	21
≧ 50	1	40	45
Total	523	523	523

(C) Esophageal Surgery

During 2017, a total of 12,336 patients with esophageal diseases were registered from 523 institutions (response rate: 92.1%) affiliated with the Japanese Association for Thoracic Surgery and/or the Japan Esophageal Society. Among these institutions, there were 139 (26.6%) where 20 or more patients underwent esophageal surgeries within the year 2017, indicating no definite shift from esophageal procedures to high-volume institutions when compared with the data from 2016 (24.5%) (Table 34). Among 2427 patients with a benign esophageal disease, 1614 (66.5%) underwent surgery and 73 (3.0%) underwent endoscopic resection, whereas 740 (30.5%) patients did not undergo surgical treatment (Tables 35, 36). Among 10,554 patients with a malignant esophageal tumor, 8525 (80.8%) underwent resection, esophagectomy was performed for 6319 (74.1%), and endoscopic mucosal resection (EMR) or endoscopic submucosal dissection (ESD) was performed for 2170 (25.5%); 2025 (23.8%) patients did not undergo any resection (Tables 36 and 37). Annual trends among registered inpatients with esophageal diseases have not changed for the past last decades (Fig. 3).

Among benign esophageal diseases (Table 35), hiatal hernia, achalasia, esophageal varices, and esophagitis (including reflux esophagitis) were the most common conditions in Japan. On the other hand, benign esophageal tumors, spontaneous rupture of the esophagus, and congenital esophageal atresia were common diseases that were surgically treated in addition to the aforementioned diseases. Open surgery was performed in 1009 (57.7%) patients with a benign esophageal disease, with 30-day mortality in 3 (0.3%) patients, whereas thoracoscopic and/or laparoscopic surgery was performed for 605 (37.5%) patients, with no instances of 30-day mortality. The difference in these death rates between open and scopic surgery appears to be related to conditions requiring open surgery.

The majority of malignant diseases were carcinomas (Table 36). Among esophageal carcinomas, the incidence of squamous cell carcinoma was 88.8%, whereas that of adenocarcinomas, including Barrett's cancer, was 4.3%. The resection rate for patients with a squamous cell carcinoma was 79.9%, whereas that for patients with adenocarcinoma was 93.8%.

On the basis of location, cancer in the thoracic esophagus was the most common (Table 37). Among 4303 patients (40.9% of total esophageal malignancies) with superficial esophageal cancers within mucosal and submucosal layers, 6319 (60.1%) patients underwent esophagectomy, whereas 2170 (20.6%) 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 1.0%, respectively.

Multiple primary cancers were observed in 2077 (19.8%) of all 10,514 patients with esophageal cancer. Synchronous cancer was found in 1008 (9.3%) patients, whereas metachronous cancer was observed in 1063 (10.1%) patients. The stomach and head and neck were common sites for both synchronous and metachronous malignancies (Table 37).

Among esophagectomy procedures, transthoracic esophagectomy via right thoracotomy was most commonly adopted for patients with a superficial cancer, as well as for those with advanced cancer (Table 38). Transhiatal esophagectomy, which is commonly performed in Western countries, was adopted in only 9.1% of patients with a superficial cancer or advanced cancer who underwent esophagectomy in Japan. Thoracoscopic and/or laparoscopic esophagectomy was adopted for 1434 patients (74.0%) with a superficial cancer and for 2422 patients (55.3%) with an advanced cancer. The number of cases of thoracoscopic and/or laparoscopic surgery for superficial or advanced cancer has been increasing for a number of years (Fig. 4).

Combined resection of the neighboring organs during the resection of an esophageal cancer was performed in 296 patients (Tables 38 and 39). Resection of the aorta, together with esophagectomy, was performed in eight cases. Tracheal and/or bronchial resection combined with esophagectomy was performed for 20 patients, with both 30-day mortality rate and hospital mortality rate at 0%. Lung resection combined with esophagectomy was performed for 60 patients, with both 30-day mortality rate and hospital mortality rate at 0%.

Salvage surgery following definitive (chemo)radiotherapy was performed for 230 patients, with 30-day mortality rate at 1.7% and hospital mortality rate at 2.6% (Table 38).

Table 35 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	261	146	115	0	0	0	0	0	0	0		32	293
2. Benign tumor	140	86	54	0	0	1 (1.2)	0	0	1 (1.9)	2 (1.4)	39	14	193
(1) Leiomyoma	78	46	32	0	0	1 (2.2)	0	0	1 (3.1)	2 (2.6)	26	10	114
(2) Cyst	16	10	6	0	0	0	0	0	0	0	0	0	16
(3) Others	46	30	16	0	0	0	0	0	0	0	13	4	63
(4) Not specified	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Diverticulum	42	28	14	0	0	0	0	0	0	0		13	55
4. Hiatal hernia	797	446	351	0	1 (0.2)	1 (0.2)	0	1 (0.3)	1 (0.3)	2 (0.3)		140	937
5. Spontaneous rupture of the esophagus	110	96	14	1 (1.0)	2 (2.1)	3 (3.1)	0	2 (14.3)	2 (14.3)	5 (4.5)		10	120
6. Esophago-tracheal fistula	14	13	1	0	0	0	0	0	0	0		4	18
7. Congenital esophageal atresia	13	13	0	0	0	0	0	0	0	0		7	20
8. Congenital esophageal stenosis	2	2	0	0	0	0	0	0	0	0		19	21
9. Corrosive stricture of the esophagus	10	8	2	0	0	0	0	0	0	0		6	16
10. Esophagitis, esophageal ulcer	93	52	41	0	0	0	0	0	0	0			93
11. Esophageal varices	56	56	0	1 (1.8)	0	1 (1.8)	0	0	0	1 (1.8)		471	527
(1) Laparotomy	12	12	0	0	0	0	0	0	0	0			12
(2) Sclerotherapy												89	89
(3) EVL												329	329
12. Others	76	63	13	1 (1.6)	1 (1.6)	2 (3.2)	0	0	0	2 (2.6)	34	24	134
Total	1614	1009	605	3 (0.3)	4 (0.4)	8 (0.8)	0	3 (0.5)	4 (0.7)	12 (0.7)	73	740	2427

(), mortality

T/L thoracoscopic and/or laparoscopic %

Table 36 Malignant esophageal diseases (histologic classification)

		Resection (+)	Resection (–)	Total
Carcinomas		8473	2025	10,498
1	Squamous cell carcinoma	7455	1870	9325
2	Basaloid(-squamous)carcinoma	86	8	94
3	Carcinosarcoma	48	5	53
4	Adenocarcinoma in the Barrett's esophagus	426	28	454
5	Other adenocarcinoma	369	62	431
6	Adenosquamous carcinoma	20	3	23
7	Mucoepidermoid carcinoma	2	0	2
8	Adenoid cystic carcinoma	4	0	4
9	Endocrine cell carcinoma	39	26	65
10	Undifferentiated carcinoma	8	6	14
11	Others	16	17	33
Other malignancies		36	4	40
1	Malignant non-epithelial tumors	8	1	9
2	Malignant melanoma	20	2	22
3	Other malignant tumors	8	1	9
Not specified		16	0	16
Total		8525	2029	10,554

Resection: including endoscopic resection

Table 37 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	6319	33 (0.5)	30 (0.5)	83 (1.3)	2170	2025	10,514
Location							
(1) Cervical esophagus	223	0	0	2 (0.9)	102	142	467
(2) Thoracic esophagus	5117	30 (0.6)	27 (0.5)	75 (1.5)	1637	1682	8436
(3) Abdominal esophagus	718	2 (0.3)	3 (0.4)	5 (0.7)	119	99	936
(4) Multiple cancers	261	1 (0.4)	0	1 (0.4)	216	41	518
(5) Others/not described	0	0	0	0	96	61	157
Tumor depth							
(A) Superficial cancer (T1)	1938	10 (0.5)	6 (0.3)	19 (1.0)	2162	203	4303
Mucosal cancer (T1a)	346	1 (0.3)	1 (0.3)	4 (1.2)	1557	39	1942
(B) Advanced cancer (T2-T4)	4377	23 (0.5)	24 (0.5)	64 (1.5)	5	1766	6148
(C) Not specified	4	0	0	0	3	56	63
2. Multiple primary cancers	1167	7 (0.6)	9 (0.8)	19 (1.6)	611	299	2077
1) Synchronous	658	6 (0.9)	8 (1.2)	16 (2.4)	260	145	1063
(1) Head and neck	231	1 (0.4)	2 (0.9)	4 (1.7)	133	50	414
(2) Stomach	203	3 (1.5)	4 (2.0)	9 (4.4)	66	34	303
(3) Colorectum	83	1 (1.2)	0	1 (1.2)	16	12	111
(4) Lung	42	1 (2.4)	0	1 (2.4)	8	17	67
(5) Pancreas	2	0	0	0	3	2	7
(6) Liver	6	0	0	0	1	2	9
(7) Others	56	0	1 (1.8)	0	16	17	89
(8) Triple cancers	35	0	1 (2.9)	1 (2.9)	17	11	63
(9) Unknown	0	0	0	0	0	0	0
2) Metachronous	509	1 (0.2)	1 (0.2)	3 (0.6)	351	154	1014
(1) Head and neck	98	0	0	0	117	31	246
(2) Stomach	104	0	0	0	76	31	211
(3) Colorectum	70	0	0	1 (1.4)	35	20	125
(4) Lung	47	0	0	0	10	19	76
(5) Pancreas	3	0	0	0	2	0	5
(6) Liver	5	0	0	0	1	2	8
(7) Others	148	1 (0.7)	1 (0.7)	2 (1.4)	60	31	239
(8) Triple cancers	34	0	0	0	49	20	103
(9) Unknown	0	0	0	0	1	0	1
Unknown	0	0	0	0	0	0	0

(), mortality %

EMR endoscopic mucosal resection (including endoscopic submucosal dissection)

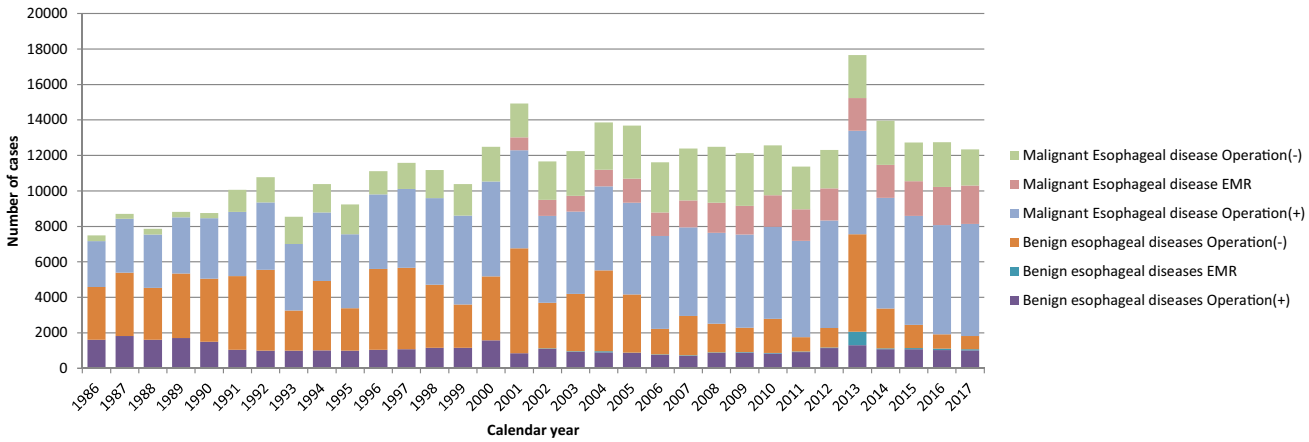

Fig. 3 Annual trend of inpatients with esophageal diseases. *EMR* endoscopic mucosal resection (including endoscopic submucosal)

Table 38 Malignant esophageal disease (surgical procedures)

	Operation (+)								EMR or ESD
					Thoracoscopic and/or laparoscopic procedure				
	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)	1938	10 (0.5)	6 (0.3)	19 (1.0)	1434	8 (0.6)	5 (0.3)	15 (1.0)	2162
Mucosal cancer (T1a)	*346*	*1* (0.3)	*1* (0.3)	*4* (1.2)	*210*	*1* (0.5)	*1* (0.5)	*4* (1.9)	*1557*
Esophagectomy	1938	10 (0.5)	6 (0.3)	19 (1.0)	1434	8 (0.6)	5 (0.3)	15 (1.0)	2162
(1) Transhiatal esophagectomy, mediascope-assisted esophagectomy	176	0	0	1 (0.6)	85	0	0	1 (1.2)	
(2) Transthoracic (rt.) esophagectomy and reconstruction	1649	10 (0.6)	5 (0.3)	16 (1.0)	1296	8 (0.6)	5 (0.4)	13 (1.0)	
(3) Transthoracic (lt.) esophagectomy and reconstruction	31	0	1 (3.2)	1 (3.2)	9	0	0	0	
(4) Cervical esophageal resection and reconstruction	20	0	0	0	5	0	0	0	
(5) Robot-assisted esophagectomy	19	0	0	0	19	0	0	0	
(6) Others	28	0	0	0	12	0	0	0	
(7) Esophagectomy without reconstruction	9	0	0	1 (11.1)	2	0	0	1 (50.0)	
(8) Not specified	6	0	0	0	6	0	0	0	
Advanced cancer (T2–T4)									
Esophagectomy	4377	23 (0.5)	24 (0.5)	64 (1.5)	2422	11 (0.5)	10 (0.4)	28 (1.2)	5
(1) Transhiatal esophagectomy, mediascope-assisted esophagectomy	240	1 (0.4)	1 (0.4)	2 (0.8)	92	0	1 (1.1)	1 (1.1)	
(2) Transthoracic (rt.) esophagectomy and reconstruction	3818	21 (0.6)	20 (0.5)	55 (1.4)	2255	10 (0.4)	9 (0.4)	25 (1.1)	
(3) Transthoracic (lt.) esophagectomy and reconstruction	89	0	0	0	4	0	0	0	
(4) Cervical esophageal resection and reconstruction	105	0	0	1 (1.0)	6	0	0	0	
(5) Robot-assisted esophagectomy	19	0	0	0	19	0	0	0	
(6) Others	57	1 (1.8)	1 (1.8)	2 (3.5)	22	1 (4.5)	0	1 (4.5)	
(7) Esophagectomy without reconstruction	43	0	2 (4.7)	4 (9.3)	19	0	0	1 (5.3)	
(8) Not specified	6	0	0	0	5	0	0	0	
(Depth not specified)	4	0	0	0	3	0	0	0	3
Combined resection of other organs	296	3 (1.0)	3(1.0)	7 (2.4)					
(1) Aorta	8	1 (12.5)	0	1 (12.5)					
(2) Trachea, bronchus	20	0	0	1 (5.0)					
(3) Lung	60	0	0	0					
(4) Others	208	2 (1.0)	3 (1.4)	5 (2.4)					
Unknown	0	0	0	0					
Salvage surgery	230	4 (1.7)	1 (0.4)	6 (2.6)	70	1 (1.4)	0	1 (1.4)	25

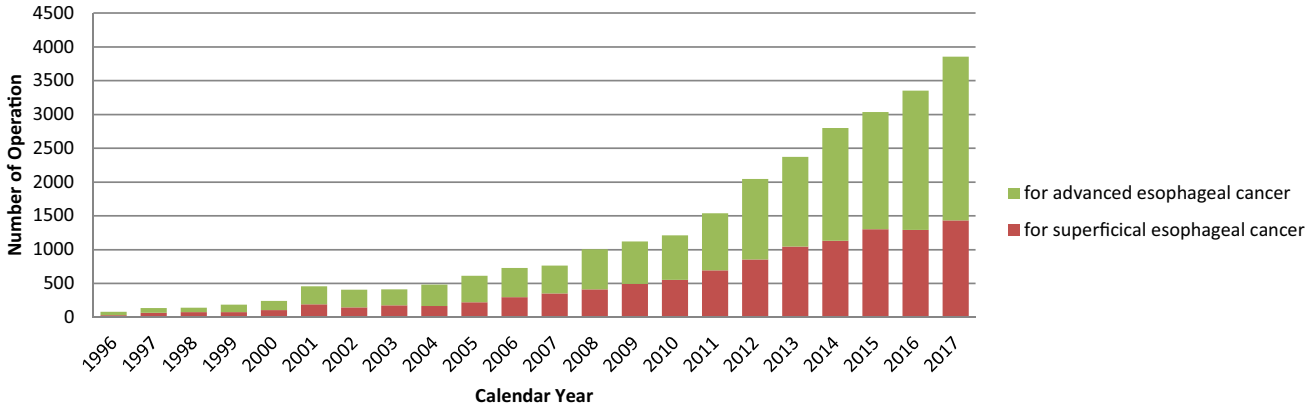

Fig. 4 Annual trend of video-assisted esophagectomy for esophageal malignancy

Table 39 Mortality after combined resection of the neighbouring 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%
2016	6158	40	0.65%	3	0	0.00%	12	0	0.00%	56	0	0.00%	155	1	0.65%
2017	6319	33	0.52%	8	1	12.50%	20	0	0.00%	60	0	0.00%	208	2	0.96%
Total	116,815	1496	1.28%	52	5	9.62%	506	20	3.95%	1364	26	1.91%	3292	50	1.52%

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

We aim to continue our efforts to gather all-encompassing survey data via more active collaboration with the Japan Esophageal Society and other related institutions.

Acknowledgements On behalf of the Japanese Association for Thoracic Surgery, the authors thank the Heads of the Affiliate and Satellite Institutes of Thoracic Surgery for their cooperation, and the Councilors of the Japan Esophageal Society.

References

1. Shimizu H, Endo S, Natsugoe S, et al. Thoracic and cardiovascular surgery in Japan during 2016—annual report by the Japanese Association for Thoracic Surgery. Gen Thorac Cardiovasc Surg. 2019;67:377–411.
2. Ueda Y, Fujii Y, Kuwano H. Thoracic and cardiovascular surgery in Japan during 2007—annual report by the Japanese Association for Thoracic Surgery. Gen Thorac Cardiovasc Surg. 2009;57:488–513.
3. Masuda M, Kuwano H, Okumura M, et al. Thoracic and cardiovascular surgery in Japan during 2012—annual report by the Japanese Association for Thoracic Surgery. Gen Thorac Cardiovasc Surg. 2014;62:734–64.
4. Kazui T, Wada H, Fujita H. Thoracic and cardiovascular surgery in Japan during 2003—annual report by the Japanese Association for Thoracic Surgery. Jpn J Thorac Cardiovasc Surg. 2005;53:517–36.
5. Kazui T, Osada H, Fujita H. Thoracic and cardiovascular surgery in Japan during 2004—annual report by the Japanese Association for Thoracic Surgery. Jpn J Thorac Cardiovasc Surg. 2006;54:363–86.

Affiliations

Committee for Scientific Affairs, The Japanese Association for Thoracic Surgery[1] · Hideyuki Shimizu[2] · Morihito Okada[3] · Akira Tangoku[4] · Yuichiro Doki[5] · Shunsuke Endo[6] · Hirotsugu Fukuda[7] · Yasutaka Hirata[8] · Hisashi Iwata[9] · Junjiro Kobayashi[10] · Hiraku Kumamaru[11] · Hiroaki Miyata[12] · Noboru Motomura[13] · Shoji Natsugoe[14] · Soji Ozawa[15] · Yoshikatsu Saiki[16] · Aya Saito[13] · Hisashi Saji[17] · Yukio Sato[18] · Tsuyoshi Taketani[19] · Kazuo Tanemoto[20] · Wataru Tatsuishi[21] · Yasushi Toh[22] · Hiroyuki Tsukihara[8] · Masayuki Watanabe[23] · Hiroyuki Yamamoto[12] · Kohei Yokoi[24] · Yutaka Okita[25]

✉ Hideyuki Shimizu
survey-adm@umin.net

[1] Committee for Scientific Affairs, The Japanese Association for Thoracic Surgery, Tokyo, Japan

[2] Department of Cardiovascular Surgery, Keio University, 35, Shinanomachi, Shinjuku-Ku, Tokyo, Japan

[3] Department of Surgical Oncology, Hiroshima University, Hiroshima, Japan

[4] Department of Thoracic, Endocrine Surgery and Oncology, Institute of BioMedicine, Tokushima University Graduate School, Tokushima, Japan

[5] Department of Gastroenterological Surgery, Osaka University, Suita, Osaka, Japan

[6] Department of Thoracic Surgery, Jichi Medical University, Shimotsuke, Japan

[7] Department of Cardiac and Vascular Surgery, Dokkyo Medical University School of Medicine, Shimotsuga-gun, Tochigi, Japan

[8] Department of Cardiac Surgery, The University of Tokyo Hospital, Tokyo, Japan

[9] Department of General Thoracic Surgery, Gifu University Hospital, Gifu, Japan

[10] Department of Cardiovascular Surgery, National Cerebral and Cardiovascular Center, Suita, Japan

[11] Department of Healthcare Quality Assessment, Graduate School of Medicine, University of Tokyo, Tokyo, Japan

[12] Department of Health Policy and Management, Keio University, Tokyo, Japan

[13] Department of Cardiovascular Surgery, Toho University Sakura Medical Center, Sakura, Japan

[14] Department of Digestive Surgery, Breast and Thyroid Surgery, Kagoshima University Graduate School of Medicine, Kagoshima, Japan

[15] Department of Gastroenterological Surgery, Tokai University School of Medicine, Isehara, Japan

[16] Division of Cardiovascular Surgery, Tohoku University Graduate School of Medicine, Sendai, Japan

[17] Department of Chest Surgery, St. Marianna University School of Medicine, Kawasaki, Japan

[18] Department of Thoracic Surgery, University of Tsukuba, Tsukuba, Japan

[19] Department of Cardiovascular Surgery, Mitsui Memorial Hospital, Tokyo, Japan

[20] Department of Cardiovascular Surgery, Kawasaki Medical School, Kurashiki, Japan

[21] Division of Cardiovascular Surgery, Department of General Surgical Science, Gunma University, Maebashi, Japan

[22] Department of Gastroenterological Surgery, National Hospital Organization Kyushu Cancer Center, Fukuoka, Japan

[23] Department of Gastroenterological Surgery, Cancer Institute Hospital of Japanese Foundation for Cancer Research, Tokyo, Japan

[24] Chunichi Hospital, Nagoya, Japan

[25] Cardio-Aortic Center, Takatsuki General Hospital, Takatsuki, Japan