

(B) General thoracic surgery

The total number of operations reported in 2014 in general thoracic surgery has reached 77070, which means 1.74-fold of that in 2001, and increased by 1764 cases compared with that in 2013 (Fig. 2, Table 10).

The number of operations for primary lung cancer was 38085 in 2014 (Table 10), showing the steady increase (31,301; 2009, 32,801; 2010, 33,878; 2011, 35,667; 2012, 37,008; 2013), and 1.95-fold of the number of operations in 2001. Surgery for lung cancer consists 49.4 % of all the general thoracic surgery.

Surgery for benign pulmonary tumor was 2171 in 2014 (Table 11).

Further information of primary malignant pulmonary tumors is shown in Tables 12 and 13. Among lung cancer subtypes, adenocarcinoma comprises an overwhelming percentage of 69.2 % of the total lung cancer surgery, followed by squamous cell carcinoma of 19.3 %. Limited resection by wedge resection or segmentectomy was performed in 9581 lung cancer patients, which is 25.2 % of the entire cases. Lobectomy was performed in 27,584 patients, which is 72.4 % of the entire cases. Sleeve lobectomy was done in 471 patients. Pneumonectomy was done in 521 patients which is 1.4 % of the entire cases.

There were 103 patients who died without discharge within 30 days after lung cancer surgery, and 59 patients who were discharged from hospital but died within 30 days after lung cancer surgery, indicating that 162 patients died within 30 days after lung cancer surgery (30-day mortality rate; 0.42 %). There were 266 patients died without discharge (hospital mortality rate; 0.70 %). 30-day mortality rate in regard to procedures is 0.12 % in segmentectomy, 0.48 % in lobectomy, and 1.53 % in pneumonectomy. Interstitial pneumonia was the leading cause of death after lung cancer surgery, followed by pneumonia, respiratory failure, cardiovascular event, and bronchopleural fistula.

Surgery for metastatic pulmonary tumors is denoted in Table 14. The number of patients undergoing operations for metastatic pulmonary tumor was 8057 in 2014 with steady increase similarly to lung cancer surgery (6248; 2009, 6748; 2010, 7210; 2011, 7403; 2012, 7829; 2013). Colorectal cancer was by far the leading primary malignancy indicated for resection of metastatic tumors, which comprises 48.4 % of the entire cases.

118 tracheal tumors were operated in 2014 (Table 15). Squamous cell carcinoma and adenoid cystic carcinoma were frequent primary tracheal tumor.

673 tumors of the pleural origin were operated in 2014 (Table 16). Diffuse malignant pleural mesothelioma was the most frequent histology. Total pleurectomy was performed in 73 patients and surpassed extrapleural pneumonectomy which was the most frequently chosen

operative method in 2013. Hospital mortality rate was 4.1 % after total pleurectomy and 4.3 % after extrapleural pneumonectomy in 2014.

698 chest wall tumors were resected in 2014 (Table 17). 362 cases (51.9 %) were benign. Among 336 malignant chest wall tumors, 208 cases (61.9 %) were metastatic tumors.

Table 18 denotes surgery for mediastinal tumors. 4685 mediastinal tumors were operated in 2014. There were 2104 thymic epithelial tumors (1773 thymomas, 296 thymic carcinomas, and 35 thymic neuroendocrine carcinoma including carcinoid), followed by 932 congenital cysts, 481 neurogenic tumors, 214 lymphatic tumors, and 122 germ cell tumors.

Thymectomy for myasthenia gravis was done in 495 patients (Table 19). Among them, 307 patients were associated with thymoma, and the remaining 188 patients were not associated with thymoma.

Lung resection for inflammatory lung diseases were done in 2287 patients in 2014 (Table 20). Inflammatory pseudotumor comprised 24.7 % of the entire cases, followed by atypical mycobacterium infection (21.9 %) and fungal infections (15.1 %).

2,608 operations for empyema were reported in 2014 (Table 21). There were 1911 patients (73.3 %) with acute empyema and 698 patients with chronic empyema. Bronchopleural fistula was associated in 469 patients (24.5 %) with acute empyema and 345 patients (49.5 %) with chronic empyema. It should be noted that hospital mortality was as high as 15.1 % in patients of acute empyema with fistula.

Operation for descending necrotizing mediastinitis was done in 103 patients in 2014 (Table 22). Hospital mortality rate was 8.7 %.

Operation for bullous diseases was done in 415 patients in 2014 (Table 23). Lung volume reduction surgery was done in only 28 patients, while emphysematous bulla was the principal target of operation.

14,572 operations for pneumothorax were reported in 2014 (Table 24).

The number of operations for spontaneous pneumothorax was 11,948. Among them, 3410 patients (28.5 %) underwent bullectomy alone, while additional procedure was performed in 7625 patients (63.8 %).

The number of operations for secondary pneumothorax was 2624. COPD was by far the most prevalent associated disease (67.2 %). It should be noted that hospital mortality rate of operation for pneumothorax associated with tumorous disease was as high as 16.7 %.

217 cases of surgery for chest wall deformity were reported in 2014 survey (Table 25). This number might be underestimated compared with the real number of operations, because chest wall deformity is more likely to be

treated in the institutes which are not associated with JATS.

Diaphragmatic hernia was treated by surgery in 55 patients in 2014 (Table 26).

Chest trauma was treated by surgery in 394 patients in 2014 (Table 27).

Table 28 denotes operations for other diseases, including 77 arteriovenous malformations and 104 pulmonary sequestrations.

Table 29 denotes lung transplantation in 2014. A total of 60 lung transplantations were performed in 2014. The number of patients undergoing lung transplantation from brain-dead donors and living-related donors was 40 and 20, respectively. The number of lung transplantation is almost constant these several years, and lung transplantation is still dependent on living-related donors in Japan.

Details of tracheobronchoplasty, pediatric surgery, and combined resection of neighboring organs are denoted in Tables 30, 31, 32, and 33.

Committee for Scientific Affairs in JATS changed the method of surveying general thoracic surgery in 2014. JATS had investigated the number of diseases and

operative procedures based on questionnaires until 2013 surveys, but JATS started to collect the number of procedures in general thoracic surgery using the database in National Clinical Database (NCD) registry. There were some differences in definition in VATS procedure between surveys by JATS before 2013 and that using NCD after 2014. While the length of skin incision in definition of VATS procedure had been less than 8 cm by JATS survey before 2013 following Swanson et al's proposal [1], NCD registry did not limit the length of skin incision in VATS procedures. On the other hand, NCD required the surgeons to choose the approach among complete VATS procedure without thoracotomy, the procedure using both thoracotomy and VATS which includes hybrid approach, and conventional thoracotomy without VATS procedure. It is presumed that hybrid approach was included in VATS procedure as far as the skin incision was shorter than 8 cm in JATS survey before 2013, but this does not seem to apply to survey in 2014 based on NCD registry, suggesting possible inconsistency in comparison between JATS survey before 2013 and NCD 2014 registry. In this report, therefore, analysis with regard to VATS procedure was not conducted.

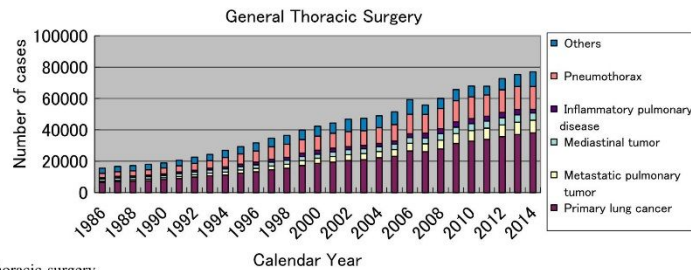


Fig. 2 General thoracic surgery

Table 10 Total entry cases of general thoracic surgery during 2014

	Cases	%
Benign pulmonary tumor	2171	2.8
Primary lung cancer	38,085	49.4
Other primary malignant pulmonary tumor	359	0.5
Metastatic pulmonary tumor	8057	10.5
Tracheal tumor	118	0.2
Mesothelioma	673	0.9
Chest wall tumor	698	0.9
Mediastinal tumor	4685	6.1
Thymectomy for MG without thymoma	188	0.2
Inflammatory pulmonary disease	2287	3.0
Empyema	2608	3.4
Bullos disease excluding pneumothorax	415	0.5
Pneumothorax	14,572	18.9
Chest wall deformity	217	0.3
Diaphragmatic hernia including traumatic	55	0.1
Chest trauma excluding diaphragmatic hernia	394	0.5
Lung transplantation	60	0.1
Others	1428	1.9
Total	77,070	100.0

Table 11

1. Benign pulmonary tumor

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
Hamartoma	481	0	0	0
Sclerosing hemangioma	103	0	0	0
Papilloma	18	0	0	0
Mucous gland adenoma bronchial	7	0	0	0
Fibroma	129	0	0	0
Lipoma	6	0	0	0
Neurogenic tumor	17	0	0	0
Clear cell tumor	2	0	0	0
Leiomyoma	19	0	0	0
Chondroma	5	0	0	0
Inflammatory myofibroblastic tumor	1	0	0	0
Pseudolymphoma	32	0	0	0
Histiocytosis	23	0	0	0
Teratoma	0	0	0	0
Others	1328	2 (0.2)	1 (0.1)	6 (0.5)
Total	2171	2 (0.1)	1 (0.05)	6 (0.3)

Values in parenthesis represent mortality %

Table 12

2. Primary malignant pulmonary tumor

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
2. Primary malignant pulmonary tumor	38,444	104 (0.3)	59 (0.2)	269 (0.7)
Lung cancer	38,085	103 (0.3)	59 (0.2)	266 (0.7)
Adenocarcinoma	26,338	33 (0.1)	23 (0.1)	82 (0.3)
Squamous cell carcinoma	7367	46 (0.6)	22 (0.3)	127 (1.7)
Large cell carcinoma	835	5 (0.6)	6 (0.7)	10 (1.2)
(LCNEC)	462	4 (0.9)	1 (0.2)	8 (1.7)
Small cell carcinoma	601	1 (0.2)	1 (0.2)	9 (1.5)
Adenosquamous carcinoma	548	7 (1.3)	0	14 (2.6)
Carcinoma with pleomorphic, sarcomatoid or sarcomatous elements	528	6 (1.1)	2 (0.4)	12 (2.3)
Carcinoid	198	0	0	0
Carcinomas of salivary-gland type	45	0	0	0
Unclassified	55	2 (3.6)	0	4 (7.3)
Multiple lung cancer	1227	1 (0.1)	3 (0.2)	6 (0.5)
Others	343	2 (0.6)	2 (0.6)	2 (0.6)
Wedge resection	5438	4 (0.1)	4 (0.1)	20 (0.4)
Segmental excision	4143	2 (0.05)	3 (0.1)	13 (0.3)
(Sleeve segmental excision)	16	0	0	0
Lobectomy	27,584	82 (0.3)	51 (0.2)	198 (0.7)
(Sleeve lobectomy)	471	5 (1.1)	7 (1.5)	10 (2.1)
Pneumonectomy	521	8 (1.5)	0	20 (3.8)
(Sleeve pneumonectomy)	13	0	0	1 (7.7)
Other bronchoplasty	46	2 (4.3)	0	2 (4.3)
Pleuropneumonectomy	1	0	0	0
Others	343	5 (1.5)	1 (0.3)	10 (2.9)
Sarcoma	40	0	0	0
AAH	126	0	0	0
Others	193	1 (0.5)	0	3 (1.6)

Values in parenthesis represent mortality %

Table 13 Details of lung cancer operation

	Cases
c-Stage (TNM)	
Ia	22,809
Ib	7213
IIa	2982
IIb	1780
IIIa	2505
IIIb	204
IV	481
NA	111
Total	38,085
Sex	
Male	23,540
Female	14,516
NA	29
Total	38,085
Cause of death	
Cardiovascular	23
Pneumonia	47
Pyothorax	4
Bronchopleural fistula	16
Respiratory failure	41
Pulmonary embolism	11
Interstitial pneumonia	78
Brain infarction or bleeding	14
Others	80
Unknown	11
Total	325
p-Stage	
0 (pCR)	295
Ia	19,666
Ib	7601
IIa	3213
IIb	2087
IIIa	3761
IIIb	179
IV	1072
NA	211
Total	38,085

Table 13 continued

	Cases
Age	
<20	85
20–29	33
30–39	219
40–49	1009
50–59	3646
60–69	12,731
70–79	15,765
80–89	4532
≥90	58
NA	7
Total	38,085

Table 14
3. Metastatic pulmonary tumor

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
3. Metastatic pulmonary tumor	8057	17 (0.2)	8 (0.1)	30 (0.4)
Colo-rectal	3902	2 (0.1)	0	5 (0.1)
Hepatobiliary/pancreatic	388	2 (0.5)	0	2 (0.5)
Uterine	387	0	0	0
Mammary	445	0	0	0
Ovarian	56	0	0	0
Testicular	84	0	0	0
Renal	618	3 (0.5)	2 (0.3)	3 (0.5)
Skeletal	148	0	1 (0.7)	0
Soft tissue	235	0	1 (0.4)	2 (0.9)
Otorhinolaryngological	422	2 (0.5)	1 (0.2)	2 (0.5)
Pulmonary	497	8 (1.6)	1 (0.2)	11 (2.2)
Others	875	0	2 (0.2)	5 (0.6)

Values in parenthesis represent mortality %

Table 15
4. Tracheal tumor

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
4. Tracheal tumor	118	4 (3.4)	1 (0.8)	10 (8.5)
(A) Primary malignant tumor (histological classification)				
Squamous cell carcinoma	15	0	0	1 (6.7)
Adenoid cystic carcinoma	9	0	0	0
Mucoepidermoid carcinoma	2	0	0	0
Others	10	0	0	0
Total	36	0	0	1 (2.8)
(B) Metastatic/invasive malignant tumor, e.g. invasion of thyroid cancer	48	4 (8.3)	1 (2.1)	9 (18.8)
(C) Benign tracheal tumor (histological classification)				
Papilloma	0	0	0	0
Adenoma	3	0	0	0
Neurofibroma	1	0	0	0
Chondroma	0	0	0	0
Leiomyoma	3	0	0	0
Others	27	0	0	0
Histology unknown	0	0	0	0
Total	34	0	0	0
Operation				
Sleeve resection with reconstruction	13	0	0	1 (7.7)
Wedge with simple closure	0	0	0	0
Wedge with patch closure	0	0	0	0
Total laryngectomy with tracheostomy	0	0	0	0
Others	29	0	0	0
Unknown	0	0	0	0
Total	42	0	0	1 (2.4)

Values in parenthesis represent mortality %

Table 16

5. Tumor of pleural origin

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
Histological classification				
Solitary fibrous tumor	122	0	0	0
Diffuse malignant pleural mesothelioma	283	3 (1.1)	0	10 (3.5)
Localized malignant pleural mesothelioma	26	0	0	1 (3.8)
Others	242	3 (1.2)	2 (0.8)	9 (3.7)
Total	673	6 (0.9)	2 (0.3)	20 (3.0)
Operative procedure				
Extrapleural pneumonectomy	70	1 (1.4)	0	3 (4.3)
Total pleurectomy	73	1 (1.4)	0	3 (4.1)
Others	140	1 (0.7)	0	4 (2.9)
Total	283	3 (1.1)	0	10 (3.5)

Values in parenthesis represent mortality %

Table 17

6. Chest wall tumor

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
Primary malignant tumor	128	1 (0.8)	0	5 (3.9)
Metastatic malignant tumor	208	0	1 (0.5)	3 (1.4)
Benign tumor	362	0	0	0
Total	698	1 (0.1)	1 (0.1)	8 (1.1)

Values in parenthesis represent mortality %

Table 18

7. Mediastinal tumor

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
7. Mediastinal tumor	4685	5 (0.1)	2 (0.04)	17 (0.4)
Thymoma*	1773	5 (0.3)	0	9 (0.5)
Thymic cancer	296	0	0	1 (0.3)
Thymus carcinoid	35	0	0	0
Germ cell tumor	122	0	0	0
<i>Benign</i>	87	0	0	0
<i>Malignant</i>	35	0	0	0
Neurogenic tumor	481	0	0	0
Congenital cyst	932	0	1 (0.1)	5 (0.5)
Goiter	75	0	0	1 (1.3)
Lymphatic tumor	214	0	0	0
Excision of pleural recurrence of thymoma	43	0	0	0
Thymolipoma	14	0	0	0
Others	700	0	1 (0.1)	1 (0.1)

Values in parenthesis represent mortality %

* Includes those with myasthenia gravis

Table 19

8. Thymectomy for myasthenia gravis

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
8. Thymectomy for myasthenia gravis	495	1 (0.2)	0	1 (0.2)
With thymoma	307	1 (0.3)	0	1 (0.3)

Values in parenthesis represent mortality %

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

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
9. Operation for non-neoplastic disease	21,976	197 (0.9)	14 (0.1)	425 (1.9)
(A) Inflammatory pulmonary disease	2287	6 (0.3)	2 (0.1)	17 (0.7)
Tuberculous infection	73	0	0	0
Mycobacterial infection	501	1 (0.2)	1 (0.2)	3 (0.6)
Fungal infection	345	1 (0.3)	1 (0.3)	6 (1.7)
Bronchiectasis	67	0	0	1 (1.5)
Tuberculous nodule	133	0	0	0
Inflammatory pseudo tumor	566	0	0	0
Interpulmonary lymph node	63	0	0	0
Others	539	4 (0.7)	0	7 (1.3)

Values in parenthesis represent mortality %

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

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
Acute empyema	1911	52 (2.7)	3 (0.2)	126 (6.6)
With fistula	469	28 (6.0)	1 (0.2)	71 (15.1)
Without fistula	1425	23 (1.6)	2 (0.1)	52 (3.6)
Unknown	17	1 (5.9)	0	3 (17.6)
Chronic empyema	697	14 (2.0)	1 (0.1)	38 (5.5)
With fistula	345	12 (3.5)	1 (0.3)	27 (7.8)
Without fistula	328	2 (0.6)	0	10 (3.0)
Unknown	24	0	0	1 (4.2)
Total	2608	66 (2.5)	4 (0.2)	164 (6.3)

Values in parenthesis represent mortality %

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

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
(C) Descending necrotizing mediastinitis	103	6 (5.8)	0	9 (8.7)

Values in parenthesis represent mortality %

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

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
(D) Bullous disease	415	1 (0.2)	0	1 (0.2)
Emphysematous bulla	322	1 (0.3)	0	1 (0.3)
Bronchogenic cyst	18	0	0	0
Emphysema with volume reduction surgery	28	0	0	0
Others	47	0	0	0

Values in parenthesis represent mortality %

LVRS lung volume reduction surgery

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

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
(E) Pneumothorax	14,572	60 (0.4)	8 (0.1)	133 (0.9)
<i>Spontaneous pneumothorax</i>				
<i>Operative procedure</i>				
Bullectomy	3410	3 (0.1)	0	12 (0.4)
Bullectomy with additional procedure	7625	2 (0.03)	1 (0.01)	7 (0.1)
Coverage with artificial material	7241	2 (0.03)	0	6 (0.1)
Parietal pleurectomy	51	0	0	1 (2.0)
Coverage and parietal pleurectomy	92	0	0	0
Others	241	0	1 (0.4)	0
Others	905	8 (0.9)	0	12 (1.3)
Unknown	8	0	0	0
Total	11,948	13 (0.1)	1 (0.01)	31 (0.3)
<i>Secondary pneumothorax</i>				
<i>Associated disease</i>				
COPD	1763	18 (1.0)	2 (0.1)	51 (2.9)
Tumorous disease	84	7 (8.3)	3 (3.6)	14 (16.7)
Catamenial	148	0	0	0
LAM	47	0	0	0
Others (excluding pneumothorax by trauma)	582	22 (3.8)	2 (0.3)	37 (6.4)
Unknown				
<i>Operative procedure</i>				
Bullectomy	372	2 (0.5)	1 (0.3)	3 (0.8)
Bullectomy with additional procedure	1509	16 (1.1)	2 (0.1)	37 (2.5)
Coverage with artificial material	1423	16 (1.1)	2 (0.1)	37 (2.6)
Parietal pleurectomy	9	0	0	0
Coverage and parietal pleurectomy	18	0	0	0
Others	59	0	0	0
Others	735	29 (3.9)	4 (0.5)	62 (8.4)
Unknown	8	0	0	0
Total	2624	47 (1.8)	7 (0.3)	102 (3.9)

Values in parenthesis represent mortality %

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

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
(F) Chest wall deformity	217	0	0	0
Funnel chest	209	0	0	0
Others	8	0	0	0

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

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
(G) Diaphragmatic hernia	55	1 (1.8)	0	1 (1.8)
Congenital	22	0	0	0
Traumatic	9	0	0	0
Others	24	1 (4.2)	0	1 (4.2)

Values in parenthesis represent mortality %

Table 27

9. Operation for non-neoplastic disease
(H) Chest trauma
Values in parenthesis represent mortality %

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
(H) Chest trauma	394	29 (7.4)	0	36 (9.1)

Table 28

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

Values in parenthesis represent mortality %

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
(I) Other respiratory surgery	1325	28 (2.1)	0	64 (4.8)
Arteriovenous malformation*	77	0	0	0
Pulmonary sequestration	104	0	0	0
Postoperative bleeding air leakage	386	11 (2.8)	0	30 (7.8)
Chylothorax	65	1 (1.5)	0	2 (3.1)
Others	693	16 (2.3)	0	32 (4.6)

Table 29

10. Lung transplantation

Values in parenthesis represent mortality %

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
Single lung transplantation from brain dead donor	23	0	0	0
Bilateral lung transplantation from brain dead donor	17	0	0	0
Lung transplantation from living donor	20	0	0	2 (10.0)
Total of lung transplantation	60	0	0	2 (3.3)
Donor of living donor lung transplantation	37	0	0	0

Table 30

11. Tracheobronchoplasty

Values in parenthesis represent mortality %

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
11. Tracheobronchoplasty	649	9 (1.4)	7 (1.1)	16 (2.5)
Trachea	27	0	0	1 (3.7)
Sleeve resection with reconstruction	20	0	0	1 (5.0)
Wedge with simple closure	0	0	0	0
Wedge with patch closure	0	0	0	0
Total laryngectomy with tracheostomy	0	0	0	0
Others	7	0	0	0
Carinal reconstruction	28	2 (7.1)	0	2 (7.1)
Sleeve pneumonectomy	15	0	0	1 (6.7)
Sleeve lobectomy	476	5 (1.1)	7 (1.5)	10 (2.1)
Sleeve segmental excision	22	0	0	0
Bronchoplasty without lung resection	13	1 (7.7)	0	1 (7.7)
Others	68	1 (1.5)	0	1 (1.5)

Table 31

12. Pediatric surgery

Values in parenthesis represent mortality %

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
12. Pediatric surgery	580	3 (0.5)	0	7 (1.2)

Table 32
13. Combined resection of neighboring organ(s)

Organ resected	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
13. Combined resection of neighboring organ(s)	1408	7 (0.5)	3 (0.2)	25 (1.8)
(A) Primary lung cancer (organ resected)				
Aorta	16	0	0	1 (6.3)
Superior vena cava	26	0	0	2 (7.7)
Brachiocephalic vein	13	1 (7.7)	0	1 (7.7)
Pericardium	143	1 (0.7)	1 (0.7)	4 (2.8)
Pulmonary artery	158	1 (0.6)	0	2 (1.3)
Left atrium	30	0	0	0
Diaphragm	51	0	0	0
Chest wall (including ribs)	360	3 (0.8)	2 (0.6)	17 (4.7)
Vertebra	16	1 (6.3)	0	2 (12.5)
Esophagus	9	0	0	0
Total	822	7 (0.9)	3 (0.4)	29 (3.5)
(B) Mediastinal tumor (organ resected)				
Aorta	2	0	0	1 (50.0)
Superior vena cava	59	0	0	1 (1.7)
Brachiocephalic vein	89	0	0	0
Pericardium	340	2 (0.6)	0	3 (0.9)
Pulmonary artery	3	0	0	0
Left atrium	0	0	0	0
Diaphragm	34	0	0	1 (2.9)
Chest wall (including ribs)	9	0	0	0
Vertebra	13	0	0	0
Esophagus	4	0	0	0
Lung	461	0	0	0
Total	1014	2 (0.2)	0	6 (0.6)

Values in parenthesis represent mortality %

Table 33
14. Operation of lung cancer invading the chest wall of the apex

	Cases	30-day mortality		Hospital mortality
		Hospital	After discharge	
14. Operation of lung cancer invading the chest wall of the apex	737	2 (0.3)	5 (0.7)	15 (2.0)

Values in parenthesis represent mortality %

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

(C) Esophageal surgery

During 2014 alone, a total of 13,958 patients with esophageal diseases were registered from 601 institutions (response rate: 96.0 %) which affiliated to the Japanese Association for Thoracic Surgery and/or to the Japan Esophageal Society. Among these institutions, those where 20 or more patients underwent esophageal surgeries within the year of 2014 were 133 institutions (22.1 %), which shows no definite shift of esophageal operations to high volume institutions when compared to the data of 2013 (33.3 %) (Table 34) Of 3,956 patients with a benign esophageal disease, 1660 (42.0 %) patients underwent surgery,

and 57 (1.4 %) patients underwent endoscopic resection, while 2239 (56.6 %) patients did not undergo any surgical treatment. (Table 35) Of 10,638 patients with a malignant esophageal tumor, 8135 (76.5 %) patients underwent resection, esophagectomy for 6247 (59.0 %) and endoscopic mucosal resection (EMR) or endoscopic submucosal dissection (ESD) for 1851 (17.5 %), while 2492 (23.5 %) patients did not undergo any resection. (Tables 36, 37) The patients registered, particularly those undergoing ESD or EMR for a malignant esophageal disease, have been increasing since 1990 (Fig. 3).

Among benign esophageal diseases (Table 35), 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 surgery was performed in 1072 patients with a benign esophageal disease, with 30-day mortality in 14 (1.3 %), while thoracoscopic and/or laparoscopic surgery was performed for 588 patients, with 1(0.2 %) of the 30-day mortality. The difference in these death rates between open and scopic surgery seems to be related the conditions requiring open surgery.

The majority of malignant diseases were carcinomas (Table 36). Among esophageal carcinomas, the incidence of squamous cell carcinoma was 90.5 %, while that of adenocarcinomas including Barrett cancer was 7.1 %. The resection rate for patients with a squamous cell carcinoma was 76.4 %, while that for patients with an adenocarcinoma was 88.3 %.

According to location, cancer in the thoracic esophagus was the most common (Table 37). Of the 3950 patients (37.3 % of total esophageal malignancies) having superficial esophageal cancers within mucosal and submucosal layers, 1892 (47.9 %) patients underwent esophagectomy, while 1848 (46.8 %) 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 1.2 % respectively. Advanced esophageal cancer invading deeper than the submucosal layer was observed in 6628 (62.6 %) patients. Of the 6628 patients with advanced esophageal cancer, 4344 (65.5 %) underwent esophagectomy, with 0.9 % of the 30-day mortality rate, and with 2.4 % of the hospital mortality rate.

Multiple primary cancers were observed in 1908 (18.0 %) of all the 10,584 patients with esophageal cancer. Synchronous cancer was found in 982 (51.5 %) patients, while metachronous cancer (found before esophageal cancer) was observed in 926 (48.5 %) patients. The

stomach is the commonest site for both synchronous and metachronous malignancy followed by head and neck cancer (Table 37).

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 38). Transhiatal esophagectomy commonly performed in Western countries was adopted in only 2.8 % of patients having a superficial cancer who underwent esophagectomy and in 1.6 % of those having an advanced cancer in Japan. The thoracoscopic and/or laparoscopic esophagectomy were adopted for 1134 patients (59.9 %) with a superficial cancer, and for 1666 patients (38.3 %) 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 330 patients (Tables 38, 39). Resection of the aorta together with the esophagectomy was performed in 2 cases. Tracheal and/or bronchial resection combined with esophagectomy was performed in 24 patients, with the 30-day mortality rate at 0 % and the hospital mortality rate at 4.2 %. Lung resection combined with esophagectomy was performed in 77 patients, with the 30-day mortality rate at 3.9 % and the hospital mortality rate at 7.8 %.

Salvage surgery after definitive (chemo-) radiotherapy was performed in 262 patients, with the 30-day mortality rate at 1.5 % and with the hospital mortality rate at 3.8 % (Table 38).

Last, in spite of the efforts of the Committee to cover wider patient populations to this annual survey, the majority of the institutions which responded to the questionnaire were the departments of thoracic or esophageal surgery. It should be noted that larger number of patients with esophageal diseases should have been treated medically and endoscopically. We should continue our effort for complete survey through more active collaboration with the Japan Esophageal Society and other-related societies.

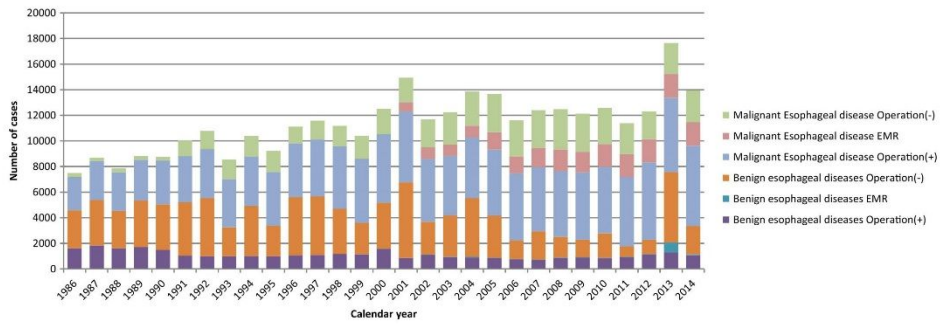


Fig. 3 Annual trend of in-patients with esophageal diseases. *EMR* endoscopic mucosal resection (including endoscopic submucosal)

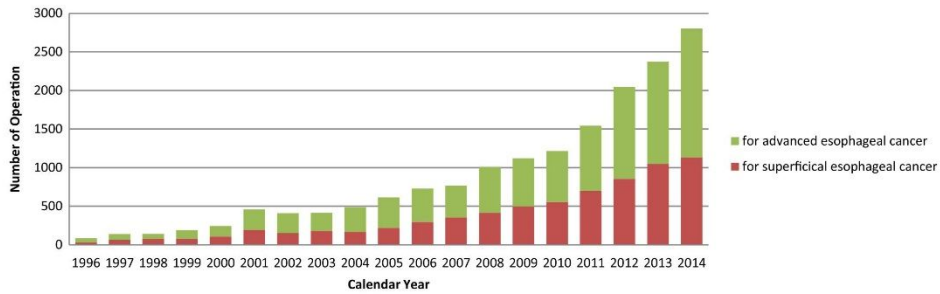


Fig. 4 Annual trend of video-assisted esophagectomy for esophageal malignancy

Table 34 Distribution of number of esophageal operations in 2014 in each institution

Esophageal surgery			
Number of operations in 2014	Benign esophageal diseases	Malignant esophageal disease	Benign + malignant
0	289	136	98
1–4	245	148	145
5–9	45	120	117
10–19	17	81	108
20–29	3	36	39
30–39	1	23	27
40–49	0	20	25
≥50	1	37	42
Total	601	601	601

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 days mortality)	~30 days	31–90 days	Total (including after 91 days mortality)				
1. Achalasia	338	179	159	1 (0.6)	0	1 (0.6)	0	0	0	1 (0.3)	52	390	
2. Benign tumor	111	73	38	0	0	0	0	0	0	43	18	172	
(1) Leiomyoma	70	43	27	0	0	0	0	0	0	17	9	96	
(2) Cyst	12	7	5	0	0	0	0	0	0	0	0	12	
(3) Others	29	23	6	0	0	0	0	0	0	26	6	61	
(4) Not specified	0	0	0	0	0	0	0	0	0	0	3	3	
3. Diverticulum	55	39	16	0	0	0	0	0	0	0	17	72	
4. Hiatal hernia	739	423	316	2 (0.5)	2 (0.5)	4 (0.9)	1 (0.3)	1 (0.3)	2 (0.6)	6 (0.8)	193	932	
5. Spontaneous rupture of the esophagus	95	87	8	4 (4.6)	1 (1.1)	5 (5.7)	0	0	0	5 (5.5)	13	108	
6. Esophago-tracheal fistula	18	17	1	0	0	0	0	0	0	0	12	30	
7. Congenital esophageal atresia	51	47	4	0	1 (2.1)	1 (2.1)	0	0	0	1 (2.0)	1	52	
8. Congenital esophageal stenosis	10	9	1	0	0	0	0	0	0	0	4	14	
9. Corrosive stricture of the esophagus	11	8	3	0	0	0	0	0	0	0	10	21	
10. Esophagitis, esophageal ulcer	87	61	26	0	0	0	0	0	0	0	1199	1286	
11. Esophageal varices	70	67	3	2 (3.0)	0	2 (3.0)	0	0	0	2 (2.9)	685	755	
(1) Laparotomy	9	6	3	0	0	0	0	0	0	0		9	
(2) Sclerotherapy											201	201	
(3) EVL											344	344	
12. Others	75	62	13	5 (8.1)	0	5 (8.1)	0	0	0	5 (6.7)	14	124	
Total	1660	1072	588	14 (1.3)	4 (0.4)	18 (1.7)	1 (0.2)	1 (0.2)	2 (0.3)	20 (1.2)	57	2239	

Values in parenthesis represent mortality %

T/L thoracoscopic and/or laparoscopic

Table 36 Malignant esophageal diseases (histologic classification)

	Resection (+)	Resection (–)	Total
Carcinomas	8100	2495	10,595
1. Squamous cell carcinoma	7233	2355	9588
2. Basaloid (-squamous) carcinoma	79	2	81
3. Carcinosarcoma	43	3	46
4. Adenocarcinoma in the Barrett's esophagus	319	21	340
5. Other adenocarcinoma	350	67	417
6. Adenosquamous carcinoma	22	5	27
7. Mucoepidermoid carcinoma	2	0	2
8. Adenoid cystic carcinoma	1	1	2
9. Enderine cell carcinoma	34	24	58
10. Undifferentiated carcinoma	7	4	11
11. Others	10	13	23
Other malignancies	35	8	43
1. Malignant non-epithelial tumors	8	2	10
2. Malignant melanoma	20	5	25
3. Other malignant tumors	7	1	8
Not specified	0	0	0
Total	8135	2503	10,638

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 days mortality)			
1. Esophageal cancer	6247	47 (0.8)	46 (0.7)	128 (2.0)	1851	2492	10,584
Location							
(1) Cervical esophagus	258	0	1 (0.4)	3 (1.2)	76	178	512
(2) Thoracic esophagus	5041	45 (0.9)	39 (0.8)	112 (2.2)	1501	2133	8675
(3) Abdominal esophagus	644	2 (0.3)	3 (0.5)	7 (1.1)	100	117	861
(4) Multiple cancers	301	0	3 (1.0)	6 (2.0)	174	61	536
(5) Others/not described	3	0	0	0	0	3	0
Tumor depth							
(A) Superficial cancer (T1)	1892	9 (0.5)	9 (0.5)	22 (1.2)	1848	210	3950
<i>Mucosal cancer (T1a)</i>	415	0	2 (0.5)	2 (0.5)	1514	49	1978
(B) Advanced cancer (T2–T4)	4344	37 (0.9)	37 (0.9)	105 (2.4)	2	2282	6628
(C) Not specified	11	1 (9.1)	0	1 (9.1)	1	0	12
2. Multiple primary cancers	1050	7 (0.7)	7 (0.7)	21 (2.0)	520	338	1908
1) Synchronous	587	4 (0.7)	2 (0.3)	10 (1.7)	210	185	982
(1) Head and neck	184	0	0	1 (0.5)	84	59	327
(2) Stomach	226	2 (0.9)	0	4 (1.8)	72	65	363
(3) Others	144	1 (0.7)	2 (1.4)	4 (2.8)	41	42	227
(4) Triple cancers	33	1 (3.0)	0	1 (3.0)	13	19	65
(5) Unknown	0	0	0	0	0	0	0
2) Metachronous	463	3 (0.6)	5 (1.1)	11 (2.4)	310	153	926
(1) Head and neck	102	0	1 (1.0)	2 (2.0)	107	38	247
(2) Stomach	114	2 (1.8)	1 (0.9)	3 (2.6)	75	36	225
(3) Others	221	1 (0.5)	2 (0.9)	5 (2.3)	86	60	367
(4) Triple cancers	26	0	1 (3.8)	1 (3.8)	42	19	87
(5) Unknown	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0

Values in parenthesis represent mortality %

EMR endoscopic mucosal resection (including endoscopic submucosal dissection)

Table 38 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 days mortality)		~ 30 days	31–90 days	Total (including after 91 days mortality)	
Superficial cancer (T1)	1892	9 (0.5)	9 (0.5)	22 (1.2)	1134	3 (0.3)	7 (0.6)	14 (1.2)	1848
<i>Mucosal cancer (T1a)</i>	415	0	2 (0.5)	2 (0.5)	223	0	0	0	1514
Esophagectomy	1892	9 (0.5)	9 (0.5)	22 (1.2)	1134	3 (0.3)	7 (0.6)	14 (1.2)	1848
(1) Transhiatal esophagectomy	53	1 (1.9)	1 (1.9)	2 (3.8)	4	0	0	0	
(2) Transthoracic (rt.) esophagectomy and reconstruction	1579	5 (0.3)	8 (0.5)	17 (1.1)	1037	2 (0.2)	7 (0.7)	13 (1.3)	
(3) Transthoracic (lt.) esophagectomy and reconstruction	43	0	0	0	7	0	0	0	
(4) Cervical esophageal resection and reconstruction	35	0	0	0	16	0	0	0	
(5) Two-stage operation	27	0	0	0	13	0	0	0	
(6) Others	155	3 (1.9)	0	3 (1.9)	57	1 (1.8)	0	1 (1.8)	
(7) Not specified	0	0	0	0	0	0	0	0	
Advanced cancer (T2–T4)									
Esophagectomy	4344	37 (0.9)	37 (0.9)	105 (2.4)	1666	11 (0.7)	11 (0.7)	32 (1.9)	2
(1) Transhiatal esophagectomy	68	0	1 (1.5)	1 (1.5)	7	0	0	0	
(2) Transthoracic (rt.) esophagectomy and reconstruction	3661	31 (0.8)	26 (0.7)	78 (2.1)	1522	9 (0.6)	10 (0.7)	27 (1.8)	
(3) Transthoracic (lt.) esophagectomy and reconstruction	137	1 (0.7)	2 (1.5)	3 (2.2)	14	0	0	0	
(4) Cervical esophageal resection and reconstruction	171	1 (0.6)	2 (1.2)	8 (4.7)	35	1 (2.9)	0	2 (5.7)	
(5) Two-stage operation	84	1 (1.2)	1 (1.2)	4 (4.8)	25	0	0	0	
(6) Others/not specified	223	3 (1.3)	5 (2.2)	11 (4.9)	63	1 (1.6)	1 (1.6)	3 (4.8)	
(7) Not specified	0	0	0	0	0	0	0	0	
(Depth not specified)	11	1 (9.1)	0	1 (9.1)	0	0	0	0	1
Combined resection of other organs	330	6 (1.8)	4 (1.2)	13 (3.9)					
(1) Aorta	2	0	0	0					
(2) Trachea, bronchus	24	0	0	1 (4.2)					
(3) Lung	77	3 (3.9)	2 (2.6)	6 (7.8)					
(4) Others	227	3 (1.3)	2 (0.9)	6 (2.6)					
Unknown	0	0	0	0					
Salvage surgery	262	4 (1.5)	4 (1.5)	10 (3.8)	55	0	2 (3.6)	2 (3.6)	26

Values in parenthesis represent mortality %

Table 39 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	6247	47	0.75	2	0	0.00	24	0	0.00	77	3	3.90	227	3	1.32
Total	98,190	1384	1.41	38	4	10.53	273	20	7.33	1181	23	1.95	2663	43	1.61

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

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