Official Journal of the Asian Pacific Society of Respirology
Respirology

ORIGINAL ARTICLE

Deaths and complications associated with respiratory endoscopy: A survey by the Japan Society for Respiratory Endoscopy in 2010

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ABSTRACT

Background and objective: **In order to survey the current status of the use and complications associated with respiratory endoscopy, the Japan Society for Respiratory Endoscopy conducted a nationwide postal questionnaire survey.**

Methods: **The survey was mailed to all 538 facilities certified by the society. The subjects were patients who underwent respiratory endoscopy in 2010. The numbers of procedures, and associated complications and deaths were investigated according to lesion and procedure using a specific inventory.**

Results: **The inventory was completed by 483 facilities (89.8%). The total number of diagnostic flexible bronchoscopy procedures performed was 103 978, and four patients died (0.004%). The complication rate according to lesion ranged from 0.51% to 2.06%, with the highest rate being observed in patients with diffuse lesions. The complication rate according to procedure ranged from 0.17% to 1.93%, with the highest rate being observed in patients who underwent forceps biopsy. The complication rate after forceps biopsy of solitary peripheral pulmonary lesions was 1.79% (haemorrhage: 0.73%, pneumothorax: 0.63%), and that after endobronchial ultrasound-guided transbronchial needle aspiration of hilar and/or mediastinal lymph node lesions was 0.46%. Therapeutic bronchoscopy was performed in 3020 patients; one patient (0.03%) died due to haemorrhage induced by insertion of an expandable metallic stent. The complication rate according to procedure was highest for foreign body removal (2.2%). Medical pleuroscopy was performed in 1563 patients. The highest complication rate was for biopsy without electrocautery (1.86%). A total of 228 facilities (47.2%) experienced breakage of bronchoscopes and/or devices.**

Conclusions: **Respiratory endoscopy was performed safely, but education regarding complications caused by new techniques is necessary.**

SUMMARY AT A GLANCE

A nationwide survey was conducted to investigate complications and deaths associated with respiratory endoscopy in 2010 according to lesion and procedure. There were five fatalities, and the complication rates associated with forceps biopsy of solitary peripheral lesions and EBUS-TBNA for hilar and/or mediastinal lesions were 1.79% and 0.46%, respectively.

Key words: bronchoscopy, interventional pulmonology, lung cancer, medical thoracoscopy, mortality/morbidity.

INTRODUCTION

Large surveys on the safety of bronchoscopy have been performed,[1–5] and mortality rates and frequencies of complications have been reported to be 0.01–0.045% and 0.08–0.3%, respectively. However, these surveys were mostly performed more than 20 years ago, and mortality and complication rates may have changed since then. There are complications that are unique to bronchoscopic procedures, and the frequency of complications varies among different target lesions. In addition, the technology of medical devices is progressing rapidly leading to the development of new techniques. The usefulness of endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA)[6] and medical pleuroscopy, also referred to as local anaesthetic thoracoscopy,[7] have been demonstrated, and although the use of these techniques has spread rapidly, no large-scale survey of complications associated with these new techniques has been performed.

To address this issue, the Japan Society for Respiratory Endoscopy performed its third survey, the

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Received 29 May 2011; invited to revise 13 July 2011; revised 15 August 2011; accepted 28 September 2011 (Associate Editor: David Feller-Kopman).

'2010 Community Survey of Respiratory Endoscopy'. In this survey, in addition to comparisons with the results of previous surveys,[8,9] the numbers of procedures, deaths and complications were investigated according to lesion and procedure, and data on additional procedures (EBUS-TBNA and medical pleuroscopy) was included in the survey. Breakage of bronchoscopes and/or devices was also surveyed.

METHODS

This was a retrospective nationwide survey of bronchoscopic procedures. The Internal Review Board of the Japan Society for Respiratory Endoscopy provided ethics approval for this study. The postal survey involved patients who underwent respiratory endoscopy between January 1, 2010 and December 31, 2010. The survey forms were mailed to 538 facilities certified by the Japan Society for Respiratory Endoscopy.

The actual status of the cases was surveyed using an inventory in the form of a table that was enclosed with the survey. The inventory was maintained by the representative at each institution using data extracted from the institution's medical records, and the numbers of procedures, complications and deaths were recorded for each procedure. The procedures were categorized into diagnostic bronchoscopy, therapeutic bronchoscopy and medical pleuroscopy. Diagnostic bronchoscopy only included cases involving use of a flexible bronchoscope. In addition to total number of procedures, the numbers of procedures targeting the following four groups of lesions were investigated: central airway lesions (lesions observable by bronchoscopy), hilar and/or mediastinal lymph node lesions, solitary peripheral pulmonary lesions, and diffuse lung lesions (overlapped). In addition, for each procedure, the numbers of procedures, complications and deaths were investigated according to lesion for: (i) central airway lesions (a) by observation alone, (b) by forceps biopsy, (c) by brush biopsy and (d) by bronchial washing; (ii) hilar and/or mediastinal lesions (a) by transbronchial needle aspiration and (b) by EBUS-TBNA; (iii) solitary peripheral lesions (a) by observation alone, (b) by forceps biopsy, (c) by brush biopsy, (d) by bronchial washing and (e) by transbronchial needle aspiration; and (iv) diffuse lesions (a) by observation alone, (b) by forceps biopsy, (c) by bronchial washing and (d) by bronchoalveolar lavage.

When multiple procedures and treatments were applied to the same lesion, these were included in the numbers of individual procedures. For therapeutic bronchoscopy, in addition to total numbers, the numbers of procedures performed for each of the following treatments were investigated: ethanol injection, laser therapy, photodynamic therapy, endobronchial electrocautery, argon plasma coagulation, microwave coagulation, endobronchial brachytherapy, silicone stent placement, expandable metallic stent placement, balloon dilatation, foreign body removal, bronchial occlusions with an endobronchial Watanabe spigot and fillers other than endobronchial Watanabe spigot. Sputum clearance and guidance for tracheal intubation were excluded. For medical pleuroscopy, in addition to total numbers, the numbers of procedures for observation alone and for biopsies with or without electrocautery were investigated.

The complications that were investigated included pneumothorax (requiring resting or thoracic drainage), haemorrhage (blood loss of 300 mL or more, or necessitating a blood transfusion), pulmonary infections (pneumonia and/or pleuritis, including patients with pleurisy before treatment that appeared to have been aggravated), bronchial asthma, respiratory failure (excluding patients treated by oxygen administration alone), lidocaine intoxication (requiring special procedures due to convulsion/loss of consciousness), complications related to the circulatory system and requiring special treatment (heart failure, myocardial infarction, arrhythmia and cerebral infarction), aggravation of central airway obstruction, and perforations. When a complication resulted from the application of several procedures, the procedure most likely to be the cause of the complication was recorded.

Specific questions relating to special complications and breakage of the bronchoscope and/or devices were included in the survey. All results were subjected to standard statistical analyses using SPSS version 19 software (SPSS, Inc., Chicago, IL, USA). Questions eliciting no response were considered invalid replies. Data are presented as percentages of the number of valid replies received.

RESULTS

The inventory surveying the actual status of the cases was returned by 483 facilities (89.8%).

Diagnostic bronchoscopy

Number of procedures

The total number of diagnostic bronchoscopy procedures performed during the survey period was 103 978, and the number performed at each facility varied from 14 to 1000 (mean 226, median 180). By lesion, the greatest number of procedures was performed for solitary peripheral lesions. By procedure, the greatest number was performed by forceps biopsy (Table 1).

Deaths

Four patients (0.004%) died as a consequence of diagnostic bronchoscopy: one patient developed a pulmonary abscess after brush biopsy for a solitary peripheral lesion; one had a cerebral infarction due to an air embolus caused by forceps biopsy of a solitary peripheral lesion; one patient had an aortic dissection during the observation of diffuse lesions; and one patient developed interstitial pneumonia that deteriorated rapidly after EBUS-TBNA for a hilar and/or mediastinal lesion.

Table 1 Total number of diagnostic bronchoscopy procedures performed according to target lesion and procedure

	Total number	Respondents	Mean number of procedures performed at each facility	Median number of procedures performed at each facility	Range of number of procedures performed at each facility
Diagnostic bronchoscopies	103 978	460	226	180	14–1000
Central airway lesions	24 283	459	53	40	1–720
Hilar and/or mediastinal lesions	5307	330	16	7	1–251
Solitary peripheral lesions	60 275	461	131	102	1–893
Diffuse lesions	17 309	445	39	28	1–327
Simple bronchoscopies	14 725	433	34	21	1–453
Forceps biopsies	57 199	467	122	91	1–720
Brush biopsies	48 759	465	105	83	1–595
Bronchial washing	53 927	444	121	97	1–783
TBNA	8704	347	25	9	1–493
BAL	12 409	429	29	20	1–317

BAL, bronchoalveolar lavage; TBNA, transbronchial needle aspiration.

Table 2 Frequency of complications according to lesion

	Total	PTX	Haemo	PI	BA	RF	LTX	CVE	CAO	PF
Central airway lesions	320 (1.32)	1 (0.004)	216 (0.89)	36 (0.15)	21 (0.09)	8 (0.03)	8 (0.03)	13 (0.05)	17 (0.07)	0 (0)
Hilar and/or mediastinal lesions	27 (0.51)	0 (0)	16 (0.30)	8 (0.15)	1 (0.02)	1 (0.02)	1 (0.02)	0 (0)	0 (0)	0 (0)
Solitary peripheral lesions	937 (1.55)	264 (0.44)	379 (0.63)	148 (0.25)	39 (0.06)	26 (0.04)	24 (0.04)	51 (0.08)	6 (0.01)	0 (0)
Diffuse lesions	356 (2.06)	151 (0.87)	76 (0.44)	36 (0.21)	13 (0.08)	63 (0.36)	9 (0.05)	7 (0.04)	1 (0.006)	0 (0)

Data are number (%) of cases.

BA, bronchial asthma; CAO, central airway obstruction; CVE, cardiovascular event; Haemo, haemorrhage; LTX, lidocaine toxicity; PF, perforation; PI, pulmonary infections (pneumonia and/or pleuritis); PTX, pneumothorax; RF, respiratory failure.

Complications

The complication rate by lesion ranged from 0.51% to 2.06%; the highest rate was noted for diffuse lesions. The rate of haemorrhage was highest for central, hilar and/or mediastinal, and solitary peripheral lesions, and that of pneumothorax was highest for diffuse lesions (Table 2).

The complication rate by procedure ranged from 0.17% to 1.93%, and the rate was highest for forceps biopsy. The rate of haemorrhage was highest for simple bronchoscopy, forceps biopsy, brush biopsy and transbronchial needle aspiration, and the rates of pulmonary infection (pneumonia and/or pleuritis) and respiratory failure were highest for bronchial washing and transbronchial needle aspiration, respectively (Table 3).

EBUS-TBNA was performed for hilar and/or mediastinal lesions in 3689 cases. Complications occurred in 17 cases (0.46%), with pulmonary infections (pneumonia and/or pleuritis) being the most frequent (eight cases, 0.22%). Forceps biopsy of solitary peripheral lesions was performed in 37 485 cases (radial-type EBUS in 3853 cases). Complications occurred in 670 cases (1.79%), with haemorrhage being the most frequent (273 cases, 0.73%), followed by pneumothorax (238 cases, 0.63%). Forceps biopsy of diffuse lesions was performed in 9674 cases, and 239 complications occurred (2.47%). The most frequent complication was pneumothorax (147 cases, 1.52%), followed by haemorrhage (69 cases, 0.71%).

The following cases were reported as being special complications: 63 cases of acute aggravation of interstitial pneumonia due to transbronchial needle aspiration or transbronchial lung biopsy (0.29%), five cases of tuberculosis among staff engaged in bronchoscopies (0.005%), 34 cases of shock apparently associated with lidocaine hypersensitivity (0.03%), three cases of mediastinitis and/or pericarditis associated with EBUS-TBNA (0.08%), 215 cases of pneumothorax requiring drainage associated with transbronchial lung biopsy (0.46%), and eight cases of embolism

Table 3 Frequency of complications associated with each diagnostic procedure

	Total	PTX	Haemo	PI	BA	RF	LTX	CVE	CAO	PF
Simple bronchoscopy	76 (0.52)	8 (0.05)	20 (0.14)	7 (0.05)	16 (0.11)	3 (0.02)	10 (0.07)	10 (0.07)	2 (0.01)	0 (0)
Forceps biopsy	1104 (1.93)	385 (0.67)	487 (0.85)	116 (0.20)	29 (0.05)	19 (0.03)	16 (0.03)	33 (0.06)	19 (0.03)	0 (0)
Brush biopsy	227 (0.47)	16 (0.03)	124 (0.25)	35 (0.07)	13 (0.03)	5 (0.01)	13 (0.03)	18 (0.04)	3 (0.006)	0 (0)
Bronchial washing	91 (0.17)	0 (0)	29 (0.05)	38 (0.07)	4 (0.01)	13 (0.02)	0 (0)	7 (0.01)	0 (0)	0 (0)
TBNA	46 (0.53)	6 (0.07)	24 (0.28)	8 (0.09)	5 (0.06)	1 (0.01)	1 (0.01)	1 (0.01)	0 (0)	0 (0)
BAL	96 (0.77)	1 (0.008)	3 (0.02)	24 (0.19)	7 (0.06)	57 (0.46)	2 (0.02)	2 (0.02)	0 (0)	0 (0)

Data are number (%) of cases.

BA, bronchial asthma; BAL, bronchoalveolar lavage; CAO, central airway obstruction; CVE, cardiovascular event; Haemo, haemorrhage; LTX, lidocaine toxicity; PF, perforation; PI, pulmonary infections (pneumonia and/or pleuritis); PTX, pneumothorax; RF, respiratory failure; TBNA, transbronchial needle aspiration.

Table 4 Total number of therapeutic bronchoscopy procedures performed

	Total number	Respondents	Mean number per respondent	Median number per respondent	Range	FBS		RBS	
						Number	Respondents	Number	Respondents
Therapeutic bronchoscopies	3020	357	8.5	4.0	1–177				
Eti	138	46	3.0	1.5	1–20	135	45	3	1
LT	197	61	3.2	2	1–36	169	53	28	11
PDT	73	19	3.8	2	1–21	68	17	5	3
EEC	220	73	3.0	2	1–30	174	63	46	14
APC	265	69	3.8	2	1–35	199	64	66	12
MWC	147	21	7.0	5	1–35	145	19	2	2
EBT	3	2	1.5	1.5	1–2	3	2	0	0
SS	253	64	4.0	2	1–40	81	31	172	41
EMS	464	147	3.2	2	1–31	344	129	120	23
BD	236	56	4.2	2	1–36	151	47	85	15
FBR	681	251	2.7	2	1–92	662	245	19	12
BO with EWS	227	86	2.6	2	1–11	221	84	6	4
BO w/o EWS	140	44	3.2	2	1–22	140	44	0	0

APC, argon plasma coagulation; BD, balloon dilatation; BO with EWS, bronchial occlusion with endobronchial Watanabe spigot (EWS); BO w/o EWS, bronchial occlusion with fillers other than EWS; EBT, endobronchial brachytherapy; EEC, endobronchial electrocautery; EMS, expandable metallic stent placement; Eti, ethanol injection; FBR, foreign body removal; FBS, flexible bronchoscopy; LT, laser therapy; MWC, microwave coagulation; PDT, photodynamic therapy; RBS, rigid bronchoscopy, either alone or with flexible bronchoscopy; SS, silicone stent placement.

associated with the withdrawal of antiplatelet and anticoagulant agents prior to bronchoscopy (0.008%).

Therapeutic bronchoscopy

Number of procedures

The total number of therapeutic bronchoscopy procedures performed during the survey period was 3020. This procedure was performed at 357 facilities (73.9%), and the number of procedures performed at each facility ranged from 1 to 177 (mean 8.5, median 4). The total numbers by procedure ranged from 3 for endobronchial brachytherapy to 681 for foreign body removal. In most cases, a flexible bronchoscope was used for foreign body removal. In many cases, placement of expandable metallic stents was performed using a flexible bronchoscope alone, whereas at 41 facilities, placement of silicone stents was performed using a rigid endoscope. Bronchial occlusion was performed with an endobronchial Watanabe spigot in 227 cases, more frequently than with non-endobronchial Watanabe spigot fillers, and flexible bronchoscopy was used in most cases (Table 4).

Deaths

Among the 3020 patients undergoing therapeutic bronchoscopy, one (0.03%) died due to haemorrhage while an expandable metallic stent was being inserted.

Table 5 Frequency of complications associated with each therapeutic procedure

	Total	PTX	Haemo	PI	BA	RF	LTX	CVE	CAO	PF
Eti	2 (1.45)	0 (0)	0 (0)	1 (0.72)	1 (0.72)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
LT	1 (0.51)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0.51)	0 (0)
PDT	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
EEC	3 (1.36)	1 (0.45)	0 (0)	0 (0)	0 (0)	2 (0.91)	0 (0)	0 (0)	0 (0)	0 (0)
APC	1 (0.38)	0 (0)	1 (0.38)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
MWC	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
EBT	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
SS	3 (1.19)	0 (0)	0 (0)	1 (0.40)	1 (0.40)	1 (0.40)	0 (0)	0 (0)	0 (0)	0 (0)
EMS	6 (1.29)	0 (0)	1 (0.22)	2 (0.43)	0 (0)	2 (0.43)	0 (0)	0 (0)	1 (0.22)	0 (0)
BD	1 (0.42)	1 (0.42)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
FBR	15 (2.20)	1 (0.15)	12 (1.76)	1 (0.15)	0 (0)	1 (0.15)	0 (0)	0 (0)	0 (0)	0 (0)
BO with EWS	3 (1.32)	0 (0)	0 (0)	2 (0.88)	0 (0)	1 (0.44)	0 (0)	0 (0)	0 (0)	0 (0)
BO w/o EWS	0 (0)	0 (0)	0 (0)	0	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Data are number (%) of cases.

APC, argon plasma coagulation; BA, bronchial asthma; BD, balloon dilatation; BO with EWS, bronchial occlusion with endobronchial Watanabe spigot (EWS); BO w/o EWS, bronchial occlusion with fillers other than EWS; CAO, central airway obstruction; CVE, cardiovascular event; EBT, endobronchial brachytherapy; EEC, endobronchial electrocautery; EMS, expandable metallic stent placement; Eti, ethanol injection; FBR, foreign body removal; Haemo, haemorrhage; LT, laser therapy; LTX, lidocaine toxicity; MWC, microwave coagulation; PDT, photodynamic therapy; PF, perforation; PI, pulmonary infections (pneumonia and/or pleuritis); PTX, pneumothorax; RF, respiratory failure; SS, silicone stent placement.

Table 6 Total number of medical pleuroscopy procedures performed

	Total number	Respondents	Mean number per respondent	Median number per respondent	Range	SFP		RTS	
						Number	Respondents	Number	Respondents
Medical pleuroscopy	1563	184	8.5	6.0	1–69				
Simple pleuroscopy	313	72	4.3	2.0	1–21	276	63	37	10
Biopsy without EC	1236	161	7.7	5.0	1–61	1006	134	230	28
Biopsy with EC	63	18	3.5	2.5	1–14	54	14	9	4

EC, electrocautery; RTS, rigid thoracoscopy; SFP, semiflexible pleuroscopy.

Complications

There were no reports of complications in patients undergoing photodynamic therapy, microwave coagulation, endobronchial brachytherapy or bronchial occlusion with non-endobronchial Watanabe spigot fillers. Among the other procedures, the frequency of complications varied from 0.38% to 2.2%, and the highest rate was noted for foreign body removal. With respect to the frequency of individual complications, haemorrhage during foreign body removal was the most frequent (1.76%), followed by respiratory failure after endobronchial electrocautery (0.91%) (Table 5).

Medical pleuroscopy

Number of procedures

Medical pleuroscopy was performed in 1563 cases at 184 facilities (38.1%), and a semiflexible pleuroscope was used in most cases. Electrocautery was not used for biopsy in most cases (Table 6).

Deaths

There were no fatalities.

Complications

The frequency of complications was highest for biopsy without electrocautery (1.86%), and among these, haemorrhage was the most frequent complication (1.05%). In contrast, there were no complications after electrocautery (Table 7).

Breakage of bronchoscopes and/or devices

Among the 483 facilities, 228 (47.2%) experienced breakage of a bronchoscope and/or devices during

Table 7 Frequency of complications associated with each type of medical pleuroscopy procedure

	Total	PTX	Haemo	PI	BA	RF	LTX	CVE	CAO	PF
Simple pleuroscopy	1 (0.32)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0.32)	0 (0)	0 (0)	0 (0)	0 (0)
Biopsy without EC	23 (1.86)	5 (040)	13 (1.05)	3 (0.24)	0 (0)	1 (0.08)	0 (0)	0 (0)	0 (0)	1 (0.08)
Biopsy with EC	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

BA, bronchial asthma; CAO, central airway obstruction; CVE, cardiovascular event; EC, electrocautery; Haemo, haemorrhage; LTX, lidocaine toxicity; PF, perforation; PI, pulmonary infections (pneumonia and/or pleuritis); PTX, pneumothorax; RF, respiratory failure.

Table 8 Breakage of bronchoscopes and devices and reasons for these breakages

	Number
Bronchoscope breakage	
Patient biting	222
Needle perforation of the forceps channel	131
Heat, such as that caused by a laser	4
Other causes	241
Difficulty in opening/closing or removing the biopsy forceps	107
Curette breakage	120

the survey period. Details of these breakages are shown in Table 8.

DISCUSSION

This was an initial large-scale survey in which the numbers of procedures, complications and deaths were investigated according to lesion and procedure. In addition, the use of EBUS-TBNA and medical pleuroscopy, which have not been investigated previously, was assessed. The advantage of a retrospective survey is that the information is acquired nationwide and is not limited to specific facilities. The overall response rate for this case inventory was 89.5%, which was higher than that of other surveys,[1–5] suggesting that the survey accurately reflected the overall state of respiratory endoscopy in Japan.

There were five fatalities in this survey, with four of these patients undergoing diagnostic bronchoscopy; the mortality rate was 0.004%, which was lower than the rate of 0.01–0.045% reported in previous large-scale surveys.[1–3,5] On the other hand, there were deaths due to air embolism caused by forceps biopsy and EBUS-TBNA, which have not been reported previously, and to which attention should be paid. All fatal cases have been reported here, so as not to compromise the objectivity of the study; however, it is difficult to clearly distinguish between cases in which bronchoscopy was the direct cause of death and cases in which it was an indirect factor or there was exacerbation of the underlying disease.

In previous large-scale surveys, the complication rate was reported to be 0.08–0.3%,[1–3,5] but the complication rates varied among procedures and target lesions. With respect to the frequency of complications by lesion, this was high for diffuse lesions. The differences in the incidence of complications may have been due not only to differences in the procedures used but also the type and severity of underlying diseases. On comparing the complication rates by procedure with those reported in 2006,[9] for diagnostic bronchoscopy, there was a major change in the rate of complications associated with transbronchial needle aspiration (0.14%→0.53%) but not with other procedures. There was no significant correlation between the number of diagnostic bronchoscopy procedures performed and the complication rate (data not shown).

The frequency of complications due to transbronchial lung biopsy was previously reported to be 2.7–6.8%,[3,10] and the frequency of pneumothorax was 0.86–5.5%,[11,12] which was high. Smyth and Stead[5] reported that the frequency of pneumothorax in patients treated with the use of fluoroscopy was 0.86%, which was lower than that in patients treated without the use of fluoroscopy. In other countries, percutaneous biopsy is performed in many patients with solitary peripheral lesions, and the incidence of pneumothorax and haemorrhage was reported to be 20.5% and 5.3%, respectively, with a mortality of 0.15–0.47%.[13,14] In the present survey, haemorrhage and pneumothorax were caused by forceps biopsy of these lesions in 0.73% and 0.63% of cases, respectively, and the overall complication and mortality rates were also low (1.79% and 0.003%, respectively). One reason for the low incidence of pneumothorax may be the use of chest X-ray in most facilities in Japan. Although a prospective comparative study is necessary, forceps biopsy may be safer than percutaneous biopsy. On the other hand, the complication (0.46%) and mortality (0.03%) rates were higher than expected in cases where EBUS-TBNA was used to treat hilar and/or mediastinal lesions. In systematic reviews of the use of EBUS-TBNA,[6,15] it was reported to be a safe procedure, and pneumothorax requiring drainage occurred in only one case. These results were obtained in facilities where the staff were well versed in these techniques. The procedure of EBUS-TBNA is complex, and the staff require training to master this technique.[16] Therefore, it is necessary to survey the application of EBUS-TBNA and the training of staff.

With respect to therapeutic bronchoscopy, no marked changes were noted other than an increase in procedures for foreign body removal (0%→2.2%) and

a decrease in laser therapy (3.66%→0.51%) as compared with the 2006 survey. Haemorrhage occurred frequently during foreign body removal, and all cases involved the use of a flexible bronchoscope. Foreign body removal by flexible bronchoscopy has been reported to rarely cause major complications,[17,18] but the frequency of haemorrhage was high in the present survey. Education is necessary regarding the selection of patients for flexible bronchoscopy and the use of haemostatic techniques, such as rigid endoscopy and argon plasma coagulation. It is also necessary to investigate other therapeutic procedures involving a larger number of cases.

This was the first nationwide survey of the use of medical pleuroscopy. Previous prospective studies have reported no major complications associated with the use of semiflexible pleuroscopy,[19–22] but the facilities surveyed were staffed by skilled operators. It is possible that the complication rate was overestimated in the present survey because there was blood mixed with the pleural effusions, and the precise amount of blood loss was unclear; however, the rate of haemorrhage during biopsy without electrocautery was high (1.05%), with most cases being associated with semiflexible pleuroscopy. In contrast, no complications occurred in patients undergoing biopsy with electrocautery. Because electrocautery may be effective for stopping haemorrhage, further education regarding safety measures is necessary.

There has been no previous survey of breakage of bronchoscopes and/or devices.[23] Nearly half of the facilities responding to this survey experienced breakages during the 1-year period, and the causes of these breakages could be divided into improper handling and patient-related causes; however, more breakages may have been due to improper handling.

Although this was a large-scale survey and the response rate was high, a retrospective method was used for the questionnaire. Therefore, this study may have had several limitations. First, some of the data may have depended on the memory of the persons completing the forms, or in the reporting of complications, there may have been some hesitation in the reporting of fatal cases, which may have reduced the individual complication and mortality rates compared with those reported in prospective studies. In addition, several therapeutic bronchoscopy procedures were applied to only a small number of cases, and the frequency of complications varied markedly depending on the number of reported complications, which may have led to an inaccurate estimation of the complication rate.

Furthermore, because the incidence changes depending on the definition of complications, caution is necessary when comparing the results with previous findings. It should be noted that cases not requiring drainage for a pneumothorax were included in this survey and that haemorrhage was defined as blood loss of 300 mL or the need for a blood transfusion. However, measurement of blood loss is difficult, and some cases involving less loss of blood may have been reported because the definition of haemorrhage was not well understood; this may explain the higher frequencies than previously reported, of haemorrhage during medical pleuroscopy without electrocautery, and during foreign body removal by flexible bronchoscopy. Finally, this was a survey of facilities certified by the Japan Society for Respiratory Endoscopy, where more than 50 examinations were performed annually, and staffed by at least one specialist with appropriate qualifications. Therefore, it should be noted that the results reported here represent those achieved by operators who had achieved a specific level of technical expertise.

ACKNOWLEDGEMENTS

The authors would like to thank all the Japan Society for Respiratory Endoscopy participants who contributed to this work by completing the survey questionnaires.

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