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Interventional pulmonology techniques in elderly patients with comorbidities

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ABSTRACT

Respiratory diseases are common cause of disability in the elderly and are often concomitant with other non-respiratory medical conditions. Interventional pulmonology includes advanced diagnostic and therapeutic techniques, successfully employed for benign and malignant pulmonary diseases with a good safety profile.

A few studies are available on the efficacy and the safety of these procedures (both bronchoscopic and pleural techniques) in the elderly. Paucity of data in these patients may support reluctant clinicians.

We carried out a non-systematic review aimed at describing the scientific literature on interventional pulmonology techniques in elderly patients with comorbidities.

We summarized indications, performance characteristics, and safety profile of bronchoscopic techniques in the elderly, comparing outcomes between older and younger patients. We explored the role of age on anesthesia and sedation protocols during endoscopic procedures and assessed the influence of comorbidities on bronchoscopic outcomes.

This review underlines that older age is not a barrier for implementing interventional pulmonology for diagnostic and therapeutic purposes.

1. Introduction

Life expectancy has significantly increased in the last century, particularly in high income countries, owing to national socio-economic improvement, prevention and control of deadly infectious diseases (e.g., vaccines, antibiotics), and public health interventions (e.g., sanitation, water potability) [1,2]. Elderly is usually associated with an age ≥ 65 years. However, geographical, sociological, and cultural factors can influence its definition and threshold [1,2].

Ageing can play a crucial role in the pathogenesis of several acute and chronic lung diseases. Respiratory disorders can be more prevalent, severe, and frequently associated with disability and comorbidities in older adults [3,4].

In particular, comorbidities can be caused by respiratory diseases and/or can share the same risk factors (i.e., smoking exposure). Their occurrence is associated with atypical clinical presentations and, then, diagnostic delays are frequently recorded [5].

Interventional pulmonology (IP) is a medical specialty relying on advanced and safe diagnostic and therapeutic procedures for the management of benign and malignant pulmonary diseases [6].

The British Thoracic Society Guidelines recommend flexible diagnostic bronchoscopy when clinically needed, independently from the age of the patient [7]. However, rare scientific manuscripts on its usefulness in the elderly may contribute to reluctant prescribing behaviors [8]. A better characterization of its performance and safety profile would be necessary, based on both the high prevalence of some

Abbreviations: IP, interventional pulmonology; BW, bronchial washing.; BAL, bronchoalveolar lavage.; BB, bronchial biopsy.; TBB, transbronchial biopsies.; TBNA, transbronchial needle aspiration.; EBUS-TBNA, endobronchial ultrasound-guided transbronchial needle aspiration.; EGFR, epidermal growth factor receptor.; ROSE, rapid on-site evaluation.; TB, tuberculosis.; COPD, chronic obstructive pulmonary disease.; EUS-B-FNA, endoscopic ultrasound with bronchoscope needle aspiration.; ASA, American Society of Anesthesiologists.; SD, standard deviation.

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respiratory disorders in older patients and the expected increase of life expectancy [8–10].

Aim of the present review is to describe the most important studies on IP techniques in elderly patients with comorbidities.

2. Methods

We carried out a non-systematic, narrative literature review. Scientific documents were mainly retrieved from Pubmed from its inception to June 2018. Only epidemiological studies performed in adult human beings and written in English were selected. The following keywords were combined to address our research question: bronchoscopy; interventional pulmonology; frail elderly; lung cancer; pleural diseases; thoracentesis; thoracoscopy; older patients.

3. Results

3.1. Bronchoscopic techniques

3.1.1. Indications

Studies did not describe similar definitions for the age group "elderly" (Table 1) [8,11–29].

The main medical conditions when bronchoscopy was performed were lung cancer (i.e., diagnosis and staging), infectious diseases (i.e., diagnosis), inhalations of foreign bodies (i.e., removal), atelectasis and hemoptysis (i.e., diagnosis and therapy) (Table 1) [8,12–29]. Few studies directly compared outcomes between younger and older population groups (Table 2) [8,13,14,17–21,26–29].

Allan et al. and Kanemoto et al. did not find different bronchoscopic indications in the above-mentioned subgroups [13,29]. However, other Authors showed that diagnosis and staging of lung cancer and foreign body removal were more frequently performed in older patients [8,17,19,20,28], whereas young persons more often underwent bronchoscopy for diffuse lung diseases, such as sarcoidosis, mirroring different epidemiological scenarios [8–10,30]. Indeed, lung cancer-related morbidity and mortality frequently occur in patients aged ≥65 years, whereas sarcoidosis is more prevalent in younger patients [9,10,30].

Only one study reported that hemoptysis was more frequently assessed through bronchoscopy in younger patients [8], in contrast with the finding of its frequent association with pulmonary malignancies [31].

3.1.2. Sampling techniques

All bronchoscopic sampling techniques may be used in the elderly. Bronchial washing (BW), bronchoalveolar lavage (BAL), bronchial and transbronchial biopsies (BB and TBB), and transbronchial needle aspiration (TBNA) were successfully and safely employed in the selected studies (Tables 1 and 4) [8,12–29].

Five studies compared the rate of employment of the sampling techniques between younger and older individuals (Table 2) [8,13,14,19,29]. Sarinc Ulasli et al. described a significantly higher use of BW in elderly associated to a lower employment of bioptic techniques [8]. Age did not influence the choice of endoscopic sampling techniques in other studies on BW, BAL, BB and TBB [13,14,19,29].

3.1.3. Safety and performance outcomes (diagnostic yield and therapeutic efficacy)

The diagnostic yield of all bronchoscopic techniques is not influenced by the age of the patients (Tables 1 and 4).

Evison et al. prospectively studied the accuracy and the safety of endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA) in the diagnosis and staging of lung cancer of 198 patients aged ≥70 years in comparison with patients aged < 70 years. Sensitivities were not statistically different (92.9% and 86.4% in older and younger patients, respectively; P: 0.12). Moreover, the negative predictive value and the accuracy resulted significantly higher in older patients (accuracy of 90.2% Vs 96.0%; P: 0.02). Notably, no age-related differences were found in terms of lung cancer subtyping and efficacy of epidermal growth factor receptor (EGFR) mutation analysis [18].

Older patients with a lower performance status showed a higher procedural tolerability despite the administration of a lower average dosage of sedatives. Similarly, no significant age-related differences were recorded in terms of rates of both minor and major complications associated with EBUS-TBNA [18].

Comparable results were showed by Vitale et al., who highlighted similar diagnostic yield (74% VS. 69%) and complication rate between patients with suspected lung cancer aged ≥ or < 70 years, who underwent conventional transbronchial needle aspiration (cTBNA) [21].

However, rapid on-site evaluation (ROSE) was not employed in both studies [18,21].

The immediate cytological assessment of the aspirate is a predictor of higher yield for central and peripheral lesions [32,33], without increasing the yield of (EBUS-) TBNA in lymph node sampling [34,35]. Moreover, it may reduce the number of biopsy sites, decreasing the complications associated with bronchoscopy and avoiding a new invasive procedure for molecular profiling [34,36].

Sarinc Ulasli et al. and Allan et al. confirmed that diagnostic yield of conventional TBNA, endobronchial and transbronchial biopsies is not different when compared between younger and older patients [8,29].

The diagnosis of tuberculosis (TB) in the elderly may be particularly difficult [37,38]. Atypical clinical and radiographic presentations and the difficulty of older patients to provide adequate sputum may contribute to delayed diagnosis and treatment [26,38]. The limited clearance of secretions might partly explain the higher incidence of endobronchial TB in the elderly [26,38].

In this context, bronchoscopy with BW, BAL, and bioptic techniques plays an important role in the diagnosis of the disease, in association with a low complication rate [26,39].

These findings are confirmed by Patel et al. who showed a more frequent use of bronchoscopy in elderly TB patients and concluded that 19.9% of all cases of geriatric TB described in their cohort might have been missed without the aid of bronchoscopy [26].

Rigid therapeutic bronchoscopy may be successfully employed in elderly, without any significant complications.

Davoudi et al. described the therapeutic outcomes of 18 octogenarian patients who underwent rigid bronchoscopy during general anesthesia and spontaneous assisted ventilation, for dyspnoea due to central airways lesions (mostly malignant). Therapeutic procedures (i.e. laser resection, stent placement, and bronchoscopic or balloon dilations) were successfully performed and patients clinically recovered. A single episode of intra-operatory hypoxemia and seven episodes of hypotension requiring vasopressors were recorded, as well as 9 post-operative episodes of hypoxemia requiring oxygen [15].

Removal of foreign bodies from the airways represents a frequent concern in the elderly. Cerebrovascular diseases, altered swallowing and cough reflexes, dysphagia, dementia or sedatives can affect consciousness and predispose to aspiration [17]. Four studies describing removal of foreign bodies reported treatment success with flexible bronchoscopy [16,17,19,29]. Boyd et al. described one case in which the foreign body (tooth) was removed with the rigid scope [17].

The vast majority of the studies which compared young and older patients did not find a higher incidence of complications in the elderly (Tables 2 and 4) [8,13,14,17–21,27,29].

Only two studies reported a higher risk of complications in older patients (both in octogenarians). Rokach et al. retrospectively compared two groups of patients, describing similar diagnostic yield and therapeutic efficacy of bronchoscopy. Mortality and adverse events (mostly arrythmias and hypoxemia) were more frequently incident in octogenarians [16].

Similar findings were described by Haga et al. who prospectively compared indications and adverse events in two groups of patients with

Table 1
Summary of studies evaluating the use of bronchoscopy in the elderly.

Author/year	Study	Patient n.	Age	Procedures (sampling techniques)	Main indications	Diagnostic and therapeutic yield (%)	Anesthesia/sedation	Major complications
Macfarlane/1981 [22]	RCS	204	> 70	Diagnostic FB (EBB, TBB)	Masses/consolidations, atelectasis	NAl	Fentanyl, droperidol iv	1 respiratory distress
Brandstetter/1984 [23]	PCS	100	≥65	Diagnostic FB (BAL, EBB TBB, Brush)	Retained secretions, infiltrates	NA	Promethazine iv	1 major hemoptysis, 1 fatal hemoptysis, 10 fever episodes
O'Hickey/1987 [24]	RCS	423	≥65	Diagnostic FB (BW, BAL, TBB)	Consolidations, atelectasis, hemoptysis	89% (sensitivity for malignancy)	NA	1 major hemoptyisis
Knox/1988 [25]	RCS	60	≥80	Diagnostic FB (EBB)	Masses/consolidations	84% (sensitivity for malignancy)	Diazepam, fentanyl iv	1 respiratory failure
Patel/1993 [26]	RCS	572	≥65	Diagnostic FB (BW)	Tuberculosis diagnosis	NA	NA	NA
Costello/1997 [27]	PCS	47	≥66	Diagnostic FB (EBB; TBB)	Malignancy/infectious disease	NA	Midazolam iv	1 major bleeding
Hehn/2003 [28]	PCS	219	≥70	Diagnostic FB	Nodules/masseslymph adenopathies	NA	Midazolam and fentanyl iv	7 PNT, 13 hypoxia events, 8 hemoptysis
Allan/2003 [29]	RCS	227	≥80	Diagnostic FB (EBB, TBB, cTBNA); Therapeutic RB	Nodules/masses infiltrates, hemoptysis	27%	Midazolam, fentanyl iv	4 hypoxia episodes
Watts/2005 [12]	RCT	50	≥75	Diagnostic FB	Malignancy, infectious disease	NA	Oral temazepam Vs Alfentanyl iv	None
Kanemoto/2006 [13]	PCS	76	≥70	Diagnostic FB (BW, BAL, EBB,TBB)	Nodules/masses	NA	NA	None
D'Ippolito/2007 [14]	RCS	191	≥75	Diagnostic FB (EBB, BAL, TBB)	Masses, atelectasis, retained secretions		Diazepam in selected cases	None
Davoudi/2008 [15]	RCS	18	≥80	Therapeutic RB (laser, stenting) dilation)	Malignant and benign obstruction treatment	100%	Midazolam, propofol, fentanyl and remifentanil iv	7 hypotension; 2 moderate bleedings; 1 hypoxia; 1 bronchospasm
Rokach/2008 [16]	RCS	150	≥80	Diagnostic FB (EBB, TBB)	Malignancy, infectious disease	63%	Midazolam, pethidine iv	9 hypoxia events 6 bleedings, 2 deaths
Boyd/2009 [17]	RCS	8	≥75	8 FB, 1 RB	Foreign body removal	87.5%	NA	None
Evison/2014 [18]	PCS	198	≥70	EBUS-TBNA	Malignancy diagnosis e staging; mediastinal lymph node diagnosis	66.1%	Midazolam, alfentanyl iv	1 bleeding; 2 hypoxia events
Haga/2014 [19]	RCS	65	≥80	Diagnostic FB	Foreign body removal and others not specifies	NA	NA	5 fever, 3 bleedings, 1 hypoxaemia, 1 bronchospasm, 1 pneumothorax
Sarinc Ulasli/2014 [8]	RCS	367	≥65	Diagnostic FB (BW, BAL, EBB, cTBNA, TBB)	Malignancy, infectious disease, hemoptysis	51.2%	Midazolam iv	14 bleedings, 3 respiratory depression, 2 bronchospasm, 1 death
Haga/2016 [20]	PCS	66	≥80	Diagnostic FB	Malignancy, infectious disease, ILD	NA	NA	7 bleedings, 8 hypoxia events, 4 fever, 2 bronchospasm and PNT
Vitale/2016 [21]	RCS	43	≥70	cTBNA	Lung cancer diagnosis and staging	74%	Conscious sedation not specified	none

RCS: retrospective cohort study; PCS: prospective cohort study; FB: flexible bronchoscopy; EBB: endobronchial biopsy; TBB: transbronchial biopsy; iv: intravenous; BAL: bronchoalveolar lavage; NA: not available; BW: bronchial washing; PNT: pneumothorax; RB: rigid bronchoscopy; EBUS-TBNA: endobronchial ultrasound transbronchial needle aspiration; cTBNA: conventional transbronchial needle aspiration; ILD: interstitial lung diseases.

Table 2
Summary of studies directly comparing outcomes between elderly and young patients.

Author/year	Age cutoffs	Baseline clinical differences between groups	Compared outcomes	Outcomes differences between groups	Outcomes similarities between groups
Patel/1993 [26]	65	NA	Rate of TB patients diagnosed by bronchoscopy	Higher TB rate in elderly	
Costello/1997 [27]	66	Greater functional impairment and lower midazolam doses in ≥66	Cough frequency Test comfort (0–10 scale) Complications	Lower cough frequency in elderly	Test tolerability Complications
Hehn/2003 [28]	70	NA	Indications	Indications (nodules/masses and lymphadenopathies diagnosis more frequent in elderly; diffuse infiltrates in young)	None
Allan/2003 [29]	80	NA	Indications Sampling methods Diagnostic yield/ therapeutic efficacy Complications Mean midazolam and fentanyl dosage	Lower fentanyl dose in the elderly	Indications Sampling methods Diagnostic yield/ therapeutic efficacy Complications Mean midazolam dosage
Kanemoto/2006 [13]	70	NA	Indications Sampling methods Final diagnosis Complications	None	Indications Sampling methods Final diagnosis Complications
D'Ippolito/2007 [14]	75	Lower FEV1 in ≥75	Indications Sampling methods Complications	None	All
Boyd/2009 [17]	75	NA	Indications Foreign body removal effectiveness Complications	Foreign body removal more frequent in elderly	Foreign body removal effectiveness Complications
Sarinc Ulasli/ 2014 [8]	65	NA	Indications Complications Lesion localization Sampling methods Final diagnosis	Indications (more foreign body and lung cancer in older; sarcoidosis, diffuse parenchymal disease and hemoptysis in younger) Sampling methods (greater use of BW in older)	Complications Lesion localization Final diagnosis
Haga/2014 [19]	80	NA	Indications TBB use Complications Mortality	Indications (higher rate of foreign body research in older)	TBB use Complications Mortality
Evison/2014 [18]	70	Poorer ECOG-PS in elderly	Sedative dose Accuracy Tissue Adequacy for EGFR mutation testing Test tolerability Complications	Sedative dose (lower in older) Accuracy (higher in older) Tolerability (better in older)	Complications Adequacy for EGFR mutation testing
Haga/2016 [20]	80	Poorer ECOG-PS in elderly	Indications Complications (type and rate ≥ 1) Mortality	Indications (higher rate of suspected malignancies in older) Complications (rate ≥ 1 higher in older)	Complications (type) Mortality
Vitale/2016 [21]	70	NA	Diagnostic yield Complications	None	All

TB: tuberculosis; FEV1: forced expiratory volume in 1 s; NA: not available; TBB: transbronchial biopsy; ECOG-PS: Eastern Cooperative Group Performance Status; BW: bronchial washing; EGFR: Epidermal growth factor receptor.

similar ages (< 80 VS. ≥80 years). Rate of bronchospasm, pneumonia, pneumothorax, bleeding, and oxygen desaturations was not significantly higher in older patients; however, the proportion of enrolled subjects with ≥1 complication was higher in the older group, increasing by age. Multivariate analysis suggested that TBB and older age were the main risk factors [20].

Emphysema is one the most prevalent chronic medical conditions in the elderly [3,4]. The decreased elastic recoil associated with the disease increases expiratory airflow resistance, leading to a dynamic hyperinflation. Respiratory muscle impairment, limited functional capacity, and higher mortality rate are frequently described in national and international cohorts of patients. Recently, several bronchoscopic techniques have been used to achieve lung volume reduction in severe emphysema cases [40,41].

No studies evaluated safety and therapeutic outcomes of these techniques in elderly subjects with emphysema, even if in the vast majority of the studies the mean age of the enrolled patients was higher than 60 years.

One-way endobronchial valves is the most frequently studied technique: they induce lobar volume reduction to minimize hyperinflation and can be effectively used in patients with severe emphysema and absent interlobar collateral ventilation.

Endobronchial coils are non-blocking, shape-retaining nitinol devices, delivered bronchoscopically into the subsegmental airways that works independently of collateral ventilation and lead to parenchymal compression, thus improving lung elastic recoil [40–42].

Many randomized controlled trials have confirmed the efficacy of these methods in terms of functional and clinical improvement in those selected patients, showing an acceptable safety profile [40,41].

Bronchoscopic thermal vapor ablation is characterized by the instillation of heated vapor in the targeted lung areas. A localized inflammatory reaction leads to fibrosis, scarring and shrinkage, and, thus, to lung volume reduction. Polymeric lung volume reduction is a similar method based on the administration of a synthetic polymer to the emphysematous destroyed lung area: a local inflammatory reaction results in remodeling and scar formation, thus targeting lobar volume

Table 3
Summary of studies reporting patients' comorbidities.

Author/year	Study aim	Comorbidities	Reported impact of comorbidities on bronchoscopic outcomes
Hehn/2003 [28]	Tolerability and safety of bronchoscopy in the elderly	COPD, CAD, ILD	None
Davoudi/2008 [15]	Safety of therapeutic bronchoscopy in patients aged 80 and older	Hypertension, CAD, COPD, arrhythmias, hypothyroidism, severe anemia	None
Rokach/2008 [16]	Safety, diagnostic and therapeutic yield of bronchoscopy	CAD, COPD, hypertension, diabetes	None
Boyd/2009 [17]	Foreign body removal rate and effectiveness	CHF, COPD, neurological	None

COPD: chronic obstructive pulmonary disease; CAD: coronary artery disease; ILD: interstitial lung disease; CHF: chronic heart failure.

reduction.

Both techniques, which were evaluated in small-sized trials, are irreversible and can be used independently of collateral ventilation. More studies are needed to assess reliable estimates of the efficacy of those techniques. Furthermore, the occurrence of significant adverse events (mostly inflammatory such as lower respiratory tract infections and COPD exacerbations) suggest careful prescription in frail elderly patients [40,41].

3.1.4. Impact of comorbidities

A few selected studies reported on comorbidities in elderly patients undergoing bronchoscopy (Table 3) [15–17,28]. However, no studies specifically evaluated their role on bronchoscopic outcomes.

Boyd et al. described successful removal of foreign bodies in patients aged < or ≥75 year) with similar comorbidities (i.e. neurological disorders, chronic obstructive pulmonary disease (COPD) and cardiac heart failure). Neither age nor comorbidities did affect the primary outcome [17].

Davoudy et al. found that successful therapeutic bronchoscopy can be achieved in octogenarians with airways obstructions, multiple comorbidities (mainly hypertension, arrhythmias, and coronary artery disease), and high ASA (American Society of Anesthesiologists) operatory risk class. Few mild and moderate intra- and post-operative adverse events were recorded, and, then, re-intubation and mechanical ventilation were not required [15].

Instead, Rokach et al. found a significantly higher rate of complications and mortality in octogenarians with comorbidities (COPD, ischemic heart disease, diabetes mellitus, hypertension) relative to younger patients. The severity of disease could have played a role in different rates, although a scientific demonstration was not showed [16].

Interestingly, Scala et al. prospectively studied 15 acutely decompensated elderly COPD patients (mean age (SD) 80 (5) years) with retention of abundant secretions and hypercapnic encephalopathy caused by community acquired pneumonia. They studied early therapeutic flexible bronchoscopy during non-invasive pressure ventilation (NPPV) and compared its safety and effectiveness with those of a group of 15 COPD younger patients (aged mean (SD) 73 (5)). Older patients were admitted more frequently to intensive care unit, were exposed to invasive mechanical ventilation, and were considered not eligible for NPPV because of inefficient mucous clearance and hypercapnic encephalopathy. Based on their findings, early therapeutic bronchoscopy is a potential alternative to intubation and invasive mechanical ventilation in old COPD patients unable to remove copious secretions during non-invasive ventilation [43].

3.1.5. Anesthesia and sedation

Sedation is prescribed to improve patient comfort and tolerability of endoscopic procedures and is recommended by international guidelines [44–46].

Ageing can be associated with increased susceptibility to some centrally acting sedative drugs, which can decline lung function and, thus, can potentially increase the rate of clinical complications [28,47].

The most frequent sedatives prescribed in the selected studies were midazolam and fentanyl (Table 1) [8,12–29]. A limited number of adverse events was attributed to sedation; in particular, hypoxemia and hypotension were the most frequent [15,18,20,22,29]. The final outcome was positive [15,18,20,22,29].

Notably, elderly, as well as younger, patients well tolerated bronchoscopy; however, lower doses of sedatives are usually needed to achieve a similar level of conscious sedation and/or tolerability (Table 4) [27,28,47].

Pink et al. assessed the 7- and 14-day comfort scores of 180 patients who underwent flexible diagnostic bronchoscopy. Experience of the bronchoscopist, position of patients during the examination (i.e., lying or sitting), intubation route (i.e., nasal or oral), dosage of midazolam, route of local anesthetic (i.e., cricoid/to scope) and sampling techniques did not affect the study outcome, with the only exception of the increasing age (patients aged < 60 years reported a higher immediate discomfort score despite the administration of a higher dose of midazolam) [45].

Few studies compared efficacy and safety of sedative drugs in old and young cohorts of patients [12,47,48].

Silvestri et al. prospectively studied the safety of fospropofol, a prodrug of propofol, in 61 elderly patients (≥65 years old) undergoing flexible bronchoscopy. It was proved a safe and effective sedation, rapid

Table 4
Suggested recommendations for maximizing diagnostic/therapeutic outcomes and minimizing procedural risks among older patients undergoing interventional pulmonology procedures.

Bronchoscopy	All bronchoscopic sampling techniques may be used in the elderly
Bronchoscopy (flexible and rigid)	No significant differences exist between younger and older patients in terms of diagnostic yield, therapeutic efficacy and rate of complications
Sedation during bronchoscopy	Ageing can be associated with increased susceptibility to some centrally acting sedative drugs. Lower doses of sedatives are usually needed in the elderly to achieve a similar level of conscious sedation and/or tolerability
Medical thoracoscopy	Medical thoracoscopy (i.e. thoracoscopy performed during spontaneous breathing, under sedation and with local anesthesia) should be considered in elderly patients as it is a feasible and safe technique (draining empyema, evacuating hemothorax, performing pericardial windows, treating chylothorax and pneumothorax, and performing lung and pleural biopsies, with or without talc insufflation)
Thoracentesis Chest tube placement Medical thoracoscopy	In elderly patients (particularly in those taking antiaggregant/anticoagulant medications) the use of a linear vascular transducer with a color Doppler function, in addition to thoracic ultrasonography, might help localize intercostal vessels and avoid their laceration with subsequent hemothorax

time to fully alert and high satisfaction in the elderly subset compared with younger patients [47].

Watts et al. did not find any differences in terms of safety between randomly assigned premedication regimens of nebulized lignocaine and oral temazepam or intravenous alfentanil in a cohort of 25 patients aged ≥75 years who required bronchoscopy. However, patients received the first sedative regimen described a better comfort [12].

Grendelmeier et al. studied the safety of propofol in a cohort of old patients with COPD undergoing flexible diagnostic and therapeutic bronchoscopy. The Authors did not observe a significant higher rate of complications in comparison with a younger healthy young control group. Nevertheless, older COPD patients showed a higher incidence of hypotension, a lower mean and nadir transcutaneous oxygen saturation, and higher transcutaneous peak carbon dioxide tension [48].

Endoscopic ultrasound (with bronchoscope) fine needle aspiration (EUS-B-FNA) is a new technique aimed at sampling lymph nodes and lung lesions located near to the esophagus in the same operative session of an EBUS-TBNA and with the same instrument (i.e., the echo-bronchoscope) [49,50]. A study of Oki et al. demonstrated a lower dose of sedatives/anesthetics, a better tolerability, a shorter procedural time, and fewer episodes of oxygen desaturation with the esophageal than the bronchial route, suggesting its prescription in patients with excessive coughing, a poor respiratory status, and/or in those requiring low doses of sedatives/anesthetics, such as fragile old patients with chronic respiratory comorbidities [50].

3.2. Pleural procedures

Few studies assessed the safety and the efficacy of pleural procedures in the elderly.

Thoracentesis is a safe and effective technique aimed at draining pleural fluid [51,52]. It is performed inserting the needle above the superior margin of the rib in the intercostal space to avoid damaging the neurovascular bundle, which normally runs behind the inferior border. Thoracic ultrasonography guidance has reduced complications associated with the procedure (e.g., pneumothorax and subdiaphragmatic organ injury), including patients exposed to antiplatelet drugs [51–54]. Nevertheless, hemothorax may occur rarely [51,53,55]. Intercostal artery laceration due to vessel tortuosity (covering 25%–50% of the intercostal space) and to traversing collateral arteries may cause this potentially life-threatening complication [55].

Elderly patients are at high risk having higher tortuosity and then wider exposure of the intercostal artery [55].

Hence, in those patients and/or in those taking antiaggregant/anticoagulant medications, the use of a linear vascular transducer with a color Doppler function in addition to thoracic ultrasonography, might help localize intercostal vessels and avoid this serious complication (Table 4) [55].

Katlic et al. demonstrated the efficacy and safety of thoracoscopy performed during spontaneous breathing, under sedation and with local anesthesia (i.e. medical thoracoscopy), in a cohort of 96 elderly patients aged 80–104 years. They proved the feasibility of the procedure draining empyema, evacuating hemothorax, performing pericardial windows, treating chylothorax and pneumothorax, and performing lung and pleural biopsies, with or without talc insufflation (Table 4). Three post-operative complications (i.e., 1 cerebrovascular accident, pulmonary embolism and air leak) and 3 deaths were described in patients with malignant pleural effusions [56].

4. Conclusions

IP procedures are effective and safe when used in the management of pulmonary and pleural diseases and can be safely employed in the elderly.

Poor variability of indications between younger and older patients was proved in relation to different epidemiologic burdens. No significant differences were found in sampling techniques, diagnostic yield, therapeutic efficacy, and complications' rate. Endoscopic procedures are well tolerated and a limited number of sedation-related adverse events related were described; however, the increased susceptibility to some sedative drugs requires caution in the elderly.

Future studies are needed to further elucidate the impact of comorbidities on bronchoscopic outcomes and to confirm the performance characteristics reported by preliminary data on pleural procedures.

Declaration of interests

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