



Review



European Cancer Organisation Essential Requirements for Quality Cancer Care (ERQCC): Lung cancer

Thierry Berghmans^{a,1}, Yolande Lievens^{b,1}, Matti Aapro^c, Anne-Marie Baird^d, Marc Beishon^{e,*}, Fiorella Calabrese^f, Csaba Dégi^g, Roberto C. Delgado Bolton^h, Mina Gagaⁱ, József Lövey^j, Andrea Luciani^k, Philippe Pereira^l, Helmut Prosch^m, Marika Saarⁿ, Michael Shackcloth^o, Geertje Tabak-Houwaard^p, Alberto Costa^q, Philip Poortmans^r

^a European Organisation for Research and Treatment of Cancer (EORTC); Thoracic Oncology Clinic, Institut Jules Bordet, Brussels, Belgium

^b European Society for Radiotherapy and Oncology (ESTRO); Radiation Oncology Department, Ghent University Hospital, Belgium

^c European Cancer Organisation; Genolier Cancer Center, Genolier, Switzerland

^d European Cancer Organisation Patient Advisory Committee; Central Pathology Laboratory, St James's Hospital, Dublin, Ireland

^e Cancer World, European School of Oncology (ESO), Milan, Italy

^f European Society of Pathology (ESP); Department of Cardiac, Thoracic, Vascular Sciences and Public Health, University of Padova Medical School, Padova, Italy

^g International Psycho-Oncology Society (IPOS); Faculty of Sociology and Social Work, Babes-Bolyai University, Cluj-Napoca, Romania

^h European Association of Nuclear Medicine (EANM); Department of Diagnostic Imaging (Radiology) and Nuclear Medicine, San Pedro Hospital and Centre for Biomedical Research of La Rioja (CIBIR); University of La Rioja, Logroño, La Rioja, Spain

ⁱ European Respiratory Society (ERS); 7th Respiratory Medicine Department, Athens Chest Hospital Sotiria, Athens, Greece

^j Organisation of European Cancer Institutes (OECI); National Institute of Oncology, Budapest, Hungary

^k International Society of Geriatric Oncology (SIOG); Medical Oncology, Ospedale S. Paolo, Milan, Italy

^l Cardiovascular and Interventional Radiological Society of Europe (CIRSE); Clinic for Radiology, Minimally-Invasive Therapies and Nuclear Medicine, SLK-Kliniken, Heilbronn, Germany

^m European Society of Radiology (ESR); Department of Biomedical Imaging and Image-guided Therapy, Medical University of Vienna, Austria

ⁿ European Society of Oncology Pharmacy (ESOP); Tartu University Hospital, Tartu, Estonia

^o European Society of Surgical Oncology (ESSO); Department of Thoracic Surgery, Liverpool Heart and Chest Hospital, Liverpool, United Kingdom

^p European Oncology Nursing Society (EONS); Deventer Hospital, Deventer, Netherlands

^q European School of Oncology (ESO), Milan, Italy

^r European Cancer Organisation; Iridium Kankernetwerk and University of Antwerp, Wilrijk-Antwerp, Belgium

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ABSTRACT

European Cancer Organisation Essential Requirements for Quality Cancer Care (ERQCC) are written by experts representing all disciplines involved in cancer care in Europe. They give patients, health professionals, managers and policymakers a guide to essential care throughout the patient journey.

Lung cancer is the leading cause of cancer mortality and has a wide variation in treatment and outcomes in Europe. It is a major healthcare burden and has complex diagnosis and treatment challenges. Care must only be carried out in lung cancer units or centres that have a core multidisciplinary team (MDT) and an extended team of health professionals detailed here. Such units are far from universal in European countries.

To meet European aspirations for comprehensive cancer control, healthcare organisations must consider the requirements in this paper, paying particular attention to multidisciplinary and patient-centred pathways from diagnosis, to treatment, to survivorship.

* Corresponding author.

E-mail address: marcbeishon@icloud.com (M. Beishon).

¹ Joint first authors: T. Berghmans and Y. Lievens contributed equally to this article.

1. Introduction: the need for quality frameworks

There has been a growing emphasis on improving quality in cancer organisations given variations in outcomes in Europe. The European Cancer Concord (ECC), a partnership of patients, advocates and cancer professionals, recognised major disparities in the quality of cancer management and in the degree of funding in Europe. Its European Cancer Patient's Bill of Rights is a patient charter that underpins equitable access to optimal cancer control, cancer care and research for Europe's citizens [1].

This followed an assessment of the quality of cancer care in Europe as part of the first EU Joint Action on Cancer, the European Partnership for Action Against Cancer (EPAAC, <http://www.epaac.eu>). It reported that there are important variations in service delivery between and within countries, with repercussions in quality of care and patient outcomes. Factors such as waiting times and provision of optimal treatment can explain about a third of the differences in cancer survival among countries. Lack of a national cancer plan that promotes clinical guidelines, professional training and quality control measures, may be responsible for a quarter of the survival differences.

The EU Joint Action on Cancer Control (CANCON), which replaced EPAAC from 2014, also focused on quality of cancer care and in 2017 published the *European Guide on Quality Improvement in Comprehensive Cancer Control* [2]. This recognised that many people with cancer are treated in general hospitals and not in comprehensive cancer centres (CCCs), and explored a model of 'comprehensive cancer care networks' that can integrate expertise under a single governance structure.

Further, research shows that care provided by multidisciplinary teams (MDTs) (or multiprofessional teams) results in better clinical and organisational outcomes for patients [3] and are the core component in cancer care [4].

Countries have been concentrating expertise for certain tumour types in such networks and in dedicated centres, or units, such as those for childhood and rare cancers, and all CCCs have teams for the main cancer types. However, for common adult tumours, at the European level there has been widespread effort to establish universal, dedicated units only for breast cancer, following several European declarations that set a target at the year 2016 for care of all patients with breast cancer to be delivered in specialist multidisciplinary centres. While this target was not met [5], the view of the ERQCC expert group is that healthcare organisations should adopt the principles of such dedicated care for all tumour types.

1.1. Lung cancer

Lung cancer is one of the most complex of all common cancers. The disease is multifaceted, given its complex tumour heterogeneity, rapidly evolving treatment landscape and huge societal impact. MDTs are critical to optimal care of patients with lung cancer and have been discussed and implemented in some countries. It is only recently that a pan-European survey of organisation has been undertaken, led by the European Respiratory Society, which revealed important differences in the infrastructure and delivery of lung cancer care in Europe [6]. This ERQCC paper complements these findings by setting out for a broad audience the challenges in lung cancer, the essential requirements for an MDT, and supporting information.

2. Lung cancer: key facts and challenges

2.1. Key facts

2.1.1. Epidemiology

- Lung cancer is the leading cause of cancer death globally [7]. It is predominantly a disease of older people, with about 65% of deaths at age 65 and older [8]. This ERQCC paper focuses on the two main

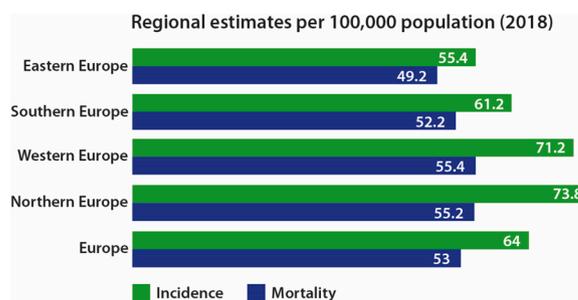


Fig. 1. European mortality and incidence.

Source: European Cancer Information System. New European age standardised rates.

types of primary lung cancer – non-small cell lung cancer (NSCLC) and small cell lung cancer (SCLC). NSCLC is by far the most common, accounting for about 85% of cases. SCLC is more aggressive and spreads rapidly (metastases).

- In 2018, the estimated incidence of lung cancer in European Union countries was about 365,000 and mortality nearly 300,000 [9]. Men represent about two-thirds of mortality – nearly 200,000 were projected to die from lung cancer in 2018. There are major differences among countries: for both sexes, Hungary, Poland, Denmark and Greece were estimated to have much higher mortality (new European age standardised rate >70 per 100,000) than Sweden and Finland (<40 per 100,000), and female deaths from lung cancer were estimated to be highest in Denmark, Hungary and the Netherlands. See Fig.1 for regional estimates.
- Survival rates for lung cancer in Europe (combining all stages and histologies) are low. The EUROCARE-5 study for the years 2000–2007 (the most recent pan-European survival study) reported 5 year relative survival for men in the age group 15–44 at 22%, dropping to 7% at age 75+ [10]. Average 5 year survival for both sexes was 13%. There was only limited improvement in survival during the study years. More recent survival data from England and Wales for the years 2010–11 showed 1 year survival of about 32% and 5 year survival of about 10% for both sexes [11]; in Belgium in the years 2012–2016, 5 year estimated relative survival was considerably better, at about 18% for males and 27% for females [12]. Age-standardised 5-year net survival was in the range 10–20% in most of the 61 countries included in CONCORD-3 [13].
- While lung cancer remains an enormous burden on European health services, mortality has declined greatly among men; for example, by 50% in men in the UK over 40 years, owing mostly to a decline in smoking, and in 27 EU countries there was a linear decrease in the age standardised mortality rate in men from 77/100,000 in 1994 to 57/100,000 in 2012, with the proviso that there was considerable variability among countries [14]. Conversely, mortality among women rose from 15/100,000 in 1994 to 20.5/100,000 in 2012, partly due to the later uptake of smoking by women, with the male–female ratio gap narrowing from 5.1–2.8 in this period. Globally, female lung cancer mortality may surpass breast cancer mortality by 2030 [15].

2.1.2. Risk factors

The primary risk factor is smoking. In Europe more than 90% of cases in men and 80% in women are caused by smoking. Other risk factors are occupational exposure to substances such as asbestos and silica, ionising radiation (radon in the home) [16], second-hand smoking and air pollution. People with a family history of lung cancer in siblings or parents are at greater risk, although there are currently no clinical testing options for identified germline variants and no guidance for medical management of variant carriers [17]. People with medical conditions such as inflammatory lung disease, tuberculosis, asthma,

chronic obstructive pulmonary disease (COPD) and pulmonary fibrosis have increased risk [18].

2.1.3. Diagnosis and treatment summary

For full diagnosis and treatment detail see European Society of Medical Oncology (ESMO) guidelines at <https://www.esmo.org/Guidelines/Lung-and-Chest-Tumours>, and National Institute of Health and Care Excellence (NICE) diagnosis and management guidance, updated March 2019, at <https://www.nice.org.uk/guidance/ng122> [19].

- Most people do not have, or have only limited, symptoms when the cancer is at an early stage. Symptoms may be due to lung infiltration, such as persistent cough, modified pattern of chronic cough due to smoking, coughing up mucous and blood, breathlessness and chest infections; other symptoms may be related to other organ involvement or may be non-specific such as tiredness and weight loss.
- The initial investigation for suspected lung cancer is usually a chest x-ray followed by a computed tomography (CT) scan. Further investigations for staging assessment may include positron emission tomography (PET)/CT, brain magnetic resonance imaging (MRI) or CT, bone scintigraphy, and upper abdomen CT, adapted according to the treatment intent (curative or palliative) and the patient's condition. The diagnosis needs histology or cytology confirmation. There is a variety of biopsy techniques depending on the location of the lesions (central or peripheral) and the probability of lymph node involvement. Biopsy is commonly carried out by fiberoptic bronchoscopy, extended with endobronchial ultrasound (EBUS) and/or endoscopic ultrasound (EUS) to evaluate lymph nodes; other biopsy procedures include image guided needle biopsy, thoracoscopy and mediastinoscopy. Finally, biopsies from a metastatic organ also have to be considered.
- Lung cancers are classified according to the World Health Organization (WHO) histology classification [20]. While NSCLC is staged according to the TNM (tumour, node, metastasis) system, SCLC is commonly grouped into two categories, limited and extensive disease according to the Veterans' Administration staging system. TNM staging has recently also been proposed for SCLC, having a more prognostic value than an operational one. Molecular diagnostics are now playing a major role in metastatic adenocarcinoma NSCLC owing to the discovery of actionable targets for new drugs.
- The therapeutic approach must take into account patient choice, functional status (respiratory and cardiac in particular) and comorbidities such as smoking-related conditions (cardiovascular disease, COPD) and other conditions (including renal failure, hepatic disease, chronic viral infections, autoimmune disease). Older patients must be informed of treatment options and should not remain untreated unless through choice; careful evaluation, integrating geriatric assessment in some cases, is needed before any treatment. Similarly, patients with poor performance status should not be denied treatment but evaluated based on the therapeutic opportunities by disease stage. Apart from comorbidities, performance status and patient choice, stage of the disease is the first variable that guides treatment decisions.
- Treatment of NSCLC:
 - o Stage I and II: Medically fit patients should be offered surgery, with minimally invasive lobectomy using video-assisted thoracoscopic surgery (VATS) preferred to open thoracotomy for better outcomes and reduced morbidity. Pneumonectomy and sleeve lobectomy should be restricted to selected cases when lobectomy is not feasible; segmentectomy for very small T1a tumours is under investigation. Stereotactic body radiotherapy (SBRT) is the preferred option for patients unfit for or declining surgery if tumours are less than 5 cm and not centrally located. If centrally located, SBRT should be discussed for feasibility and to determine the most appropriate technique. The same holds for local ablative therapies (radiofrequency ablation, microwave and cryotherapy),

which may have a role in non-surgical candidates with tumours up to 3 cm. Adjuvant chemotherapy is a standard for completely resected stage II disease where there are no contra-indications.

- o Stage III: Patients with locally advanced disease may be offered perioperative therapy (chemotherapy or chemoradiotherapy) plus surgery in selected operable tumours, whereas chemoradiotherapy, ideally delivered concomitantly when feasible and tolerable, is the mainstay in the majority of cases. When a tumour is not de novo amenable to local therapy, patients should be offered induction chemotherapy before a new evaluation for local treatment, or treated as stage IV. Maintenance immunotherapy in non-progressing patients after concomitant chemoradiotherapy is a new standard of care.
- o Stage IV: There is now a wide range of systemic therapy options in metastatic NSCLC with chemotherapy, immunotherapy, combined chemo-immunotherapy or targeted drugs in case of actionable molecular alteration (currently ALK, EGFR, ROS1 and BRAF). There is also growing interest in offering additional local ablative treatment in oligometastatic lung cancer, with the intent to obtain long-term disease control and potentially a cure.
- Treatment of SCLC:
 - o Patients with limited disease are treated by concomitant chemoradiotherapy or occasionally may be offered surgery.
 - o Metastatic SCLC treatment is mainly palliative with chemotherapy remaining the standard, immunotherapy providing added value, and consolidative loco-regional radiotherapy a validated treatment option; there are as yet no targeted therapy recommendations.
 - o Prophylactic radiotherapy to the brain may be offered in patients with limited disease responding to chemoradiotherapy, and discussed on a case-by-case basis for metastatic disease.

2.2. Challenges in lung cancer care

2.2.1. Screening and detection

- The high rate of diagnosis at advanced stages is a major challenge in lung cancer, and in recent years there has been a growing interest in screening. In the United States, the National Lung Cancer Screening Trial (NLST) [21], so far the world's largest randomised controlled trial (RCT) of using low dose CT, led to a change of recommendations in the US to screen healthy people at a certain level of risk. This and the results of other RCTs in Europe (including the NELSON trial) [22, 23] have also led an EU expert group to recommend that health organisations prepare for screening [24], albeit with caution about defining the at-risk population, the CT method, and how to deal with false positive findings. In addition, organisational aspects and cost-effectiveness should be accounted for. It is stressed that management of detected nodules above certain sizes should only be carried out in a multidisciplinary setting that has experience in lung imaging and managing suspicious findings, which is likely to place more pressure on resources and organisation, but also affords an opportunity to promote lung cancer units.
- Despite lung cancer being a common disease, most primary care doctors (GPs) only see one or two new cases a year and any suspicious lesion must be referred to a lung physician. A study in the UK on more than 20,000 cases identified that patients who have more visits to GPs before investigation are likely to die earlier [25]; the reasons for diagnostic delay are, though, complex and multifactorial [26].
- Lowering barriers to chest x-ray and CT-scan access, including the ability of patients to demand one, are possible ways forward in health systems where GPs act as gatekeepers. A better strategy is said to lie in the use of risk prediction tools to aid GPs, but there is a pressing need to determine which tools are the best to use [27].

- GPs and other professionals such as community pharmacists also play a vital role in prevention but need access to smoking cessation services, which need adequate funding and availability, and to education about lung cancer.
- As men in Europe form a large majority of patients with lung cancer, it is important that barriers to their awareness of symptoms and willingness to seek help are addressed [28]. For both sexes, the stigma attached to lung cancer owing to its connection with smoking may also delay visits to health services [29], and the success of anti-smoking campaigns may have given people a false sense of security as about half of people with a smoking history who present with lung cancer are not active smokers, and the number of non-smokers who develop lung cancer is increasing. Awareness campaigns need to address all risk factors; symptom awareness campaigns are associated with a shift to earlier diagnosis [30,31].
- Many patients with lung cancer are first diagnosed in emergency departments. These patients have worse outcomes, which is another compelling reason to increase awareness and detection, but it is a challenging issue [32]. Data from 11 hospitals in 8 countries in Europe showed that 23.1% of patients with lung cancer were diagnosed as part of an emergency presentation, with rates among countries ranging from 13.2%–47.7% [33].

2.2.2. Diagnosis and staging

- Diagnosing and staging lung cancer is complex and it is essential that experienced specialists including radiologists, pulmonologists, pathologists and nuclear medicine specialists determine results from imaging and pathological samples. A successful management plan, especially for radical interventions, depends on their input to the MDT.
- It can be challenging to obtain adequate biopsy samples in lung cancer in both quantity and quality. The site having the best chance for a valuable pathological sample should be chosen as early as possible. Liquid biopsy (tests on circulating DNA in blood) to test for EGFR mutations is a non-invasive alternative that could be added to the conventional pathological evaluation for appropriate patient cohorts.
- There are challenges in overstaging or understaging lung cancer concerning infiltration of the mediastinum or suspected distant metastases, leading to misclassification and inadequate treatment strategy.
- Pathological confirmation is crucial in determining the appropriate treatment plan for patients, especially with the advent of targeted therapies and immunotherapy in NSCLC [34]. Molecular diagnostics for all the new targeted drugs for lung cancer may not be available at initial diagnosis and during the course of the disease, and expertise in interpreting molecular findings and their clinical significance is important [35]. There is a need for more molecular pathologists and specialised pulmonary pathologists.
- ¹⁸F-FDG PET/CT allows more precise disease staging in lung cancer and is essential when curative treatment is intended (surgery, chemoradiotherapy) and must be available at all centres but at present may not be on-site. Other interventions such as brain MRI and EBUS may also lack availability.

2.2.3. Treatment and outcomes

- Treatment for lung cancer can be highly complex and the current guidelines have many options and uncertainties owing to various levels of evidence and rapidly evolving therapeutic possibilities, particularly in medical treatments. Guidelines stress that MDTs are vital to selecting the best strategies for local and advanced disease; assessment at multidisciplinary meetings can change the treatment plan in a significant number of cases [36] but discussion of new cases in such meetings has been reported to be low in some countries [37]

and regional differences are also reported [38]. Detailed assessment of patient suitability and informed decision-making with patients, their family, carers and primary care doctors are fundamental parts of lung cancer treatment planning.

- A large majority of patients with lung cancer are not eligible for surgery and it is essential that multidisciplinary care is given equal weight for all stages of the disease.
- Lung cancer surgery can be complex, challenging and high risk, and better outcomes have been shown by surgeons specialising in thoracic surgery, but currently there is no designation of this specialism in all European countries [39], and patients may be operated on by cardiothoracic and general surgeons. Similar considerations hold for radiotherapy, with subspecialisation in thoracic oncology advocated for optimal care. In addition, access to advanced radiotherapy technology and techniques such as intensity modulated radiotherapy (IMRT) and SBRT is necessary to provide optimal care and outcomes.
- After a long period with few systemic therapies for lung cancer (mainly platinum based chemotherapies), there has been a rapid introduction of targeted therapies and immunotherapies in advanced NSCLC, posing major challenges for medical oncologists and respiratory physicians on optimal treatment algorithms and toxicity management [40]. In treating locally advanced NSCLC, a survey of specialists in Italy has found variations in management that suggests that appropriate multidisciplinary approaches have not been mandatory [41].
- Some countries (such as Belgium, France, Germany and the Netherlands) have developed positions for pulmonary physicians who specialise in thoracic oncology, or can additionally administer medical therapy (such as Portugal and Sweden), which add important skills to the MDT, but this specialisation is provided in only a minority of countries.
- There can be wide variability in treatment outcomes among patients. In data from the UK, the proportion of patients with lung cancer alive after 1 year in 2013 varied by 55% down to just 12% in the hospitals that treated the disease, and even when outliers at the top and bottom are removed the variation was 48% down to 20% [42]. High volume lung cancer units are associated with better outcomes [43], even when they have a patient mix with more co-morbidities and of lower socioeconomic status [44,45]. These centres are likely to perform more surgical resections as a percentage of cases, and use more minimally invasive techniques such as VATS and robotic assisted thoracic surgery (RATS) with lower morbidity (see also MDT section 3.2). It has been reported that if all areas of the UK had the same access to surgery as the cancer network with the highest resection rate, over 5000 deaths from lung cancer would be prevented every 3 years [46].
- Excellent post-operative care for patients with lung cancer can be vital for better outcomes, especially in high-risk patients, and can involve intensive care such as for major cardio-respiratory complications. It is important that care is organised according to pre-operative risk [47].
- Lung cancer nurse specialists are promoted in a number of countries such as Belgium, the Netherlands and the UK as key components of quality care, but contact with such nurses may be limited or not available [48]. The presence of lung cancer nurses may be associated with greater receipt of treatment, in particular surgery, as evidenced in the UK [49].

2.2.4. Support services and survivorship

- The long-term survival rate of those who have been diagnosed with lung cancer is increasing and so are the support needs of this population, which can include physical and neuropsychological symptoms such as shortness of breath, fatigue, short-term memory loss and anxiety. Lung cancer is associated with higher disease burden,

more physical hardship and greater symptom distress than some other cancer types. There is a need for survivorship programmes dedicated to lung cancer, owing to the complex nature of the disease and particular experience of patients.

- Patients with lung cancer are a neglected population for psychosocial needs compared with some other cancers, partly owing to the stigma of the disease as being self-inflicted through smoking, and they report increased distress as a result. Failure to detect distress in patients might serve as barriers to treatment, decreasing patients' health-related quality of life, increasing healthcare costs, and negatively impacting smoking cessation efforts.
- Surveillance of survivors is an increasingly important concern as numbers rise, but evidence suggests that more frequent surveillance after surgery is not associated with improved survival [50]. Hospitalisations among long-term survivors are common and occur most often owing to cardiovascular, pulmonary and gastrointestinal diseases [51].
- Carers of patients experience rising emotional, physical and financial costs with increasing incidence of cancer and other life limiting illnesses, with lung cancer likely to be a significant contributor, including at end of life [52].

2.2.5. Palliative and supportive care

- Currently, a great majority of patients with lung cancer will require high-quality palliative and supportive care, which may not be available at all locations. Symptoms caused by the disease and its treatments can be profoundly debilitating and it is in lung cancer that studies have been first carried out on the benefits of early introduction of palliative care, finding benefits not just for patients but also for carers and healthcare systems [53].
- A review of supportive care in lung cancer considers it to be a rapidly expanding and multidisciplinary field with an urgent need to develop more effective interventions and focus on neglected symptoms [54]. A trial in Belgium has shown that early and systematic integration of palliative care is more beneficial for patients with advanced cancer than palliative care consultations offered on demand, even when psychosocial support has already been offered [55].
- A Lancet Oncology Commission has proposed the use of standardised care pathways and MDTs to promote integration of oncology and palliative care [56]; ESMO has introduced an accreditation programme called Designated Centres of Integrated Oncology & Palliative Care (<https://www.esmo.org/Patients/Designated-Centres-of-Integrated-Oncology-and-Palliative-Care>).

2.2.6. Inequalities

- The variation in outcomes for lung cancer in Europe both among and within countries indicates that there may be inequalities in access to high-quality care, although comparisons are hard to make owing to widely varying incidence and quality of registry information. What is certain is that as with other cancers, some countries in eastern Europe lack access to drugs, radiotherapy and new diagnostic techniques that may be critical to improving care, as documented by ESMO and ESTRO for medical therapies and radiation oncology [57–59]. In addition, lack of well-trained professionals may not only limit the availability of the latest therapeutic advances, but also limit access to the current standards of care [60].
- Lung cancer is primarily a disease of older people, and due to the demographic transition, this population is increasing. There are pronounced challenges in caring for a population that has several comorbidities and in making shared and informed treatment decisions. In older patients, treatment decisions are more complex because of the scarcity of data from large randomised studies in the elderly and the heterogeneity of this population concerning functional status, comorbidity and polypharmacy [61]. In Belgium, for example, it has

been shown that older patients are less frequently discussed by MDTs, which may result in lower uptake of radiotherapy [62]. There is a pressing need to develop the evidence base for defining the role of treatments such as chemoradiotherapy and immunotherapy in older patients, especially vulnerable and frail individuals. Not age, but comorbidity, life expectancy, and patient preferences should be decisive factors when offering treatment [63].

- Patients with lung cancer living in more socioeconomically deprived circumstances may be less likely to receive treatment, including surgery and chemotherapy [64]. These inequalities may not be accounted for by socioeconomic differences in stage at presentation or by differences in healthcare systems.

2.2.7. Research

- The range of research challenges for lung cancer is wide, extending from risk stratification and methods of diagnosis, to new localised treatment techniques and optimal combination of local and systemic treatment strategies, to individualising medical treatments as more new agents become available for advanced disease, and to improving quality of life.
- However, the global level of research on lung cancer relative to its huge burden lags significantly behind that of other cancers [65].
- Evidence also suggests that treatment at institutions with an interest in clinical trials [66] and higher clinical trial accrual volume is associated with longer overall survival [67].

2.2.8. Cancer registration and data availability

- Cancer registration practice, coverage and quality are highly unequal across Europe [68]. Consequently, basic epidemiological data on incidence, mortality and survival are not uniformly available for all countries. Also, only a minority of cancer registries can provide sufficient data for the calculation of parameters necessary for the assessment of outcomes and quality of care [69].
- In a 2015 survey, only 6 countries – Denmark, Germany, Hungary, the Netherlands, Slovenia, and United Kingdom – reported a lung cancer data collection, or audit, programme in addition to a cancer registry [70,71]. The creation of a pan-European dataset is a significant challenge but will expose variation in practice, identify best practices, show where improvement is needed, and guide investment in resources. In 2018, the European Respiratory Society announced its intention to develop harmonised standards for lung cancer registration and services in Europe [72].

3. Organisation of care

3.1. Care pathways and timelines

- Care for people with lung cancer must be organised in pathways that cover the patient's journey from their point of view rather than that of the healthcare system. Pathways must correspond to current national and European evidence-based clinical practice guidelines on diagnosis, treatment and follow-up. The European Pathway Association defines a care pathway as “a complex intervention for the mutual decision making and organisation of care processes for a well-defined group of patients during a well-defined period”. This broad definition covers terms such as clinical, critical, integrated, patient pathways that are also often used. See <http://e-p-a.org/care-pathways> and also the WHO framework on integrated people-centred health services, <http://www.who.int/servicedeliverysafely/areas/people-centred-care>.
- Examples of lung cancer care pathways are from the National Institute for Health and Care Excellence (NICE) [73], the UK NHS Lung Cancer Clinical Expert group [74], NHS Cancer Programme [75], Cancer Council Victoria, Australia [76], and Cancer Care Ontario

[77]. Integrated care plans (ICPs) have been proposed as a way to improve patient-oriented quality in the highly complex diagnosis and treatment care pathways for lung cancer [78,79]. ICPs are described as structured multidisciplinary care plans for a specific clinical condition. They describe the tasks to be carried out together with their timing and sequence and the discipline involved in completing the task.

- Delays in referral to a hospital cancer centre from primary care have been addressed above (section 2.2.1). The biggest cause of delay in secondary care has been reported as access to definite diagnostic procedures and results, with other delays caused by waiting for multiple specialist consultations, lack of rapid MDT assessment, and surgical and radiotherapy treatment delays [80]. However, there have been mixed results on whether not meeting guideline times has an impact on survival [80]. A recent study at a single centre found that delays in investigation and treatment do not appear to negatively affect clinical outcomes, but added that studies are needed to evaluate whether efficient work-up and treatment influence other important variables, such as quality of life, cost of care and access to therapies [81]. Treatment for SCLC must be offered promptly as the disease progresses rapidly.
- With emergency presentation being a major problem in lung cancer, there must be pathways to ensure patients are seen in lung cancer units as soon as possible.
- After a diagnosis, it must be clear to the patient which professional is responsible for each step in the treatment pathway and who is following the patient during the journey (usually called a case manager or patient navigator) [82]. In some countries, case managers during the main stages of treatment are cancer nurses.
- Follow-up, support and care for long-term survivorship, and palliative care, must be part of a care pathway.

3.2. Lung cancer units/centres and MDTs

- The diagnosis and treatment of lung cancer must be managed by a core and extended MDT of professionals described below, at a lung cancer unit or centre. The ERQCC expert group considers that optimal care is delivered when all members of the core MDT work in a single unit or centre, but it is recognised that some members of the MDT may be based at nearby or other locations, which may have part of the expertise necessary (such as diagnosis and radiotherapy) and collaborative structures must be in place. Some patients will not live near specialist units, in which case there must be a structure in place to enable discussion of patient management in teleconferences with an expert centre.
- Lung cancer is one of the few cancers for which systematic reviews of multidisciplinary management have been published [83,84], but there was a lack of evidence of a causative effect on outcomes. Benefits for patients of MDTs include concordance with guidelines, an increase of treatment rates, and better patient satisfaction and quality of life, particularly important in patients with metastatic disease. Clinicians also benefit from support for difficult decisions, education and review. At a national level, MDTs can also feed into better databases for audit and research [85]. It is recognised that there are significant obstacles to MDTs in cost and time, attendance at meetings, team working and leadership, and potential delays [85].
- Lung cancer MDTs were initially put in place mainly in the United States and United Kingdom [85] and are now found in a number of hospitals in most countries in Europe, although the proportions of patients discussed at MDT meetings and clinicians who make up the MDT vary considerably. Some countries such as Belgium have provided financial resources for MDT meetings. A number of studies have shown the impact of lung cancer MDTs:
 - o Investigators in Australia compared clinicians' management plans before MDT meetings with the consensus plans post-meeting [36]. Of the 55 eligible cases, the MDT meeting changed management

plans in 58%. These changes included additional investigations (59%), changes in treatment modality (19%), treatment intent (9%), histology (6%) and tumour stage (6%)

- o Also in Australia, a cohort study of presentations at MDT meetings found an association with survival [86]
- o Although there is a substantial gap between actual and optimal evidence-based uptake of radiotherapy for lung and other cancers in Belgium, MDT recommendations are well applied, suggesting that there are other barriers to optimal treatment [62]
- o In Italy, a study found that the implementation of an MDT increased the 1-year survival rate of patients who underwent a surgical resection for NSCLC [87]
- o In England, it has been found that geographic variations in treatment and survival of patients were more likely to reflect differences in clinical management between local MDTs [45]
- o A study in the US suggested improved survival with an MDT model versus traditional care [88].
- Certain countries have taken steps in recent years to consolidate expertise in high volume lung cancer centres, notably Denmark, which now carries out surgery in just 4 centres, and also has fewer locations where lung cancer is diagnosed and evaluated, reduced to 13 sites from about 50 previously [42,89]. Some larger countries have set high targets for lung cancer volume. In Germany, the target for a certified lung cancer centre is 200 cases a year (all new presentations of lung cancer) [90]. In England, the target is for all units to carry out at least 150 resections a year, based on evidence developed in the country, and that no unit should provide a lung cancer surgical service on fewer than 70 patients a year [46]. However smaller countries have set lower targets – the Netherlands specifies that at least 50 new cases per year are treated at each hospital that treats lung cancer, and at least 20 lung resections are carried out [91].
- Audits carried out in countries such as Germany and the UK have now added metrics on treatment of advanced stages as well as the more commonly collected data on surgical treatment of early stage disease and on the quality of lung cancer surgery. The inclusion of extended team members, such as geriatric oncologists and palliative care [55], may also likely to be playing a key role in outcomes.
- On the basis of the evidence for lung units/centres and MDTs, the ERQCC expert group considers that given current variability of health systems in Europe it is not possible to define an essential requirement for case volume at a centre in addition to the presence of the core and extended MDT members described below, but the correct direction is towards higher volume and consolidation of treatment centres.

3.3. The MDT for lung cancer

Treatment strategies for all patients with lung cancer must be decided on, planned and delivered as a result of consensus among a core MDT that comprises the most appropriate members for the particular diagnosis and stage of cancer, and patient characteristics and preferences, with input from an extended community of professionals. The heart of this decision-making process is normally a weekly or more frequent MDT meeting where all cases are discussed with the objective of balancing the recommendations of clinical guidelines with the needs of the individual lung cancer patient.

To properly treat lung cancer, it is essential that the core MDT comprises health professionals from the following disciplines:

- Pulmonology/respiratory medicine
- Pathology
- Radiology
- Nuclear medicine
- Thoracic surgery
- Radiation oncology

- Medical oncology
- Nursing.

According to the case, some or all of this core MDT meets to discuss:

- All cases after diagnosis and staging to decide on optimal treatment strategy
- Patients with a recurrence, or where changes to treatment programmes are indicated and have multidisciplinary relevance and/or planned deviations from clinical practice guidelines.

Healthcare professionals from the following disciplines must also be available whenever their expertise is required (the ‘extended’ MDT):

- Anaesthesia/intensive care
- Interventional radiology
- Oncology pharmacy
- Geriatric oncology
- Psycho-oncology
- Rehabilitation

- Palliative care.

Some lung cancer centres have two MDTs – one for diagnostic work-up, and a main MDT for treatment. In the UK, for example, some centres have a diagnostic MDT that typically comprises a coordinator or specialist nurse, a respiratory physician and a thoracic radiologist to plan diagnostic work-up, and may include non-cancer cases.

See Fig. 2 for a schematic of the lung cancer MDT.

3.4. Disciplines in the core MDT

General statements

- The ERQCC expert group recognises that specialists may have multiple skills and certifications and job titles may not convey this. The core and extended MDTs are described as specialist areas within which personnel must have certain skills and knowledge.
- Core MDT members must have excellent communications skills to engage patients and their family and carers in the benefits and risks of therapies to ensure that treatment options are explained to, and

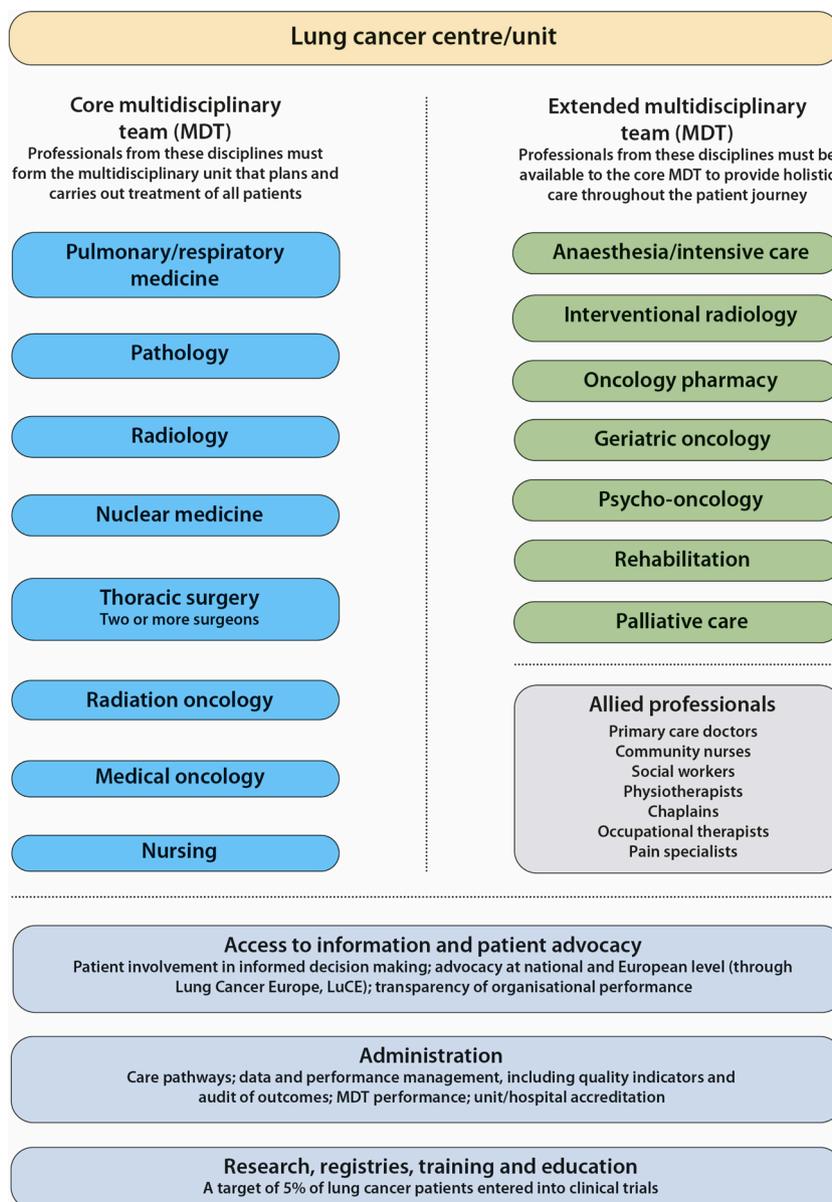


Fig. 2. Schematic of lung cancer centre.

are appropriate for, the patient, and are not unduly influenced by age but more by medical fitness and choice.

3.4.1. Pulmonology/respiratory medicine

Pulmonologists, also known as chest or respiratory physicians, specialise in the diagnosis and treatment of all lung diseases. They are involved in the care of high-risk patients such as smokers, patients with chronic bronchitis, COPD or interstitial lung disease and can prompt these patients to undergo testing for early diagnosis of lung cancer, and play a fundamental role in the investigation and management of patients with suspected or proven lung cancer [92].

They are pivotal in the histological and molecular confirmation of lung cancer diagnosis and in mediastinal staging through bronchoscopy and EBUS/EUS. They also have a key role in the assessment of lung function and fitness for treatment, including surgery and radiotherapy.

Pulmonologists are also involved in the follow-up and management of pulmonary comorbidities and side-effects: breathlessness, cough, haemoptysis, respiratory failure, pulmonary infections and pneumonitis. They are also involved in palliative care, and, again though bronchoscopy, can help debulk central tumours or insert stents.

In countries such as Germany, Belgium and the Netherlands, pulmonologists have an option to train as pneumo-oncologists (called thoracic oncologists in the Netherlands) and are approved to deliver medical therapy to patients with lung cancer, and are also often the lead clinician in the lung cancer MDT.

Essential requirements: pulmonology/respiratory medicine

- Pulmonologists must take part in all pathways of lung cancer care.
- Pulmonologists must be able to interpret all relevant imaging studies, including PET/CT and thoracic ultrasound.
- Pulmonologists must be experienced in bronchoscopic techniques, both diagnostic (including EBUS) and palliative.
- Those administering medical therapy must also meet the requirements of medical oncologists (section 3.4.7).

3.4.2. Pathology

Pathology, including molecular pathology, has a crucial role in lung cancer – characterisation of histologic and molecular subtype is playing an increasingly pivotal role in the MDT for both diagnosis and management.

The current WHO histopathological classification of lung cancer [93] highlights a greater use of immunohistochemistry for precise characterisation and standardised criteria and terminology for diagnosis. This should be performed not only on resected samples but also on small biopsies and cytology, given that the majority of patients with lung cancer present with high-stage disease and are not surgical candidates [94,95].

The WHO classification and recent international statements provide guidance for molecular testing on carcinoma types, especially adenocarcinomas, recognising the therapeutic importance of targetable genetic alterations [96].

The role of specialist pathologists includes carrying out a detailed morphological study of the tumour to provide the most accurate possible diagnosis in association with therapeutic biomarkers. Pathologists also coordinate molecular testing, with attention to all pre-analytic procedures to preserve tissue quality and quantity and to select the most appropriate tumour block/samples. Tissue management and turnaround time for histology and predictive biomarkers are particular interdisciplinary challenges for the MDT.

Essential requirements: pathology

- Pathologists must have expertise in lung disease, mainly in an oncology setting, with knowledge of current guidelines and reviews

on tumour grading/staging. They must supply a diagnosis including appropriate reporting of biomarker testing results as recommended by professional organisations – International Association for the Study of Lung Cancer (IASLC), European Respiratory Society (ERS), College of American Pathologists (CAP), Association for Molecular Pathology (AMP).

- Pathologists must work in the MDT to favour the best tissue procurement procedure and thus improve the success rate of sampling and the quality of testing.
- As immunohistochemistry is now largely used in the diagnosis and investigation of several biomarkers, care must be taken to ensure high-quality staining and participation in a quality assurance programme is essential, such as that promoted by the European Society of Pathology (ESP Lung External Quality Assessment Scheme; accredited by BELAC, Belgium's accreditation body, conforming to ISO 17043).
- With the increasing importance of molecular data in therapeutic decisions, access to an accredited molecular pathology laboratory must be guaranteed if not on-site.

3.4.3. Radiology

Radiologists are involved in the early detection, diagnosis, staging and restaging of lung cancer and play critical roles in the MDT. Diagnosis and staging of lung cancer require a broad variety of imaging modalities [97]:

- The initial imaging modality used to evaluate patients with a suspected lung cancer is usually a CT of the chest, which is frequently complemented by a PET/CT to stage the mediastinum or to detect/exclude distant metastases
- MRI is performed to detect brain metastases, to investigate a suspected infiltration of the chest wall or the mediastinum and to further investigate suspected distant metastases (i.e. to characterise adrenal masses or liver lesions).

Radiologists use the combination of imaging modalities to detect tumour characteristics, determine the radiologic disease stage, identify lesions that warrant tissue sampling for diagnosis and staging, assist in planning surgical or radiation therapy, and restage disease extent after therapy.

Essential requirements: radiology

- Radiologists must be familiar with management guidelines of pulmonary nodules [98,99].
- Radiologists must know the peculiar pattern of lymphatic and haematogenous spread of lung cancer (including uncommon sites of spread).
- Radiologists must have a profound knowledge of the TNM lung cancer staging system and its pitfalls [100,101].
- Radiologists must be familiar with the strength and limitations of bronchoscopic interventions.
- Radiologists must be familiar with image guided biopsies and radiological treatment options (i.e. radiofrequency ablation, stenting).
- Radiologists must be familiar with treatment responses to radiotherapy, chemotherapy, targeted therapy and immunotherapy, and adverse events following treatment.
- Radiologists must be familiar with surgical procedures to assist surgeons in the planning of surgery.
- State-of-the-art CT, MR imaging and PET/CT must be available. Radiologists must know when to refer a patient to nuclear medicine for PET/CT.

3.4.4. Nuclear medicine

Nuclear medicine plays an important role in the management of lung cancer; [102–106] there is evidence of the efficacy of ^{18}F -FDG PET/CT in selected clinical indications.

- Initial staging of patients with stage I–II NSCLC: For patients with resectable NSCLC, ^{18}F -FDG PET/CT provides more precise disease staging, especially regarding the mediastinum, and is essential when curative treatment is intended (surgery, SBRT). All patients should undergo a diagnostic thin section CT followed by a ^{18}F -FDG PET or ^{18}F -FDG PET/CT with a CT technique with adequately high resolution for initial staging to rule out detectable extra-thoracic extra-cranial metastasis and to assess potential mediastinal lymph node involvement, ideally within 4 weeks before the start of treatment. Single PET-positive distant lesions need pathological confirmation [102–105].
- Initial staging of patients with locally advanced NSCLC: ESMO guidelines state that all patients planned for definitive stage III NSCLC treatment should undergo a diagnostic thin section CT followed by ^{18}F -FDG PET/CT with a CT technique with adequately high resolution for initial staging to rule out detectable extra-thoracic extra-cranial metastasis and to assess potential mediastinal lymph node involvement, ideally within 4 weeks before the start of treatment. Single PET-positive distant lesions need pathological confirmation [105,107].
- NSCLC treatment: PET/CT is recommended to guide target volume delineation in preparation for curative-intent radiotherapy or chemoradiotherapy in patients with NSCLC; a diagnostic CT scan with intravenous iodine contrast (unless contra-indicated) and diagnostic whole body ^{18}F -FDG PET/CT are considered mandatory. The ^{18}F -FDG PET/CT should be performed within 3 weeks before start of treatment since ^{18}F -FDG PET/CT information may otherwise be outdated with increasing time to treatment [108]. Apart from these ESTRO guidelines, EORTC similarly recommends FDG/PET in the process of target volume definition [109]. In patients treated with radiotherapy or chemoradiotherapy, an initial ^{18}F -FDG PET/CT and during follow-up (where suspicion of relapse cannot be defined with CT only) are useful for predicting areas with greater potential for recurrence or treatment failure [105].
- SCLC: ^{18}F -FDG PET/CT is optional in localised disease. PET findings, which modify treatment decisions, should be pathologically confirmed [110].
- Restaging: (a) restaging for detection of local recurrence; (b) restaging after initial treatment (surgery, chemoradiotherapy or radiotherapy); and (c) restaging for detection of metastases [103, 104].

Other clinical situations with limited evidence, but with ongoing research and promising preliminary results are:

- Evaluating candidates with probable oligometastatic disease before SBRT [111]
- Guiding biopsies with the information supplied by ^{18}F -FDG PET/CT, improving the probability of a successful extraction of diagnostic tissue.

The role of the nuclear medicine physician is to oversee all aspects of PET/CT and radionuclide therapy for patients who require these procedures, including indications, multidisciplinary algorithms and management protocols.

Essential requirements: nuclear medicine

- PET/CT must be available and nuclear medicine physicians with expertise in PET/CT must be available.

- Nuclear medicine departments must be able to perform daily verification protocols and to react accordingly. Quality-assurance protocols must be in place. An option for ensuring the high quality of PET/CT scanners is provided by the European Association of Nuclear Medicine (EANM) through EARL accreditation.

3.4.5. Thoracic surgery

Surgery is carried out on a minority of patients with lung cancer according to a range of criteria including resectability, cardiorespiratory function and patient fitness and co-morbidities. Traditionally, lung resection has been performed by thoracotomy. Over the past 15 years there has been an increase in minimally invasive surgery, mainly VATS and more recently RATS. Results from a number of studies demonstrate superior short-term and long-term outcomes with VATS [112] and RATS [113].

Studies have shown short-term and long-term benefits in managing oncological thoracic procedures by specialised thoracic surgeons vs non-specialists [114,115]. There is evidence to suggest that the appointment of surgeons with a full-time thoracic job plan in preference to mixed-practice cardiothoracic surgeons is associated with an overall increase in lung cancer survival in England [44,116].

Lung cancer surgery requires certain perioperative facilities and experienced team members to work with surgeons on achieving high quality outcomes.

Essential requirements: thoracic surgery

- Lung cancer surgery must be carried out only in specialist centres by teams of appropriately trained surgeons.
- There must be at least 2 experienced surgeons per unit who dedicate a significant amount of their time to lung cancer. Centres must have sufficient volume of patients to ensure maintenance of expertise.
- Perioperative care for patients undergoing lung cancer surgery must be provided by specialist teams of nurses (both in the operating theatre and on the wards) and anaesthetists/intensivists with access to intensive care and high dependency beds, and in a thoracic surgical ward also attended by physiotherapists and paramedical staff.
- Patients with early stage lung cancer must be offered minimally invasive surgery where appropriate.
- Outcomes of patients undergoing lung cancer surgery must be audited [117].

3.4.6. Radiation oncology

Radiotherapy has a central role in the multidisciplinary treatment of lung cancer.

- In locally advanced NSCLC, which represents the majority of patients with non-metastatic lung cancer, it is the treatment of choice – in all cases with optional combination with chemotherapy – for patients who are inoperable due to local tumour extent and/or medical inoperability.
- For patients amenable to surgery, the combination of radiotherapy and chemotherapy has been shown to result in similar survival as a surgical multimodality treatment [118,119].
- For patients with early-stage NSCLC, SBRT is the reference treatment for inoperable patients or those refusing surgery [120].
- In limited disease SCLC, standard treatment again relies on a combination of chemotherapy and radiotherapy [121].
- In all situations where radiotherapy is combined with chemotherapy, a concurrent administration of both yields superior outcome, and, more specifically for SCLC, more intense schemes (i.e. with early start of radiotherapy, twice daily radiotherapy delivery) have been shown important for outcome [122].
- In NSCLC, recent evidence does not support dose escalation beyond 60–66 Gy total dose, but has shown that the use of IMRT reduces treatment-related toxicity [123]. Standard fractionation schedules

are used in case of concurrent chemoradiotherapy, whereas hypofractionation is advocated for patients who do not receive concurrent schemes [124].

- In the metastatic setting, besides the typical palliative indications such as pain control or the treatment of brain metastases, thoracic radiotherapy is used to alleviate symptoms related to local tumour burden (e.g. dyspnoea, cough, vena cava superior syndrome) or as a consolidation after chemotherapy in the case of SCLC [125]. In addition, prophylactic radiotherapy is used in SCLC to decrease the risk of developing clinically relevant brain metastases [125].
- An emerging field of interest is using local consolidative treatment after systemic therapy in patients with oligometastatic disease [126, 127].

The role of radiation oncologists (or clinical oncologists in some countries) is to define the radiotherapy indication in the context of the MDT and determine the dose-fractionation prescription in keeping with national and international guidelines. They oversee the radiotherapy care pathway from the start with image acquisition in treatment position, to definition of the target volume and organs at risk, evaluation of the treatment plan, and quality of the treatment delivery including image-guidance, motion management and the potential need for adaptive radiotherapy, and follow-up.

Essential requirements: radiation oncology

- Radiation oncology departments treating lung cancer must have access to up-to-date radiotherapy technology and techniques such as IMRT and SBRT, ideally on-site or at a centre through a formal collaborative agreement that includes a common MDT.
- Radiation oncologists must know the indications of radiotherapy for lung cancer, and the place, expected efficacy and potential side-effects of thoracic radiotherapy in multidisciplinary treatment regimens. They must have a special interest and expertise in the multidisciplinary treatment of lung cancer and of other thoracic malignancies to select the optimal treatment for each patient, considering the specific oncologic situation and comorbidities.
- Multimodal imaging including a CT in treatment position and/or a PET/CT scan are mandatory to define the target volume, along with pathological information obtained through mediastinal staging – either EUS-EBUS or mediastinoscopy – in the case of locally advanced disease.
- Radiation oncologists treating lung cancer must have a team of radiation therapists, dosimetrists and medical physicists with expertise in lung cancer and thoracic malignancies.
- Radiation oncologists must be aware of ongoing clinical trials and their methodology performed at their centre or in associated centres.
- The radiation oncology centre must have regularly updated protocols for radiotherapy and concurrent chemoradiotherapy for lung cancer based on international guidelines.
- Image guidance, motion management and adaptive radiotherapy policies and quality assurance guidelines must be clearly described and documented. External quality assurance audits are highly recommended.
- Radiation oncologists must follow up patients to act on early or late toxicity, and in case of relapse.

3.4.7. Medical oncology

- Medical treatments are essential for therapeutic management of both NSCLC and SCLC, whatever the disease extent.
- Adjuvant platinum-based chemotherapy has increased survival in early stage (IB–IIIA) completely resected NSCLC [128] while induction chemotherapy has also proved effective [129].
- In borderline resectable IIIA disease, chemotherapy is always part of the multimodality treatment approach, whichever local treatment strategy – surgery or radiotherapy – is considered [118,119].

- In unresectable locally advanced NSCLC, the addition of chemotherapy to radiotherapy improves cure rate in comparison to radiotherapy alone [130].
- In metastatic NSCLC, three therapeutic options are currently available: targeted therapies in case of oncogenic driver mutation (EGFR, ALK, ROS1, BRAF V600E) which demonstrated major clinical benefit in terms of response rate and progression-free survival; chemotherapy in case of first-line or salvage therapy; and immunotherapy. Immunotherapy has revolutionised the therapeutic approach of wild type NSCLC either administered alone or in combination with chemotherapy.
- In SCLC, chemotherapy has a major role combined with radiotherapy in limited disease or alone for extensive/metastatic disease. Currently, immunotherapy has showed promising results and is considered a standard of care if available, in addition to platinum-etoposide in extensive/metastatic SCLC [131].

Medical oncologists often coordinate the MDT (and the MDT meeting), and they are essential in interpreting the work-up to define the therapeutic strategy and patient selection for a surgical or non-surgical approach in coordination with the surgeon and the radiation oncologist. In coordination with pneumologists, they also interpret cardiorespiratory functional assessment and diagnosis/staging in minimally invasive procedures (bronchoscopy, EBUS/EUS).

Essential requirements: medical oncology

- Access to medical treatment (chemotherapy, immunotherapy, targeted therapy) must be provided in a centre or in a specific unit dedicated to medical cancer treatment and by specialised personnel (medical oncologists and/or pneumo-oncologists). The centre must have regularly updated protocols for systemic cancer treatment administration based on international guidelines.
- Medical oncologists must know the indications of medical treatment and combined modality protocols (with radiotherapy or surgery) for lung cancer, as well as the place, expected efficacy and potential side-effects of each treatment and their combination in multidisciplinary treatment regimens.
- Medical oncologists must be aware of clinical trials and their methodology and conduct performed at their centre or in associated centres.
- Medical oncologists must have access to supportive and palliative care specialists (such as internal medicine specialist, geriatrician, endocrinologist, cardiologist, pneumologist, infectious disease specialist, cancer nurse) with interest in lung cancer and thoracic malignancies and with knowledge of specific adverse events in chemotherapy, targeted therapies and immunotherapy. Liaison with geriatricians and others with specialist knowledge of older patients must be considered to assess and deliver optimal treatment and supportive/palliative care to meet the complex needs of this population.
- Medical oncologists must be responsible for follow-up, including management of early and late toxicity, and survivorship issues. Protocols for the management of immune toxicities are recommended.

3.4.8. Nursing

Nurses provide information, care and support to patients and their families throughout the patient pathway. They are a key contact for patients, provide information to facilitate informed decision-making for treatment options, advocate for patients' wishes and concerns in the MDT, undertake holistic needs assessment, and help manage symptoms. Due to the increasing complexity of care, specialised cancer nursing carried out by advanced nurse practitioners is in place in some countries and the skill set they bring is being recognised internationally [48]. In lung cancer, recent research suggests that their specialist knowledge can result in better outcomes in terms of life expectancy, avoiding unnecessary hospital admissions and managing the effects of treatment [132].

Introducing advanced practice nurses can pose organisational challenges regarding acceptance of the role from the perspective of patients and healthcare professionals. This was explored in a study from Switzerland [133] and application of a framework developed in the Canadian healthcare system [134]. In contrast, such roles have been in place in other countries for some time; for example, the National Lung Cancer Forum for Nurses in the UK was established in 1999 to provide networking and support to nurses specialising in the care of people with lung cancer (<https://www.nlcfn.org.uk>). The Netherlands has a similar pulmonary oncology network for nurses and nurse specialists that aims to optimise care (<http://www.oncologieverpleging.nl/45/pulmonale-oncologie>).

The ERQCC group recognises also the contribution of the European Oncology Nursing Society (EONS) and its Recognising European Cancer Nursing (RECaN) project (<https://www.cancernurse.eu/research/re-can.html>).

Essential requirements: nursing

- Nurses must conduct holistic nursing assessments to ensure safe, personalised and age-appropriate nursing care, and promote self-efficacy throughout the patient journey. They must promote a culture of shared decision-making.
- Nurses must provide information and education to both the patient and family, provide signposting to support organisations, and be the point of contact where they act as case managers.
- Nurses must ensure systematic screening throughout the disease trajectory to uncover physical symptoms such as pain and dyspnoea, psychosocial distress, impairment of physical functioning, malnutrition and frailty. Validated instruments (e.g. distress thermometer) must be used where appropriate.
- Healthcare systems must consider implementing roles for specialist/advanced lung cancer nurse practitioners as part of the MDT.

3.5. Disciplines in the extended MDT

3.5.1. Anaesthesia/intensive care

Anaesthesiologists have key roles in the management of patients undergoing surgery for lung cancer. These include:

- Surgical risk assessment
- Preoperative optimisation of co-existing medical conditions
- Perioperative clinical pathway management (including intra-operative care)
- Postoperative management and management of complications in intensive/critical care facilities
- Acute and chronic pain management.

Enhanced recovery pathway guidelines for lung cancer surgery have recently been published and should be implemented to facilitate perioperative care [135].

Several risk models are available to predict post-operative outcomes following lung cancer surgery. Estimation of the risk of death (such as by Thoracoscore) ensures the patient is aware of the risk before giving consent for surgery [136].

Surgical centres must have the necessary anaesthetic and critical care expertise and infrastructure not only to manage elective lung cancer surgery but also to provide the often complex support for postoperative complications in high-risk patients, which may include extended cardiovascular support and invasive ventilator support.

Essential requirements: anaesthesia/intensive care

- Patients undergoing lung cancer surgery must have appropriate preoperative assessment led by anaesthesiologists, who must use a global risk score such as Thoracoscore to estimate the risk of death.

- Anaesthesiologists undertaking lung cancer surgery must have adequate experience in thoracic surgery anaesthesia including one-lung ventilation, the use of double-lumen endotracheal tubes and bronchial blockers, and awake fibre optic bronchoscope intubation; and epidural analgesia and thoracic regional techniques.
- Postoperative care must be undertaken on a thoracic surgery ward or in intensive/critical care facilities.

3.5.2. Interventional radiology

Interventional radiologists must be available whenever their expertise is required for biopsy or treatment [137].

Image-guided percutaneous biopsy has become the modality of choice for diagnosing lung cancer, and in the era of target therapies is a tool to help define earlier patient-specific tumour phenotypes for personalised therapy [138].

Interventional radiologists also play a role in palliative situations for patients with thoracic pain or haemoptysis.

A further role is in the treatment of patients who are not candidates for surgery and/or radiation therapy mainly as a result of cardiorespiratory comorbidity or insufficient vital lung function.

Therefore, the role of the interventional radiologist is to:

- Evaluate clinical risks and nodule imaging characteristics before performing image-guided percutaneous core needle biopsy of unclear pulmonary lesions or mediastinal and hilar lymph nodes
- Provide expertise and support for ablative treatment (which may also be carried out by radiologists) in selected non-surgical patients [139–142]
- Perform interventional pain management techniques for patients with thoracic chest wall pain who do not have effective pain relief with conventional pharmacologic treatment or radiation therapy. These procedures include intercostal nerve blocks/neurolysis, paravertebral nerve blocks/neurolysis, and radiofrequency ablation of thoracic nerves
- Perform embolisation of massive haemoptysis.

Essential requirements: interventional radiology

- Image-guided biopsies must be performed by an experienced interventional radiologist with access to appropriate interventional CT equipment (CT-fluoroscopy and 3D-CT imaging are recommended).
- Interventional radiologists must be available to the MDT to discuss the role and proposed use of local ablative techniques for treating lung cancer in patients not amenable to, or combined with, surgery or radiotherapy.
- Interventional radiologists must have access to angiography and expertise in palliative treatments such as embolisation for patients with haemoptysis or pain therapies including intercostal nerve blocks/neurolysis, paravertebral nerve blocks/neurolysis, and ablation of thoracic nerves.

3.5.3. Geriatric oncology

The MDT must have access to geriatricians with oncology experience, or specialist geriatric/medical oncologists. Older patients with lung cancer require particular attention to ensure they are not under- or overtreated; treatment decisions should not be based on chronological age but on patient's health and preference.

The role of the geriatric specialist is to coordinate recommendations to other specialists about the need for personalised treatment for older patients with increased vulnerability. Performing geriatric assessment using appropriate tools can help select appropriate treatments with improved outcomes (including quality of life) and reduced toxicities [143,144].

The aim must be to provide optimal, personalised care, including early supportive and palliative care, to older patients through risk stratification and shared decision-making. This must take into account

current knowledge – and gaps in knowledge – of survival outcomes and toxicity in this older population given the recent increase in treatment options such as immunotherapies, and lack of representation of older patients in clinical trials [145].

Essential requirements: geriatric oncology

- All older patients (70+) must be screened with a simple frailty screening tool, such as the adapted Geriatric-8 (G8) [146].
- Frail and disabled patients must undergo a geriatric assessment [147]. The assessment can be based on self-report combined with objective assessments that can be performed by a specialist nurse in collaboration with a physician (geriatrician/specialist in internal medicine).
- Cognitive impairment affects all aspects of treatment – ability to consent, compliance with treatment, and risk of delirium – and screening using tools such as Mini-Cog [148] is essential. A geriatric psychiatrist or neurologist would preferably be involved with impaired patients.
- For frail and disabled patients, a geriatrician or specialist nurse must be present in the MDT meeting to discuss treatment options aligned with the patient's goals of care.

3.5.4. Oncology pharmacy

Oncology pharmacy plays a critical role in the extended MDT in the care of patients with lung cancer, given the importance of systemic treatment. The complexity and often low safety profile of oncology drugs together with the high cost of drugs involved in lung cancer treatment means that it is essential to optimise pharmacotherapy.

The role of the oncology pharmacist is to:

- Liaise with the medical oncologist/clinical oncologist/respiratory physician to discuss cancer specific treatments, including interactions with other treatments
- Counsel patients about their drug treatment
- Supervise the preparation of oncology drugs.

Essential requirements: oncology pharmacy

- Oncology pharmacists must have experience with antineoplastic treatments and supportive care; interactions between drugs; drug dose adjustments based on age, liver and kidney function, and toxicity profile; utilisation and monitoring of pharmacotherapy; patient counselling and pharmacovigilance; and knowledge of complementary and alternative medicines.
- Oncology pharmacists must comply with the European Quality Standard for the Oncology Pharmacy Service (QuapoS) [149]. Oncology drugs must be prepared in the pharmacy and dispensing must take place under the supervision of the oncology pharmacist.
- Oncology pharmacists must provide personalised information for patients on their drug therapy to support adherence.
- Oncology pharmacists must work with medical oncologists on clinical lung cancer trials.

3.5.5. Psycho-oncology/psychosocial care

Many patients with lung cancer are highly distressed before, during and after treatment. The overall prevalence rate of distress for lung cancer has been put at about 43% [150], and about half of patients were interested in accessing one or more psychological services [151]. Some reports show that in newly diagnosed patients the incidence of depression is even higher, approximately 50%, and about 1 in 3 in patients with metastatic lung cancer are depressed [152,153].

Depressive coping, emotional distress, and anxiety have been found to be associated with shorter survival and increased lung cancer-specific mortality, after controlling for demographic, biomedical, and treatment prognosticators [154]. Failure to detect increased levels of distress

might act as a barrier to treatment, decrease patients' health related quality of life, increase healthcare costs, and negatively impact on smoking cessation efforts.

Although psychosocial screening and care is becoming increasingly embedded in lung cancer care [155], health-related stigma has not been fully addressed in supportive care [156], suggesting that priority should be given to interventions that enhance stigma resistance skills and resilience [157].

At cancer centres, psycho-oncologists are essential members of the extended team in addressing such concerns. Their role is to:

- Ensure that psychosocial distress [158], and other psychological disorders and psychosocial needs, are identified by screening throughout the disease continuum, and are considered by the MDT
- Promote effective communication between patients, family members and healthcare professionals
- Support patients and family members in coping with multifaceted disease effects.

Essential requirements: psycho-oncology/psychosocial care

- Psychosocial care must be provided at all stages of the disease and its treatment for patients and their partners and families.
- Patients must have psychological assessment by the healthcare team. This can be via a self-administered tool (such as a distress thermometer). Scores below a certain level must be routinely managed by the primary care team; above that level there must be further clinical interviewing and screening for anxiety and depression, and referral to the most appropriate professional, such as a mental health physician.
- Psychosocial interventions must be based on clinical practice guidelines or the NCCN Guidelines for Distress Management (http://www.nccn.org/professionals/physician_gls/default.aspx).

3.5.6. Rehabilitation

There is growing evidence for exercise interventions to reduce morbidity in lung cancer, to prevent deterioration and to maximise or restore physical status prior to, during and following treatment [159]. Pulmonary rehabilitation exercise programmes after surgery or treatment aim to restore physical status and to maximise function, physical activity, psychological status and health-related quality of life; exercise for people with advanced lung cancer aims to prevent deterioration in physical and psychological status and maximise independence [159, 160]. Exercise training after NSCLC surgery has been shown to be important in postoperative management [161]. Larger trials are needed to confirm and expand knowledge on the effects of exercise in patients with advanced lung cancer [162].

Evidence for prehabilitation – exercise delivered prior to lung cancer surgery or treatment – is in its early stages but it may have a positive impact on the occurrence and severity of postoperative complications after minimally invasive surgery [163].

Smoking cessation is important for all patients with lung cancer, but cessation should not be a condition for offering treatment. A Cochrane review did not find effectiveness of any type of smoking cessation programme for people with lung cancer [164], but there are no RCTs, and the ERQCC expert group considers that while more research is needed, a service must be in place for patients.

Essential requirements: rehabilitation

- Physiotherapists trained to provide exercise programmes to patients with lung cancer after treatment must be available in the hospital and after discharge.
- A smoking cessation service must be available locally for patients.

3.5.7. Palliative care

Palliative care, as defined by the World Health Organization, applies not only at end of life, but throughout cancer care (<http://www.who.int/cancer/palliative/definition>). Palliative care means patient and family centred care that enhances quality of life by preventing and treating physical, psychosocial and spiritual suffering [165,166].

Supportive care is often used as an alternative term that conveys less stigma about advanced cancer (and can lead to better take-up of interventions) [167], but is most accurately ‘the prevention and management of the adverse effects of cancer and its treatment’, as defined by the Multinational Association for Supportive Care in Cancer (MASCC, <https://www.mascc.org>). In recent years, supportive/palliative provision has become increasingly integrated and important in meeting major unmet needs, including in lung cancer, and ESMO has proposed the use of the term ‘patient-centred care’ to encompass both supportive and palliative care [168].

An important study found that, compared with patients receiving standard care, patients with metastatic NSCLC receiving early palliative care had less aggressive care at the end of life but longer survival, and significant improvements in both quality of life and mood [169]. A recent review has recommended that early institution of palliative care should become a standard of care for patients with advanced NSCLC [170].

Good communication techniques are also essential for early integration of palliative care, to promote prognostic awareness, and introduce or adapt advance care planning [171].

Palliative care includes palliative and supportive care provided by oncology professionals in the MDT and other clinicians who are responsible for cancer care, and specialised care provided by a multidisciplinary palliative care team [172,173].

Essential requirements: palliative care

- The MDT must offer optimal supportive and palliative care at the earliest opportunity.
- There must be access to a dedicated palliative care unit with a specialist team that provides expert outpatient and inpatient care and good knowledge of cancer disease and cancer treatments.
- The palliative care team must include palliative care physicians and specialist nurses, working with an extended team of social workers, psychotherapists, physiotherapists, occupational therapists, dieticians, pain specialists and psycho-oncologists.
- The palliative care team must have experience of taking care of frail older patients and their families.
- To ensure the continuity of care at home, the palliative care team must work with community/primary care providers.
- Palliative care specialists and oncologists must aspire to meet the standards of ESMO Designated Centres of Integrated Oncology and Palliative Care (<http://www.esmo.org/Patients/Designated-Centres-of-Integrated-Oncology-and-Palliative-Care>).

4. Other essential requirements

4.1. Patient involvement, access to information and transparency

- Patients must be involved in every step of the decision-making process. Their satisfaction with their care must be assessed throughout the patient care pathway. Patients and their families and carers must be offered timely, relevant, objective and understandable information, which may include decision support aids, and signposting to support and advocacy organisations, to help them understand the process that will be followed with their treatment from the point of diagnosis. They must be supported and encouraged to engage with their health team to ask questions and obtain feedback on their treatment.

- It is also essential that support and advocacy organisations are involved in improving quality. These groups work to:
 - Improve patients’ knowledge, understanding and empowerment including through information in patient friendly language
 - Fight stigma associated with the disease
 - Secure access to innovative therapies and improve quality of diagnostics, treatment and care
 - Support lung cancer research, such as by being involved in the better design of clinical trials
 - Advocate at European and national health policy level.
- Patient groups and information include:
 - At European level, Lung Cancer Europe (LuCE, <https://www.lungcancereurope.eu>) was established in 2013 and has a number of advocacy members, most at national level. LuCE has been successful in raising awareness of lung cancer challenges at the European Parliament and has published reports on challenges and disparities
 - The Global Lung Cancer Coalition (<http://www.lungcancercoalition.org>) numbers several European advocacy organisations in its membership and has an interactive map detailing statistics in countries and whether they have a cancer plan and registry, and have implemented the WHO Framework Convention on Tobacco Control
 - The European Lung Foundation (ELF) (<http://www.europeanlung.org>), founded by the European Respiratory Society (ERS) in 2000, aims to bring together patients and the public with respiratory professionals to influence lung health, and includes cancer in its remit.
- Conclusions on each case discussion must be made available to patients and their primary care physician. Advice on seeking second opinions must be supported.
- Healthcare providers must publish on a website, or make available to patients on request, data on centre/unit performance.

4.2. Performance and quality

4.2.1. Metrics

A lung cancer centre must develop:

- Performance measurement metrics/quality indicators based on the essential requirements in this paper and on clinical guidelines, in alignment with national requirements and legislation
- Operational policies to ensure the full benefits of a coordinated clinical pathway based on published guidelines
- Accountability within the governance processes in individual institutions
- Systems to ensure safe and high-quality patient care and experience throughout the clinical pathway
- Effective data management and reporting systems
- Engagement with patients, their carers and support groups to ensure reporting of patient outcomes and experience.

This includes national audits and mandatory participation in some countries (see examples in 4.2.4 below). But as noted, only 6 countries in Europe have a lung cancer data collection, or audit, programme (section 2.2.8 above), and the expert group considers there is an urgent requirement for consistent collection of a minimum set of structure, process and outcomes measures for all centres treating lung cancer. Appointing a clinical data lead for each MDT with allocated time to promote data quality is good practice, and ideally a lung cancer centre should have a dedicated data manager as part of the MDT.

4.2.2. MDT performance

- All MDT decisions must be documented in an understandable manner, and must become part of patient records. Decisions taken

during MDT meetings must be monitored, and deviations reported to the MDT. It is essential that all relevant patient data meet quality standards and are available at the time of the MDT meeting.

- The core and extended MDTs must meet at least once a year to review the activity of the previous period based on the audited metrics, discuss changes in protocols and procedures, and improve the performance of the unit/centre. MDT performance must be quality assured both internally and by external review with demonstration of cost-effectiveness of quality improvements, and MDT guidance must be promoted nationally and written into national cancer plans. The use of tools and data feedback to improve MDT performance should be considered [174,175].
- The ERQCC expert group strongly recommends that further attention be given to measures of patient reported outcomes, not only to agree which tools should be used, but also to use them more systematically as part of discussions and evaluation within the MDT. For example, symptom monitoring via weekly web-based patient reported outcomes has been associated with increased survival compared with standard imaging surveillance in lung cancer [176].

4.2.3. Accreditation

The ERQCC expert group strongly recommends participation in national or international accreditation programmes, e.g. Organisation of European Cancer Institutes (OECI) accreditation, <http://oeци.selfassessments.eu/cms>[177].

4.2.4. National quality and audit examples

Most national initiatives on quality in lung cancer care are recent, demonstrating that much work needs to be carried out to embed best practice, and that variation in processes is likely to be uncovered. They include the following.

- NICE in the UK has published a quality standard for lung cancer, updated in March 2019 [178]; the statements most relevant to MDT working are:
 - o People with known or suspected lung cancer have access to a named lung cancer clinical nurse specialist who they can contact between scheduled hospital visits
 - o People with lung cancer are offered a holistic needs assessment at each key stage of care that informs their care plan and the need for referral to specialist services
 - o People with lung cancer have adequate tissue samples taken in a suitable form to provide a complete pathological diagnosis including tumour typing and subtyping, and analysis of predictive markers
 - o People with lung cancer are offered assessment for multimodality treatment by a MDT comprising all specialist core members
 - o People with lung cancer have access to all appropriate palliative interventions delivered by expert clinicians and teams
 - o People with lung cancer are offered a specialist follow-up appointment within 6 weeks of completing initial treatment and regular specialist follow-up thereafter, which can include protocolled clinical nurse specialist follow-up.
- The National Lung Cancer Audit for England, Wales, Guernsey and Jersey for the audit year 2017 [179] reported that 37% of patients were alive at least 1 year after diagnosis, a significant improvement on the 31% diagnosed in 2010, but the same as the year before; the audit also identified the highest and lowest-performing regions. The audit reported on curative treatment rates for early stage disease, and although the rate was about 80%, that still left 1 in 5 patients with no curative treatment. In a change, pathological confirmation was reported for early stage only, instead of for all patients, as physicians said it may not be in the best interests of patients with advanced disease and poor status to undergo invasive biopsy. The rate of patients being seen by a lung cancer nurse specialist (LCNS) did not improve, with 71% of patients being seen and 58% having an

LCNS present at the time of diagnosis, well below targets of 90% and 80%. The audit also included surgery rates in NSCLC, which rose to 18.4%, and systemic therapy rates in advanced NSCLC and SCLC; multimodal treatment rates were also reported.

- As of the end of 2018, the Germany Cancer Society reported 52 certified lung cancer centres. Its annual report detailed surgical case by tumour stage, stage distribution, and noted that all centres met the target of seeing 200 primary cases a year (median 335.5 cases). There was no target for the number of lung resections but the median was 106. Most centres met the target for presenting pretherapeutic cases in an MDT meeting, and the rate for presenting recurrent or remote metastatic cases improved. The audit also records the percentage of patients receiving psycho-oncology care, social services counselling, and patients participating in clinical studies, and there are a number of indicators and targets for factors such as the share of pneumonectomies in lung resections, bronchoplasty/angioplasty procedures, revision surgeries, radiotherapy and chemoradiotherapy, pathology and mortality after surgery (which has a target of 5% or less, which all but one centre met). Annual reports and a catalogue of requirements for centres are available online [90].
- A study in Belgium looked at quality and variability of lung cancer care in Belgian hospitals. Twenty indicators were measured for a total of 12,839 patients. Good results were achieved for 60-day post-surgical mortality (3.9%), histopathological confirmation of diagnosis (93%) and for the use of PET/CT before treatment with curative intent (94%). Areas to be improved included the reporting of staging information to the Belgian Cancer Registry (80%), the use of brain imaging for clinical stage III patients eligible for curative treatment (79%), and the time between diagnosis and start of first active treatment (median 20 days). High variability between centres was observed for several indicators. Twenty-three indicators were found relevant but could not be measured [180]. Belgium's Health Care Knowledge centre (KCE) has also published quality indicators for managing lung cancer [181].
- The Netherlands has set out standards for hospitals treating lung cancer, which include the MDT set out in this paper, and a number of volume requirements. It is a summary of organisational, technical and clinical requirements [91]. The Netherlands also started the nationwide Dutch Lung Surgery Audit (DLSA) in 2012. Participation in the DLSA is mandatory and required by health insurance organisations and the National Healthcare Inspectorate. It is reported that guideline adherence has increased, and 96.5% of lung cancer patients were discussed in preoperative MDTs. Overall postoperative complications and mortality after NSCLC operations were 15.5% and 2%, respectively. The audit has been extended to data from nonsurgical lung cancer patients, including treatment data from pulmonary and radiation oncologists [182] in the Dutch Lung Cancer Audit, which is described as a unique registry to evaluate the quality of multidisciplinary care [183].
- A practical data set for lung cancer MDT to use for optimal treatment recommendations and to evaluate team performance has been developed through a consensus methodology; 51 data elements across 8 domains (patient demographics, risk factors, biopsy data, staging, timeliness, treatment, follow-up and patient selection) achieved consensus [184].
- A paper by the lung cancer working group of the International Consortium for Health Outcomes Measurement (ICHOM) considered that lung cancer outcome measurement has been mostly limited to survival, and there is a need to include measures of the value of treatments according to other factors such as complications, degree of health, and quality at end of life. The authors have put forward a set of patient-centred outcomes [185].
- The European Organisation for Research and Treatment of Cancer (EORTC) has revised its questionnaire for assessing quality of life of patients with lung cancer. The original 13 item questionnaire has

been extended to 29 items, primarily to assess treatment side-effects of traditional and newer therapies [186].

5. Education and training

- It is essential that each lung cancer centre provides professional clinical and scientific education on the disease and that at least one person is responsible for this programme. Healthcare professionals working in lung cancer must also receive training in psychosocial oncology, palliative care, rehabilitation and communication skills. Such training must also be incorporated into specialist postgraduate and undergraduate curriculums for physicians, nurses and other professionals.
- An international curriculum in thoracic oncology has been developed by the European Respiratory Society and the HERMES (Harmonising Education in Respiratory Medicine for European Specialists) initiative. It aims to address the training needs of members of the MDT, any of whom can lead a thoracic oncology MDT team with appropriate training [187]. The European School of Oncology offers a certificate in advanced studies in lung cancer (<https://bit.ly/2OWhmrx>).
- An expert group on cancer control at the European Commission has endorsed a recommendation for multidisciplinary training of cancer specialists to improve the value of MDTs and patient care [188].

6. Clinical research and population registries

- Centres treating lung cancer must have clinical research programmes (either their own research or as a participant in programmes led by other centres). The research portfolio should have both interventional and non-interventional projects and include academic research. The MDT must assess all new patients for eligibility to take part in academic and industry sponsored clinical trials at the centre or in research networks.
- The German Cancer Society specifies a minimum accrual rate for clinical trials of 5% and the OECI requirement for CCCs is >10%. The ERQCC expert group considers that the 5% target is an important recommendation for all lung cancer units.
- Collaboration with European academic networks is strongly recommended – see the lung cancer group of the EORTC (<http://www.eortc.org>), and the European Clinical Research Infrastructure Network (ECRIN – <http://www.ecrin.org>). Correlative biomarker research is a crucial part of all phases of clinical studies, and requires close cooperation with programmes such as EORTC's SPECTA (<http://www.eortc.org/specta>). Prospective monitoring of lung cancer patient populations using real-world data should be carried out through the use of platforms such as E²-RADiAtE, which is supporting radiotherapy research in Europe (<https://project.eortc.org/e2-radiate>).
- In countries where clinical trials are less available, centres treating lung cancer should engage with policymakers to investigate referring patients to other countries (as proposed with European Reference Networks) and should be prepared to participate in clinical trials from an organisational standpoint. Researchers at other centres should be considered as part of the extended MDT for at least annual discussion of clinical trial participation. Generally, pan-European action should be taken to increase participation of lung cancer patients in clinical trials (both industry-sponsored and academic), and internet access to local clinical trial databases should be developed.
- Older adults are currently underrepresented in cancer clinical trials despite having a disproportionate burden of disease. Strategies to increase the participation of older adults must be implemented and trials designed to take their needs into account. In lung cancer, research needed on older people includes modified schedules of chemotherapy; who can best receive chemoradiotherapy and

immunotherapy in locally advanced disease, and the role of immunotherapy generally; and strategies for patients aged over 80.

- Cancer control plans must include high-quality cancer population and specialist registries to inform clinical research and to improve the quality of care.
 - o A population example is Nordcan (<http://www-dep.iarc.fr/NORDCAN>), which includes lung cancer in 50 cancer types in the Nordic countries
 - o The Danish Lung Cancer Registry (DLCR) has recorded all primary lung cancer cases since the year 2000 and includes patient characteristics such as age, sex, diagnostic procedures, histology, tumour stage, lung function, performance, comorbidities, type of surgery, and/or oncological treatment and complications. Since 2013, it also includes patient reported outcome measures [189]. Research based on the data in DLCR has included comorbidity and inequality
 - o I-O Optimise is a pan-European research platform based on real world evidence in lung cancer treatment [190].

7. Conclusion

Taken together, the information presented in this paper provides a description of the essential requirements for establishing a high-quality lung cancer service. The ERQCC expert group is aware that it is not possible to propose a 'one size fits all' system for all countries, but urges that access to MDTs and specialised treatments is guaranteed to all people with lung cancer.

Declaration of Competing Interest

The authors declare no conflicts of interest for this paper.

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